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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

TORONTO HARBOR IMPROVEMENT PROJECT

BRIEF REVIEW OF THE ENTIRE UNDERTAKING, OF THE WORK THAT HAS BEEN ALREADY ACCOMPLISHED, AND OF THAT WHICH IS UNDER WAY THIS SEASON.

THE development of the waterfront and harbor at Toronto involves an expenditure of about $25,000,000. In the details of the original plan, as described in *The Canadian Engineer* for November 21st, 1912, the estimated expenditure was given as $19,142,088. More new docks are contemplated, however, that will increase the expenditure by five or six millions.

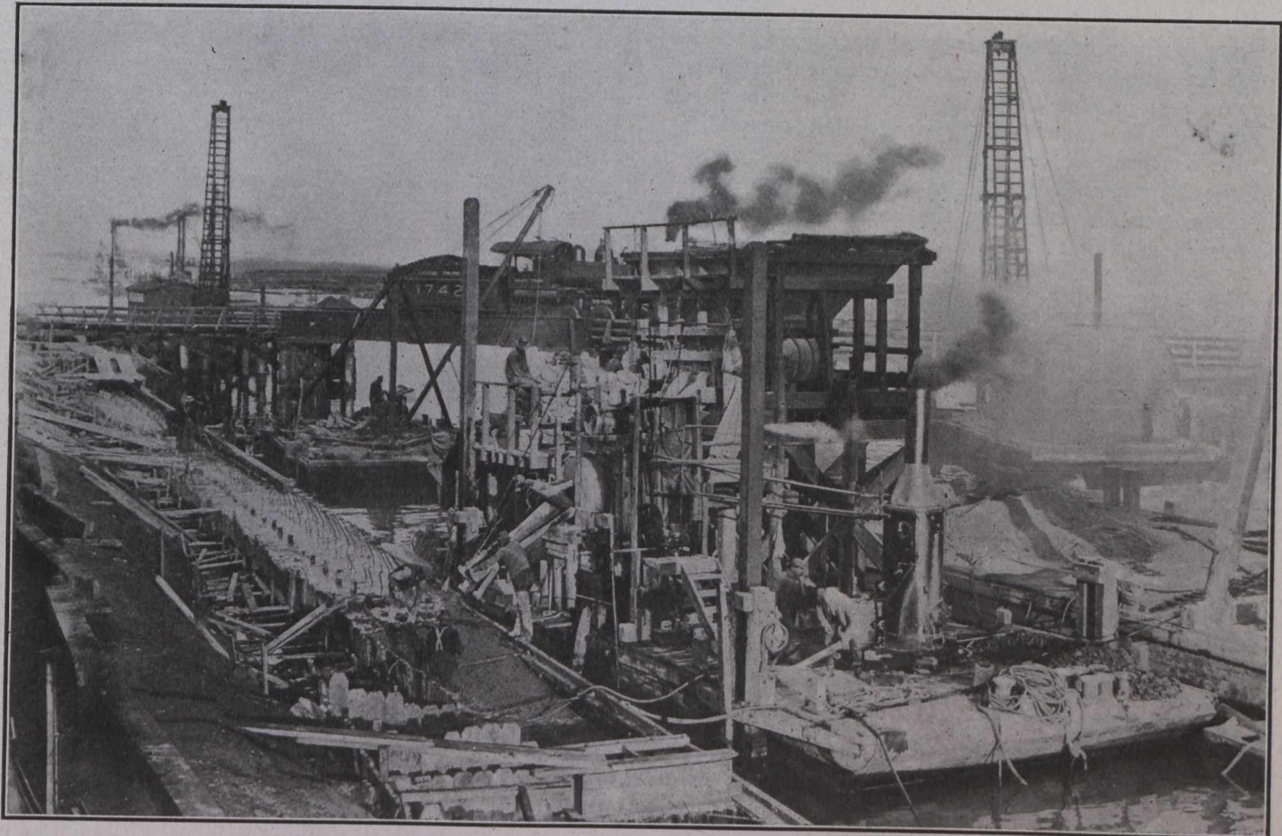


Fig. 1.—Concrete Handling Plant at Work on Don Diversion Channel Walls, Toronto Harbor Commission.

In our issue of October 1st, 1914, a review appeared of the progress made in 1913 and of the operations that were under way at the time of writing. To better comprehend the extent of the work that is in hand this season, and its relation to the completed scheme, the following brief summary of the entire undertaking will be found of value. Following it an outline will be given of the operations under way or contemplated for this year.

One feature of the development, which is the most comprehensive to be found in North America, is the creation of an industrial district in the eastern portion of the harbor. When completed, an area of 646 acres will be afforded for factory sites; about 235 acres will be occupied by railway tracks and streets, while the district will be served by interior waterways covering about 130 acres.

Another important feature is the provision of a new and complete set of docks to replace those existing along the water front, already inadequate for the city's commerce and destined to be much more so upon the completion of the new Welland Ship Canal. This feature, like the preceding one, involves considerable reclamation work and dredging.

These two schemes, of great industrial and commercial import, are accompanied by a third by which the city will be enriched to the extent of over 540 acres of park land, including boulevards, protected waterways for aquatic sports and sites for summer residences. This feature extends from the Humber River on the west along the main land to the the western channel, thence by way of Toronto Island to the eastern channel and east to Victoria Park, a distance of about 14 miles.

The expenditure involved in this development is being borne jointly by the Dominion Government, the City of Toronto and the Toronto Harbor Commission. Preliminary plans were completed in 1912, and after approval by the Toronto city council and Federal Government in June, 1913, preparations at once began for the early commencement of work. The undertaking was divided into three sections, the western section comprising a length extending from the Humber River to the vicinity of Bathurst Street and the western channel; the central section, including the water front of the inner harbor and the bay shore of the Island to a line joining the eastern channel and Parliament Street; and the eastern section comprising that portion from the eastern channel to Victoria Park.

In the western section the work is almost entirely that of shore protection, and park reclamation. It includes the construction of a breakwater at a distance varying from 500 to 900 ft. from the present shore line, a retaining wall about 900 ft. long near the mouth of the Humber, and the reclamation behind the breakwater of about 190 acres of new land. The sheltered waterway, which will extend all the way from the Humber to Victoria Park, has a width of about 500 ft., on the average, in this western section.

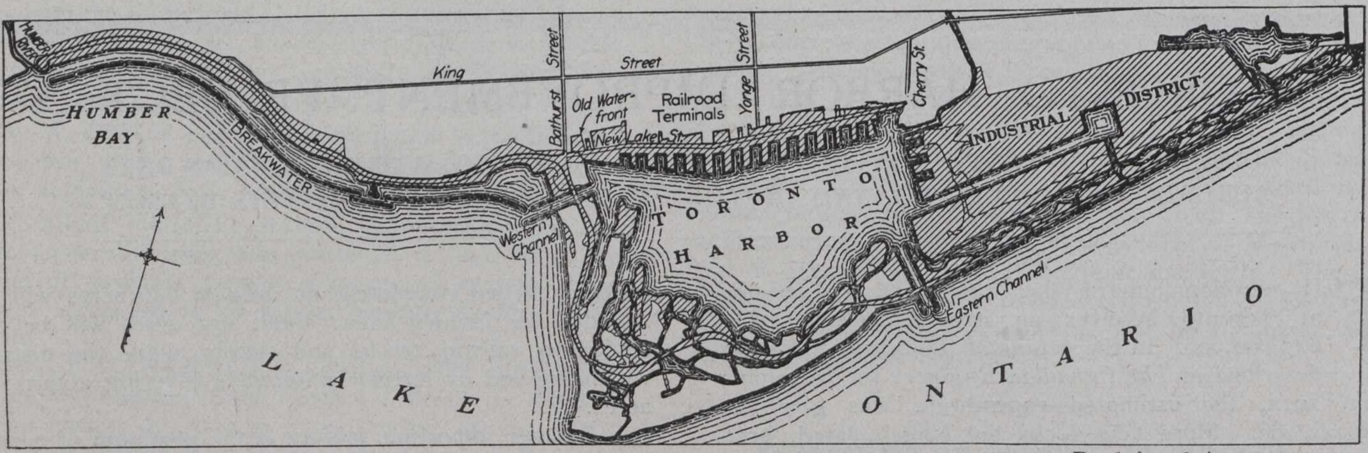


Fig. 2.—General Plan of Improvements Under Way. Hatched Portion Indicates Reclaimed Areas.

The central portion includes the reclamation of 352 acres of park land around Toronto Island, the development of a number of lagoons, etc., and a system of boulevards winding their way through and forming a connecting link with those of the eastern and western sections. The central section includes also the dock development and the reclamation of a 17-acre industrial site near the present western harbor entrance.

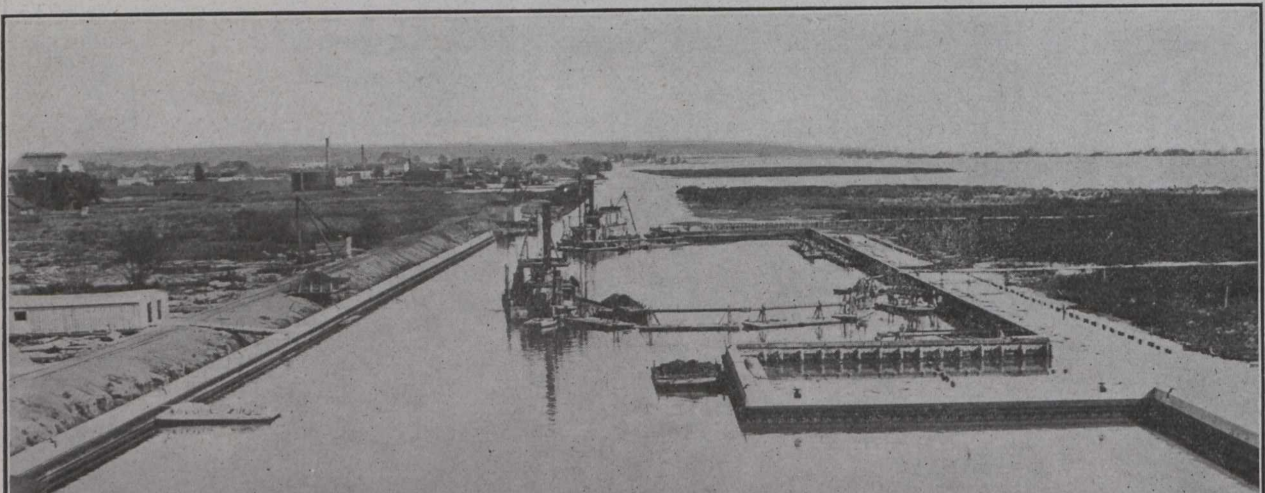
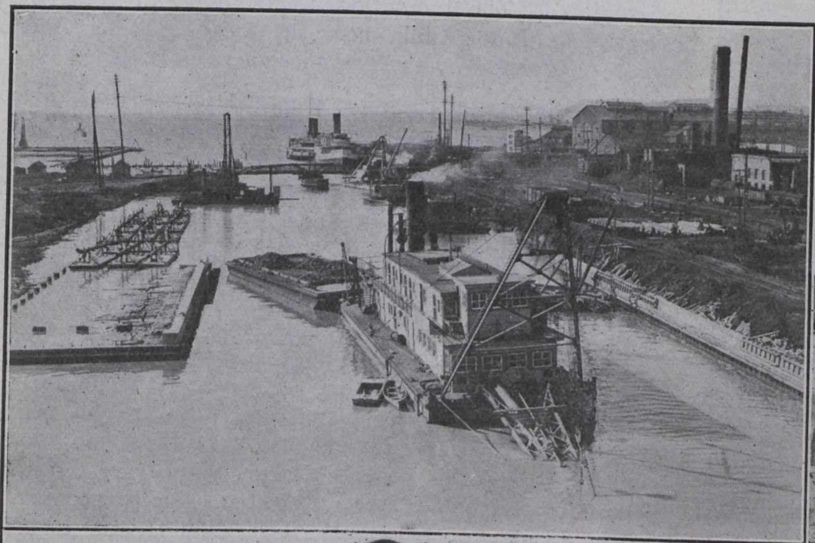
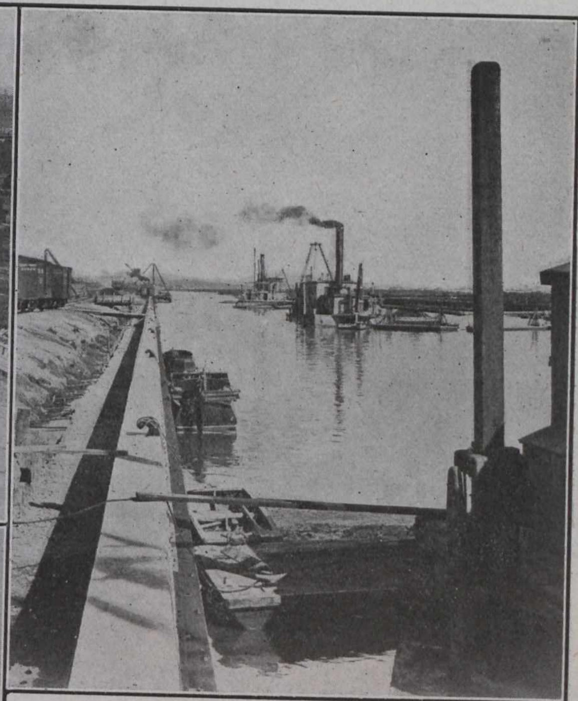


Fig. 3.—General View, Looking East, of Retaining Wall of Don Diversion Channel.

