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DRAINAGE PROBLEMS IN SASKATCHEWAN

DIFFICULTIES ENCOUNTERED IN WESTERN DRAINAGE SYSTEMS—MODERN METHODS OF CONSTRUCTION—ENGINEERING FEATURES OF LAND DRAINAGE.

By C. T. LOUNT, A.M.Can.Soc.C.E.

THE importance of drainage in reference to farm lands, and its wide benefits in various forms are being widely recognized in Saskatchewan. The purpose of this article is briefly to set forth, with certain remedial suggestions, some of the causes militating against successful drainage work in the province; to outline a method of location and design of drains; to indicate various methods of construction; and, finally, to attempt to show the benefits accruing from drainage work, both to the farmer and to the province at large.

Difficulties Encountered.—The factors restricting drainage progress are mainly three, *viz.*:—

(1) The limitations of the Drainage Act.

(2) A negligent application of Section 20 of the Drainage Act.

(3) The peculiar physical and climatic conditions of those areas most in need of drainage.

The Saskatchewan Drainage Act involves in effect the following procedure:—

In the case of any proposed drain, the owners of at least one-half the area of the land affected by the said drain must petition for the same to the Government. Upon receipt of this, the latter will send an engineer to report upon the feasibility of the scheme. If, upon investigation, the engineer reports that the benefit is not sufficient to warrant the construction, the cost of the investigation is charged to the petitioners.

If, however, the engineer reports the proposed construction to be an economic improvement, the Government prepares an assessment sheet advising each resident owner affected as to the amount of his land to be reclaimed and the estimated individual cost. (The farmers are allowed to meet the cost of this work by yearly payments extending over a period of 30 years).

The resident owners are given 30 days for consideration of the matter. If, within that time, the owners of at least one-half the area to be benefited enter protest against the proposed work, the Government takes no action further than to assess the incurred cost of the work to date against the original petitioners.

In the event, however, of the owners of the major part of the land affected being desirous of proceeding with the work, the Government deals with the matter according to the provisions of the Public Works Act, i.e., the work is let by tender.

Since all unpatented homestead and school lands are owned by the Crown and not by the province, they are not affected by provincial laws and, consequently, are not affected by the Saskatchewan Drainage Act.

Areas most in need of drainage are naturally sparsely settled, a large proportion therefore belonging to the Crown. Hence, the few must not only, under the present Drainage Act, bear the cost of improving their own lands, but also large areas of Crown land.

In many districts where drains are badly needed, both for farm and highway improvement, the area of Crown land is so great as to absolutely prohibit construction.

This is a very real loss, not only to the province but to the Dominion, as the most fertile land lies within these wet and submerged areas, which, in their natural state, are not possible as homesteads. Undrained areas also seriously obstruct the construction of highways.

The Saskatchewan Government in the last three years, recognizing both the importance of drainage work and the disabilities under which it is carried on, has endeavored to come to some arrangement with the Dominion Government by which the evils of the present system might be mitigated. A meeting at Ottawa for this purpose was arranged for June 3, 1914, between representatives of the Alberta and Saskatchewan Governments respectively and the superintendent of irrigation for the Dominion. Several methods of bridging the difficulty were suggested. So far as the question of drainage for the improvement of farm lands was concerned the following plan met with the most favor:—

That the Provincial Government make the usual survey for any proposed drainage scheme, and in the event of Crown lands being affected send complete plans with all data to the Dominion Government for approval. If satisfactory, the Dominion Government would then pass an order-in-council authorizing itself to sell the affected lands to the Provincial Government at one dollar per acre.

The assessment is then made covering all lands benefited, the Provincial Government paying its share.

After completion of the drain, the Provincial Government may sell such lands by public auction under regulations approved by the Dominion Government.

Comparison With Laws of Other Countries.—It seems unnecessarily complex that needed drainage work should be retarded pending the approval of the Dominion Government for each separate drain. A study of the laws governing construction in various states and countries where such drainage work is extensively conducted invites comparison of the above proposal with the Volstead Federal Drainage Law which obtains in Minnesota. There were in this state large tracts of federally owned, rich, swamp lands lying idle and unproductive for want of drainage. The Volstead Law brought them under the conditions of the State Drainage Act by the following clauses:—

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all lands in the State of Minnesota, when subject to entry, and all entered lands for which no final certificate have been issued, are hereby made and declared subject to all of the provisions of the laws of said state relating to the drainage of swamp or over-flowed lands for agricultural purposes to the same extent and in the same manner in which lands of a like character held in private ownership are or may be subject to such laws. Provided, That the United States and all persons legally holding unpatented lands under entries made under the public-land laws of the United States are accorded all the rights, privileges and benefits given by said laws to persons holding lands of a like character in private ownership.

This act further states that the Federal Government will not be liable for the cost of draining the unpatented lands, but that the state may reimburse itself for drainage expenditure by selling these lands, the Federal Government to receive one dollar and twenty-five cents per acre of the sale price.

This is the price the Federal Government receives for any areas of unpatented lands sold by them. Thus, the Volstead Act binds the government to sell to the state at a fixed price per acre any unpatented areas which are hindering drainage work. The state then sells such lands at public auction to defray the cost of the land and expenditure for drainage.

It would seem that no more simple, just and effective method of equalizing the cost of improvements over drainage areas could be devised. It is obvious that the conditions obtaining in the State of Minnesota and in Saskatchewan are analogous. As the Volstead Act has completely solved this difficulty for Minnesota we may logically conclude that an effective solution for Saskatchewan's difficulty would be a similar law passed by our Dominion Government.

In the second place the cost of construction work to the farmer is increased by failure on the part of engineers to recognize the full importance of drainage with particular regard to roads for the municipality at large, and a consequent superficial assessment as provided for in Sections 10 and 28 of the Drainage Act. These state in effect that all roads directly or indirectly benefited by the drain shall be assessed. The writer is of the opinion that the benefit accruing to the municipality has not been to date sufficiently recognized and would submit the following suggestions as a method of arriving at the actual benefit received:—

The engineer, before the construction of any proposed drain, shall make an estimate of the cost of constructing roads within the bounds affected by the proposed drain, and also of the cost of constructing such roads after completion of drain. The difference between the two costs is an actual cash gain to the municipality for which they should be assessed in the same proportion as is the farmer for his benefited areas. The fact that the municipality might not immediately construct such roads does not cancel this gain.

Further, the cost of upkeep in a drained area is insignificant as compared with the cost under previous conditions. The municipality, therefore, should, in addition, be assessed the amount of an annuity which would give the difference in cost of upkeep for a period equal to the life of the drain.

Some such method of assessment would materially lessen the burden for the individual farmer.

The Provincial Government gives the construction a great deal of attention, and spends a large proportion of the money devoted to public works on highway improvement. Until the last couple of years, large sums have been annually spent in these wet areas on roads which were annually washed away. The government has finally recognized the futility of trying to build permanent roads in a district subject to floods and has, therefore, materially decreased expenditure in this region. The need of roads remains, however, and until they are built the homesteading of regions any distance from a railway will be negligible.

It would seem, then, that the government might bear some proportion of the assessment for road improvement levied on the municipality.

The physical and climatic conditions of Saskatchewan, as they affect drainage work, are to its disadvantage as compared with conditions existing in those areas where drainage work has previously been carried on.

In Italy, France and various parts of the United States, for example, where the greatest proportion of drainage work has been conducted, those areas drained consist in the main of overflowed and swamp lands. Such areas are comparatively easy to drain. Location of the drain presents no serious difficulty. With a fairly uniform cut, which must exist in these areas, construction cost is light, as machines that will excavate at a remarkably low rate per yard have been specially designed for this work.

Climatic and Soil Conditions.—The drainage areas of Saskatchewan do not lend themselves to such simple treatment. Probably the most fertile area now in need of drainage stretches from Humboldt on the west to Kamsack on the east, a distance of almost 130 miles, and approximately 30 miles in width. This area drains south from the height of land with a very rapid fall. Far from being swamp land, it is decidedly rolling, with numerous depressions, large and small, which are flooded for at least half the summer season. Cultivation is consequently made impossible. To date, machinery has not been designed that will excavate in such country as cheaply as in flat lands.

For specific comparison, consider Minnesota. The areas flooded in this state are, as a rule, the bottom lands along rivers, the Red River in particular. This river, in places, annually overflows its retaining banks. Owing to the flatness of the adjacent country, the land is so long submerged that seeding is greatly retarded and often made impossible. Further, the seepage from the higher lands at a distance after excessive rainfall also tends to keep the flat areas in a flooded condition. In Saskatchewan the rivers do not overflow but every little depression fills with water which stays there until removed by evaporation. The sub-soil is a heavy impervious clay through which there is very little seepage. Also, there are few creeks to carry off this water which are not badly clogged up with beaver dams and brush. If these streams were cleaned out so as to be effective drainage channels, conditions would undoubtedly be much improved as there would be a constantly increasing amount of seepage water finding an outlet.

The short summer season in Saskatchewan adds appreciably to the cost of drainage construction. Owing to the severity and the length of our northern winters the ground freezes to a depth varying from five to eight feet. It is usually impracticable to work at depth before the end of May in the Humboldt-Kamsack region. (In the prairie regions construction may commence about the first of May.) The season closes about the first of November, leaving only five months in a year for actual construction, and results in a very heavy monthly interest and depreciation charge.

It is obvious, then, that physical and climatic conditions greatly enhance the cost of drainage work.

Location and Design of Drainage System.—The proper location of a drain is most important both from the standpoint of economy and efficiency. Haphazard location increases the amount of material to be moved, both in the main drain and in the laterals which tap the adjacent areas. Again, a poorly located ditch fails to receive the surplus water from areas which might readily be drained into a properly located ditch. A hastily located drain is most unfair to the farmer. The cost of the little extra time required to make an efficient location is repaid many times by the larger area drained and a decreased yardage.

Even in the most rolling country the surplus water at flood time follows a certain main line of flow. This course should in general be adopted as the centre-line of the main ditch. It occasionally happens, however, that large sloughs may be more easily drained by a short heavy cut than by the line of natural flow. The expediency of either course is easily determined. Abrupt turns should be avoided in a drain and a general straightening of the course will give a ditch of maximum efficiency. In the small ditches at present under consideration in Saskatchewan no curvature greater than 10° should obtain. Experience has shown that any greater degree of curvature seriously impairs the usefulness of the ditch.

There is a popular fallacy among farmers to the effect that ditches drain off needed water in time of drought. It must be borne in mind, however, that only the hydrostatic water drains into the ditch, the capillary water always remaining to do its work. Ditches, therefore, work no injury during the time they are not needed, and are a necessity at other times, their value at such times being measured by their ability to receive the surplus water necessary to save the lands and crops from injury.

The centre-line of the ditch having been established, the area of the cross-section necessary to carry the water must be determined. A simple formula, applicable to conditions in Saskatchewan, is given by the chief of the Reclamation Bureau of the United States. It is considered, for ordinary drainage schemes, to give as good results as the more involved formulae which may be found in the various text books on the subject. The area may be determined from

$$v = \sqrt{\frac{a}{p}} \times 1\tfrac{1}{2}f, \text{ and } Q = av$$

where a = to area of waterway,
p = wet perimeter,
f = fall in feet per mile, and
Q = discharge in cubic feet per second.

Also, $A = \frac{Q}{n}$ where A = number of acres and n = number taken from table given below.

Table of cu. ft. per sec. which must be discharged from a drain to relieve one acre of land of various depths of water in twenty-four hours:—

Cu. ft.	Inches per acre.	Cu. ft.	Inches per acre.
.0420	1	.0140	1/3
.0315	3/4	.0105	1/4
.0210	1/2	.0052	1/8

It may be mentioned that ½ inch per acre is the generally accepted standard for the prevailing conditions.

Q must first be determined, and, knowing the number of acres in the drainage district, this amount is easily determined from the above formula. With the value of Q fixed, a is assumed and by trial in the above formula one determines if the assumed value is correct. A few trials will give the proper value for a.

With the area of the cross-section of the ditch known, the proportions of the cross-section, the second factor in the process of design, must next be determined. The relation of the depth of the cut to the width is influenced by several independent factors, of which the most important are: Lateral drainage; levels of the surrounding country to be included in the drainage system; and, character of the soil.

Where subsidiary drains are few, as in Saskatchewan, good lateral drainage is obtained with a minimum cut of not less than seven feet. This alone would seem to indicate that the drains should be of minimum width and maximum depth.

Areas requiring drainage usually have a great number of depressions whose levels closely approximate those of the main drain. In order to drain these, considerable cut in the main drain is essential. In this respect it should be pointed out that areas which to the eye appear capable of drainage, are found upon construction of the drain to be below the drainage level. The farmer, however, has been unjustly assessed for an assumed improvement. It is, therefore, important that the engineer take the levels of all parts of the area to be drained. Such levels will also assist in establishing the grade of the drain.

Although the need of lateral drainage and the topography of the drainage areas necessitate a deep cut in the main drain, the soil in the side walls of the drain, on the contrary, retains its position much better in a shallow cut. The decrease in the rate of flow in a wide shallow cut as compared to a deep narrow one, minimizes the danger of erosion. A cave-in in a shallow cut is not nearly so liable to occur as in a deep one, and when it does occur does not offer nearly so serious an obstacle to the water flow.

The determination of the grade constitutes the third factor in the process of design. Obviously, the grade of a drain is, broadly speaking, determined by the natural fall of the country.

In most large drainage areas it is a difficult matter to obtain sufficient fall to ensure an adequate flow. In Saskatchewan, on the contrary, the grade is so steep as to cause considerable danger from erosion. With such rapid fall in the case of a narrow cross-section the ditch is bound to be self-cleaning. A fall of approximately four feet per mile will make the ditch self-cleaning and the fall in the Saskatchewan drains is, as a rule, much more than four feet.

If the grade line be set to make a very light cut in the bottom of each slough intercepted by the drain it will usually be found that there is a series of heavy cuts on the intervening ridges. Therefore, although one might have a more efficient drain by excavating to such a depth of cut in a slough that the banks would not overflow at this point in flood time, it will be found impracticable to deepen the cut to any appreciable extent at such points on account of the extremely rapid increase of the quantities of material to be removed for the correspondingly trifling extra depth obtained.

Where the fall is as great as described, precaution should be taken to prevent washes which when once begun are most difficult to control. Ditches should discharge into a coulee, river or other outlet without an overfall or abrupt drop, since a drop causes a continual sloughing off and cutting back of the channel. They should, if possible, discharge into the usual water line of the latter, the drop being taken up by means of a gradual slope. Much silting of ditches and natural streams can be obviated by observing this precaution.

Where ditches are liable to become clogged by sand bars blown in by the wind the maintenance of a grass strip a rod or more wide along each side has been found effective.

The engineer, in designing crossings for a drain, should in no case consider the building of culverts in the main line of the drain. All crossings should take the form of open bridges. In practically every case where culverts have been built the spring freshets have lifted them, and used the timbers thus released as battering rams against any structures farther down the drain.

In regard to side slopes, authorities state that the manner of excavation is an important factor. With clay sub-soil, if excavated by teams, where rapid fall exists, the sides should be given a slope of almost two to one. When under the same conditions excavation is made by a dredge, the slope may be made one to one or less. A berm of at least six feet should intervene between the ditch and the toe of the waste bank.

Methods of Excavation.—These may be dealt with under the three main subdivisions of hand labor, team labor and mechanical means.

In certain parts of the world, particularly in Europe and Asia, comparatively large contracts are executed by manual labor. In Saskatchewan unskilled labor commands so high a wage as to make it prohibitive where any other method is practicable. The supply of even unskilled labor is most irregular. In the spring or fall it is scarcely possible to obtain men for construction work owing to the large number required for the planting and harvesting of crops at this period. Manual labor is therefore the last resort for the contractor in Saskatchewan.

On certain sections of a drain drag scrapers may be used to advantage. There are nearly always some portions of a drain which are dry enough to give good footing for horses. And, if the ground is not too stony, teams will handle such excavation at almost minimum cost. If the drainage scheme consists of a fairly dry main drain tapping one large area of flooded land, teams may here be used to advantage. The majority of drains, however, cut through a succession of sloughs and intervening comparatively dry ridges. In such cases it does not pay to employ teams for the minor part of the work when a different method must be adopted for excavating the wet material. The use of team labor, therefore, in drain excavation, is greatly limited.