The eastern section includes the construction of a sea-wall from the eastern channel to the eastern city limits, about 700 ft. beyond the sand-bar at present existing there. This sea-wall will be 4⅓ miles in length and the area between it and shore will be, for the most part, the industrial district mentioned above, filled in to an elevation of 8 ft. above mean water level. There will also be an extensive parkage between the sea-wall and the industrial site. A 66-ft. street will be bordered by sites for summer cottages, to the south of which will extend a boulevard and driveway 50 ft. in width.

The industrial area in this section has been arranged with every consideration for the benefit and advantage of the various industries to which it will be leased by the Commission. Railway facilities include connections with the Canadian Pacific, the Grand Trunk and the Canadian Northern transcontinental lines. The ship channel serving the area is 6,800 ft. in length and 400 ft. wide, with a turning basin 1,000 ft. square at the ends. Three and a half miles of dockage accommodation is provided in and around this channel. The area, as well as that at





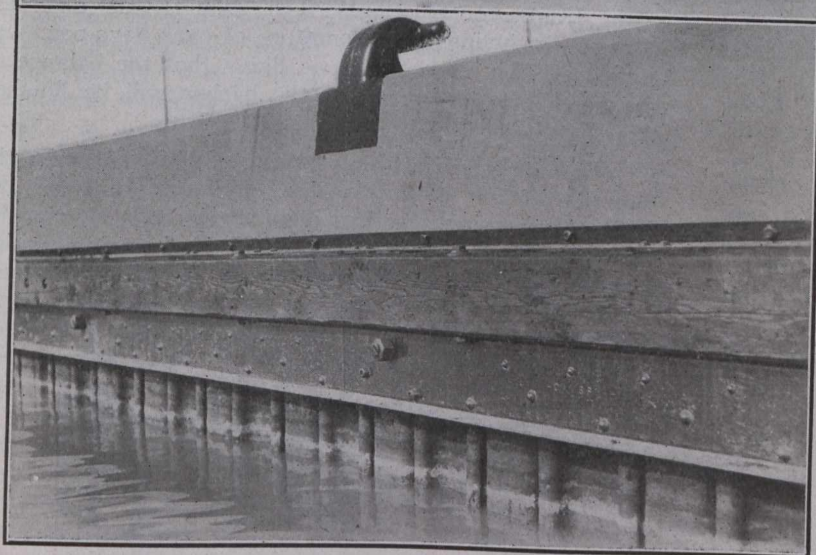


Fig. 4.—(Top Left) Don Diversion Work, Viewed from G.T.R. Trestle. (Right) Completed North Wall of Don Diversion. (Below) Detail of Completed Wall.

the foot of Bathurst Street, which will have nearly two miles of dockage, will be supplied with warehouses, freight sheds and adequate dock equipment.

In September, 1913, the commissioners awarded a contract to the Canadian Stewart Co. for the removal of about 31,000,000 cu. yds. of material which the borings indicated to be 70 per cent. sand and gravel and 30 per cent. sand, silt and clay. This material was to be taken from the bed of the bay and of the lake adjacent to the industrial area and deposited on the site of the latter. The contract, which was at 19½ cents a cubic yard, will amount to approximately $6,000,000. It is of interest to note that the average length of delivery in this work is about 4,000 ft., that the material is being placed hydraulically, and that the two largest suction dredges in existence will be in operation in connection with it in a short time. One of them, "The Cyclone," has been operating since last fall, and is capable of depositing over 1,000 cubic yards an hour. It is a 24-inch suction dredge built by the Polson Iron Works, Toronto, who are just completing a sister dredge, "The Tornado," similar in every respect. Other dredges are operating under the same contract.

In September, 1913, the Department of Public Works, Ottawa, also awarded a contract to the Canadian Stewart Company for the portion of the work undertaken by the Government. This includes the ship channel and turning basin in the industrial area, the eastern sea-wall, 4⅓ miles long, the marginal way or bulkhead construction between the ship channel and the city side of the harbor, and the western breakwater 4 miles in length. This contract, totalling $5,400,000, and requiring several years to complete, is one of exceptional magnitude, as will be realized from the following tables of the chief quantities involved:—

Eastern breakwater: Piles, 663,500 lin. ft.; hemlock lumber, 522,460 ft.; southern pine or B.C. fir, 8,594,136 ft.; concrete blocks, 28,912 cu. yds.; mass concrete, 5,763 cu. yds.; structural steel shapes, 3,645,850 lbs.; and stone talus, 33,000 tons.

Western breakwater: Piles, 83,328 lin. ft.; cribwork, 162,000 cu. yds.; concrete blocks, 22,363 cu. yds.; mass concrete, 17,203 cu. yds.; reinforcing steel, 1,626,443 lbs.; structural steel, 1,865,570 lbs.; rock fill, 23,000 cu. yds.; and dredging, 48,515 cu. yds.

Ship Channel: Piles, 1,290,534 lin. ft.; hemlock lumber, 691,260 ft.; southern pine or B.C. fir, 7,794,348 ft.; concrete blocks, 17,897 cu. yds.; mass concrete, 25,705 cu. yds.; structural steel, 3,755,220 lbs.; white oak or B.C. fir, 215,365 ft.; and dredging, 3,078,000 cu. yds.

Marginal way: Piles, 228,412 lin. ft.; hemlock timber, 490,300 ft.; southern pine or B.C. fir, 3,127,000 ft.; concrete blocks, 4,400 cu. yds.; mass concrete, 3,082 cu. yds.; reinforced steel, 372,667 lbs.; structural steel, 439,947 lbs.; white oak or B.C. fir waling, 84,654 ft.; and dredging, 48,515 cu. yds.

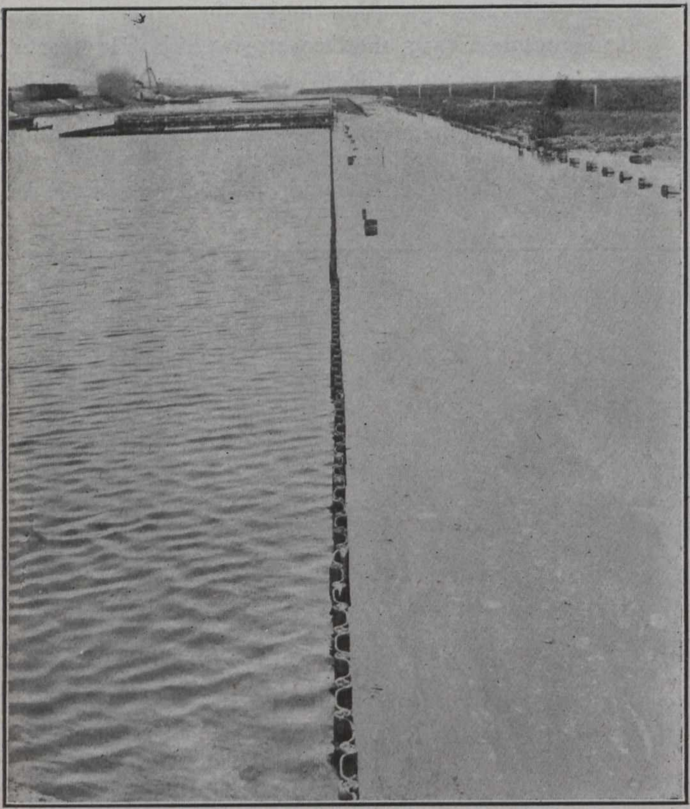


Fig. 5.—Sheet Piling on South Side, Don River Diversion.

Operations were commenced early last year and an expenditure of about $1,500,000 was made before the close of the season. This year's expenditure will probably exceed that amount, as the contracts outlined above will be in full swing in addition to other contemplated work. In the western section over 3,000 ft. of crib work has been placed and filled eastward from the Humber, and about 1,000 ft. opposite Stanley Barracks and running westward from a point about 200 ft. from the western channel entrance to the bay. This crib work will be continued this year, and a portion of the concrete superstructure will likely be placed. The crib work is of pile construction and the topping will consist of concrete blocks. About a million yards of reclamation work will also be done this year, and the construction of a retaining wall about 900 ft. long near the mouth of the Humber is also contemplated. The foundations for the new club house of the Parkdale Canoe Club, near the foot of Triller Avenue, were completed by the commissioners in 1914.

In the eastern section the reclamation work in connection with the industrial area commenced last year is rapidly proceeding, and this season's operations there will probably aggregate over 3,000,000 cu. yds. of fill. A commencement will likely be made on the construction of a bascule lift bridge, 88 ft. wide and 120 ft. span across Keating's Cut at the foot of Cherry Street, at an estimated cost of $105,000. Dock work on the marginal way and ship channel is also proceeding, about 1,000 ft. of wall having been completed. This is also of pile construction, but with mass concrete top. About 4,000 ft. of the substructure has been completed and topping will be proceeded with. It is estimated that 9,000 ft. of substructure will be placed this year. A large quantity of fill is now being placed behind the completed wall to provide for early track construction. The Don River diversion channel, involving an expenditure of over $170,000, was completed last year, and it is likely that the balance of the north slip extending to the harbor will be finished this season.

The engineering work is being carried out under the direction of Mr. E. L. Cousins, chief engineer, and Mr. J. R. Wainwright, acting chief engineer. Mr. L. H. Clarke is chairman of the Toronto Harbor Commission and Mr. A. C. Lewis its secretary.

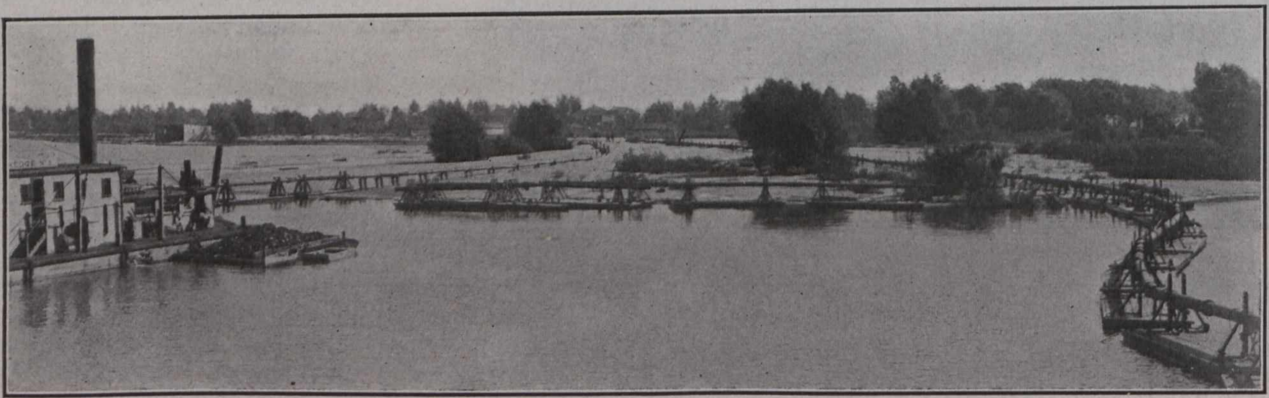


Fig. 6.—Reclamation Work at Centre Island, Toronto.

In the Crow's Nest Pass, British Columbia, the Corbin Coal and Coke Company are operating a seam of coal 125 feet thick.

According to the final statement of the Hamilton Board of Works concerning the construction of roads, sewers, and walks, under the local improvement plan, in 1914, the expenditure was as follows: Roadways, $243,353.95; walks, $145,363.65; sewers, $41,594.36.

The coal production in Prussia in 1914 was 152,957,673 tons, as compared with 179,861,015 tons in 1913.

In the Bostonnais River bridge of the Transcontinental Railway the deck plate girders are supported on comparatively low concrete piers, and the spans are tilted out of a horizontal plane so that the girder webs are slightly inclined to the vertical and provide without shimming for the superelevation of the outer rail on a curve.

COUNTRY ROAD CONSTRUCTION AND MAINTENANCE.

In our issues of April 29th and May 13th, 1915, the subject of earth roads was effectively dealt with in the matter of drainage and general care, in extracts from sets of instructions prepared by Hiram Donkin, C.E., road commissioner and provincial engineer for Nova Scotia.

The following notes from the same source deal also with earth road construction and maintenance. The suggestions are simple and in the main inexpensive. They are based entirely on a thorough system of drainage, and if applied with common sense and judgment, according to the particular needs of each locality, better roads are sure to follow.

The wearing surface of a road must be, in effect, a roof; that is, the section in the middle must be the highest part, and the travelled roadway should be made, by consolidation, as impervious to water as possible, so that the rainfall or melting snow will flow freely and quickly into the gutters alongside. Probably the best shape for the cross-section of the earth road is an arc of a circle with a gradual fall from the centre to bottom of ditch of about 1 to 6, after the surface has been thoroughly rolled or compacted by traffic. Such a surface can be constructed and repaired with the road machine, and a roller can be used upon it to good advantage. If the crown is too great, the traffic will follow the middle of the road, and this will result in making ruts and ridges which retard the prompt shedding of the water into the side ditches. Too much crown is as detrimental as too little.

Where new roads are to be built, all stumps, roots, vegetable matter, rocks, etc., should be removed from the surface, and the holes should be filled in with suitable material carefully and thoroughly tamped. In forming a permanent embankment no perishable material should be used. If unsuitable material is discovered in the sub-grade it should be removed and replaced with good material, which should be tamped or rolled until smooth and compact. The longitudinal grade should be kept down to 3 or 4 per cent., if possible, and should under no circumstances, except in mountainous regions, exceed 5 per cent. After the road-bed has been brought to the required grade and crown, a roller should be used in consolidating the material. All ruts or depressions discovered during the rolling should be levelled off and re-rolled.

The width of the travelled way will depend upon the requirements of traffic. Sometimes 12 feet will suffice, but this can only be permitted where the soil is hard and very small ditches are required. The usual widths for the various classes of country traffic are 13, 18 and 24 feet. The right-of-way should be much wider than the travelled way, in order to provide for widening when traffic requires it.

In level countries where the natural drainage is poor, it is very desirable that roads should be elevated above the sub-grade or surrounding ground. For this purpose the required material may be secured by widening the side excavations or from cuttings on the line of the roadway by means of road machines, elevating graders, or modern dumping wagons. When the earth is brought up to the desired level it should be thoroughly mixed by harrowing, then trimmed with a road machine, and finally rolled with a road roller, the weight of which should be gradually increased by ballast, as the rolling progresses. During the rolling the surface should be sprinkled with water if the character of the soil requires such aid for its proper consolidation. The crown of the roadway should be carefully maintained during the rolling by the addition of earth as needed.

Treatment of Clay Roads.—On clay roads a thin layer of sand, gravel, or ashes will prevent the sticking of clay to the roller or to the wheels of vehicles. Clay soils, as a rule, absorb water quite freely and soften when saturated, but water does not pass through them readily. When used alone, clay is the least desirable of all road materials, but roads composed of clay may be treated with sand or small gravel, from which a hard and compact mass is formed, which is nearly impervious to water. Material of this character found in the natural state, commonly known as "hardpan," makes, when properly applied, a very solid and durable road. In soil composed of a mixture of sand, gravel, and clay, all that is necessary to make a fairly good road is to crown the surface, keep the ruts and holes filled, and the ditches open and free, with a good drag.

Importance of Rolling.—Earth is composed of small, irregular fragments which touch each other at points, leaving voids between. When the earth is broken up and pulverized these voids are almost equal in volume to the solid particles, and as a result the earth will absorb almost an equal volume of water. In the rebuilding or maintaining of earth roads it is, therefore, very desirable that these small, irregular particles be pressed and packed into as small a space as possible, in order that surplus water may not pass in and destroy the stability of the road. To this end rolling is very beneficial. The work of maintaining dirt roads will be much increased by lack of care in properly rolling the surface.

After the material has been placed on the surface, it should not be left for traffic to consolidate or for rains to wash off into the ditches, but should be carefully surfaced and then rolled. If loose earth is left in the middle of a road the narrow-tire wheels will cut in and knead it into uneven ridges and ruts, which hold water, and this ultimately results, if in the winter season, in a sticky, muddy surface, and in dry weather in covering the surface with dust. If, however, the surface be crowned with a road drag and properly rolled with a heavy roller it can be made sufficiently firm and smooth to sustain the traffic without deep rutting and to resist in a large measure the penetrating action of the water. Such work should be done while the soil is in a plastic state, when it will pack. The rolling not only consolidates the small particles of earth and leaves less space for water, but puts the road in proper shape for travel immediately. If there is anything more trying on man or beast than travelling over an unimproved road, it must be travelling over one which has just been worked by the slipshod methods followed in many places.

Filling Holes and Ruts.—With earth roads there is a pronounced tendency to rut, and when ruts begin to appear on the surface great care should be used in selecting new materials with which they should be immediately filled. Every hole or rut in the roadway, if not tamped full of some good material, like that of which the road is constructed, will become filled with water, and will be made deeper and wider by each passing wagon. A hole which could have been filled with a shovelful of material will soon need a cartful. The rut or hole to be repaired should be cleared of dust, mud, or water, and just sufficient good fresh earth placed in it to be even with the surrounding surface, after having been thoroughly consolidated with a pounder. Sod should not be placed on the surface, neither should the surface be ruined by throwing upon it the worn-out material from the gutters alongside. Ruts and holes should not be filled with stone nor gravel unless a considerable section is to be so treated; for if such material is to be dumped into the holes or ruts, it does not wear uniformly with the rest of the road, but produces lumps and ridges and in many cases results in making two holes for every one repaired. As it is impracticable to make a desirable road from a mixture of clay and boulders if the larger quantity of the material is clay, boulders should be taken out at least 18 inches below the surface of the finished roadway. If the larger quantity is boulders, then it might be advisable to fill in the spaces between the boulders with rock, on the Telford principle. Where ledge rock comes up to the surface, especially in side hills, if there is any surface water the clay cannot be held in place without back drains or channels cut in the rock.

Use of Road Machines in Making Repairs.—Reversible road machines are often used in drawing the material out of ditches to the centre of the roadway, which is left there to be washed again into the ditches by the first heavy rain. A far more satisfactory method, when the roadway is sufficiently high, and where a heavy roller cannot be had, is to trim the shoulders and ridges off and smooth the surface with the machine. This work should begin in the centre of the road, and the loose dirt should be gradually pushed to the ditches and finally shoved off the roadway or deposited where it will not be washed back into the ditches by rain. Where this method is followed, a smooth, firm surface is immediately secured, and such a surface will resist the action of rain, frost, and narrow tires much longer than one composed of loose and worn-out material thrown up from the ditches.

In making extensive repairs, ploughs or scoops should never be used, for such implements break up the compact surface which age and traffic have made tolerable. Earth roads can be rapidly repaired by a judicious use of road machines and road rollers. The road machine places the material where it is most needed, and the roller compacts and keeps it there. These two labor-saving machines are just as effectual and necessary in modern road work as the mower, self-binder, and thresher are in modern farm work. Road machines and rollers are the modern inventions necessary to satisfactory and economical earth-road construction and repair. Two good men, with four teams, can build or repair more road in one day with a road machine and roller than many times that number can with picks, shovels, scoops, and ploughs and do it more uniformly and more thoroughly.

While the earth road, under favorable traffic and climate conditions, can be made excellent and satisfactory in every way, yet it must be borne in mind that the earth road is essentially a light traffic road. When the traffic of a road increases beyond a certain point it becomes necessary to supply new material to take the place of a large amount worn by traffic and carried off by the wind and rain, or the way will soon wear down to such an extent that drainage will become a very difficult problem. As the traffic of most roads increases slowly, the adjacent earth can first be used for repairs, then gravel or crushed stone. These, however, are problems to be solved by those familiar with the local conditions, and should be regulated by the requirements of traffic, the availability of material, and the cost of necessary repairs. The large majority of roads for some time to come will require only earth for their construction, and for this reason it is essential to the prosperity of each community that the earth road be properly cared for.

USE OF EXPLOSIVES IN OPEN EXCAVATION WORK.

BULLETIN 80 of the U.S. Bureau of Mines, prepared by C. E. Munroe and C. Hall, contains some very instructive information on the methods of using explosives, when necessary, in excavation work. The following abstract contains the chief points of special interest to the engineering-contractor:

Kind of Explosive to Use.—Practically every kind, class, and grade of explosive is used in open work blasting. In such work the efficiency of the explosive is the most important factor, its liability to evolve poisonous gases being of secondary importance, and its liability to ignite gas or dust needing rarely to be considered. Explosives used in blasting are frequently bought solely on descriptions which give little or no information concerning their nature, properties, or characteristic components. This oversight accounts largely for the use of explosives of a kind or in a quantity not suited to a given piece of work. Energy and money have often been wasted in blasting operations because of the use in them of expensive, high-grade explosives when cheaper, low-grade explosives would have been more effective and more economical, provided that they had been used in the proper location, had been sufficiently stemmed and tamped, and had been fired by sufficiently strong detonators.

As a guide in making a proper selection of explosives for use in excavation work the following general recommendations are given:

If the texture of the material to be excavated is very tough and hard, as in tough granite or hard boulders, 60 per cent. "straight" nitroglycerin dynamite is recommended for use. If the material is of moderate toughness and somewhat brittle, 50 per cent. "straight" nitroglycerin dynamite is recommended. For hard earth or compact sand a 30 to 20 per cent. "straight" nitroglycerin dynamite is recommended. In material such as a soft crumbly, or seamy rock that requires a stronger explosive than black blasting powder, but a slower explosive than dynamite, a granulated nitroglycerin powder containing 5 per cent. of nitroglycerin is recommended.

For very soft material in cuts and fills or for quarry work when dimension stone is sought, black blasting powder is recommended. In grading work the blast hole may be chambered with dynamite before being charged with granulated nitroglycerin powder or with black blasting powder, but before it is charged care should be taken to make sure that the dynamite charge has not left any fire in the hole. In "plastering" or "adobe" work on boulders and spawls, or in "block holing," a strong dynamite should be used. "Block holing" is the more effective and economical method for use with boulders.

If the straight nitroglycerin dynamites recommended above are found to be too quick or too violent for use and the results obtained are not such as are desired under the given circumstances, ammonia dynamites, which give more of a heaving and rending action, are recommended. They are made in several grades and are rated as of a certain percentage of strength, but this rating is not always made in a scientific way.

In driving a railroad cut in comparatively soft material, black blasting powder or a low-grade explosive is usually loaded in the drill holes after they have been chambered with dynamite, for on firing the charge the ground is thoroughly loosened, and can then easily be handled by steam shovels. In this work the holes are always drilled below the grade stakes in order that the removal of the dirt by the steam shovels may be expedited. When rock is encountered and the cut is unusually deep the material is sometimes blasted and excavated in two or more benches. A higher grade explosive is used than is used in earth excavations, the row of drill holes driven is placed closer to the face, and these drill holes are put nearer together. The bottom of the drill holes is not chambered to the same extent as when black blasting powder is used, because it is desirable in such work to have the explosive charge extend well up in the drill hole, for the charge then breaks the rock more completely and reduces the number of large fragments that might be produced.

Use of Large Blasts.—In excavation work of magnitude it is sometimes advantageous to drive a small tunnel into the bank and to load this cavity with explosives. Following is a description of a large blast of this character made at a railroad cut in 1911:

The purpose of the blast was to remove a large mass of hard rock consisting of a pegmatitic and biotitic granite that stood in the form of a point or nose about 55 feet high and 100 feet across. On account of the contour of the hill it was impracticable to erect 6-inch well drills on top and follow the usual procedure in quarry blasting, as was desired, and therefore the tunnel method was adopted and carried out in the following way:

A small tunnel, or drift, varying in width from 4 to 5 feet and in height from 6 to 7 feet, was driven into the side of the hill to a distance of 80 feet, and at the upper end of this drift one crosscut was run 65 feet to the right and one crosscut 26 feet to the left. Two additional crosscuts were then driven near the mouth of the main drift, one 15 feet and the other 12 feet. The cross-section of the excavation averaged 35 square feet in the main drift and 24 square feet in the crosscuts. In driving these drifts compressed air drills of 1¼-inch diameter were used to bore the holes, and No. 2, 40 per cent. strength, low freezing dynamite, fired by electricity, was used to bring down the rock. The tunnel as thus made was fairly dry, though there was a little water leaking through the roof in a few places. As the rock in the main drift and in the left-hand crosscuts was much harder than in the 65-foot right-hand crosscut, it was decided to use a granulated powder containing 5 per cent. of nitroglycerin in the 65-foot right-hand crosscut and to use a 60 per cent. nitroglycerin dynamite in all other places.

The dynamite was taken out of its boxes and the cartridges loaded into place without removal of their paper wrappers. The granulated nitroglycerin powder was loaded into place in the original 12½-pound paper bags in which it was received. Ten No. 8 electric detonators, each containing 2-gram charges of 90 per cent. mercury fulminate and 10 per cent. potassium chlorate, but having different lengths of No. 20 wires according to location, were used for firing the blast. All connections were made on the outside of the tunnel.

The following table shows the quantity and the cost of the explosives and detonators used:

12,000 pounds of 60 per cent. strength low-freezing dynamite, at 12½ cents per pound	$1,500.00
20,250 pounds of 5 per cent. granulated nitroglycerin powder, at 7 cents per pound	1,487.50
Total	$2,987.50

1	140-ft. No. 8 electric detonator	$ 0.69
1	120-ft. No. 8 electric detonator	.59
3	100-ft. No. 8 electric detonators	1.46
2	80-ft. No. 8 electric detonators	.78
1	60-ft. No. 8 electric detonator	.31
3	45-ft. No. 8 electric detonators	.64
		$ 4.47
	Discount of 25 per cent. and 5 per cent.	1.29
	Net cost	$ 3.18

The legs of the detonators were long enough to extend beyond the bore holes and all wires passed out through a 2-inch iron pipe, 20 feet long, that was embedded in the concrete plug used in stopping the tunnel. An effort was made to reduce the air spacing in all drifts to a minimum by filling with sand and broken rock all spaces not occupied by the explosives. Two weeks was required in loading and tamping the explosives and in building the solid concrete plug in the entrance of the main drift, the leading wires from the detonators being brought through the iron pipe enclosed in the plug. Before the shot was fired the resistance of each of the detonators was measured, and after they had been connected in series the galvanometer showed a total resistance of 32 ohms. Four hundred feet of No. 14 leading wire was then connected to the leading wires at the portal and the resistance of the entire circuit was found to be 36 ohms. A No. 4, 50-hole, push-down firing machine was then tested by firing one electric detonator which was connected in series with a testing coil with a resistance equal to that in the circuit of the blast, and, having been found efficient, this machine was used in firing the blast.