The handling of wet material requires machinery. On the comparatively small drains of Saskatchewan only two general types of machines will be found practicable. A light weight type of dragline excavator may be used to a limited extent, while a dredge has the most general usefulness.

There has been designed a light weight type of dragline which cuts fairly true to theoretical cross-section, and of which all the parts may be transported on wagons, an important consideration in a country of long distances and poor roads. It has a frame supported by four large wheels and when properly planked will travel over any ground that will sustain an empty wagon. As many of the slough bottoms will not support even this light weight the machine is often unable to excavate these places which must then be done by hand labor. Such a dragline has another conspicuous disadvantage. Since it is a machine of small capacity it cannot handle the large boulders so often encountered in the drainage regions of the north and fails to make any headway in hardpan. It is readily seen that a small dragline is not in any sense adequate for general drainage work, although it must be admitted that in suitable material the cost of excavation per yard is less than with any other method so far employed.

There are two types of dredge employed in drainage work, the walking and the floating dipper dredge.

The walking dredge, as its name implies, is propelled by a sort of walking motion. It consists of a rectangular framework mounted on large feet, one at each corner, and connected transversely by a light timber. This requires the members of each pair to move in the same direction, the direction being controlled by a chain which runs from each corner foot to a drum operated by the cranesman. Midway of the machine on either side is a large foot which can be moved longitudinally. Without going into further details of construction it is enough to add that the machine may be moved on these feet a distance of about six feet for each "set." It can propel itself across country at the rate of almost a mile per day. It is hard to see that the walking dredge has any advantage over the floating dredge other than its ability to travel from one drain to another, provided they are situated near together. The floating dredge must of necessity be dismantled in order to reach new work. It is obvious that the walking dredge operates with difficulty in soft material and is, therefore, not of practical use under conditions ruling in Saskatchewan.

The floating dredge is essentially a steam shovel mounted on a scow which is steadied when excavating by spud legs which are dropped vertically into the bottom of the ditch or else angle from the sides and press against the banks of the ditch. The smaller sizes of such a type require at least three feet in which to float, a condition which usually obtains in the drainage areas under discussion.

This is the most efficient type of machine yet devised for the excavation of drains. It will dig in any material (blasting is, of course, necessary for rock) and will handle boulders. In contrast to the dragline type and the walking dredge, wet ground aids rather than retards its efficiency.

Although the floating dipper dredge has been found the most satisfactory, it yet labors under great disadvantages in a northern country where drainage is in its infancy. The drains so far designed are small, having usually about a four-foot bottom and with one and one-half to one side slopes. A dredge large enough to handle any reasonable yardage, *i.e.*, not under a one-half yard machine, cannot excavate to a bottom much less than seven feet, particularly in shallow work. This means that the contractor must excavate from 25 to 100% more material than is called for by the specifications and must consequently charge more per yard for the actual pay yardage than if he were getting remuneration for his total excavation. A source of additional outlay to the northern contractor is found in the fact that fuel, laid down at the machine, costs at least three times as much as to the contractor in the States to the south. Since the work in progress at the present time lies hundreds of miles from any point carrying dredge repairs in stock there is occasionally great and costly delay when breakages occur. The supply of the needful unskilled labor is variable and of poor quality. Skilled labor for this work must be brought from a distance. The small amount of work in progress and the short five months' season make it difficult to obtain good men except at a very high wage and on practically their own terms.

It is apparent that until drains are needed with larger capacity than at present, the cost of construction to the contractor and consequently to those benefited must be comparatively high.

Summary.—Just here might be interpolated certain statements and conclusions taken from a series of reports on drainage work issued by the United States Bureau of Reclamation, which seem naturally to group themselves under construction, which may be of use to the engineer with no previous experience on drainage work.

Experience in drainage areas has shown that new land requires less drainage to produce good crops than land which has been cultivated for some time and that the necessity for drainage is likely to increase rather than diminish as the country becomes more densely populated.

The efficiency of natural watercourses can be increased by improving the channels where they are subject to overflow, since any obstruction in a stream causes an accumulation of sediment which greatly injures the efficiency of the channel. Low bridges, dams, or piling which in any way cause an obstruction or catch drift, and also timber and brush growing upon the banks above the ordinary high-water line, should be removed. This will secure a good flow and permit the channel to enlarge by erosion during the high-water period instead of being reduced in size by the accumulation of drift and sediment, as is now the case. Where bridges across channels are necessary, piling or piers should not be placed in the centre of the channel but near the banks.

The larger the area to be drained and the greater the quantity of earth to be removed, the less cost per cubic yard for doing it.

The only feasible way in which large areas of wet lands can be drained is by the use of a dredge of some kind.

Where there is much water on the surface or many trees and stumps to be removed a floating dipper dredge is best suited for the work.

For small ditches on firm ground some type of traction machine is best suited.

A floating dredge must commence at the upper end of the ditch and work downstream and a traction at the lower end and work upstream.

Machines of the scraper type cut the most accurate slopes.

Benefits Accruing to Community.—The engineer ought to be thoroughly cognizant of the benefits conferred by drainage in order that he may convincingly present them to the farmer, who, ignorant of the importance of the work, refuses his support of the drainage scheme, and thereby deprives himself and others of a work of great advantage. Of the many arguments which might profitably be advanced in favor of drainage work we need discuss only a few.

Of prime importance to a farmer in Saskatchewan is the fact that, with proper drainage, he can begin work upon his land from one to two weeks earlier in the spring than would otherwise be possible. Obviously this means much in a region with a brief summer season and early frosts.

The temperature of drained is higher than that of undrained areas. Prof. King in his book "The Soil" proves that drainage raises the average temperature of the soil.

A third advantage of drainage is found in the firmer soil, composed of finer grained particles. And the finer the soil the greater the resistance to drought, as experiments have proven that the finer soils retain much more capillary water than do the coarser soils.

Former unproductive wet areas now produce the best of crops, and there is also considerable increase in the production of the adjoining areas. Since the farmer's fields are no longer broken by waste stretches into small patches, the cost of production per acre is appreciably reduced. An advantage that should strongly appeal to the farmer is the fact that, with drainage, there is a permanent increase in the market value of his land.

And, finally, statistics show that a noticeable increase in the health of the community follows the construction of proper drains.

Any improvement in the condition of the individual farmer reacts directly upon the province as a whole. The reclaiming of large areas of waste land adds to the prosperity of the province. It costs the province very much less to build roads in drained areas as compared to the cost in their undrained condition. It is to the interest of the province, then, to further this work with vigor.

The physical and climatic conditions of Saskatchewan are such that drainage work will always be somewhat more costly than further south. Yet, even under present disabilities, the benefits are far in excess of the outlay.

If laws can be placed on the statute books providing for an even distribution of the cost against all lands which are improved, whether Crown or privately owned, if time be allowed the engineer for making a careful location, if the municipality be taxed for the benefit it actually receives, thus lessening the burden for the individual farmer, then drainage work should take its rightful place as a work of prime importance, both to those directly interested and to the province as a whole.

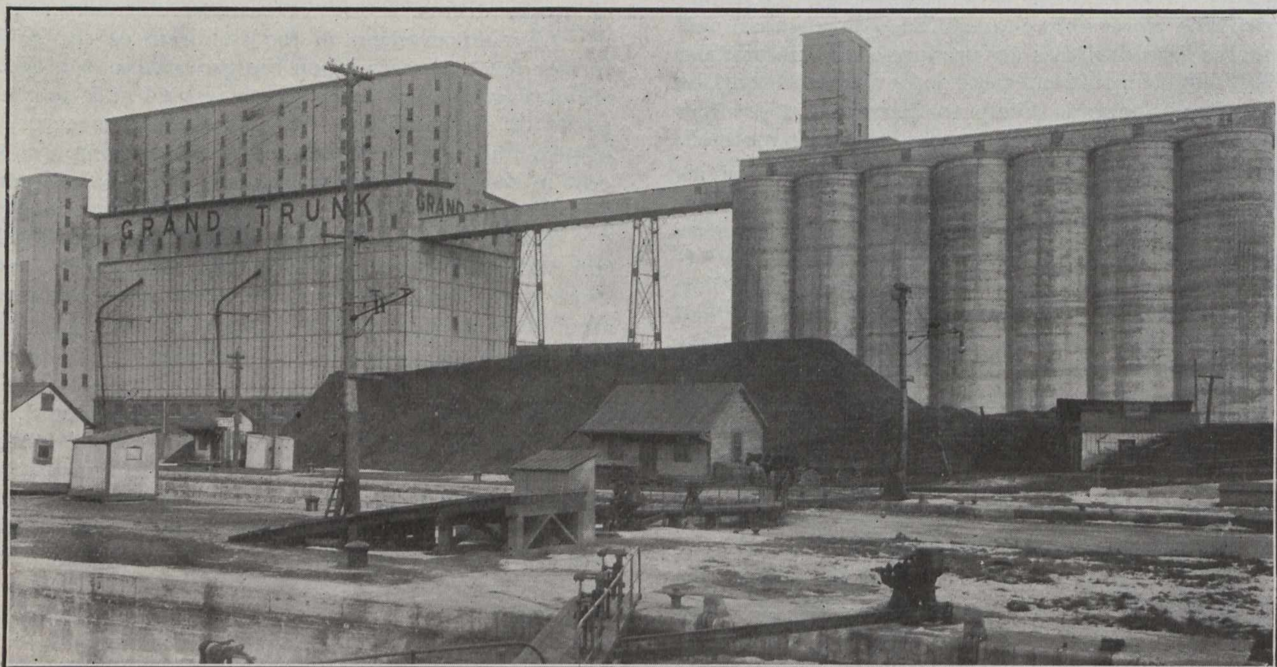
DAM CONSTRUCTION AT TOULON.

In "Annales des Ponts et Chaussées" M. Boutan describes the new water supply of Toulon which, until recently, obtained its water supply from subterranean sources. Owing to insufficiency of supply at certain seasons, a dam has been erected across the Dardennes, which impounds not only the water of the river proper, but also the ground water overflow during wet weather. The dam is of concrete, and in plan is convex towards the upstream, the radius being 984 ft.; the length is 450 ft., the height 110 ft., and the volume impounded 330 million gals. In calculating the stability of the dam, both the Bouvier and the Levy formulas were used, and according to the latter, which gave the higher figure, the maximum pressure at the toe was 8.5 tons per sq. ft. The "puddle-wall has a thickness of 7 ft., and on filling the reservoir it was found that considerable leakage took place both here and under the foundations of the main dam. The geological formation is rather disturbed, but a bed of marl serves as an impervious foundation. To overcome the leakage, holes were put down in the foundation material, and as much cement grout forced down under a pressure of about 60 lb. per sq. in. as the hole would take. The result of this grouting was entirely satisfactory.

During 1914 approximately 260 miles of low-tension wood pole lines were constructed in Ontario by the Hydro-Electric Power Commission, consisting of about 245 miles in the Niagara District and 15 miles in the eastern section of the Province. The right-of-way department was engaged continuously in this connection, arranging pole and tree trimming rights, etc. These lines are purchased on the 30-year easement plan. Some 700 farmers have been dealt with, agreements taken and the consideration paid, all without litigation or arbitration.

G. T. R. WINDMILL POINT ELEVATOR ANNEX, MONTREAL.

LATE in 1913 the Canadian Stewart Co., Limited, completed for the Grand Trunk Railway System a large annex to the latter's elevator between Windmill Point and the Lachine Canal Basin, Montreal. It consists of 28 storage tanks of approximately 1,070,000 bushels total capacity, and is located south of the main elevator at a distance of about 175 ft. from it. These tanks are arranged in four rows of seven each, and are 110 ft. in height with an inside diam. of 24 ft. 3 in., and with walls 7 in. in thickness. The entire structure is of reinforced concrete. The tanks have their adjacent sides rigidly united so that the 4-pointed star-shaped spaces between the circular tanks may be used for storage as well as the tanks themselves.



Windmill Point Elevator and Annex—Lachine Canal in Immediate Foreground.

The foundation consists of a concrete mattress resting upon piles arranged under the tank walls and interspaced bins to obtain a maximum of direct bearing and to economize on reinforcing steel and concrete in foundation slab without impairing its efficiency. The piles were supplied by the Simplex Piling and Construction Co., also of Montreal.

The tank walls were carried down to the foundation slab, thus eliminating an expensive foundation arrangement. The tank bottoms were constructed of concrete and steel in the form of conical hoppers supported upon concrete posts. Inclined slabs, spanning the interspaces formed the bottoms of these bins.

The tanks were surmounted by a concrete cupola of the ordinary storage annex type, with a head house at the end toward the old elevator to accommodate the elevator leg and scale. A steel conveyer gallery was also built to connect the old and the new buildings at the elevation of the bin floor. This gallery was constructed with concrete floor and corrugated sides and roof.

For filling the tanks and interspaces of this new annex there is a 36-inch belt conveyer running out from the bin floor of the old working house. This conveyer receives grain from any of the scales in the working house and discharges on to a system of cross and longitudinal conveyers of the same size on the bin floor of the storage annex, so that grain may be taken from any car or part of the old elevator to any part of the new elevator.

For shipping grain from the annex there are four 36-inch belt conveyers in the basement, one under each row of tanks, which by means of two cross conveyers discharges to a shipping leg having an elevating capacity of 15,000 bushels an hour. The elevator leg discharges into a garner over the scales where the grain is weighed, and from thence spouted on to a belt conveyer running into the old elevator, where it may be placed in any of the shipping bins, and from thence it will go out to vessels on the previously existing conveyer gallery system.

End View of Annex.

The conveyers are electrically operated, each having a separate motor.

The Canadian Northern tunnel under Mount Royal has been excavated to its full dimensions of 31 feet wide by 23½ feet high for practically the entire length of the tunnel, which is 3⅓ miles.

WATER-POWERS IN BRITISH COLUMBIA.

THE report for 1913 of R. G. Swan, A.M., Can. Soc. C.E., chief engineer of the British Columbia Hydrographic Survey, has just been issued and contains some extremely valuable data on the water resources of Southern British Columbia. It is published as Water Resources Paper No. 8 of the Dominion Water Power Branch.

Since the publication of the previous report some important changes have been made in the hydrographic organization of the Dominion Government in British Columbia. It will be remembered that in May, 1911, the Railway Belt Hydrographic Survey was inaugurated, under the direction of Mr. J. B. Challies, then hydraulic engineer of the Railway Lands Branch, now Superintendent of Water Powers, Department of the Interior. Mr. P. A. Carson, B.A., D.L.S., was appointed chief engineer in direct charge of the survey, the objects of which were: (1) To investigate the complex water rights situation on the ground; (2) to suggest a practicable and efficient form of Dominion water administration; (3) to study the water supply of all streams and the water resources of the Railway Belt; (4) to investigate storage possibilities with a view to conserving and beneficially using the limited water supply; (5) to make the surveys necessary to the proper conservation and use of the said water resources; and (6) to report on the various irrigation, reclamation and water-power projects.

This railway belt was a strip of territory about 40 miles wide and 500 miles or more in length, extending from the eastern boundary of the province (i.e., the summit of the Rocky Mountains) almost to the Pacific coast, being bounded on the west partly by the Mesliloet River and partly by the north arm of Burrard Inlet. Previous reports of the hydrographic survey in British Columbia referred entirely to this railway belt. Besides the hydrographic data in them, there is some interesting historical information concerning the water right situation and the legislation referring thereto which have been referred to in previous issues of this journal.

The year 1914 witnessed proceedings between Mr. J. B. Challies, Superintendent of Water Powers, and Mr. William Young, Comptroller of Water Rights, Department of Lands, British Columbia, regarding the extension of territory for hydrographic work to ultimately cover the entire province. This met the approval of both governments in September, and the title of the work was thereupon changed to "British Columbia Hydrographic Survey." About this time Mr. P. A. Carson, chief engineer, tendered his resignation, and the position was accepted by Mr. R. G. Swan, who had been assistant chief engineer. The territory of the lower section of the province was divided for the time being into three main divisions, with headquarters at Kamloops, New Westminster and Nelson. In charge of these respective divisions were Messrs. E. M. Dann, C. E. Richardson, and C. G. Cline, as division engineers.