The shot firer, protected by a concrete arch, was 400 feet away. When the shot was fired earth or air waves were hardly noticeable. Hence the shot was probably well proportioned. The smoke from the blast was rather dense and had a strong odor of hydrogen sulphide. The blast was entirely successful, a complete and rapid detonation having been obtained. Few, if any, large pieces were thrown to a distance of over 400 feet. A few trees were uprooted. An old schoolhouse about 250 feet away was demolished by a falling rock and several thousand yards of boulders and rocks were thrown down below the grade line. The engineer in charge estimated that 19,500 yards of rock had been moved. The blast had taken out more rock in the back than was expected, but there was solid rock left at the end of the 65-foot crosscut in which the granulated 5 per cent. nitroglycerin powder was used.

Explosives for Under-water Work.—The selection of an explosive for submarine work is of especial importance because of the wetting and low temperature to which the explosive is subjected and because the great expense involved in the preparation of each blast makes a failure serious. It has been generally recognized that any explosive does less useful work when used for blasting under water than it does when used for excavating on land. This lessened effect is due to the fact that the temperature of the products of the explosion is reduced by the chilling effect of the surrounding water and that the pressure of the water on the material to be blasted more than counteracts the beneficial efforts of the water as a stemming. The procedure usually followed in submarine excavating is to drill the holes in the underlying rock by means of machinery placed on a drill boat that is moved about as desired by adjustable legs on the boat and mooring lines attached to the shore. The steel drills are guided by long iron pipes, which are usually 4 inches in diameter, and are so lowered from the side of the boat as to rest on the underlying rock. The sediment and drillings that accumulate in the 4-inch pipe during drilling are at intervals removed from it by means of a goose-neck iron pipe 1 inch in diameter. After the holes have been drilled to the required depth they are loaded by lowering charges of dynamite into them through the 4-inch pipe. After the holes have been charged and the primer containing the electric detonator has been placed on top of the charge, the iron pipes are carefully removed and the wires from the detonators are connected in series. The drill boat is then moved away to a safe position and the leading wires are connected to a push-down firing machine. Waterproof electric detonators should be used in work of this kind, so that the detonating composition in them may be protected when submerged under water. In this kind of work, and in all other blasting operations in which electric detonators are to be fired in series, it is important to provide a firing machine of adequate capacity and to operate it in such a manner that it will yield its maximum energy.

The results of tests made by the bureau indicate that "straight" nitroglycerin dynamites are more suitable for submarine blasting than any other type of explosives, provided the paper wrappers on the cartridges are not distorted or broken in loading, and provided also that the charges are not submerged under water for a period longer than one hour. The "straight" nitroglycerin dynamites are also more likely to detonate than are other types of nitroglycerin explosives when the temperature of the water is such as to cause the nitroglycerin to freeze. When the temperature of the water is above the freezing point of nitroglycerin and it is necessary for the charge of explosive to remain under water for several hours, the gelatin dynamites have been found to be more suitable for use than "straight" nitroglycerin dynamite, and under these conditions gelatin dynamite will develop greater energy and do more work than will "straight" nitroglycerin dynamite.

Blasting in Densely Populated Districts.—The common methods of using explosives in quarrying and open work are those in general used in making excavations for cellars, sewers, and trenches in cities and towns, and to some extent for grading. However, in the crowded communities where the blasting is on or adjacent to thoroughfares and near inhabited buildings, especial care must be exercised in so placing a shot, limiting the quantity of explosive used, and confining it that when fired the shock from the shot shall be almost imperceptible, shall do no damage to adjacent structures, and inflict no discomfort on their inhabitants or on passers-by. Moreover, the blast must be so covered that none of the fragments from it and no part of the system can be thrown so as to harm persons or property.

No specific rules as to the quantity and kind of explosives to be used can be given to meet all of the great variety of conditions encountered in practice. For each new project in untried rock or hard-pan a test hole of 2 feet deep containing one-half a stick of 40 per cent. "straight" dynamite, stemmed to the collar, well tamped, and thoroughly covered, may be tried, and from the results the plan of procedure as to the depths of holes, the number of holes in a shot, and the size of charge for each hole may be evolved.

The material used as a cover for the blast naturally differs with the circumstances of the locality. As the cover will be subject to hard usage and liable to destruction, it must be cheap. Usually such waste material as old lumber, timber, railroad ties, and brushwood may be used, the lighter materials presenting the larger surface being placed directly over the blast and weighted with the heavy timber or ties placed upon them. It is to be borne in mind that advantage may be taken of the resistance that the atmosphere offers to the movement of bodies through it by choosing for the units of the covering material those with as large a surface as possible, by weaving these units together so that the cover will move as a whole. and by making the surface of the cover as large as practicable, so that it will press against a large surface of the atmosphere. The covering must be of such material, so woven together, and so placed that none of the pieces thrown off from the rock by the blast shall be thrown through or around it.

SEWAGE DISPOSAL IN CHILLIWACK.

CHILLIWACK, B.C., is situated in the Fraser valley, which is about six miles wide at its broadest point. It is the eastern terminus of the British Columbia Electric Railway interurban line and is 70 miles from Vancouver. The population, which is increasing very rapidly, is 2,500. For some years the need for a sewer system has been felt, as the use of cesspools has become quite a nuisance and a menace to public health in times of heavy rains during the winter months. Early in 1914 the city decided to construct a sewer system and called for plans and bids. The work was entrusted to Messrs. Cleveland and Cameron, consulting engineers of Vancouver, and the contract for the work was let to Robert McLean & Company of Vancouver. Construction began in May and was completed in December.

During high water in the summer the general surface of the city is below high-water level, but a most effective system of diking was constructed some years ago, surrounding the greater part of the city. The general formation in the city consists of seven to nine feet of alluvial deposit overlying quicksand and gravel. Where the alluvium is of sufficient depth, the work of sewer construction is as easy as can be asked; but where the excavation penetrates the sand and gravel the work becomes extremely difficult. The necessity of providing for the draining of basements in the business part of the city made it necessary to lay the sewers here to a depth of over ten feet, a considerable length of which was in the quicksand.

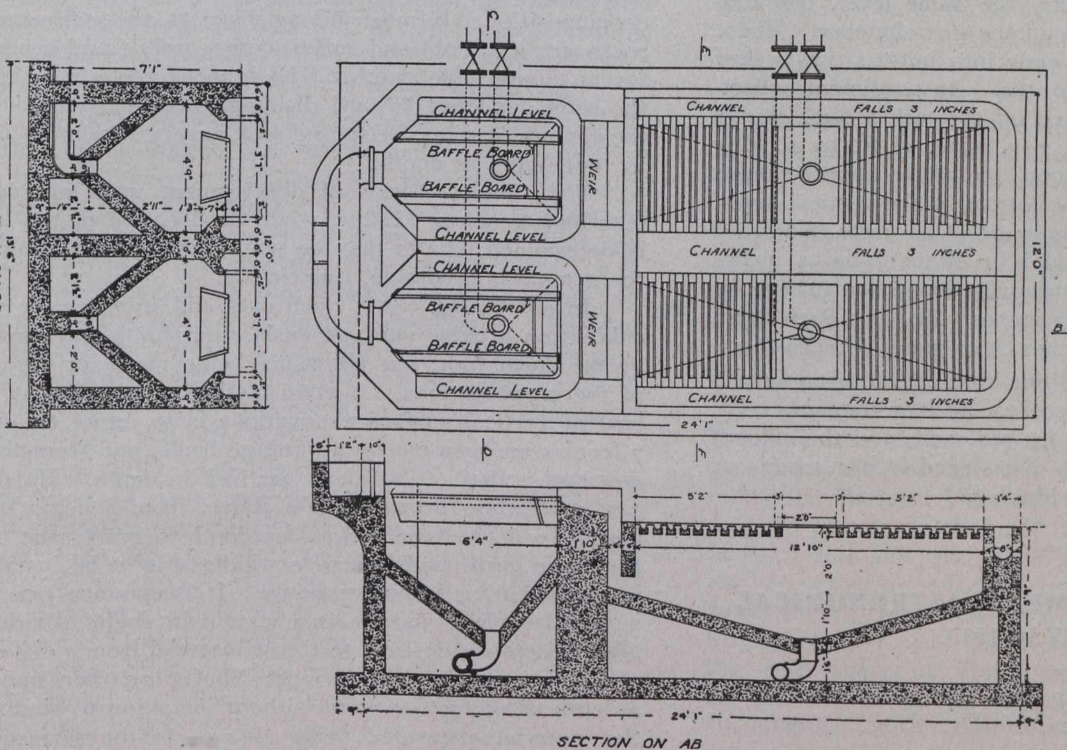
The plan which was carried out consisted of a system of sewers from six to twelve inches in diameter, a pumping chamber at the lowest point in the district, outfall works at sufficient height to allow for flood water in the river and a rising main from the pump well to the outfall. The sewage is treated by what is known as the separator system. The original idea was to use pneumatic ejectors at two or more points within the district, but this was afterward discarded in favor of the single pumping plant as being more economical. The total cost of the works was about $35,000.

The grades of the sewers throughout the city vary from .22 to .45 per cent. Considerable difficulty was encountered in laying the pipes in certain portions of the city, owing to the quicksand in the lower strata, and in some cases sheet piling was driven down to a depth of from 15 ft. to 20 ft.

During the construction of the pump chamber, which is of solid reinforced concrete, with walls one foot thick and a total depth of 21 ft., resting on a natural gravel formation, an excavation had to be made 20 ft. by 25 ft. and 21 ft. deep. Ground water appeared at a depth of three feet, to remove which a centrifugal pump, driven by an 11-h.p. induction motor with a speed of 1,130 r.p.m., and having a capacity of 300 gals. per min., was in continuous operation. Two plunger type pumps driven by 5 h.p. gasoline engines were occasionally used as auxiliaries. During the laying of the concrete foundation, blowholes kept appearing, and this difficulty was overcome by building a half-inch iron pipe into and extending through the foundation and later filling this with cement. Two manholes extending two feet above the surface are provided, one for lowering machinery into the chamber, and the other for the inspection of apparatus. On completion, the chamber was subjected to a 48-hour test for leakage when completely submerged. This was done to satisfy the city officials, who declared it to be quite watertight.

The pumping equipment includes three 3-inch Byron Jackson vertical centrifugal pumps, bottom suction, countered. In the rising main about 1.36 ft. is lost owing to friction. Thus the total head for the pumps to operate against is 28.48 ft.

Each pump is driven by a 5 h.p. type UH Fairbanks-Morse vertical induction motor, 220 volts, 60 cycles, 3-phase, 1,200 r.p.m., direct connected through a flexible coupling. The service is a three-wire, lead-covered cable run from the power company's transformers, carried underground in conduit to the motors. The motors are in the top chamber, while the pumps are situated in the lower chamber, the shaft which connects the two being about 6 ft. in length. The bottom part of the sewage chamber is divided into two sections; in one section the sewage collects, while the other, which contains the pumps is dry and accessible at all times. The pump suctions pass through the wall, and the pumps, being set below the level of the sewage, are practically submerged so far as priming is concerned. They are controlled by a 5-inch gate-valve on the suction side and a 3-inch gate-



Plan and Sections of Chilliwack Separator

equipped with brass open runners and brass shafting, having a capacity of 20 g.p.m. against a total head of 33 feet. The pumps are so designed that none of the bearings can come into contact with the sewage, and the self-oiling thrust bearings are placed inside the motor bases, where they are easily accessible. With this arrangement of bearings in motor bases, it is not necessary to withdraw the entire unit to raise the sump cover when it is desired to examine the bearings. The suction pipes are 5-inch cast iron and the outlets are 3-inch cast iron. These three outlet pipes join into a common 6-inch cast iron main, and a few feet beyond, this increases to a 12-inch rising main.

The distance from the centre of the city to the pumping chamber is, roughly, 6,000 ft., and from here to the separator tank 4,000 ft. The total loss in friction in the pumping equipment and piping amounts to 5 per cent. The amount of head that the pumps have to contend with at the pumping chamber is 15.8 feet, including losses. At the separator tank an additional head of 11.32 ft. is en-

valve on the outlet. A 3-inch check-valve is placed on the outlet, which serves to stop back-flow to an idle pump. An automatic float-switch is provided to each motor, and a control panel installed by means of which any motor may be connected to any one of the three controls, or disconnected from the system; a maximum of flexibility is thus possible.

A special feature of this direct connected pump is non-overloading. The constant horse-power characteristic insures long life to the motors and avoids disputes with power companies, which prefer this type because it enables them to figure on a constant load factor.

The treatment plant consists of a detritus tank or grit chamber and a separator, both in duplicate. They are constructed of concrete and all but the foundations extend above the ground surface. The grit chambers are each 4 ft. 9 in. wide by 6 ft. 4 in. long and 5 ft. deep at the centre of the hopper-shaped bottom and 2 ft. 2 in. to the bottom of the vertical sides, both measured from the level of the overflow weir. This gives them each a capacity of

800 gallons. The plant is designed for 600,000 U.S. gallons per day, which gives the detritus tank a capacity of about 2 minutes' flow when containing no grit. At the lowest point of the hopper bottom is a 6-in. pipe for removing sludge.

The sewage enters the grit chamber at one end and leaves it by flowing into a gutter over a weir which surrounds it on the other end and the two sides, passing meantime under baffle boards whose lower edges are submerged 11 inches, which retain all floating matter. The gutters discharge the effluent into the separator.

The sewage enters the separator by passing under a baffle wall which is submerged about 2 feet. It leaves the separator by flowing into a set of weir channels, 20 in number in each separator, which it enters in a thin film. As each of the weir channels is 3 ft. 7 in. long and takes sewage over both edges, the whole is equivalent to a weir 143 ft. 4 in. long. The velocity of flow at any point of departure is, therefore, very low. The edges of these weirs are all at exactly the same level, one foot lower than that of the gutter of the grit chamber. These channels discharge at both ends into butters which flow down both sides of the separator. Any sediment collecting in the separator is drawn off through a 6-in. sludge pipe. The separator is 3 ft. 7 in. wide, 12 ft. 10 in. long and 4 ft. 2 in. deep to the lowest part of the hopper-shaped bottom and 2 ft. 4 in. to the bottom of the vertical sides. Each of the weir channels is made of concrete reinforced with ½-inch wire mesh, and is in shape a bar 4 inches wide and 3 inches deep, rectangular in section except for a groove in its upper face 3 inches wide by 1 inch deep. These bars are set with 2 inches clear space between them.

This is the only plant of this kind operating in British Columbia, and is quite a success. By it over 90 per cent. of the solids in suspension are removed, and the effluent is sufficiently clarified to be discharged into a stream or purified further on filters.—Municipal Journal.

DOMINION GOVERNMENT ASTRONOMICAL SURVEYS—1915.

The following survey parties are being made up at Ottawa under the direction of Dr. King, Director of Astronomical Surveys:

Mr. Thomas Fawcett, D.L.S., will this season conduct surveys on the eastern boundary of the province of Quebec.

Triangulation parties of the Geodetic Surveys will be under the charge of N. J. Ogilvie, on the Pacific Coast; A. J. Brabozon, at the Bay of Fundy; A. M. Grouh in Quebec and Ontario; J. M. Riddell and L. O. Brown in Ontario.

Observations for latitude and longitude will be taken by T. C. Dennis at points in the basin of the Upper Ottawa and A. H. Seienburne on the line of the Transcontinental Railway. Mr. Dennis will use wireless telegraphy for comparison of his local time with standard. Mr. Seienburne will exchange time signals with the Dominion Observatory at Ottawa by telegraph wire.

Mr. F. A. McDiarmid will continue his work of last season on determination of the force of gravity. He will observe at stations in the Maritime Provinces and at points on the main line of the C.P.R. from Winnipeg to Vancouver.

Mr. C. A. French will take magnetic observations at points in Alberta and British Columbia.

COST OF INITIAL MINING EXCAVATIONS.*

By Eugene D. Gardner, M.E.

A LARGE part of the early development work on most mining properties consists of surface excavations, such as open cuts, trenches, shallow shafts, and short tunnels. Of this work the greater proportion may be classed as the annual labor performed on unpatented claims. This assessment work entails the expenditure of large sums each year throughout the mining regions of the west. The unit cost of this work, of course, varies greatly under the peculiar conditions applicable to particular localities. There is, however, a much greater difference in the cost of mining work in separated regions as depth is reached.

It sometimes occurs, though seldom, that a shaft or tunnel may be started at the surface where the rock is unaltered and may be as difficult to excavate as at depth. Ordinarily, the work in rock is affected by weathering and decomposition. In most mining districts, the sedimentary rocks are shattered and softer at the surface and beneath for an appreciable depth. The igneous rocks also have the same tendency toward disintegration, particularly in the vicinity of veins. Exposed rock is very seldom as hard as that found at depth.

The simplest forms of development work are open cuts and trenches. Later, when the location of the lead is determined, shafts may be sunk, or, if the contour of the ground is favorable, tunnels run.

In computing costs, open cuts and trenches are calculated on a cubic yardage basis, and shafts and tunnels by the linear foot, due allowance being made for the size of the cross-sections. A good method of arriving at the cost of vertical surface excavations is to figure the first 7 feet as an open cut on a yardage basis, and from there down as a shaft at so much per foot in depth. Material can be readily thrown with a shovel from a depth of 7 feet. To do so from a greater depth increases the cost per cubic yard, and, where a windlass is to be installed in any event, it is not economy. It is common practice in city trenches, and to some extent in shafts where no greater depth is desired, to throw material from a distance of 8 or 9 feet below the surface. Shafts are often sunk to a depth of 15 feet or more without installing a windlass, the material excavated being thrown to the surface by means of benches. The broken rock is thrown from the bottom to a bench, and from there to the surface.

The cost per cubic yard of open cuts varies from 50 cents to several dollars; prospect tunnels from $2.50 to $30 per foot; and prospect shafts from $4 to $40 per foot, depending upon the varying conditions. The cross-sections of such tunnels and shafts are generally 4 x 6 feet.

At Butte, with miners' wages $3.50 per 8-hour shift, the cost of open cut work averages about $1.00 per cubic yard. The formation is a quartz monzonite, locally known as the Butte granite. This rock, with the exception of unaltered boulders and an occasional ledge of solid granite which outcrops, decomposes at the surface and to quite a depth in the proximity of veins. The boulders are mainly at the surface, but are frequently found below and in veins at depth. There is nearly an entire absence of any angular slide over-burden. At points where the granite is well disintegrated, the cost of open cut work will be less than $1.00 per cubic yard. On the other hand, where

*From a paper read before the Montana Society of Engineers April 10, 1915.

boulders are encountered and in ledges of solid granite, the cost will be considerably higher. Excavations in this district are nearly always started in the decomposed granite. There is not much object in starting them in hard rock, as no vein outcrops are found in the unaltered portions. The altered granite near the surface is mostly picking ground, and little blasting is required in open work.

The cost of short tunnels from the surface at Butte runs from $3.00 to $8.00 per foot, except some work on the main range and in hard aplite which costs over $10.00 per foot. In the majority of cases involving decomposed granite, the cost is between $4.00 and $5.00 per foot. This includes cutting the timber, if standing on the claim or nearby, and placing it in the tunnel, but not its purchase price or the expense of bringing it from a distance. Generally, where the rock is soft enough to require timbering, the greater ease with which it is broken will compensate for the extra labor of cutting timber and putting in sets. Where the tunnels run into spiling ground and into hard boulders, the cost will, of course, be increased. These figures, of course, do not refer to tunnels of large cross-section in the solid granite in the deep mines.

The cost per foot of sinking prospect shafts in the Butte granite depends on the amount of decomposition of the rock, and on the depth of the shaft. Prospect shafts are generally about 4 ft. wide and 6 ft. long, as this makes a convenient sized excavation in which one man may work. The average cost of a 4 x 6 shaft 15 ft. deep is about $5.00 per foot below a depth of 7 feet, the upper 7 feet being figured on a yardage basis. The cost increases with depth. A 4 x 6 shaft 10 ft. deep is generally considered by some of the U.S. mineral surveyors as costing $25. This is generally a fair valuation, but in some cases it is a little high.

Patent work amounting to $25,000 done under the supervision of two men on about fifty scattered lode claims, ranging from four to six miles from Butte, showed a cost of 80 cents to $1.25 per cubic yard for open cut work, and an average of $5.00 per foot for tunnels. The work done on a single claim of this number for an expenditure of $500 aggregated 113 cubic yards of open cuts and a partly timbered tunnel 3 x 6 x 84 ft. long. The cost of the tunnel, by allowing $1.00 per cubic yard for the open work, was $4.60 per linear foot. The work on all of the claims consisted of open cuts and tunnels, with a few shafts. The deepest shaft was 55 ft. deep, and the others were comparatively shallow. The cost of the deepest shaft to a depth of 47 ft. was $370, or nearly $8.00 per foot, and to the depth of 55 ft. $470, making the last 8 feet cost $12.50 per foot. This shaft was sunk on a vein on a 45° incline, and was cribbed with an inside measurement of 3 x 5 feet. The broken rock was hoisted by a hand windlass in a bucket sliding up on guides. In this case, the construction of the windlass and frame and other extra work made up for the smaller cost of the first 7 feet. The formation was more or less decomposed Butte granite, and required blasting. From the last part of the shaft some water had to be bailed. Fifty-five feet is just about the limit for economical sinking with a hand windlass.

Another shaft 4 x 6, 15 ft. deep, cost $48. This amounted to $1.00 per cubic yard for the first 7 feet, and little over $5.00 per foot for the remainder.

During the last few years the cost to the city of Butte of excavating the material in sewer trenches within the granite area amounted to $2.16 per cubic yard. The trenches were 2 feet wide and averaged 9 feet deep. All the work was done by contractors. Wages for ditch diggers are $4.00 per 8 hours, this being the minimum price for all laborers on city work, and is 50 cents per day more than is now paid to miners. This rate of wage has been fixed by ordinance of the city government. City contractors have to contend with numerous labor union regulations. The higher cost per yard of this work than for open cut mining is due to the labor situation, the great depth and small width of the trenches, and the larger proportion of solid granite, consisting of boulders and ledges included in the softer material which has to be moved.

A 300-ft. tunnel run from the surface in a hard, compact granite cliff at the head of Rattlesnake Creek, Mont., cost $28.00 per foot. Several hundred feet of prospect tunnels on the Porphyry Dyke were run by contract for $3.00 per foot. Prospect tunnels in the soft porphyry in the lowlands district cost from $2.00 to $5.00 per foot. Tunnels in the soft schist in the Crevasse mining district cost from $4.00 to $5.00 per foot.

In the Coeur d'Alene mining district there are very few outcrops, and the surface on the mountain sides is generally covered with soil and angular wash to a depth of 2 to 8 or 10 feet. Under the overburden, the formation in place usually is broken and shattered to an appreciable depth, but very seldom over 15 feet or 20 feet. The formation is a series of sedimentary rocks which are, on the whole, easily eroded and weathered. There are a few hard strata, such as the copped beds in the Revette quartzite, which resist weathering, and are as hard at the surface as at depth, but these comprise only a very small part of the whole series. Miners' wages are $3.50 for 8 hours. The cost of surface cuts here is found to be a little higher than at Butte, averaging about $1.20 per cubic yard for the material removed. Individual cuts cost from 75 cents per cubic yard when in wash, to $2.00 per cubic yard when in the harder rock. The average cost of a series of cuts up to 7 feet in depth on flat surfaces and with 12-foot faces on side hills, was $1.20 per cubic yard. In classifying the material, most of the rock in place in open cut work would come under the head of loose rock. The average rock in the Coeur d'Alene is much softer than the solid granite at Butte, but harder than the altered granite.

The cost of prospect tunnels in the Coeur d'Alene ranges from $3.50 to $10.00 per foot, according to the hardness of the rock, with an average of about $6.00. The contract price of a tunnel in the shale above Pottsville, Idaho, from 400 to 500 feet from the portal, was $4.50 per foot. The total cost to the contractor, however, was $3.50 per foot. Surface prospect tunnels run by one of the mining companies in hard quartzite at Burke, Idaho, cost $10.00 per foot.

Annual assessment work on five placer claims twelve miles from the railroad on Pend Oreille River, in Washington, showed an average cost of $3.23 per cubic yard of rock removed. Wages, $3.50 for 9 hours. The formation was tough, compact limestone and dolomite, with an entire absence of all surface weathering and overburden. The cuts were made in the bluffs above the river.

Development work in open cuts on lime placer claims at Metaline Falls, Wash., in solid limestone, cost from $2.50 to $4.10 per cubic yard.

The cost per cubic yard of open cuts on a vein in disintegrated andesite on the north half of the Colville Indian reservation, Wash., was 94 cents per cubic yard. The cuts averaged 34 feet long, with 15-foot faces. Wages were $3.50 for 9 hours.

The contract price for excavating solid rock in trenches 3 x 9 feet deep in the city of Spokane was $4.75 per cubic yard. This rock is a basalt of extreme toughness, and requires an excessive amount of drilling and blasting. The contract price for the same work in open cuts in street work was from 90 cents to $1.25 per cubic yard. The cost to the city for removing gravel in the same size trenches was 90 cents to $1.00 per cubic yard. Wages are $3.00 for 8 hours, for city work. The contractors figure 20 per cent. of the cost consists of overhead charges, interest and depreciation, and 6 per cent. tax for workmen's compensation.

Open cuts made at Bingham, Utah, in weathered limestone and quartzite and slide rock, under the direction of the writer, cost 80 cents per cubic yard. Prospect tunnels in the same formation cost $4.00 to $6.00 per foot. Miners' wages were $3.25 for 8 hours.

Hand placer work is cheaper, on the whole, than the same kind of work on lode claims, which is to be expected from the nature of the material which is handled in each case. The formation of placers consists of stream gravel, sand, or clay, with an occasional boulder, and in some cases cemented strata. Hand placer excavating is straight pick and shovel work, except where boulders are encountered. In hand sinking on many placer properties, the amount of water which has to be bailed or pumped out is the greatest factor in determining the cost, and quite often the quantity of water prevents sinking entirely. In many places cemented strata are entirely absent, and what boulders are found are near bedrock and need not be moved in prospect work.