From the newly-issued report, which, in addition to hydrographic data from metering stations, etc., contains for each division, a general description of its main characteristics, particularly climate, agriculture, irrigation, reclamation, lumbering, fishing, transportation, mining, manufacturing, municipal water supply, and water power, we abstract the following summary of the last-mentioned resource:—

Coast Division.—There are a large number of good sites for developing water-power in various amounts. Several plants have already been constructed, and a number of other propositions are being investigated by various companies and individuals. The following are brief descriptions of developed sites:—

Coquitlam River.—The Vancouver Power Company generates its power mainly at its two plants on Buntzen Lake. These plants are situated on the north arm of Burrard Inlet and use the water of the Coquitlam River under a head of 400 feet. There is a storage dam on Lake Coquitlam, and the water is conveyed through a tunnel 12,775 feet long to Lake Buntzen. This latter lake acts as an equalizing reservoir, and from it the water is led through penstocks to the power-house.

The power generated is used for lighting and industrial purposes in Vancouver, New Westminster, Steveston, Chilliwack, and the lower mainland generally, as well as for operating city and interurban car lines in the same district.

Stave River.—The Western Canada Power Company has a plant at Stave Falls. A series of dams near the power-house raises the level of Stave Lake, and provides good storage. Short steel penstocks carry the water from the dam to the power-house. The head varies from 100 to 120 feet, according to the level of the lake.

Gilley Creek.—Gilley Bros., of New Westminster, operate a rock quarry on Pitt Lake by means of water-power from Gilley Creek. A wooden stave pipe is used to convey the water to two small Pelton wheels, which drive the screening plant and air-compressor mechanically. A third wheel is used to drive a small dynamo, which supplies current for lighting at night. There is a storage dam on Munro Lake to regulate the flow of the stream. The total available head is about 2,000 feet, but only 600 feet is being used at present.

Jordan River.—The Vancouver Island Power Company has a plant on Jordan River and supplies power to the Victoria branch of the British Columbia Electric Railway Company.

Puntledge River.—The Canadian Collieries (Dunsmuir), Limited, has a plant on Puntledge River, near Union Bay, on the east coast of Vancouver Island, supplying power to a number of mines and operating electric railways connecting the mines with tide-water.

Powell River.—There is a water-power plant on the Powell River, which operates by direct mechanical drive the large pulp mill of the Powell River Co., Limited. This company manufactures news-print paper exclusively and has an annual capacity of 70,000 tons. The hydro-electric plant has a capacity at present of 24,000 h.p., with an ultimate capacity of 34,000 h.p.

The following are the undeveloped power sites in the division (exclusive of Vancouver Island):—

Bridge River.—A head of 2,000 feet could be developed at Bridge River by driving a tunnel through the ridge separating it from Seton Lake. The water would be diverted into the tunnel from Bridge River and conveyed from the other portal by steel penstocks to the power-house situated on Seton Lake. A great amount of power could be developed here, but the cost of the tunnel would render a large initial development necessary. The Pacific Great Eastern Railway, which is being constructed along the north side of Seton Lake, would provide good transportation, but extra precaution would have to be taken to prevent a washout by any leaks or breaks in the tunnel or penstocks. Special provision might have to be made for carrying the extra discharge from Seton Lake.

Chehalis River.—The plan of development on this stream includes a storage and intake dam near the lower end of Chehalis Lake, and a large concrete pipeline, some 10 miles in length, to an equalizing reservoir near the mouth of the river. The penstocks would lead from the reservoir to the power-house, and would give a head of about 400 feet. Chehalis Lake would give splendid storage. It might be possible to divert the flow of the west fork (Statlu Creek) into the lake or into the pipeline.

Chilliwack River.—This is quite a large stream, having a fall of about 2,000 feet between Chilliwack Lake and the Fraser River. At one time it was proposed to carry water from Chilliwack Lake to Jones Lake, but this scheme was abandoned owing to the heavy expense which would be involved, and also as it was found that Chilliwack Lake was not at a sufficiently high elevation above Jones Lake. Another proposal is to construct a tunnel from the Upper Chilliwack valley to the valley of the Fraser River. This plan is probably quite feasible, but sufficient surveys have not been made to develop all its features. On account of the great expense of the tunnel, it would be necessary to make a large initial development.

Coquihalla River.—About 6 miles from Hope, and just above the mouth of the Nicolum River, the Coquihalla flows through a narrow gorge from 30 to 70 feet wide. The precipitous rock walls rise to a height of 150 feet. By constructing a dam at this canyon a head of 100 or 125 feet could be obtained. The power-house could be built opposite the mouth of the Nicolum River, and the water conveyed to it from the dam through a tunnel.

Below the mouth of the Nicolum River is another small canyon and falls (Natural Bridge), but it would be rather expensive to utilize this fall with the other.

Green River.—At Nairn Falls there is a good site for a development. An intake dam could be built on a rock foundation above the falls and connected by a short penstock with the power-house built below the falls. The Pacific Great Eastern Railway is being built along the river bank within a few hundred feet of the falls, and would give good transportation. The presence of the railway along the east shore of Green Lake will seriously interfere with the use of the lake for storage, and there would be very little pondage at the falls, but it might be possible to store water on the tributaries, Soo River or Six-mile Creek.

Jones Creek.—The Vancouver Power Company has been investigating Jones Creek as a possible source of power. The plan is to drive a tunnel through the ridge between Jones Lake and the Fraser valley. The tunnel would be 10,200 feet long. Steel penstocks, 6,000 feet in length, would lead from the portal to the power-house on the bank of the Fraser River. A dam near the outlet of the lake would provide considerable storage. Boulder Creek could easily be diverted into the lake. This plant would utilize the combined flow of Jones and Boulder Creeks, and would be fairly well regulated by the storage in Jones Lake, under a head of 1,800 feet.

Mesliloet (Indian) River and Tributaries.—The Westminster Power Company proposes to develop power here and has already made extensive surveys. Splendid storage facilities are available in Norton, Young, and Ann Lakes; from the first-named lake a head of 2,000 feet could be developed.

North Lillooet River.—A small amount of power could be developed at a falls on this river. The municipality of Maple Ridge, however, has applied for the right to use part of the water for domestic purposes.

Rainbow Creek.—A series of falls near the mouth of the creek give a head of 630 feet in about half a mile. A small diversion dam could be built at the head of the falls to turn the water into the pipe line. A power-house could be built on the flat at the mouth of the river, a few hundred feet from Pitt Lake.

Raven (Rushton) Creek.—This is a small creek flowing into Pitt Lake. Rushton Lake is 700 feet above Pitt Lake and only 4,000 feet distant. About 1,000 feet from Pitt Lake there is a fall of 100 feet. Mr. E. J. Fader proposes to run a pipeline from the head of the falls to a power-house to be built near the mouth of the creek. The power is to be used for running a rock quarry and gravel-screening plant, neither of which have been built as yet.

Silver Creek (near Hope).—It would be quite possible to develop power on Silver Creek, which flows into the Fraser River, near Hope, though as yet no definite details of any such scheme have been worked out. There is a fall of 1,100 feet from Silver Lake to the Fraser, but it is pretty evenly distributed over a distance of 5 miles. A long flume line would be necessary to develop any considerable amount of power. Silver Lake might be used for storage as long as it did not damage the Pacific highway, which is being built up the creek valley and along the lake.

Silver Creek (tributary Pitt River).—This stream might be used for developing a small amount of power, but the municipality of Coquitlam is planning to obtain its water supply from it.

Slollicum Creek.—This small stream discharges into an arm of Harrison Lake. It has a series of falls near the mouth, with a total drop of 2,000 feet in about half a mile.

South Lillooet River.—Various plans have been proposed at different times for developing power on this stream. Probably the simplest method from a physical standpoint would be to drive a tunnel from Lillooet Lake to Stave Lake. This would enable the Western Canada Power Company to use the water in their present plant at Stave Falls, and also in the plant they propose to construct near the mouth of the river. Another plant could be constructed on Stave Lake below the outlet of the tunnel to utilize the fall from Lillooet Lake to Stave Lake, some 100 feet. This plan would give a very efficient means of utilizing the whole fall between Lillooet Lake and the Fraser River.

Kamloops Division.—The principal hydro-electric development in the Kamloops division is the city of Kamloops municipal plant of the Barrière River, for which Messrs. Ducane and Dutcher, of Vancouver, are designing and constructing engineers.

The plant* will operate under a head of 196 feet, water being carried by 17,800 feet of flume line to the penstocks. Good storage facilities are afforded, and no serious interference from frazil or anchor ice is anticipated.

The initial capacity of the plant will be 1,600 to 2,000 h.p., and provision is being made for its ultimate extension to 10,000 h.p. The cost of this initial undertaking is estimated at $237,600. The ultimate development will probably increase the cost by $250,000 to $300,000. Power will be generated at 2,200 volts, 3 phase, 60 cycles,

* [Note.—This plant was completed in 1914. See *The Canadian Engineer*, Nov. 5, 1914.—Editor.]

being stepped up to 44,000 volts for transmission. Step-down transformers, switchboard, etc., will be located at the auxiliary steam plant power-house at Kamloops.

Two 1,200 h.p. Francis type turbines are to be used for the initial development, each designed for direct connection. The flume line is of timber construction, but will probably be replaced by metal flume or concrete-lined canal for the ultimate development. The forebay and power-house are of concrete construction. Fifteen-foot timber dam of rock-filled cribbing is designed for the flume's intake.

The town of Spence's Bridge receives light and power from Murray Creek, where a small development of 100 h.p. has been made. A Pelton wheel operating under a 220-foot head is used, 16-inch rivetted steel pipe conveying water to the wheel, the upper 175 feet of pipe being laid in rock tunnel.

Forest Mills, Limited, of Taft, B.C., has a Pelton wheel development of 160 h.p. operating under a head of 175 feet. Power is used for the sawmill and for lighting the town of Taft.

The development of the Hedley Gold Mining Company on Twenty-mile Creek, in the Similkameen valley, is a Pelton wheel development, the power being used for operating the company's forty-stamp mill and concentrator, as well as for electric tramway and cable cars.

A small hydro-electric plant on the Bonaparte River, from which power has been used for the town of Ashcroft, has been out of commission owing to the failure of the dam during the freshet of 1913. It is understood that the dam may not be replaced, in which case the town will continue to derive its power from its auxiliary steam plant.

Future developments include the following:—

The Coteau Power Co., controlled by Mackenzie and Mann interests, propose an extensive development at Coteau Falls, on the Shuswap River, near Lumby, B.C. About 9,000 h.p. will be the capacity of the plant, which, if constructed, may be used for the electrification of the Okanagan branch of the C.N.R.

The Hedley Gold Mining Company propose a development of 1,500 h.p. on the Similkameen River at Hedley.

The most important undeveloped sources of power in this division are: The Adams River, near Chase, where a head of 200 feet in 6 miles, with a probable mean discharge of 1,200 second-feet could be obtained. Adams Lake forms an excellent storage basin, and no very important interests would be affected by damming its outlet.

The Clearwater River has falls of considerable size, while on its main tributary, Myrtle Creek, there is one sheer fall of 450 feet. Excellent storage is also said to be available. As yet no accurate data in regard to these powers are available, but the collection of information on these important streams will probably be begun during the coming season.

The Seymour River and Celeste Creek, in the Shuswap Lake drainage area, are important sources of water-power, while many smaller mountain streams will no doubt soon be utilized to supply the needs of progressive communities.

Kootenay Division.—By far the most important development is that of the West Kootenay Light and Power Company, situated at Upper Bonnington Falls, on Kootenay River, 11 miles from Nelson. This plant is operating under a 64-foot head. Two 8,000 h.p. units are in operation, and a third unit of 10,000 h.p. is now being installed. The capacity of the plant is 36,000 h.p., and it was designed to use 3-runner turbines. Power is supplied to mines in Nelson, Rossland, and Boundary districts, to the smelters at Trail, Grand Forks and Greenwood, to light the towns of Rossland, Trail, Eholt, Grand Forks, and Phœnix, and for pumping for irrigation purposes in Grand Forks district.

The West Kootenay Power and Light Company has two auxiliary plants, one at Lower Bonnington Falls, on Kootenay River, 12 miles from Nelson, and one on Kettle River at Cascade. The plant at Lower Bonnington Falls has a capacity of 4,000 h.p. and operates under a head of about 40 feet. At Cascade the plant is operated under a head of 155 feet, and the development exceeds 5,000 h.p.

The city of Nelson light and power plant is situated at Upper Bonnington Falls, on the opposite shore to the West Kootenay Light and Power Company's plant. It is operated under a 60-foot head, and at present generates 1,250 k.w. The power is used to light the city of Nelson, to operate the city street railway, for manufacturing purposes in Nelson, and to operate one or two mines in the vicinity of Nelson.

On the north fork of Kettle River the Granby Mining, Smelting and Power Company have a small development. This plant is operated under a head of 30 feet, and supplies light and a small portion of the power used in the smelter; 700 h.p. is generated.

Greenwood City power and light plant is located at Boundary Falls, on Boundary Creek. The plant is operated under a head of 130 feet, and supplies light to the city of Greenwood. Capacity, 250 h.p.

The city of Revelstoke power and light plant is located on Illecillewaet River, about 2 miles from Revelstoke. A concrete dam has been built, and water is carried to the power-house, some 200 yards below, through a 6-foot stave pipe. The present plant is in duplicate on a 450 k.w. capacity basis.

The C.P.R. have a small installation on the Illecillewaet, near Glacier, the power generated being used for lighting their hotel at that point from May to October. The plant is operated under a head of 60 feet and about 100 h.p. (Twelve-hour power is obtained.) A concrete dam, 15 feet high and 100 feet long, affords a small storage, and to increase the flow in the early morning water is diverted from Asulkan Brook.

New Denver, Silverton, and Kaslo have small developments for lighting purposes on Carpenter Creek, Four-mile Creek, and Kaslo River, respectively.

SEASON'S ROAD WORK IN NORTHERN ONTARIO.

The programme for this summer in connection with the Northern Ontario development and colonization roads movement involves an estimated expenditure of $615,000. Of this amount $90,000 will be devoted to the extension of a highway along the T. & N. O. Railway, and $70,000 to a similar highway along the N.T.R. In addition, $50,000 will be spent on a trunk road from Sturgeon Falls to the outskirts of Sudbury.

Under the Northern Development Branch apportionments for road-building are made to various districts as follows: Rainy River district, $35,000; Kenora, $25,000; Port Arthur, $40,000; Fort William, $50,000; Sault Ste. Marie, $50,000; Sudbury, $40,000; North Bay, $50,000; Nipissing, $35,000; Haileybury and South Lorrain, $55,000; other specially designated roads, $102,000.

MEASUREMENT OF STREAM FLOW IN ONTARIO.