By considering how much gravel a man can handle per shift, and his daily wage, it would be possible theoretically to arrive at the cost of most placer excavations. Byrne, in his Inspector's Handbook, gives the average amount of material a man can loosen per hour with a pick as:

Clay or cemented gravel	1 cubic yard
Loam or loose gravel	2 to 3 cubic yards
Sand	4 to 6 cubic yards

On the same page he gives the average quantity a man can shovel per hour with a limit to the cast of 6 feet vertically and 12 feet horizontally, as:

Rock	1 cubic yard
Clay or heavy soils	1.7 cubic yards
Loose earth or sand	2 cubic yards

By taking Byrne's figures of 2½ cubic yards per hour for loosening gravel, and of 1.7 cubic yards per hour for shovelling, a man, in an 8-hour shift, could excavate a trifle over 8 cubic yards of material. By allowing, for miners, $3.50 for 8 hours, the cost per cubic yard would be 44 cents. This yardage agrees fairly well with other authorities, such as Gillette and Trautwine.

On placers, the cost of open work or trenches up to 7 feet deep, with little or no water, varies from 40 cents to $1.00 per cubic yard, depending upon the nature of the material and the price of labor. Timbered prospect tunnels in gravel cost generally from $4.00 to $6.00 per linear foot. The cost of a 10-foot shaft, with little or no water, is generally taken as being $10. Frozen gravel is not taken into consideration.

Trenches in city streets, particularly in a mountainous country, are quite often in material similar to that found on placers. Costs are generally kept fairly close on this work, and in similar material can be used as a basis of comparison for placer work.

It costs the Missoula Light & Water Company an average of 36 cents per cubic yard to do the excavating for city water trenches 2 x 6 feet deep. The work is done by day labor, with wages at $3.00 for 8 hours. The material moved is almost entirely wash gravel, with an occasional hardpan.

The Great Falls Water Company, in excavating for city water pipes, moved 89 per cent. earth, 5 per cent. solid rock and 6 per cent. loose rock at an average cost of 34 cents per cubic yard. Wages were $2.25 for 10 hours.

S. Lefevre gives the cost of surface excavations at Mineville, N.Y., in hardpan and boulders at 80 cents to $1.00 per cubic yard. Wages for this kind of work are about $2.00 for 10 hours.

Well diggers sink 5 x 5 feet wells up to 30 feet in depth on the Missoula flat, on contract, at $1.50 per foot including placing, but not cost of timber. Below 30 feet the cost increased. The flat is an old river bottom, and consists mostly of river gravel.

CANADA AND SWITZERLAND.

Certain unfounded rumors having lead a part of the Canadian public to erroneously believe that Switzerland was completely isolated in the centre of Europe between four powerful belligerent nations and, since the entry of Italy in the war, had been shut off from any outlet on the sea and was consequently prevented from exchanging products with Canada, Mr. Henri Martin, Consul-General of Switzerland for the Dominion, has just received from the Swiss Political Department in Berne the following cable:—

"There is in Switzerland absolutely no interruption of traffic with foreign countries. All said traffic goes through French ports direct or via Great Britain. Route through Rotterdam could also be used, but sailing opportunities are scarcer from Holland."

The Consul-General states also that, according to a recent agreement with the Swiss National Bank and the Bank of Montreal, all Canadian payments intended for Switzerland can be made in Canada through the channel of all offices of the Bank of Montreal in the Dominion.

COURTENAY BAY CONTRACT CANCELLED.

Owing to slow progress in the construction of the dry dock, terminals and other improvements in Courtenay Bay harbor, St. John, N.B., the Department of Public Works, Ottawa, has cancelled its $7,000,000 contract with the Norton-Griffiths Construction Company. The contract called for the completion of the work within two years. One year has elapsed and it is reported that very little has been done, although the contractors were notified by the Government that unless the work were expedited the contract would be cancelled.

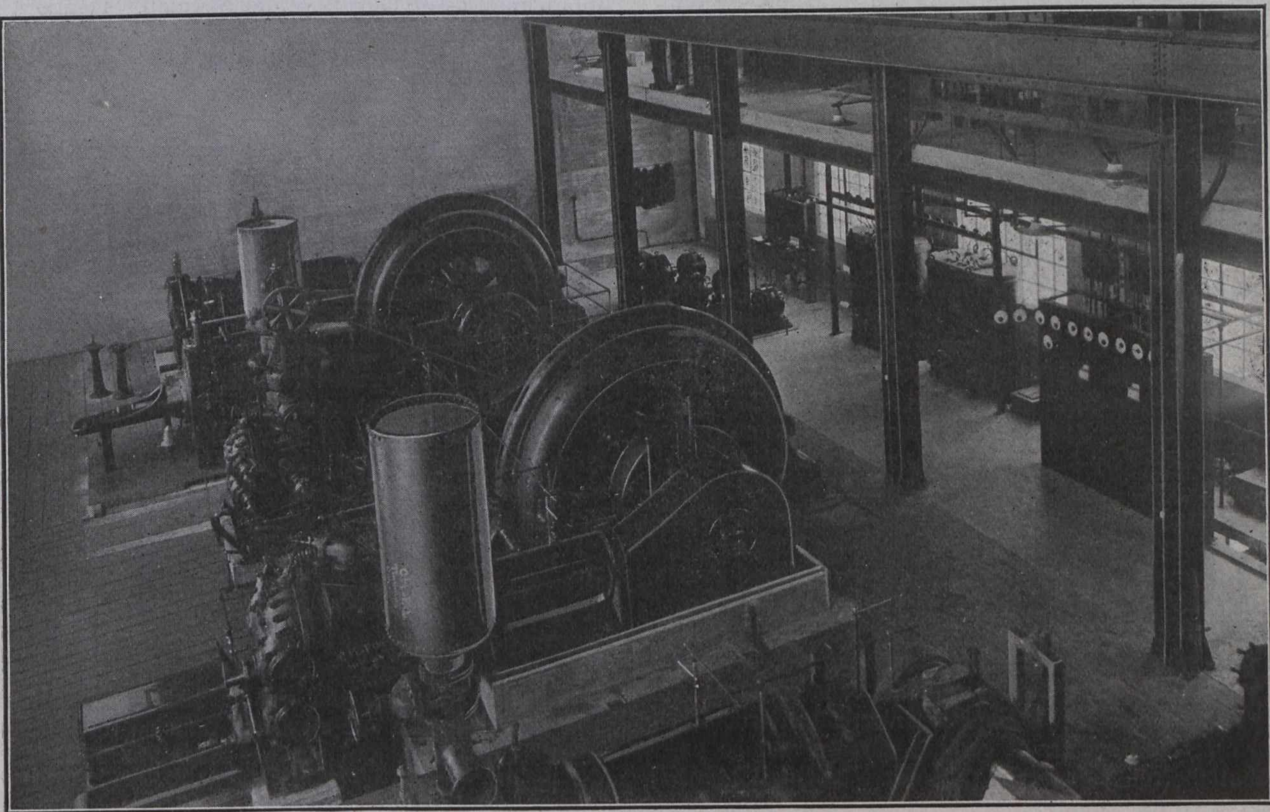
It was one of the largest contracts in Eastern Canada. It is understood that new tenders will be called for, although no formal announcement has yet been made by the Government.

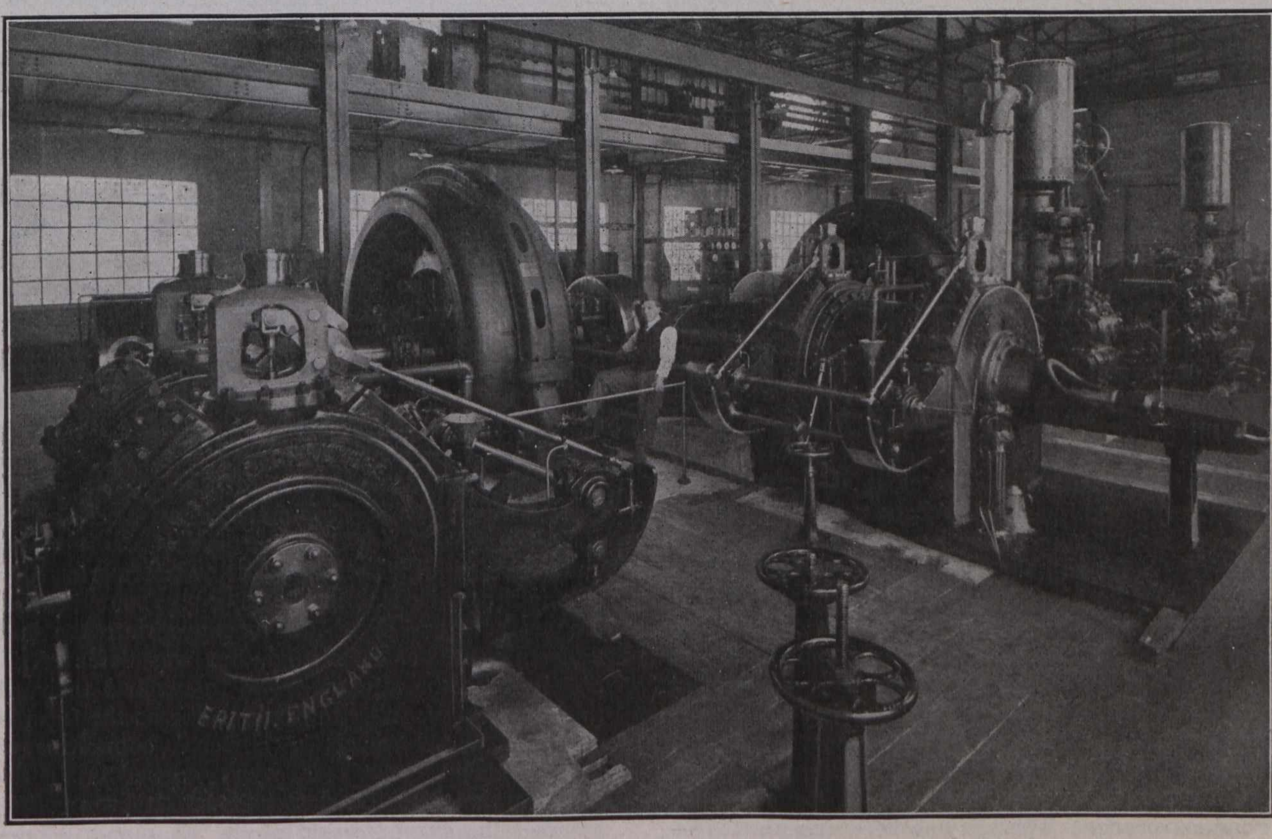
Falsework for the erection of the N.T.R. Bush River bridge truss spans and for the preliminary temporary support of a contractor's service track was made with the main bents capped at the proper elevation to support the chamber blocks for the trusses, and surmounted by centre pony bents to carry track stringers and rails and provide for a construction track in advance of the bridge erection.

POWER PLANT AT GILLIES LAKE, ONTARIO.

THE Canadian Mining and Finance Co., Limited, completed last year the construction of a central power plant on the south side of Gillies Lake, Ont. This company owns the Acme and Millerton properties, Porcupine gold fields, and has a controlling interest in the famous Hollinger. The new plant is described by Arthur A. Cole, mining engineer to the Timiskaming and Northern Ontario Railway Commission, in his recent report on the mining industry of Northern Ontario. We are indebted also to Mr. Cole for the accompanying illustrations.

The building is of steel frame construction, with con-





Interior Views of Air Compressor Plant, Canadian Mining and Finance Co., Limited, Timmins, Ont.

crete curtain walls and roof. It is 51 feet wide x 120 feet in length, and was designed to accommodate four compressors each of 4,500 cu. ft. of free air per minute capacity. Three compressors are now in commission, with space left for an additional unit. One compressor, designed and built by Fraser & Chalmers, of London, England, is of special design, being fitted with Hoerbiger valves of variable volume gear of the Doerfel type, which automatically adjust the output of the machine to the exact requirements of the demand for air, thus doing away with peak loads and thereby reducing the cost of power, which is purchased upon a basis of peak loads. The cylinders are 22½ in. x 38 in. x 30 in. stroke. The speed is 125 r.p.m. This machine has a complete range of capacity from zero to full load, automatically controlled by suitable governor gear. The other two compressors were designed and built by the Nordberg Manufacturing Company, of Milwaukee, Wis. They are designed to run at full load continuously, and have no variable volume gear; the cylinders are 22 in. x 37 in. x 31 in. stroke. The valves are Corliss and the speed is 125 r.p.m. These compressors possess the unique advantage of being reversible; thus in the event of an interruption to the supply of electric power they may be operated as steam engines and their motors may be driven as generators of electric power. The supply of steam for this purpose can be obtained from a battery of four Wickes vertical water-tube boilers, each having 3,000 sq. ft. of heating surface and connected through suitable breeching to an induced draft fan which enables the boilers to be run at a high overload during such time as the compressor plant is being used as an auxiliary steam-driven electric power plant.

In addition to the usual intercoolers each compressor is equipped with a Fraser & Chalmers vertical aftercooler, each having 1,100 sq. ft. of cooling surface and so designed that the tubes and tube plates can be lifted out of the cooler shell for cleaning.

The boiler house is built on the east end of the compressor building and is of the same type of construction. It accommodates the electrically driven pumps for mill water. A concrete intake and suction well has been built to insure a liberal supply of clean water at all seasons of the year.

SURVEY WORK IN THE TRENCHES.