SINCE 1912 the Hydro-Electric Power Commission of Ontario has carried on continuously a systematic measurement of stream flow. In *The Canadian Engineer* numerous references have appeared respecting the extent and value of these hydraulic investigations. The report for 1913 of the Commission presented some most useful information along this line. That pertaining in particular to the Beaver River appeared in our issue of April 16th, 1914, and several of the important hydraulic curves covering the seasons 1910 and 1911 were also reproduced, in connection with the then contemplated and since constructed hydro-electric plant at Eugenia Falls. The recently issued report for 1914 supplements this information with data collected up to the end of 1914, greatly enhancing its value and reliability. A review of the season's operations, together with some important curves relating to the Eugenia Falls development is given below:—

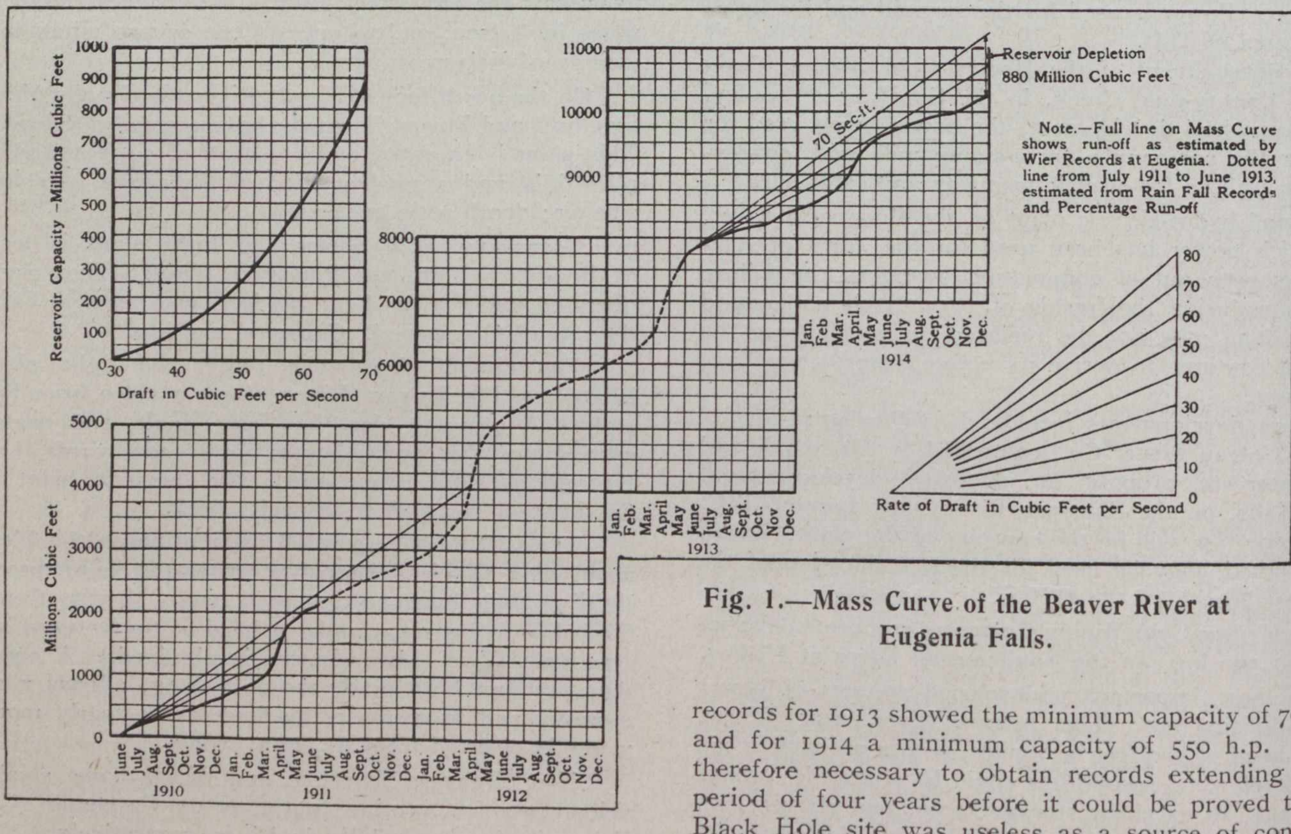


Fig. 1.—Mass Curve of the Beaver River at Eugenia Falls.

While this work has been under way for a comparatively short period the results are extremely valuable in that they constitute the first attempt that has been made to ascertain with accuracy the flow characteristics of the important rivers of the province. Records of this kind, extending over considerable periods of time, are absolutely indispensable in connection with working up schemes of hydraulic development, flood prevention and river improvement. These records are also exceedingly valuable in connection with the design and construction of bridges, and as a basis of study in connection with the classes of work above specified, they should ultimately be the means of saving the province from the recurrence of the immense losses which have hitherto been occasioned through flood damage and the improper design of dams and bridges. Work of this kind being essentially of a preventative nature, must of necessity be carried out through a governmental agency, and in the matter of hydraulic development it is also evident that no private enterprise can afford to wait four or five years to collect sufficient records of stream flow for a proper study of any specific scheme under consideration.

The necessity for obtaining accurate stream flow records may be illustrated by the case of the Maitland River. At the request of the council of the county of Huron, the Commission in 1912 reported on the possibility of developing power at the Black Hole on the Maitland River for the purpose of supplying power to the county. The circumstances were such that it was necessary to make this report at the earliest possible date, and the only dependable records of stream flow available were those taken by the Commission between May, 1911, and May, 1912. On the strength of these records, it was stated that the probable minimum continuous capacity of the site was 800 h.p. The records for the summer of 1912 showed a minimum capacity in excess of 800 h.p., but the records for 1913 showed the minimum capacity of 700 h.p., and for 1914 a minimum capacity of 550 h.p. It was therefore necessary to obtain records extending over a period of four years before it could be proved that the Black Hole site was useless as a source of continuous power. Furthermore, if the construction of the plant had been proceeded with on the basis of the 1911 records, a disastrous failure would have resulted. The same danger exists at the present time on practically every river in the province.

The scope of the stream measurement work has been gradually extended, until at the present time all the principal rivers in the south-western peninsula of the province are under observation, as are also the rivers flowing into Georgian Bay and Lake Huron.

Permanent metering stations have also been established on the principal rivers in the Cobalt and Porcupine mining districts and westward along the line of the Transcontinental Railway. The English and Winnipeg rivers and their tributaries, and the rivers tributary to Rainy Lake, have been under observation for the past year and a considerable amount of valuable data has been obtained, although the difficulty of obtaining gauge recorders in the unsettled districts and the long distances to be covered by the field men, has made the collection of data a much slower process in this territory than in the case of the other districts before mentioned.

Enamelled steel staff gauges have been set at all stations where good rating curves have been secured and where it was possible to obtain a gauge reader. Wherever possible, these gauges are read twice a day and the records sent to the Toronto office at the end of each week. At many of the stations it has been found impossible to eliminate the effects of back water, and wherever possible these stations have been abandoned and more favorable ones chosen. While this source of error has by this means been largely eliminated in the case of the stations on the northern rivers, it has been found impossible to altogether eliminate it in the case of several rivers in the south-western peninsula, principally on account of the large number of mill dams located upon the same.

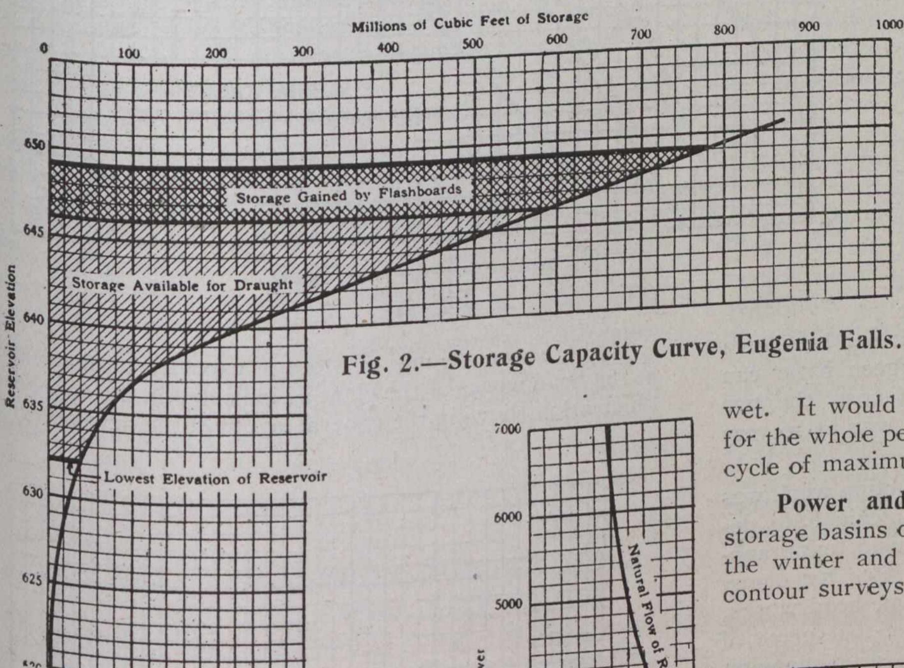


Fig. 2.—Storage Capacity Curve, Eugenia Falls.

Tabulated results of the stream measurement work up to December 31st, 1914, are given in the report. All discharge measurements were made with standard meters, and except where otherwise noted are accurate within a limit of five per cent. The rating curves from which the discharge tables were compiled are, in most cases, well defined, but in the case of certain streams some revision of the tabled discharges may be necessary when further data on winter discharge has been obtained and extra points fixed in the middle range of some of the rating curves.

The most important hydrometric studies carried on during the past year were those on the Grand and Beaver rivers. Work on the Grand River has been laid out in considerable detail and fifteen metering stations located throughout the watershed. Considerable data has been obtained which will aid in fixing the minimum flow of the main river and tributaries, but owing to the unusually light freshet which occurred in the spring of 1914, no data is yet available in connection with extreme high-water conditions similar to those which have obtained in former years. Until this data has been obtained as a result of the actual measurement of the higher ranges of flood discharge, the hydrometric investigations on the Grand River cannot be used as a basis for the study of a flood prevention scheme.

The hydrometric study of the Beaver River has been carried on continuously during the past year and a considerable amount of essential information has been obtained bearing upon the economics of the power development at Eugenia Falls, which is now in course of construction. The maximum discharge at Eugenia Falls as determined to date is about 550 cu. ft. per second, or about 7 cu. ft. per second per square mile of watershed. The minimum measured flow is 20 cu. ft. per second, which means a run-off of .27 cu. ft. per second per square mile of watershed. Weir discharge records from May, 1910, to June, 1911, and from May, 1913, to date, together with an estimate of the run-off during the intervening period, based on weir and precipitation records, indicate that the average flow from the watershed above Eugenia Falls is about 71 cu. ft. per second. Also, an analysis of the accompanying mass curve covering the same period, indicates that this average flow may be impounded for useful work with a storage capacity of 900 million cu. ft. The precipitation records for the period above mentioned appear to be fairly representative, as the year 1910-11 was dry, the year 1913-14 the driest on record, and the year 1912 was very wet. It would seem, therefore, that the average run-off for the whole period is derived from a fairly representative cycle of maximum and minimum flow conditions.

Power and Storage Surveys.—Surveys of possible storage basins on the Grand River were carried on during the winter and most of the summer of 1914. Accurate contour surveys were made of two projected storage loca-

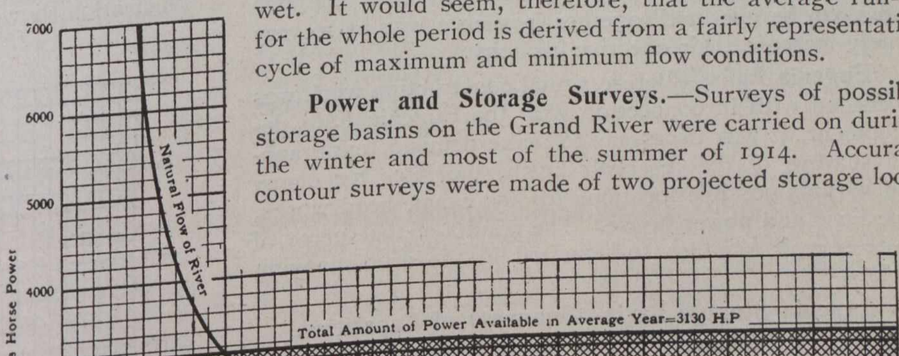


Fig. 3.—Power-percentage of Time Curve, Eugenia Falls. (Net Head, 530 Feet; Efficiency, 80%.)

tions on the main river, one near Blair and one below Elora, also a location on the Conestogo River and one on the Nith River near Canning. These surveys have been plotted and the information as to storage capacity which it will be possible to obtain from them, together with the stream flow data which is being collected from the fifteen stations in the Grand River watershed, serves to indicate whether or not the projected flood prevention scheme on the Grand River is physically feasible.

During the summer of 1914 a field party was kept continuously employed in making surveys of possible power sites on the rivers flowing north across the line of the Transcontinental Railway into James Bay. Eight power sites in all were surveyed on the Abitibi, Blanche, Groundhog, Frederickhouse, Kapuskasing and Mettagami Rivers. These surveys, together with the stream flow measurements taken in that territory, will be of great assistance in working out schemes to supply the rapidly growing power market, and in supplying information which may lead to the establishment of industrial enterprises.

A survey was made during December, 1914, of a power site in the vicinity of the village of Cobden with a view to ascertaining whether or not it could be economically utilized as a source of power for the municipal and industrial requirements of the village.

A survey is being made near the mouth of the Saugeen River with a view to ascertaining whether sufficient head can be economically created to justify the development of power at this point as an adjunct to the water power now being developed by the Commission at Eugenia Falls. The high head and large storage capacity at Eugenia Falls afford unusually favorable facilities for peak load operation, and if it can be shown that the lower stages of flow on the Saugeen River can be developed within reasonable limits of cost, the two plants can be operated together in such a way as to very largely increase their effective capacity.

Eugenia Falls.—Before actual construction work was proceeded with in connection with the Eugenia Falls development, it was necessary to make detailed topographical surveys of the reservoir basin, the sites for dams, and various possible locations for the canal, head works, pipe lines and power house. The results of the survey of the reservoir site are summarized in the accompanying table:—

Eugenia Storage Basin—Summary of Capacities.

Contour.	Volume between contours. Cu. ft.	Total volume. Cu. ft.	Area in acres.
610			
	750,000	750,000	
615			6.9
	3,210,000	3,960,000	
620			22.9
	8,032,500	11,992,500	
625			51.1
	15,660,000	27,652,500	
630			92.8
	41,612,500	69,265,000	
635			291.0
	161,600,000	230,765,000	
640			1,194.0
	284,250,000	515,015,000	
645			1,420.0
	336,875,000	851,890,000	
650			1,675.0

The accompanying storage capacity curve shows the impounding capacity of the main reservoir for different contour elevations. As indicated on this curve, the gross capacity with 3 feet of flash boards is about 780 million cubic feet, of which 190 million cubic feet is secured by the use of the flash boards. About 40 million cubic feet of this total capacity is not effective, as it is below the minimum limit of reservoir draft.

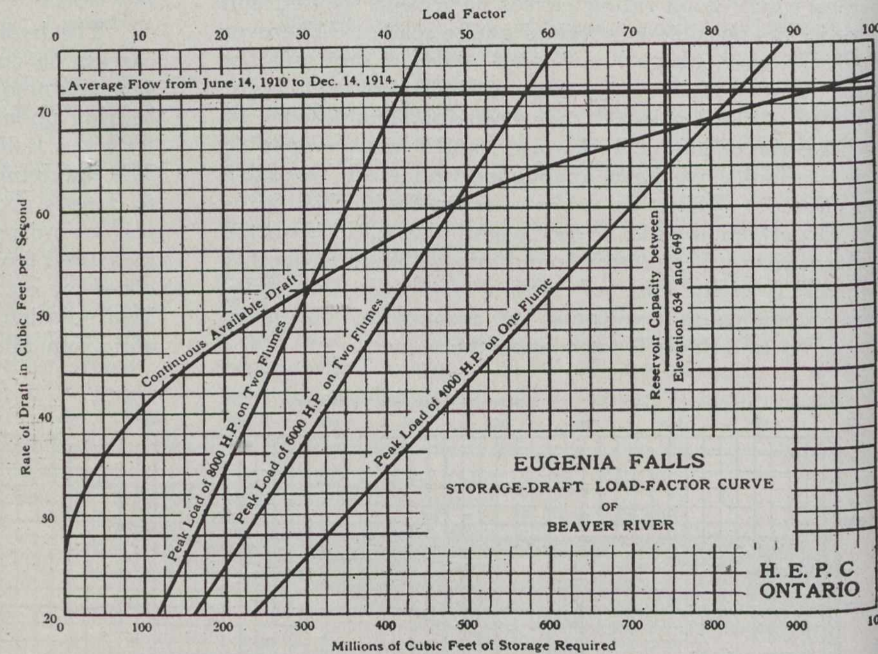


Fig. 4.

The above volume of storage capacity is obtainable at the head works of the plant as indicated in the appended illustration showing the general layout of the development.

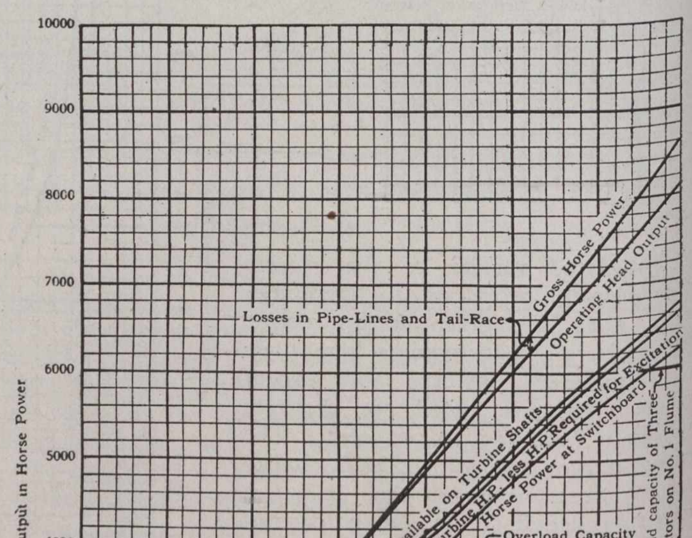


Fig. 5.—Efficiency Losses and Available Output for Initial Installation, Eugenia Falls. (Average Gross Head 545 Feet.)