Writing from the trenches in France to the editor of *The Canadian Engineer*, Eric S. Fowlds, formerly assistant engineer, Trent Valley Canal, now attached to the 2nd Field Company, Divisional Engineers, First Canadian Contingent, states: "Engineering conditions out here are, as might be expected, rather different from those in civil life, and a survey in the trenches is quite a novel experience. It is all prismatic compass work, of course, and in spite of the amount of iron close at hand I have gotten some very good results,—especially as a great deal of it must be done through a periscope. One holds the compass in one hand and the periscope in the other and tries to hold them both steady despite what is going on around him. A periscope has the unfortunate habit of drawing a fire if held up too long in one spot. But by the time the fire gets heavy we have generally moved along, and the infantry get it, whereupon they pass some very vivid reflections upon our meddlesome ways. One picks up some new and very original expressions out here in that way. It's a great life, though, and in many ways a very good experience. There is another thing about it—employment out here is very good."

COMPLETION OF SOOKE LAKE WATERWORKS SYSTEM FOR VICTORIA, B.C.

ON Friday, May 28th, Mayor Stewart opened the gate valves at the Sooke Lake dam, and put into operation Victoria's new water supply of 17,000,000 gallons per day. This supply is about three times the present consumption of the city, including that of the municipalities of Oak Bay and Saanich. Hence it will be ample for many years to come.

The new system is the third to serve the city of Victoria. The first was by carrier and the second was a municipal plant established in 1874. For the past ten years or more the scheme just put into service has been the subject of consideration and controversy. So interesting is its history that the following outline is abstracted from a full account in The Times (Victoria) of recent date. The location of Victoria, at the extreme south end of Vancouver Island, and surrounded on two sides by salt water, greatly augmented the difficulty of solving its problem of water supply. A northern source had been the first selected by the early advisers of the city, but twenty years after its inauguration fault was found both with the quantity and quality of Elk Lake water. However, by supplementing existing sources, the day when a definite choice of an abundant supply would have to be made was put off for a number of years.

History of the Scheme.—Arthur L. Adams, of San Francisco, an expert who had reported fully on the Goldstream supply in 1905 (controlled by the Esquimalt Waterworks Company) was called in to make a supplementary report on the possible sources of supply. He reported in December, 1907, on the various schemes, both to make Elk Lake afford a supply in the interval till a new supply could be secured, and also on the Millstream and Sooke proposals.

Sooke Lake he recommended on account of its being an almost ideal source of supply, and submitted two alternative schemes, one involving a tunnel under the mountain, to Goldstream, and the other a natural outlet down Sooke River and then paralleling the coast to Victoria.

This latter route, which was eventually adopted, had been recommended by Mr. Devereux a year earlier, as the only practicable route for obtaining a gravity water supply from Sooke Lake to the city. The route was not examined then as his instructions did not embrace the detour.

In the January following, a referendum was adopted in favor of Sooke Lake as the eventual future supply for Victoria. A private bill was promoted in the legislature to enable the council to proceed to Sooke Lake for the supply, and to seek to sell power for commercial purposes. Strong opposition developed, and the bill was withdrawn ultimately. Little progress was made on the general scheme in that year, temporary improvements patching the system up till the following year. In 1909 a bill was carried through the legislature to enable the council to submit a by-law for the purpose of expropriating the undertakings of the Esquimalt Waterworks Company. The agitation continued during the summer, and on August 26, 1909, a by-law to expropriate the lands and undertakings was submitted, but was defeated.

In 1910 the electors failed to reaffirm their adhesion to the policy of going to Sooke Lake as the future supply of the city. However, a citizens' committee was appointed early in the year, which carried out a thorough investigation into the rival claims. It eventually recommended the expropriation of the Esquimalt Waterworks Company's undertakings. The decision was based on the belief that the Goldstream supply was sufficient for the city up to a population of 150,000, and that the whole of the supply would be in municipal control, preventing conflict of interests in the years to come. The proposition from a business connection was advocated on account of the revenue to be derived from Victoria West, and the sale of water to the B.C. Electric Railway for power purposes. The ratepayers voted against it, however, sounding the death knell of the expropriation proposals.

Mr. Herman, of Herman & Burwell, hydraulic engineers, Vancouver, was then called in to make a survey of the Sooke line. In January, 1911, the electors were asked to express their approval of the Sooke scheme. Mr. Wynn Meredith, consulting engineer, San Francisco, was called in during the summer of 1911, and preliminary surveys were at once made. The information gathered formed the basis of the report presented to the council on November 10, 1911, which embraced the principle of using the southern route by Mount Shepherd.

The battle of the routes had been a factor for years. Humpback is a natural basin in the hills near Goldstream, and the problem was to secure a grade for a flow line to that point. The northern route by the Malahat would have involved tunnels, and the water would have been conveyed by way of Finlayson arm. Then there was the much discussed tunnel under the Sooke hills which, while it would have taken four and a half years to construct, would have provided a supply for all time, whatever dimensions of pipe were necessary.

Each of these proposed routes had one drawback. Either would involve crossing the holdings of the Esquimalt Waterworks Company, encouraging litigation of which the council had had enough in its waterworks undertakings.

With reference to power, Mr. Meredith, in his report, said: "With 16 million gallons, equal to about 30 cubic feet per second, utilized or reserved for city use, there would be available for power purposes about 70 cubic feet per second for some years to come, or until the city required it for domestic use. This would be best utilized for power purposes by carrying it from the outlet of tunnel No. 2 in a comparatively short power pipe line to Finlayson arm, where it could be delivered to the water wheels under an average effective head of about 550 feet, and this quantity of water under this head would yield continuously approximately 3,500 h.p. As the city's requirements for some years to come will not exceed the 30 cubic feet per second, it is evident that all capital expenditure required to make available the 70 cubic feet of water per second for power purposes would be properly chargeable against the power produced. A carefully compiled estimate clearly shows that the capital expenditure for power purposes on this basis would be excessive, and commercially impracticable, and therefore need not receive further consideration."

However, a practicable route by the south was found, and the council adopted the report. Tenders were invited, and the contract was awarded to the Westholme Lumber Company on December 19, 1911. The tender was $1,169,170 for construction.

The contract was subject to the consent of the ratepayers, which was given in January, 1912.

The company, however, according to the official report of Mr. Meredith, consulting engineer, backed up by the water commissioner, failed to show due expedition with the work, and they recommended in April that the council should exercise its powers of removal under the contract. However, the council declined to do so, and the work went on till the end of the year, considerable grading being done, and the land being cleared around the lake. On July 31, 1912, Mr. Boyd Ehle became engineer in charge of the work, and under him the bulk of it was carried out.

The situation went on without any satisfactory decision as to the company's position after a change was made in the position of water commissioners on November 1, 1912, when Mr. C. H. Rust took charge, and eventually on April 12, 1913, the council took over the work.

The summer of 1913 was largely occupied with organization, the city having to assume the position of contractors to purchase the plant from the receiver to carry out the work with the knowledge that it was doing the work for other people, and that an accounting with the Westholme Lumber Company would have to be made at the end of the contract. A lawsuit was commenced by the Westholme Company on April 13, 1913.

In the fall of 1913 the water commissioner recommended that the making of the pressure pipe and the conduit flow line should be done by contract, but it was not until the power of the commissioner under the act had been established by the supreme court that he was able to enter into the contracts.

The telephone line was let by contract. The Pacific Lock Joint Pipe Company received the contract for the 27½ miles of concrete flow line, the diameter of the pipe being increased from 40 to 42 inches, while the pressure pipe was awarded to the Burrard Engineering Company. The former company established a plant at Cooper's Cove, and the latter bought the Westholme plant at Thetis Cove from the receiver of the company. The city had there already a large supply of plate, which was made up and rolled by the company. The trenching was done by day labor.

Mr. Ehle stayed till the end of February, 1915, in charge of the work, having seen the pressure pipe line finished at Christmas. Since that time Mr. F. L. Young has been in charge of the work. The Pacific Lock Joint Pipe Company completed its labors during the winter.

The Humpback reservoir has been in service for more than two months, and the operation of the system in its entirety will now permit the termination of an agreement entered into May, 1913, to purchase water from Goldstream on the terms of payment as fixed by statute. The agreement expired on June 1st.

The System.—An illustrated article in *The Canadian Engineer* for July 23rd, 1914, described the system. Briefly, it is divided into four parts, the headworks at Sooke Lake, the flow line to conduct the water along the mountain side, the Humpback reservoir and the pressure line to carry the water from the reservoir into the city distributing system.

The area of the watershed is 31⅓ square miles, on which the rainfall is about 55 inches annually. The scheme follows the reports of earlier engineers, has a low dam, 12 feet high, at the lake, and the storage provided is 5,555,000,000 gallons. The later development contemplates an additional run-off from Leech River and 45-foot raise, when the capacity will be 17,360,000,000 gallons. The flow from the present dam to the reservoir has by actual test been shown to be between 21,000,000 and 20,000,000 gallons.

The conduit pipe to connect the lake with the reservoir is of reinforced concrete, 42 inches internal diameter and is placed on a grade of 1:1,000. It is carried on one steel bridge with five reinforced concrete syphons across the streams and ravines.

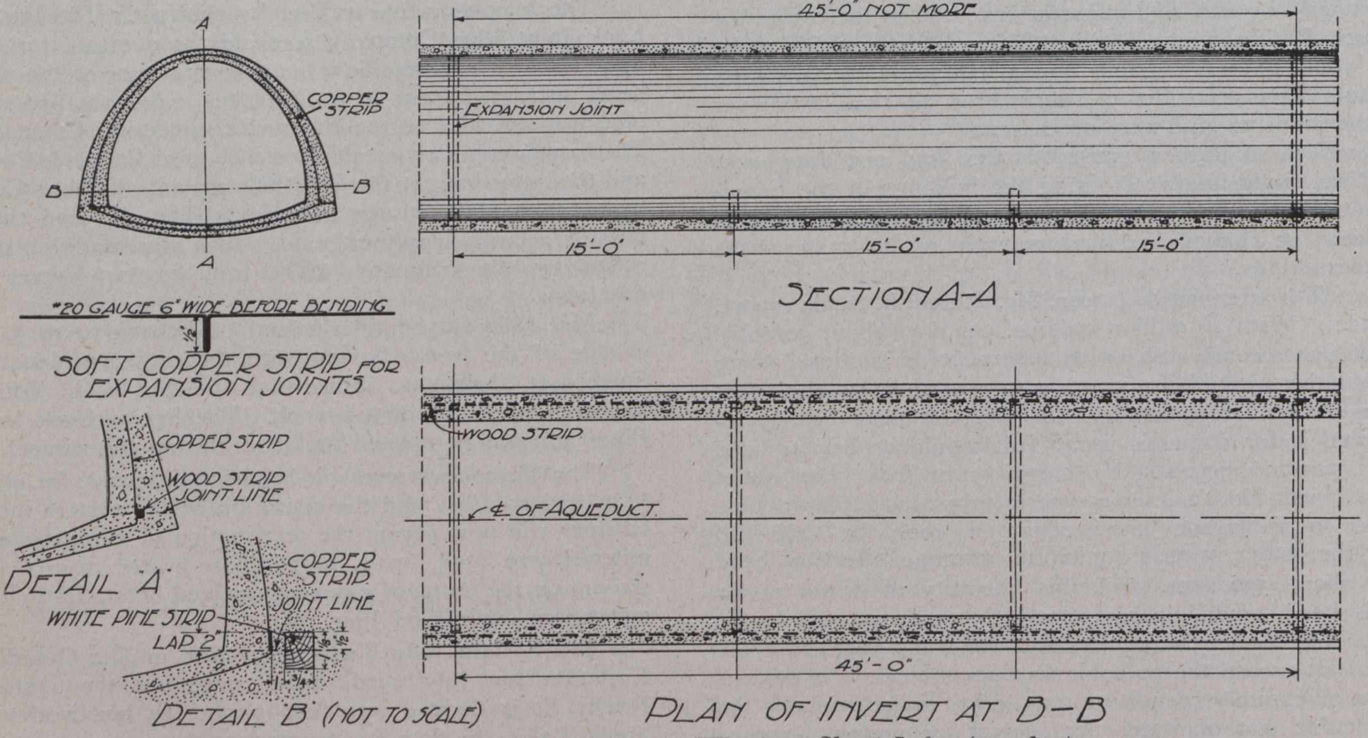
The capacity of the reservoir, which is located in a natural hollow about one mile from Goldstream station on the Esquimalt & Nanaimo Railway, is 136,000,000 gallons. The water, on arrival by the flow line, is cascaded down steps, in order to aerate it and then passes either direct into the pressure pipe to the city, or else to the reservoir.

The watershed area of the reservoir is about one square mile. The pressure pipe line from the reservoir to the distribution system in Victoria is about 10¾ miles long, of which about four miles is of 5/16 inch, and the remainder ⅜ inch plate, made into a continuous riveted steel conduit 36 inches in diameter, with five sectionalizing valves. The connections for the Saanich distributing system are shortly to be installed. The approximate elevations above the sea level are: Sooke Lake, 567 feet; Humpback reservoir, 380 feet.

The project has been carried out under the direction of Mr. C. H. Rust, city engineer and water commissioner for Victoria. Mr. Wynn Meredith, consulting engineer, supervised the work. Besides Mr. Boyd Ehle the resident engineers were Messrs. E. E. Carpenter, H. Hartwell and F. L. Young.