To show clearly the benefit derived from the creation of this storage, the power-percentage of time curve, shown herewith, has been plotted. The curve indicates that the minimum continuous capacity of the Eugenia Falls site is about 1,200 h.p., while under the conditions existing as a result of the present scheme of development, the continuous capacity available will be about 3,130 h.p., a capacity which, under natural conditions, would only be available for 73 days in each year. This curve shows that an additional 50 per cent. of power is derived from the impounded water, while the continuous capacity of the stream is increased to nearly three times its natural minimum capacity.

The accompanying storage-power curve indicates that with a reasonable deduction for evaporation and seepage, a commercial load of 6,000 e.h.p. can be carried with an annual load factor of 53 per cent., or a commercial load of 8,000 e.h.p., with an annual load factor of 38 per cent. It also indicates that sufficient capacity has been provided in the present storage reservoir to equalize the flow of the river for all ordinary years.

When the full capacity of the plant has been reached, operating conditions may indicate the desirability of providing additional storage as insurance against the possibility of three abnormally dry years coming in succession. In such event the additional storage necessary can be obtained a few miles up the river near the village of Feversham, when 300 million cubic feet of storage can be secured at reasonable expense. The creation of this additional storage would provide sufficient protection against any scarcity of water arising from an abnormally protracted period of light precipitation, although there is little likelihood of a condition ever arising that will necessitate additional storage at Eugenia.

MOVING TRANSMISSION TOWERS ON WELLAND CANAL SITE.

Some very interesting notes appear in the recent report (for 1914) of the Hydro-Electric Power Commission of Ontario relative to the moving of several steel towers belonging to the high-tension transmission system that crosses the site of the new Welland Ship Canal. On account of the extent of excavation and construction work on the Canal it was found necessary to lengthen the transmission spans across it from 407 to 532 ft. To do this, one standard tower was removed from the transmission line, one anchor tower was moved 45 ft. and the two high towers supporting the Canal crossing span were moved, one 63 ft. and the other 62 ft.

The important part of this construction was the moving of the two latter towers. Each weighed twenty-five tons, and each was supported on a heavy reinforced concrete footing. The overall height was 168 feet. For many reasons it was decided to move these towers standing, and for this purpose heavy timber skidways were built, the towers well guyed, and then pulled along the skidways to the new concrete foundations.

In order to ensure continuous power during this work, two temporary lines were built, one on the northerly side of the crossing to carry circuit No. 1 and the other on the southerly side for circuit No. 2. These two crossings were made far enough apart to allow room for the largest lake vessel, and by this means a boat could pass through with very little delay and without having a complete shut-down on the power circuits.

ONTARIO MINERAL INDUSTRY IN 1914.

THE growth which marked the output of the mining industry of Ontario during the previous decade underwent a decided check in 1914, according to the latest report of the Department of Lands, Forests and Mines. The value of the production was $46,632,105, as compared with $53,232,311 in 1913—a decrease of $6,600,206, or 12.3 per cent. It fell below the level of 1912 by $1,641,406, but considerably exceeded that of any preceding year. The decrease was somewhat greater in amount in the metallic than in the non-metallic products, being $3,638,438, as compared with $2,961,768. The causes of this diminution were the general depression in business which became apparent early in the year, and the outbreak of hostilities in Europe.

Of gold the production was the largest in the history of the province, 268,942 ounces, worth $5,529,767. Much the greater part came from Porcupine, the Hollinger mine being the leading producer. The Dome, Porcupine Crown and McIntyre Porcupine mines also contributed largely. There were in all 608,200 tons of ore crushed, the average yield being $9.14 per ton.

The output of silver in 1914 was 25,999,374 fine ounces, being a decrease, as compared with 1913, of 3,725,557 ounces, or 12.5 per cent., or 17.4 per cent. as compared with 1911, when the Cobalt mines were at their maximum and produced 31,507,791 ounces. The return to mining companies was $13,209,726, an average of 50.807 cents per ounce. The production by camps was as follows:—

	Ounces.	Value.
Cobalt proper	24,940,613	$12,678,181
Casey township	499,643	236,298
South Lorrain	104,665	54,310
Gowganda	399,300	211,184
	25,944,221	$13,179,973
Silver recovered from auriferous ores	55,153	29,753
Total	25,999,374	$13,209,726

Since the opening of the mines at Cobalt the production of silver has amounted to over 211 million ounces, having a value of more than 111 million dollars.

Nickel was produced to the extent of 22,760 tons, and copper 14,453 tons. The source of these metals was the nickel-copper ore of the Sudbury district, of which there was raised 1,072,207 tons and smelted 947,053 tons. Some 79,825 tons of similar ore came from the Alexo mine in Dundonald township. The nickel contents of the matte were less than 1913 by 2,178 tons, and the copper contents more by 1,512 tons.

Iron ore, including concentrates, was shipped from the mines and works to the extent of 240,059 tons, valued at $531,379.

The production of pig iron fell from 648,899 tons worth $8,719,892 in 1913 to 556,112 tons worth $7,041,079 in 1914. Four blast furnace plants were in operation, namely, at Sault Ste. Marie, Hamilton, Port Colborne and Deseronto.

Motor transportation is being rapidly developed and utilized by the farmers. By this means greater distances can be covered, and farmers at a considerable distance from markets, with the advent of better roads, will be able to bring their produce to the consumer in larger quantities and at less expense.

DUST PREVENTION.*

By Major W. W. Crosby,
Consulting Engineer, Baltimore, Maryland.

A GENERAL agreement among highway authorities has developed the fact that dust proceeds not only from attrition of the roadway surface by hard tires and the feet of animals, but also comes from the grinding on each other of the pieces of aggregate or road metal forming the pavement or crust. This internal wear of the surfacing is much greater than was formerly suspected, and it largely accounts, in many cases, for the layer of mud and dust to be found on macadam, for instance, even when freely removed from the surface at frequent intervals by scraping or sweeping.

The amount of the internally produced mud seems to bear a relation to the weight of the traffic, and to the moisture present—such as results from sprinkling with water—as well as to the friability of the stone used and to the methods of construction.

Heavy vehicles, even when shod with rubber tires, set up severe strains in the road crust, and tend to make the particles of stone in macadam rub against each other in resisting these strains. If water is present in excess in the mass at the same time the stones wear into mud more easily. Soft materials, of course, produce more fine material than harder ones under the same conditions. If the particles of material composing the macadam are closely knit and mechanically or physically bound together by their angular shapes, they naturally move less under the strains, and the rubbing and consequent fine material produced is less in amount.

Real dust prevention, it will be seen, begins, therefore with the construction of the road crust. In this work it will be necessary to avoid, as far as practicable, the subsequent production of both superficial and internal dust, which latter rises eventually to the surface, and becomes appreciable externally—selecting road metal of the most appropriate hardness considering the traffic, by providing thorough proper drainage against the continued presence of an excess of water in the road crust, and by securing the firmest angular bond that the metal is capable of in the macadam.

It has been found that, even where good road metal was used, and under light traffic, road crusts built with the use of an excess of fine material in their first construction have proved to be subsequently more dusty under the same conditions than where the fine material used was kept to a minimum. Evidently the excess of fine material, not only from its presence easily furnished more dust to be raised, but also it prevented the closest interlocking of the coarser particles. This resulted in an increased movement of them under strains on the surface, and therefore the production of more internal dust. The dustiest kind of a stoned roadway is an old turnpike, where the stones were liberally mixed with earth in order to help their compaction under traffic, and where they are bedded, like plums in a pudding, in a matrix of fine material.

With modern machinery and the construction of the macadam by sufficient rolling, the use of fine material should always be kept as low as possible. It will have to be used, to some extent, for filling the voids between the coarser particles; but even then a selection for the finer particles should be made, and, as far as practicable, that chosen should be highly resistant to the tendencies toward its reduction to dust. It will pay in using limestone to use at least 50 per cent. of the fine material required for bonding the macadam of clean sand such as would be suitable for mortar. In many cases all the fine material necessary may profitably be such sand even when used with crushed trap rock, and with shells no fine material, except such sand, should ever be used. In no case are the best results ever obtained by the use of clay, silt or loam for binding macadam. A further reduction in the quantity of fine material used in filling the voids of macadam is possible by the use of bituminous material for this purpose, and this "pitch" has also another effect referred to later.

No matter how built, a roadway, even in city streets, may become superficially dusty, and the suppression of the dust on its surface from becoming objectionable may be desirable. Frequent cleaning or removal of the dust with the dirt may solve the problem, or it may be impracticable to that extent, and other means of relief may be necessary.

The simplest of these is sprinkling with water to "lay the dust." The objections to this are that it is seldom done efficiently, because it has to be done periodically, and between the times of sprinkling, when a temporary excess of water is applied, the surface condition varies from muddy to dusty again; further, the cost of sprinkling with water may not be economical if that is the sole reliance for the suppression of the dust. Proper cleaning, with sprinkling or washing of the street surface, may, under some city conditions, be satisfactory.

Efforts have been made to increase the effectiveness of water sprinkling by the use of sea water, which contains hygroscopic salts, or by the addition of such salts as calcium chloride to the water. Under some conditions the results have seemed to be successful to a certain extent. These salts absorb moisture from the air, and tend to keep the roadway surface moist enough to hold down the dust even after the water originally applied with them would otherwise have disappeared and failed to do this. Their effect, however, is not permanent, nor is it powerful enough to meet severe conditions of traffic tending to produce or raise dust; further, these salts are soluble, and are washed away to the gutters and water-courses by rain. Their re-application becomes necessary at intervals more or less frequent according to local conditions.

The salt (calcium chloride) itself has been used on the same principles by being spread in a finely divided and dry state over the roadway surface. In this way the effects of its are, perhaps, stronger, and more noticeable or lasting.

Another what might be called "chemical" process consists of the use of concentrated sulphite liquor usually produced as a waste or by-product at wood-pulp mills, and commercially known as glutrin. The glutrin is used either with or without the addition of water. The effects of the glutrin are composite. It has some cementing powers, such as exists with sugar. It also, through its tannic acid contents, has a chemical effect on some of the materials composing the road crust, which tends, perhaps, to strengthen their normal binding power. For instance, it may make a clay much more plastic and tenacious; further, road surfaces treated with glutrin seem to "set up" harder, and, to some extent, to resist abrasion better.

The glutrin is, however, more or less soluble in water, and eventually will be washed out of the road

*Paper presented at Second Canadian and International Good Roads Convention at Toronto, on March 24th.

crust, even if the impregnation is fairly deep, as subsequent wetting of the crust brings the glutrin gradually to the surface. Under some conditions the use of glutrin as a dust preventive has been fairly successful.

The most successful of the materials used for either the prevention or suppression of dust on roadways are the bituminous materials, and they can generally be used for both purposes.

If the voids in the road metal are, for instance, filled with bituminous materials, the internal production of dust is prevented. The external production of dust even may also be reduced because of the cushioning effect of the pitchy matrix and the greater resiliency thus given the piece of road metal subjected to the shock or attrition of traffic. If the bituminous material is only applied to the surface of the road crust, it still reduces the dust nuisance by suppressing the raising of the dust underneath or mixed with it, and in many cases by protecting the road metal from any superficial wear from traffic.

Further, a proper bituminous material possesses to a large degree, and greater than in the cases of other materials, the ability to absorb a considerable amount of dust produced elsewhere, and, perhaps, brought on to the roadway through various agencies. This is important from the economic point of view.

What is a "proper" bituminous material will depend so largely, in any case, upon the local conditions that no close definitions can be given in this paper. Perhaps it might be said that, generally speaking, the asphaltic oils are better for this work than the paraffin base oils, that a good bituminous dust layer will give benefits other than the mere reduction of dustiness on the roadway—such, for instance, as the reduction of noisiness and an increase in sanitariness—and that usually its proper application will be in the interests of both economy and general satisfaction.

On the other hand, the improper use of an unsuitable bituminous material will produce results on the roadway second to none as far as nastiness and general dissatisfaction are concerned.

Discussion by Mr. A. T. Laing,

Lecturer in Highway Engineering, University of Toronto.

The dust problem, like many other road problems in its present acute form, dates from the introduction of the self-propelled vehicle. This innovation in the methods of transportation brought about conditions as to load traction and velocity that formerly were little dreamed of. All three features mentioned have a direct bearing on the question under consideration. The heavy load of the motor truck not only breaks up the crest but produces as well internal attrition in the road metal and the fine material works to the surface to form dust. In addition to this, the driving power of the engine is transmitted to the periphery of the wheel, thus producing a shearing or grinding effect on the road surface and then the speed of the passing car finishes the work begun by the other two agencies and we have the results which are so disastrous to the roads, add so much to the discomfort of the traveller and which are such a menace to health.

The dust problem is two-fold in character. First, that of mitigating the evil by treating the dust with a palliative or a dust layer, and second, that of treating the surface in such a way as to prevent as far as possible the formation of dust. These features should have careful consideration in determining which method is to be employed in a given case. In all probability we will, for some time at least, have to resort to the use of palliatives in many cases and at this point the question becomes complicated. The climate, the volume and nature of the traffic all have a bearing, and added to this is the fact that there are on the market a great number of compounds from which a selection must be made and, as Major Crosby has pointed out, conditions vary so that there is no best material or method. It becomes highly important, therefore, at this point that the advice should be sought of one who has a thorough knowledge of the subject. Major Crosby states in his paper that of all the materials on the market the bituminous compounds are generally the most satisfactory. This may seem simple, but it is in reality a very complex matter as there is such an infinite variety of these compounds. One important characteristic of any such compound is that it should have strong cohesive properties. As the presence of paraffin will reduce this property an oil low in paraffin content is to be preferred. It is also undesirable that there should be present a high percentage of sulphur. A high percentage of low boiling products may be the source of unpleasant odors and will necessitate more frequent treatments. The ingredient to be desired is asphalt, but this must be fluxed with oils that will keep it in a plastic condition and at the same time render it convenient to handle. It will be seen, therefore, that even though a decision may have been made in favor of bituminous as against other compounds the selection of the particular bituminous mixture is not a simple matter and the aid of the chemist or expert should be sought. It is desirable that the kind that is used should be cumulative in its effect.

As regards the second phase of the question, that of treating the surface so that it will not yield dust, it is one very largely of the selection of the bituminous materials employed. The economic value of such a method commends itself as one is thereby preserving the road and we come to the point where it is difficult to differentiate between dust prevention and maintenance.

Dust is deterioration, and the extent to which we eliminate its formation do we contribute to the maintenance. In this latter question the nature of the traffic will have a direct bearing. The mat surface produced by using bituminous materials with gravel gives highly satisfactory results for automobile traffic, whereas it might fail under the shoes of horses and narrow-tired vehicles.

Much might be said, if time would permit, regarding methods of application, the temperature of the compound and the comparison of hot applications with cold. It would be interesting if this discussion would bring out some of these points.

The 11th unit has been installed in the plant of the Electrical Development Company, at Niagara Falls, Ont. This completes the equipment of this plant. The capacity of the machinery now installed in the plant is rated at 147,000 h.p., all of which is to be used in Toronto. The last generator was started on February 15. The first machine, a generator of 13,000 h.p., was installed on November 1, 1906. Four of this type of generators were installed, after which the size was increased to 15,000 h.p., and seven of these machines have been installed. The generators are manufactured by the Canadian General Electric Company, while the wheels are of the I. P. Morris type. The company was chartered to generate a maximum of 125,000 h.p. and the extra machinery is installed to protect the company in case of a breakdown. This plant is the first of the Canadian power plants at Niagara Falls to be equipped up to its maximum capacity.

ONTARIO GOVERNMENT ELECTRIC RAILWAY PROJECT.

IN the report for 1914 of the Hydro-Electric Power Commission of Ontario, the work carried on by the Electric Railway Department during the past year is summarized as follows:—

1. Advice to municipalities as to possibilities, routes, etc., of proposed lines.

2. Reconnaisance and rough reports on various lines.

3. Preliminary surveys of desired routes.

4. Preparation of plans and profiles of preliminary surveys and projection and taking out of quantities on lines along such surveys.

5. Estimates of cost of construction and equipment of proposed lines.

6. Collection of traffic data from the various districts showing the amount and distribution of business both inbound and outbound.

7. Estimates of the annual revenue and expenses that might be expected from the construction and operation of various lines.

8. Reports and advice to municipal committees and representatives as to the most profitable routes of those surveyed through various districts.

9. Assistance to municipalities in the preparing of by-laws and presentation of such to the ratepayers for ratification.

10. Preparation of standard estimating costs of each portion of the work entering into the construction of the complete line.

11. Preparation of standard rules and specifications with drawings covering the forms of construction proposed for these lines.

12. Preparation of specifications and plans covering standard materials such as rails, concrete pipe, etc., required for roadbed construction.

13. Selection of a system of electrification.

14. Compiling statistics of traffic, revenue and expenses of existing railways for the purpose of comparison with proposed lines.

15. Preparation of specifications for electrical equipment for substations, cars and locomotives.

The report states that resolutions had been received from 138 townships, 38 villages, 42 towns, 11 cities, 4 police villages, and 7 miscellaneous committees, such as Boards of Trade, etc., asking for surveys, reports and estimates on proposed lines. Two survey parties had been at work for almost the entire year making preliminary surveys of some 1,200 miles of line. The information so obtained had been plotted and used for the purpose of preparing estimates on the cost of roadbed construction. In making the surveys topography was taken for approximately 400 ft. on each side of the traverse line. When this information was plotted the proposed lines were then projected and quantities figured along such lines.

Traffic men have been sent into the various districts for the purpose of collecting information showing the amount of freight and passenger business that is obtained by the present railways in the district, and whose duties are to estimate on the business that may be done by the proposed lines. Full information is now being taken by these men showing not only the amount of business, but the revenue that is derived therefrom and the destination or shipping point of freight business; thus the information may be used for other lines that may be proposed in the future without requiring the traffic men to return to the district.

The most important work done during the year was in the Toronto-Northeastern district. Meetings with the representatives of the municipalities in this district were attended during the year, and it was decided by the representatives during the summer that the councils of the municipalities should pass by-laws to cover the construction, equipment and operation of the line, and that these by-laws should then be placed before the people on October 19th for ratification. Agreements between the Commission and the municipalities covering construction and operation of the line were prepared and a number of meetings were held in all centres throughout the district, for the purpose of explaining the proposition to the ratepayers. Representatives of the Commission were present at practically all of these meetings to assist in giving this information, and the result of the voting on October 19th showed that the municipalities as a whole were very anxious for the construction of the line along the route recommended by the Commission. Eleven out of the thirteen municipalities that voted on this date passed their by-laws by very substantial majorities.

It is of further interest to note here that since the preparation of the Commission's report, and during the 1915 session of the Ontario Legislature, the Government was approached by a municipal representation, several thousand strong, urging Government aid for the construction of the hydro-radials. The Government, while forced to hold the matter in abeyance for the present, evidently foresees the staunch support which the municipalities will accord the radials after construction, and there is little likelihood of any longer delay than absolutely necessary.

There was one significant course of action followed during the last session that bespeaks earnest governmental consideration of the hydro-radial proposition. It was the cancellation of a number of railway charters, which had come up for renewal, but which were in certain measure opposed to the Commission's scheme. It is evident from this that early commencement of the hydro-radial system is not unlikely.

The Commission's report for 1915 will undoubtedly contain some interesting information on the electrification of the London and Port Stanley, now in the final stages of completion and scheduled to begin operation in June. This will be the first municipally owned line to be operated under the Hydro-Electric Power Commission of Ontario.

During the year 1914 the Hydro-Electric Power Commission of Ontario purchased from the Ontario Power Company the distribution systems and transformer stations in the town of Welland and the city of St. Catharines, Ont.

Owing to the rapid increase during 1914 in the consumption of power by the municipalities using power from the Hydro-Electric Power Commission's system, it was found necessary to duplicate the transmission line from Niagara Falls to Dundas, a distance of 50.02 miles. This was also found necessary owing to the fact that this is the main trunk line of the whole system, and the Commission felt it wise to minimize the danger of interruptions to the service. It was decided to purchase a 66 ft. strip of right-of-way on the same plan as that followed on the Windsor line—i.e., the land to be purchased outright and not on the easement plan. The original line between Niagara Falls and Dundas was run along the roads and the fronts of the farms and was purchased on the easements plan. In the case of this duplicate line, however, the towers were located at the back of the farms and the land was purchased outright.

Editorial

GOOD ROADS AND THEIR INCOMES.

The economic benefits arising from country road improvement may be placed in three classes: the measurable, the tangible, and the intangible. Of the tangible, there are many. For instance, there is the development of motor traffic, linking more closely the railroad terminal city and the country village, and at the same time acting as a feeder for the railroad itself. The reduction in the upkeep cost of automobiles must alone amount to many millions of dollars annually. Another is the stimulus to education, shown by the immediate increase in school attendance accompanying any road improvement. Still another is the improvement in local business which invariably follows in the sections contiguous to the betterment. Less tangible, but no less real, is the increase in direct distribution which must come with better roads. These are but a few of the more obvious effects.

Then there is the measurable benefit which must be regarded as the direct return to the community upon its investment in road betterment. It lies in the difference between the hauling cost over a road before and after it has been improved. Of course, this is subject to considerable variation, depending as it does upon the condition of the road before improvement, as well as upon other factors. Nevertheless, it cannot be disputed that the reduction in all cases is very large.

This measurable benefit should be given the important consideration it demands when a community is thinking of borrowing money for road improvement. An investment therein returns an annual income to the community, arising from the reduction in cost of haulage. This reduction may be termed, as the railroads are disposed to call it, an operating income. While many factors influence it, it may be estimated with conservatism, for, while basing an estimate on existing tonnage over the road, there is always a decided increase in annual tonnage as a result of the improvement, and a corresponding increase in operating income.

In 1914 the Dominion of Canada produced nearly 600,000,000 bushels of grain, the greater part of this coming from the western fields, and being marketed, let us say, over prairie roads. It is difficult to arrive at a figure for the average haul to the elevators. In older Ontario the average haul to market is approximately six miles. A conservative figure for the Dominion, particularly the western grain country, might be taken as ten miles. The cost of hauling a ton over a mile of country road may vary from 20c. to 50c. or even higher, depending upon the condition of the road. This cost might be conservatively considered to range in Canada between 20c. and 35c. per ton-mile. On first-class highways in Europe, where labor is cheap, ton-mile costs as low as 10c. are common, but a realization of this figure is hardly to be expected in Canada with team haulage and high-priced labor. The reduction in this cost effected by road improvement, would depend, of course, on the difference between the original and finished conditions of the highway. A mere improvement of earth road might readily save 5c. per ton-mile, while its replacement by a macadam road would probably cut the cost of haulage in half.

Applying these figures, then, to the marketing of Canada's 1914 grain crop, if the 600,000,000 bushels had been marketed, and if the average haul to the shipping point had been ten miles, a saving through light road improvements of only 5c. per ton-mile would have reduced the country's marketing cost on grain alone by about $18,000,000. A method of arriving at an estimate of the total possible saving in the haulage of Canadian produce is, of course, not feasible, but there can be no doubt that it would amount to many times the total for the grain crop referred to above.

As we all know, the railways spend millions of dollars in the effort to reduce the ton-mile cost of hauling freight only two or three mills. It is, they find, money well invested; and it is illustrative of what may happen in the development of better roads when the people of this country come to realize that such improvement may mean a saving, on the hauling of many millions of tons, not of a fraction of a cent, but a saving which may amount to as much as 10 cents, 5 cents or even 2 cents per ton-mile.

PROFESSIONAL CHARGES OF ENGINEERS.

The Council of the Institution of Civil Engineers have communicated to the corporate members the following statement regarding professional charges, in the hope that it may be of assistance to them and at the same time conduce to uniformity in the basis upon which these fees are fixed:—

The Council are of opinion that the nature of professional engineering services renders it difficult to lay down any comprehensive scale of fees to cover the varied conditions under which such services are given. Engineers with larger experience command fees for such work on a higher scale than younger and less experienced engineers, but it may be expedient that some authoritative statement should be made by the Council as to professional charges, which will afford some recognized measure of the value of certain engineering services.

The Council accordingly state that the customary remuneration for ordinary professional engineering services, as distinct from remuneration by salary, for the design and superintendence of the construction of works in the United Kingdom is a commission of 5 per cent. upon their cost, which commission, however, is liable to be varied in accordance with the nature and magnitude of works and the character of the services rendered, as follows:—

(1) In the case of undertakings where the services rendered by the engineer are large relatively to the extent and cost of the work, or in the case of undertakings involving a considerable amount of intricate and detail work, the commission of 5 per cent. may be increased. On the other hand, in the case of exceptionally large undertakings, the commission may be reduced by agreement.

(2) The preparation of bills of quantities, payments to resident engineers and inspectors, and also personal travelling expenses, are matters for arrangement depending upon the nature of the work and the circumstances under which it is carried out, and may be included or not included in the engineer's remuneration, according to the extent and difficulty of the works and the amount of detail

work involved in the preparation of the plans, drawings, specifications and bills of quantities, and also the amount of superintendence by the engineer's staff necessitated by the character of the work.

When the works are designed in sufficient detail to enable a contract for their execution to be made or to enable the local government board to hold an inquiry into the propriety of allowing an authority to borrow money for the purposes of the works, but where the carrying out of such works is deferred indefinitely or abandoned, the fee for services up to this stage is one-half of the ordinary commission.

The council are advised that plans and specifications prepared by an engineer belong, as chattels, to the client, after payment of the agreed fees, both the copyright in all ordinary matter contained in such plans and specifications remains vested in the engineer. Neither the client or any other person is entitled to multiply copies of plans and specifications so far as the original matter therein contained is concerned; and further, if such original matter has "an artistic character or design" the plans can only be used for the purpose of the particular structure for which they were prepared by the engineer, or for such other purposes as he may authorize. Original matter in specifications is defined by counsel to be a composition or arrangement of the author—something which has grown up in his mind and would, if applied to patent rights, be called invention.

Charges for reports on engineering proposals must necessarily be largely dependent upon the extent of the inquiry and research upon which the reports are based and upon the professional standing of the engineer employed, and cannot therefore be dealt with in any scale of fees.

Remuneration for services in preparing for and giving evidence before parliamentary committees or other tribunals, generally consists of a preliminary fee and a charge per diem while engaged upon the preparatory work and during the hearing of the inquiry, as well as all out-of-pocket expenses.

AMERICAN WATERWORKS CONVENTION.

WATERWORKS superintendents should direct their attention to Superintendents' Day (May 13th) at the 35th annual convention of the American Waterworks Association to be held in Cincinnati, Ohio, during the week of May 10th. The entire day and evening will be devoted to practical papers, of interest to waterworks operators; answering questions; and a general discussion of practical waterworks subjects. The following short practical papers will be taken up at this session, *viz.*:

"Assessing Cost of Extensions in Municipally Owned Plants," by D. A. Reed.

"How to Determine Size of Tap and Meter," by Jacob Klein.

"A Mercury Column Alarm for Stand Pipes," by W. E. Haseltine.

"Water from Gravel Wells," by C. N. Wiles.

"Difficulties in Designing and Operation of Medium Sized Waterworks Plants," by E. B. Black.

"Plumbing and Control of Plumbers," by Scotland G. Highland.

"City Fire Limits," an illustrated lecture by Albert Blauvelt.

"Pneumatic Pumping as Applied to Municipal Plants," by John Olyphant, illustrated with lantern slides.

"Artesian Wells and Methods of Pumping Them," by John D. Kilpatrick.

Question Box.—The following questions have been propounded and are typical of those that will be discussed:

1. Experience in the use of caps instead of plugs on dead ends and unconnected branch pipes—is there any economy or advantage in the use of such caps?

2. What legal right has a water company to the use of public streets after the expiration of its franchise?

Experiences of water companies whose franchises have expired, especially in cases where duplicate public works have been built.

3. What experience have you had in the use of lead wool for joints in cast iron pipe? Is it as economical and satisfactory as melted pig lead?

4. Is it your practice to test new water meters or meters repaired at the factory, or do you rely on the factory tests?

If tests of such meters are made, do they indicate that the new or factory repaired meters are accurate, or not?

5. Are meter bills of municipal waterworks a lien on property? If so, how are they regulated?

A long list of topical subjects has been presented to the membership for oral or written discussion.

IMPROVED DESIGN OF AUTO FLUSHER.

What appears to be a most comprehensive and serviceable machine for street sprinkling and flushing, has just been designed and built by the Tiffin Wagon Co., of Tiffin, Ohio. The new machine consists of a 3½ tons capacity motor truck, of conventional design, upon which is mounted a 900-gallon tank, with devices that allow power pressure flushing, power pressure sprinkling, or gravity sprinkling. The machine is a most efficient one, compared with the horse-drawn gravity sprinklers in general use throughout Canada, and is worthy of note as a decided advance in scientific street cleaning methods.

For propelling the truck over the street, a four-cylinder motor is used, located forward under the hood as on any motor truck. Pressure for flushing and sprinkling is produced by a second four-cylinder motor, mounted at the rear, with separate ignition and cooling system, but taking its gasoline supply from a common tank. The pump for pressure is of centrifugal type, giving up to 60 pounds pressure, and is in no wise connected with the vehicle propelling mechanism, thus allowing the operator to change the vehicle speed at will without affecting the water pressure. All controlling devices, both for running and for sprinkling or flushing, are convenient to the operator's seat.

The two flushing nozzles are provided with universal ball and socket joints, enabling the operator to throw two streams on one side of the street, or at any angle desired. The nozzles being well to the front, their work is always observed. The sprinkling nozzles, which are located at the extreme front, can be operated by pressure or gravity as desired. So successful is this pressure machine in operation, that it has a range to cover the widest streets found anywhere. While it would ordinarily be most convenient to fill the machine from hydrant or stand-pipe, it is capable of pumping its charge from rivers or cisterns.

GRAND TRUNK PACIFIC EQUIPMENT FOR OIL FUEL.

Since the first conversion of a coal burner to an oil burner for regular service by the Southern Pacific in 1900, much attention has been given to the use of oil fuel in railway locomotives. This use has steadily increased until in the spring of 1913 oil-burning locomotives were operated exclusively upon considerably over 20,000 miles of line in the United States and on some 587 miles in Canada. They were further operated in conjunction with a proportion of coal-burning locomotives on 4,720 additional miles. In Canada the Great Northern Railway is the pioneer in this respect, embracing all lines in the vicinity of the Pacific coast.

During 1912 the Canadian Pacific Railway established oil-burners on its main line between Kamloops and Field, B.C., and on the Arrow and Okanagan branches. There is reason to believe that eventually oil will be used on all of the main line of the C.P.R. west of Calgary, Alta., except in the long tunnels which are being constructed through the Rockies. Here electricity is to be the motive power.

The Esquimalt and Nanaimo Railway has installed oil on its 134 miles of line between Victoria and Alberni, on Vancouver Island.

The preparations now under way by the Grand Trunk Pacific for the use of oil fuel on all trains operating in British Columbia was the subject of a paper read in March to the Western Canada Railway Club and prepared by Mr. J. G. Legrand, bridge engineer of the Grand Trunk Pacific Railway. According to the writer, this oil fuel equipment will probably be completely installed for use before the end of June. Fuel oil will be furnished by the Imperial Oil Company, who are building a storage plant at Prince Rupert. The oil will be brought in oil steamers from Southern California. It will be taken through a 12-inch pipe carried on an approach incline trestle about 200 feet long, then on a bridge 710 feet long. From the end of this bridge the pipe runs on the ground to a pump house, and then to large storage tanks 115 ft. diameter by 35 feet high. The oil will be pumped from the storage tank to an oil delivery rack, six-car capacity, where the G.T.P oil tank cars will be filled. The oil will also be delivered to a service tank of a capacity of 21,000 Imp. gal. (600 barrels) serving the outbound tracks, where engines coming from the roundhouse can be filled.

The bridge carrying the pipe is a wooden structure composed of spans 74 feet and 84 feet supported on frame bents. This bridge has been designed to carry two 12-inch pipes, and three 8-inch pipes, through which different kinds of oil will be pumped. It is also designed as a foot bridge 4 feet wide to allow the men to cross the yard safely.

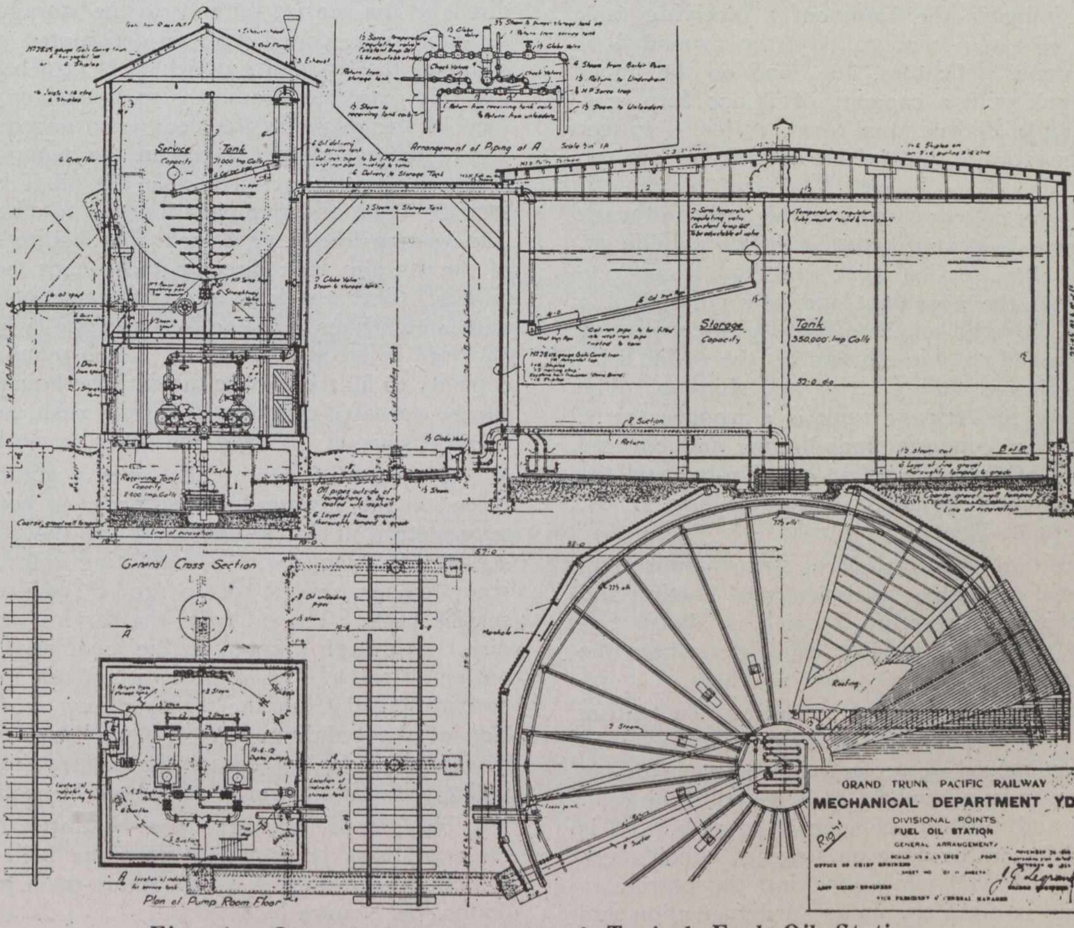


Fig. 1.—General Arrangement of Typical Fuel Oil Station.

Special care has been taken to have the main fuel oil pipe protected from cold weather, the pipe being enclosed in wooden conduits in which steam pipes are located.

The oil tank cars belonging to the railway will be filled at the oil rack and forwarded to supply the fuel oil stations located at divisional points—Pacific, Smithers, Endako, Prince George, McBride and Jasper.

While oil has been used for locomotive fuel on other western roads for a number of years, it has not been used under as extreme climatic conditions, the nearest approach being the Canadian Pacific lines, from 300 to 500 miles south. Along the line of the Grand Trunk Pacific the thermometer which for weeks at a time stays in the neighborhood of zero, frequently descends to 40° below. On the other hand, California crude oil has the consistency of molasses and cannot run or be pumped unless it is at a temperature of 60° F. This oil to be delivered from the service tank to the locomotive must be heated to at least 100° F. and not more than 110°, as a higher temperature would start evaporation of the volatile parts, thus reducing the efficiency of the said oil as a fuel. From the above data it is evident that the proper heating of this oil is a question of great economic importance, and the design, therefore, has been worked out to meet the above conditions.

Each fuel station, at the various divisional points, is located at 400 feet from the centre of the roundhouse near the boiler room, from which the necessary steam for heating is obtained.

The station is composed of two buildings, one 20 x 20 x 35 feet, containing in the basement a receiving tank with a capacity of 8,400 Imp. gal., on the ground floor a set of two pumps, indicators, etc., and on the upper floor a service tank with a capacity of 21,000 Imp. gal. The other building of dodecagonal form, 56 feet x 27 feet high, contains the storage tank with a capacity of 350,000 Imp. gal.

The service tank delivers the oil to the outbound track and a storage track is located between the two buildings. The building of the service tank rests on a concrete foundation forming the basement and is composed of a wooden structure, covered on the outside with corrugated galvanized iron nailed to ship-lap and on the inside with ship-lap, hair insulator, nailing strips and ship-lap. The building containing the storage tank is a wooden frame structure resting on concrete foundations and covered with a roof made of five-ply roofing on ship-lap and the sides made of ship-lap, hair insulator, nailing strips, ship-lap and corrugated galvanized iron.

The receiving tank, which replaces the concrete sump generally used, will overcome the difficulty of heating and maintaining a concrete structure, which is almost impossible to keep water or oil-tight, especially where the ground is soft as it is at McBride and Smithers.

The receiving and storage tanks include a new feature in the design of their bottoms. Usually these large tanks have a bottom composed of rectangular plates with lap joints, which have to be assembled and riveted in the field. The assembling and riveting of such a large bottom is very difficult and has to be done on staging, which afterwards has to be removed while lowering the bottom to the ground. This is often the cause of deformation and rupture of rivets and plates and the disturbance of the foundation ground, which ought to be well levelled. It is not an unusual occurrence to be obliged to raise the tank several times before water-tight joints are finally obtained. Besides these difficulties, it is very hard to completely clean the bottom of the tank when necessary or to replace parts affected by rust or other causes of deterioration. To overcome all of these difficulties the bottom of the tank is divided into segments of such a size as can be readily furnished by the mills. These segments have small angles shop riveted on them, the vertical legs of which are punched in order to connect the different segments together by riveting in the field. The whole bottom has a slight grade towards the centre, which is made of a shallow tank one foot deep, shop riveted and with the top angle turned inside; on this top angle the narrow ends of the segment are riveted. This arrangement allows the foundation, made of gravel and sand, to be well prepared, rolled to a true surface after the placing of the centre part, then the different segments are placed side by side, temporarily bolted and the riveting is done without disturbing the bottom. In case of accident, the replacing of a part is easily accomplished by cutting the rivets in the vertical legs of the angles.

To operate these fuel oil stations one to three cars, placed on the storage track, are located so as to have their outlet pipes directly over cast iron catch basins which carry the oil through 8-inch pipes direct to the receiving tanks. Steam pipes going through the said pipes are used to heat the oil running through the pipes and also the oil in the cars, by means of hoses connecting the ends of the steam pipes to the heating systems in the cars. The oil in the receiving tank is heated, if necessary, by a set of steam coils placed in the centre; the temperature being controlled automatically by a regulating valve, which will keep a constant heat of 60° F. This oil can be pumped direct to the service tank or to the storage tank through a 6-inch pipe, ended with an articulated galvanized iron spout to the extremity of which is attached a float keeping this extremity from two to three feet below the surface of the oil. To the float is attached a cable which works the indicators placed in the pump room. When there are no oil cars available the oil is taken from the storage tank and pumped directly to the service tank. The suction line is an 8-inch pipe leading from the floor of the storage tank directly underneath the tracks to the pumps. Both the inlet and outlet suction pipes together with steam lines, passing between the two buildings, are enclosed in wooden conduits. Each pump is of sufficient capacity to fill the service tank in two hours. Both pumps can be operated together in case of rush, and either pump may be shut off allowing the other to work.

A system of steam coils, with a regulating valve, is placed in the storage tank, in order to keep the constant temperature of 60° required around the suction pipe. A set of steam pipes with a regulating valve, giving a constant temperature of 100 to 110° F. is also placed in the service tank. The oil from the service tank is delivered directly through a spout to the locomotive placed on the outbound track. This spout, when not in use, is raised and protected from the weather in a recess built in the side of the building. A "Bowser" self-regulating pipe line measure is located on the delivery pipe in order to indicate the amount of oil delivered to each engine.

The steam necessary for heating and pumping in these stations is provided from the boiler room of the roundhouse through a 4-inch steam main at a pressure of 60 lbs. per square inch.

All the above conveniences to handle oil properly would be off-set if the proper cars, to transport the oil from Prince Rupert to the different divisional points, where not provided. The ordinary oil tank car which is generally used is certainly not suitable for this country, and especially for a long haul, economical handling, and quick service.

The ordinary tank is usually of too small a capacity, *i.e.*, 8,000 U.S. gallons, which would mean transportation of a comparatively heavy dead-load for a small quantity of fuel. This would not be economical on a long distance. A great objection to the ordinary car also, is that the valve is located above two feet off the centre line, which means that in making up a train, careful attention has to be taken to have the cars headed the same way, which in railway practice is almost an impossibility. Another great objection to the ordinary tank car is the small opening in the dome which is generally closed by a round cover, provided with a thread. This arrangement is very objectionable, especially in very cold weather. These tank cars are not provided with steam heating pipes, and the outlet being only 4 inches and exposed to the cold weather, it takes a long time to empty the car, and it is almost impossible to empty it completely, the bottom of the car being level, which means that a great quantity of the thick oil stays inside. This quantity may amount to several hundred gallons, according to the severity of the weather, and, of course, makes quite a reduction in the capacity of the car, outside of having to carry this quantity of oil back and forth on the line.

To obviate all the above objections, a tank car has been designed as follows:—

1. On account of the long haulage, the tank car has a capacity of 10,000 Imp. gal. The dome is provided with an opening of 18 in. x 36 in., the cover being hinged and hermetically closed by means of eye bolts and hand nuts.

starting from the centre will travel at once towards the two ends, and then come back to the centre around the outlet valve which is provided with a steam jacket, the condensation water being discharged on the ground through a "sarco" valve with ample capacity to avoid any water remaining in the pipes.

4. To solve the third condition, that is to say, the complete emptying of the car, the tank is provided with a trough running longitudinally between the bolsters. This trough, 8 inches wide, riveted to the bottom of the tank, has a semi-cylindrical bottom, and a depth of 6 inches at the outside extremity and 1 foot in the centre. The outlet valve is riveted to this trough. Six 6-inch diameter holes and one 6-inch x 18-inch hole in the centre will let the oil run through the whole length of the car into the trough. The return steam pipe is placed in the bottom of this trough, and is connected to the steam jacket of the outlet valve. With such an arrangement the oil will be heated

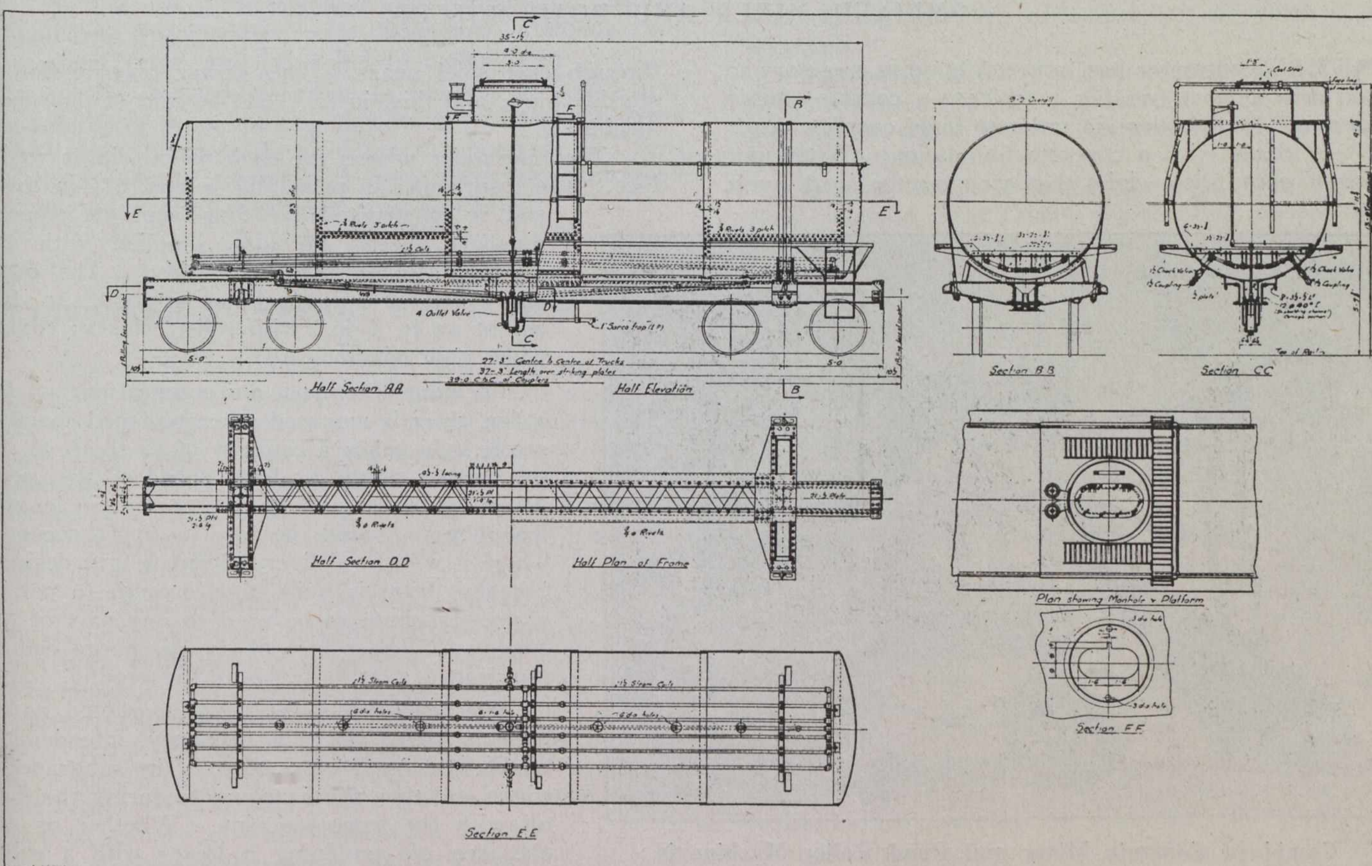


Fig. 2.—Design of G.T.P. Fuel Oil Tank Car.

This arrangement will allow an easy opening of the cover in any kind of weather. The opening in the dome is long enough to facilitate the spotting of the car at the oil delivery. The car is so designed that, when arriving at a fuel station it can be spotted, heated and emptied completely, all these operations being done in the shortest possible time.

2. To solve the first condition, that is to say, the spotting of the cars, which will be three at a time, the car has been provided with the outlet valve exactly in the centre, and the steam inlets for heating the car, also placed exactly on centre, one on each side of the car. In short, the car has been designed so as it can be headed either way.

3. To solve the second condition, *i.e.*, heating, the car is provided with the piping so arranged that the steam

thoroughly, and, therefore, run quickly, and the 6-inch fall of the trough towards the outlet valve will allow the car to be emptied completely.

In designing this car, the trough placed under the tank was considered in figuring the thickness of the shell of the tank, and it was found that the strength of such section was 30% stronger than similar section of tank without the trough. This allowed us to make this tank with a shell of 5/16 inch throughout, except the two ends which are ⅜ inch in thickness.

The body of the car is composed of a centre sill and two body bolsters, the whole resting on trucks. The centre sill, 37 feet and 3 inches in length out to out of striking plates, which means 39 feet c. to c. of couplings, is made of two 12-inch at 40 lbs. ship building channels (Carnegie section) spaced 12⅞ inches back to back. The two ends of the centre sill up to the bolsters are covered top and bottom by a ½-inch cover plate. Between the bolsters, the bottom flanges of the two channels are strongly latticed together, and the top flanges are reinforced by two 8-inch x 3½ x ½-inch angles. The tank is strongly riveted in the centre to the sill in order to transmit any shock which might occur in shunting. The tank rests on two body bolsters. This arrangement allows free expansion from the centre towards the ends. The centre sill, as a column, will have a safe capacity of 458,000 lbs. (approximately 230 tons), which means a breaking capacity of more than double, which is ample to resist the ordinary impact due to shunting. The body bolsters have cover plates extended in order to act not only as splices for the main material of the centre sill, but also to be able to resist the strain due to "poling." The casting which is placed at each end of the bolster is provided with a pocket to receive the "pole."

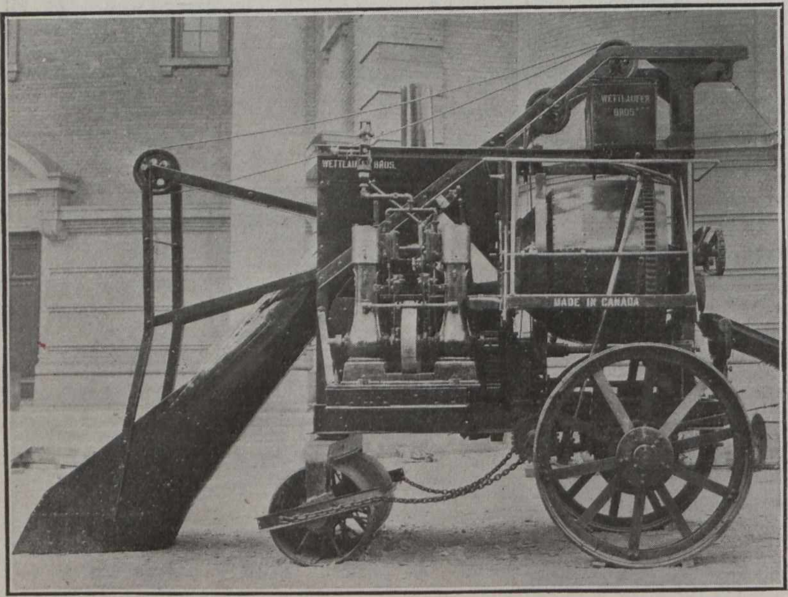
The saving of weight due to this kind of design is about 3,500 lbs. per car, the approximate weight of an ordinary tank car of the same capacity being about 44,000 lbs.

The car is provided with necessary walking planks to pass from one car to another, and a platform on the top around the dome to facilitate the operation of filling the tank.

Only forty cars of such a design will be required to take care of the fuel oil necessary for running trains between Jasper and Prince Rupert, this allowing three cars at each of the six divisional points, while 18 empty cars are going back to Prince Rupert for filling purposes, leaving four cars to spare in case of repair or accident.

COMBINED MIXER AND ROAD ROLLER.

EVERY contractor has hitherto found it necessary to own at least two big machines—a concrete mixer and a road roller—in order to build concrete roads or roads with a concrete foundation. Wettlaufer Bros., Toronto, now claim that a contractor need invest in but one machine, which will take the place, they say, of both mixer and roller.



Combined Concrete Mixer and Road Roller Machine is Here Shown with Small Wheels. Larger Wheels are Used for Rolling.

They have just placed on the market a most ingenious and unique machine—a combined concrete mixer and steam-driven road roller. The machine weighs 24,000 lbs. with road roller wheels; 15,000 lbs. with small wheels. The entire machine is controlled by one man from one platform, all levers being within reach. He is not required to leave the operating platform excepting to stoke the fire occasionally.

The machine is capable of rolling at a speed of 9,284 ft. per hour. The power is developed from a dry back horizontal boiler of 16-18 h.p. (at 125 lbs. steam), by means of a pair of 5 x 5 twin engines, with a speed of 300 r.p.m. The machine has two speeds forward, and is reversible at each speed. The power is transmitted through cast steel gears. The power transmission is sturdily built, and this, in fact, can be said of the whole machine.

The rear roller wheels are each 60 in. dia. x 17 in. face. The front roller is 34 in. dia. x 5 ft. 9½ in. face, and is constructed as four separate wheels. Smaller wheels are also supplied with the machine, to be used as desired. The overall length of the machine is about 10 ft.; height 12 ft. 6 in., with roller wheels; rolling width approximately 9 ft.

Forming a compact and integral part of the roller, there is mounted a heart-shaped concrete mixer, which has a capacity of 14 to 16 cu. ft. per batch, with a drum speed of 16 r.p.m. The drum is 48 in. diam. x 44 in. in length. The hopper speed is from 8 to 15 seconds. There is a boom delivery of any length desired, but the drum is built high enough to permit a gravity chute to be used to any part of the roadway. The centre of the discharge end of the drum is 6 ft. 9 in. above the ground.

The machine is not being marketed as an asphalt roller, but is primarily intended to enable the contractor to roll the subgrade at night and then to mix concrete during the day, all with the same machine. Whether or not the idea of combining a mixer with a roller proves to be practical and economical, the machine is certainly a new idea and interesting, and it will find a place in paving history.

The two principal copper producers on the British Columbia coast are the Granby and Britannia companies, and when the plants being installed by them are completed these two companies together will be able to register an output for the coast of 80,000,000 lbs. to 90,000,000 lbs. of copper per annum.

What is said to be the largest aqueduct in existence is that along the Owens River, at Los Angeles. It is designed to deliver a minimum of 258,000,000 gallons of water daily into the San Fernando reservoir, 25 miles north-west of the city. No pumping plant is required, as the source of supply is several hundred feet above the city. The water will furnish power—7,000 horse-power is anticipated—for electric lighting and other purposes. The total cost of the waterworks will be $25,000,000, and the installation of the power plant will cost approximately $5,000,000 more.

AMERICAN SOCIETY FOR TESTING MATERIALS.

The 18th annual meeting of the American Society for Testing Materials is to be held in Atlantic City, N.J., June 22-26. A provisional programme has come to hand covering ten sessions devoted to reports of committees and papers. Each of the following topics has an entire session devoted to it: Non-ferrous metals; steel; heat treatment of steel; testing apparatus; cement and concrete; ceramics, gypsum and lime; preservative coatings and lubricants; road materials, timber and rubber.

Attention is called to proposed amendments of the by-laws, which, if adopted, will result in:

1. The reduction of the age limit for junior members from 30 to 25 years;

2. The requirement of initiation fees of $10 for members and $5 for junior members, the latter being subject to a supplementary fee of $5 on their transfer to the grade of member;

3. The use of the inclusive term "Standards" for (*a*) Standard Specifications, (*b*) Standard Methods, (*c*) Standard Tests, and (*d*) Standard Definitions;

4. The requirement that in general proposed new standards or proposed amendments of existing standards shall be published in the year-book for one year as "Tentative Standards" on which written discussions addressed to the appropriate committee shall be invited.

VANCOUVER IN MARKET FOR POWER SITES.

The city council of Vancouver, B.C., is investigating for itself the water power possibilities of several sites in the vicinity with a view of establishing a municipal light and power plant. One of these sites is located on the Cheakamus River, sixteen miles north of Squamish, the second on the Indian River at the head of the North Arm of Burrard Inlet, and the third on the Bridge River, ten miles west of Lillooet.

The B. C. Power & Electrical Company hold the rights on the Cheakamus River, Howe Sound, capable, it has been estimated, of producing 100,000 horse-power. The minimum cost of generating and transmitting to Vancouver is estimated at $52 per horse-power and the maximum $80 per horse-power, depending on the form of construction. The property is 16 miles above Newport and the intake about a mile from the railway, which should help to reduce construction costs.

It is claimed that power can be generated for three-tenths of a cent per kilowatt-hour. The maximum cost of the construction of the plant is estimated at about $3,900,000.

The one on Indian River, near the head of the North Arm of Burrard Inlet, is 25 miles from the city and is capable of developing at a single power house 40,000 horse-power of continuous electrical energy. It is claimed that this could be easily increased to 50,000 horse-power by short pipe lines to develop a smaller site not at present included in the plans. The static head of the larger portion of the power is 2,200 ft. Additional power may be developed by building a second power house four miles further up the river. This development could be made at a cost of $60 per horse-power at the power house switch-board, or $80 per horse-power at the receiving station in the vicinity of Vancouver.

The other power site is approximately 150 miles from Vancouver at Seaton Lake, ten miles this side of Lillooet, on the Pacific Great Eastern Railway. There 200,000 horse-power may be developed, and by additional storage this amount could be increased to 400,000 horse-power. The cost at the power house switch-board is estimated at $35 per horse-power and $65 per horse-power in Vancouver.

At the request of the council, the supervising city engineer, Mr. F. L. Fellowes, is also preparing a report on the power possibilities of Seymour and Capilano Creeks.

COAST TO COAST

St. John, N.B.—The new plant of the Atlantic Sugar Refinery has just been completed. It is a concrete and steel structure with a daily capacity of 1,000,000 pounds.

Prescott, Ont.—It is stated that arrangements are now being made for the construction of the Ottawa-Prescott highway, the estimated cost of which is about $600,000.

Vancouver, B.C.—The city council has notified the Great Northern Railway to proceed at once with the preparation of plans and the construction of its proposed terminal buildings.

Ottawa, Ont.—A large labor deputation from the New Welland Ship Canal, representing boiler makers, electricians, bricklayers, carpenters, machinists, dredgers and hoist-men, waited on the Minister of Railways and Canals with a request for shorter hours.

Vancouver, B.C.—Construction work will begin early this month on the new government elevator, for which Messrs. Barnett, McQueen & Co. were the successful contractors. Plant and equipment are being assembled and installed.

Ottawa, Ont.—Mr. John B. McRae, consulting engineer, has submitted plans for the Lemieux Island overland pipe project for supplying the city with water for fire protection. These plans call for high-lift pumps affording a pressure of 120 pounds.

Moose Jaw, Sask.—While excavating for the new intersecting sewer in Oxford Street, a flow of water amounting to about 200,000 gallons per day was struck. Mr. George D. Mackie, city engineer-commissioner, states that the supply is unfit, however, for domestic consumption.

Vancouver, B.C.—The city is investigating the advisability of installing its own light and power plant. Propositions for power sites on Indian River, Cheakamus River, and Seaton Lake, have been presented. Water power rights on Capilano and Seymour creeks are also being investigated.

Toronto, Ont.—The York County Highway Board will spend about $120,000 this year on about 30 miles of roadway. Since undertaking the work in 1911 about 70 miles of road have been improved, the cost being about $480,000. If 30 miles are reconstructed this year there will be a remainder of 15 miles still to improve before the county highway project of 1911 has been completed.

Cobalt, Ont.—The emptying of Cobalt Lake into Lake Timiskaming, to make possible the recovery of rich silver ore in the upper workings of the Cobalt Lake mine underneath, is a proposition that has invoked considerable interest. Dewatering will begin in the course of a few days, the electrically operated machinery and pumps having been recently installed. It is expected that the work will accupy the greater part of the summer.

Winchester, Ont.—A very enthusiastic mass meeting in the interests of the proposed radial line between Ottawa and Morrisburg was held at Winchester on April 22nd.

Calgary, Alta.—There are indications of considerable railway activity in the province. In addition to the work on the Alberta and Great Waterways Railway, on the Canadian Central Railway and also on the Edmonton, Dunvegan and British Columbia Railway, recently mentioned in these columns, the Bassano and Bow River Railway will soon be under construction, according to a recent announcement. It will give employment to upwards of a thousand men during the summer. Other local lines are projected.

Toronto, Ont.—A series of civic incinerators are now being built to replace the old one on Strachan Avenue. Contracts for the erection of two new plants, one alongside the Don River and the other on Toronto Island, have recently been let. Dr. J. W. S. McCullough, provincial health officer, was in Buffalo last week looking over the garbage disposal system there. Although that city saves $55,000 a year by separating marketable debris by hand from its rubbish, Dr. McCullough does not approve of the method, owing to the unsanitary and unhealthy conditions surrounding those engaged in the work.

Cobalt, Ont.—A new cyanide mill, with a daily capacity of treating 170 tons of slimes, was put into operation last week. It has been erected as an addition to the Cobalt reduction concentrator and will treat the slimes from the stamp mill as well as those from Cobalt Lake mill, the latter being pumped across the lake and railway tracks through a five-inch pipe. From now on the company will ship bullion instead of concentrates. A refinery is now being constructed.

Victoria, B.C.—The progress made by the Pacific Lock Joint Pipe Co. on the concrete flow line of the Sooke Lake water system is reported as follows: The company, during March, manufactured about 500 feet of pipe per day, and at the end of the month had only 700 more feet to manufacture. During the month 13,469 feet of pipe were laid, taking the contractors to a point one and a half miles north of Cooper's Cove. About the middle of March another gang was started laying at the lower end, and it laid 3,367 feet, but the work had to be discontinued as there was not a sufficient stock of matured pipe available. The total length of pipe laid in March was, therefore, 16,836 feet, leaving 18,600 feet, or 3½ miles to be laid.

Merrickville, Ont.—The Rideau Power Co. is constructing a plant to supply surrounding factories. The design calls for two units of 562 k.v.a. each, one of which is now being installed. The water wheel will develop 650 h.p. under a head of 26 ft., and the generator is designed for normal operation at a load of 562 k.v.a., 600-volt, 3-phase, 60-cycle, 240 r.p.m. This generator is supplied with direct connected exciter. The equipment also includes four-panel marble switchboard. It is expected that the plant will be in operation in a few weeks. The William Hamilton Co., of Peterborough, Ont., and the Swedish General Electric Co. supplied the hydraulic and electric equipment respectively with the exception of the water-wheel governor, which was supplied by the Lombard Governor Co.

COMMISSION ON WAR MUNITIONS.

An independent commission to take over the purchasing of war materials for the Canadian troops and to assist in the purchases for Great Britain in the Dominion, has been appointed, consisting of Hon. A. E. Kemp and Messrs. H. Laporte and G. F. Galt.

PERSONAL

E. R. GRAY, B.A.Sc., of the engineering staff of the city of Toronto, has been appointed assistant city engineer of Hamilton.

GEORGE D. ARCHIBALD, city engineer of Saskatoon, has been appointed superintendent of the street railway in addition to his former duties.

W. H. WINTERROWD has been appointed assistant to the chief mechanical engineer of the Canadian Pacific Railway, with office in Montreal.

JOSEPH RACE, city bacteriologist of Ottawa, addressed a meeting in Montreal of the Society of Chemical Industry last week, his subject being "Chlorination of Water."

J. A. SHAW has been appointed electrical engineer of the Canadian Pacific Railway. Mr. Shaw joined the service in 1904 as assistant electrical engineer of motive power at the Angus shops, and in 1908 was made electrical engineer of eastern lines.

PROMOTIONS ON CANADIAN GOVERNMENT RAILWAYS.

The following promotions in the engineering department of the Canadian Government Railways took effect on May 1st:—

W. R. Devenish is appointed principal assistant engineer of the Canadian Government Railways, with office at Moncton, N.B.

A. R. Macgowan is appointed division engineer of the Intercolonial and Prince Edward Island Railways with office at Moncton, N.B., vice Mr. W. R. Devenish.

W. A. Cowan is appointed assistant division engineer of the Intercolonial and Prince Edward Island Railways, with office at Moncton, N.B., vice Mr. A. R. Macgowan.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

NATIONAL CONFERENCE ON CITY PLANNING.—June 7-9. This year's Conference to be held in Detroit, Mich. Secretary, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Annual meeting to be held in Atlantic City, N.J., June 22nd to 26th. Secretary, Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Charles Warren Hunt, 220 West 57th Street, New York.

INTERNATIONAL ENGINEERING CONGRESS.—To be held in San Francisco, Cal., September 20th to 25th, 1915. Secretary, W. A. Catell, Foxcroft Building, San Francisco, Cal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—Annual convention to be held in San Francisco, Cal., October 4th to 8th, 1915. Secretary, E. B. Burritt, 29 West 39th Street, New York.