EXPANSION JOINTS FOR MONOLITHIC CONCRETE PRESSURE PIPE.

CONSIDERABLE interest has centered around the details of expansion joints for use in pressure pipe constructed of concrete. The accompanying diagram shows the design and arrangement of the joints that are being made in the Winnipeg-Shoal Lake aqueduct. In the construction of this pipe line the invert will be laid first in sections 15 ft. in length. Between the adjacent ends of these sections copper expansion strips will be inserted as shown. These strips will each consist of a sheet of No. 20 gauge copper, 6 ins. wide, and extending across the full length of the joint. This strip is bent along the centre line to form a half-inch offset, as illustrated, this offset occurring exactly on the joint between the adjacent concrete faces.



Details of Expansion Joint for the Winnipeg-Shoal Lake Aqueduct.

After the invert has been allowed to thoroughly set, the arch is constructed upon it in sections 45 ft. in length, the joint occurring in all cases directly over every third joint in the invert. In the 8 ft. circular section of the aqueduct the expansion joints in the arch are to be placed at not more than 30 ft. centres. A copper strip of the same dimensions as noted above is also used in the arch. The idea underlying the use of this copper strip, bent as shown in the drawing, is that when any contraction in the concrete occurs the offset portion will simply open up without any tendency to break the bond between the anchorage surfaces of the copper and the concrete.

In order to prevent any percolation through the horizontal joints between the arch and the invert concrete, the engineers of the Greater Winnipeg Water District, under whose direction the aqueduct is being built, are using in the joint a continuous ¾-inch by 1⅛-inch well-seasoned white pine strip, dressed on two opposite sides, to form a seal. This strip is to be built into the concrete of the invert throughout the length of the aqueduct in the position shown in detail B, and care is to be taken to protect it from disturbance until the concrete shall have completely set.

The matter of expansion joints for concrete pressure pipe is one of great importance. The above information, concerning the form of joint adopted by the District, was supplied us by Mr. W. G. Chace, chief engineer, and should be of considerable interest. The aqueduct is to be 447,300 ft. in length (84.73 miles) with a capacity of 85 million gallons a day; with a variable gradient and variable cross-sections to correspond, and with considerable internal pressure, chiefly in the last 26,000 feet of its length at the Transcona end.

Editorial

THE WAR AND THE ENGINEERS.

The prestige of Canadian valor and loyalty in the allied armies of Europe is being nobly maintained. The stand of our soldiers alongside veterans of long military service in peace and other wars is a glorious evidence of the thoroughness and efficiency of our military training. More than that, it is a clear vindication of a full reverence for the underlying principles of honor and right.

At Langemarck and Ypres Jack Canuck has shown his mettle. May our boys continue to strike with such telling effect for the principles at stake. When the last gun has announced the extinction of barbaric militarism may they return to us as fully deserving as they are at present of gratitude, esteem, glory and success. May they return in large numbers—the seething battle lines of Europe are exacting a terrible toll.

Few are the industries and remote the corners of the Dominion that have not seen flocking to the colors the best types of manhood the country had to give. This war has been fairly described as a war of engineering, and both the profession and practice have made large sacrifices on its behalf. What numbers of professional engineers are serving in the trenches or on the way, and what the country is losing through their experience of labor and knowledge of materials, it would be difficult to compute. The morning mails bring messages from relatives and friends of some of our readers advising us of their service at the front, many of whom we were unaware had joined the colors. Our policy is, in these cases, to suspend the mailing of copies and to allow the balance of the subscriptions to lapse until their return.

Reports of the service of our men in the battle lines are very characteristic of the men we know them to be. Camp life is a second nature. The old saying that an engineer's home is under his hat is merely being exemplified in another form and among new surroundings. But there was much of the old to conform in some measure with the new. Engineers are accustomed to variety and no man living is better adapted to enter into the spirit of things as they are found, and to master problems impromptu in nature and formidable in degree.

The cap has replaced the hat, the transit is put aside for the rifle, but the duty before him is the same, one of unqualified service, skill and importance.

THE TORONTO BUREAU OF MUNICIPAL RESEARCH.

One year has passed since the organization was effected in Toronto of a Bureau of Municipal Research. During the year there has been some substantial progress made. This has been along lines of ascertaining significant facts as to the city's government; analyzing and interpreting these facts; making public these facts with explanations and interpretations, and co-operating with city officials by strengthening their hands through publicity, making studies of departmental methods, and reporting cases where action is desirable. There has been a decided willingness on the part of the chiefs of the various city departments to accept suggestions and to adopt them where it seems to them to be desirable and practicable. The Bureau makes no claims regarding, and asks no credit for, any progressive steps taken, but is satisfied with using all means at its disposal to strengthen desirable tendencies and methods, and to weaken undesirable ones in the city's business.

In the first annual report, just issued, Dr. Horace L. Brittain, Director of the Bureau, urges the earnest consideration at the earliest possible moment of the addition to the staff of an engineer with training and experience in municipal problems. He asserts that the effectiveness of the Bureau would be thereby greatly increased.

This is Dr. Brittain's firm conviction at the close of the first year of the Bureau's activity, a year chiefly devoted to emergency work, with each day's routine determined by the things most necessary to be done that day. We believe that Dr. Brittain has a broad conception of the engineer and his work—broader than that of most people, even including some engineers.

Engineering education and practice develops the mental characteristics of order, precision, system and accuracy, which characteristics are the progenitors of integrity and essential to notable success in engineering and other work as well. The engineer's service is no longer limited to purely professional functions, ceasing when the stages of inception and design have been attained. Those of constructive execution, economical management, conservation and efficiency are included. The field is decidedly greater and broader than that which previously existed, but the addition of efficiency engineering in the management of affairs has developed in the engineer a usefulness directly in line with the education and training with which he is equipped. The engineer is most efficient in these larger fields. Like the engineering of other days, they demand a similar exercise of good judgment, good commonsense, executive ability and good management.

The Toronto Bureau of Municipal Research is dealing with municipal problems in the solution of which the training and experience of a municipal engineer would be of great service.

BOUNDARY WATER CONTROVERSY IN THE WEST.

The chief question taken up by the International Waterways Commission at its recent sitting at St. Paul was that of the distribution of the waters of the St. Mary and Milk rivers. By a waterways treaty of 1911, it was agreed that the waters of the St. Mary and Milk rivers and their tributaries should go in equal portions to the state of Montana and the provinces of Alberta and Saskatchewan; but in the case of the St. Mary River, the Alberta Irrigation Company, which has its intake on that river, was to have the right of an additional 500 second feet, and the American irrigation scheme dependent on the Milk River should also have 500 second feet additional on that river.

The Saskatchewan Government interest in the controversy is comparatively small, consisting mainly of tributaries which, south of the range of hills, flow to the boundary, and some of them join the Milk River. To Alberta the matter is one of the first importance. So far as Alberta and Saskatchewan are both concerned, the ultimate decision in these matters rests with the Dominion Government, but both provincial governments were invited to take part in the conference and to state their case. The finding of the Commission will be awaited with great interest. Canadian interests were looked after at the sitting by Messrs. E. F. Drake, Dominion superintendent of irrigation; F. H. Peters, of Calgary, Dominion commissioner of irrigation; C. S. MacInnis, K.C., counsel for the Dominion; J. S. Dennis, head of the natural resources and irrigation section of the C.P.R.; J. Walker, counsel for the natural resources section of the C.P.R.; William Pearce, of Calgary, representative of the Western Canada Irrigation Association; and J. Burleigh, representative of the Cypress Mills Water Users' Association; John Stocks, deputy minister of public works, Alberta; and J. D. Hunt; counsel on behalf of the government of Saskatchewan, A. F. Mantle, deputy minister of agriculture.

NEW FREIGHT TERMINALS AT QUEBEC, P.Q.

THE Canadian Pacific Railway has just completed the construction of what have been termed by prominent railway engineers the most up-to-date freight terminals in America. The work commenced in August, 1914, and comprised the construction of an inbound shed 600 ft. long and 50 ft. wide, an outbound shed 300 ft. long and 30 ft. wide, and a 2-story fireproof office building. The location and general layout of these are shown in the accompanying diagram. The photographs illustrate the general design and the work of construction. each shed is so erected that when necessity requires it may be lengthened by additions of further units.

The office building is of fireproof construction with steel frame reinforced concrete floor construction and brick walls. It is faced with tapestry face brick and has limestone trimmings, presenting exceedingly pleasing architectural effects. The office structure is 50 ft. 8 ins. wide, the inner and outer sides being 101 ft. and 121 ft. long respectively. The ground floor provides customs office, bond rack room, trucking passage and offices for checkers, foremen, etc. The general office and the record and freight agents' rooms are on the first floor.

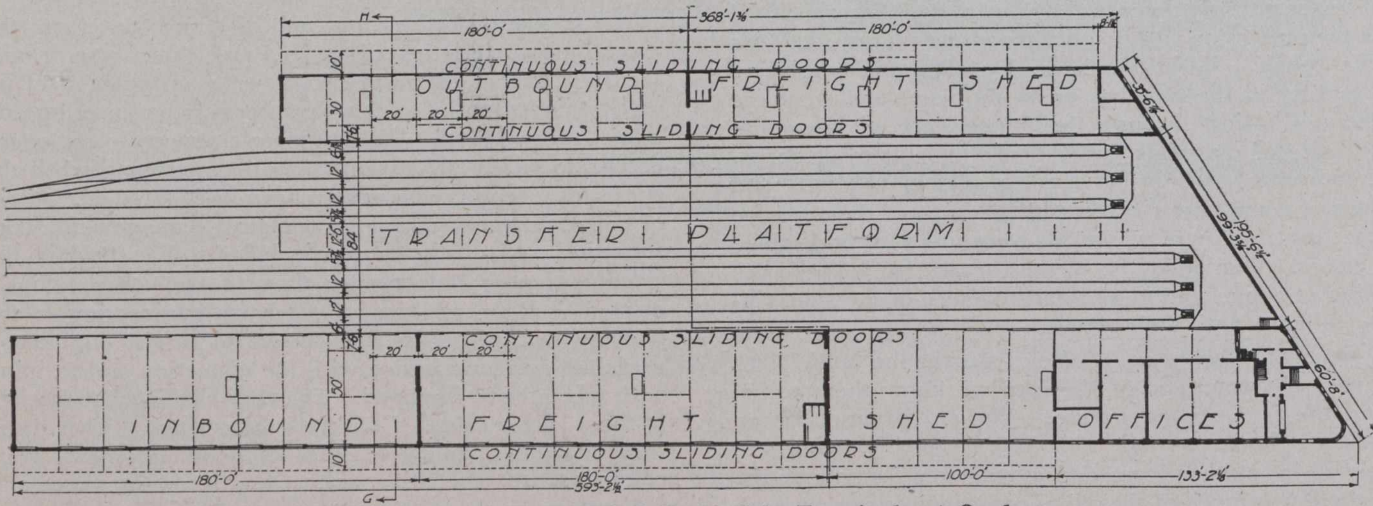


Fig. 1.—Layout of C.P.R. Freight Terminals at Quebec.

The freight sheds and office building are on pile foundations, Raymond concrete piles having been used throughout. The freight sheds have reinforced concrete floor construction, steel frame and mill construction roof. The sides are enclosed by continuous sliding tin-covered fire doors. The sheds are divided into fire sections by additional fire doors and brick walls.

As illustrated, a transfer platform intervenes between the sheds, while tracks have been laid in such manner that freight cars may be shunted alongside both platform and shed. The sliding doors are continuous for the full length of both track and roadway sides of the shed. The terminals are both constructed on a system of units, *i.e.*,

The terminals were designed by the Engineering Department of the Canadian Pacific Railway and erected by W. S. Downing-Cook, contractor, under the supervision of D. H. Mapes, engineer of buildings, C.P.R. The cost of the structure was approximately $167,000.

Now that the freight terminals have been completed, the construction of the new station will proceed without delay. In fact the contract for its erection was awarded last week by the Canadian Pacific Railway to Mr. W. S. Downing-Cook.

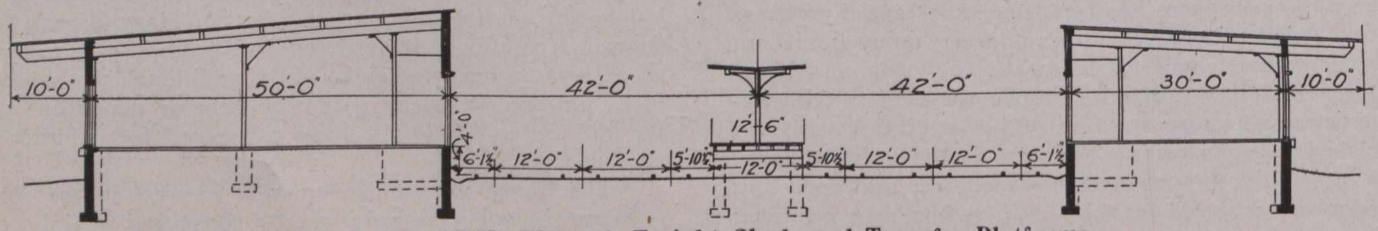


Fig. 2.—Section (G-H) Through Freight Sheds and Transfer Platforms.

WATER POWER IN NEW ZEALAND.

THE first of the New Zealand Government's schemes for developing electric power from hydraulic sources has just been completed. This plant at Lake Coleridge is the first-fruit of the much criticized Water-Power Bill, the aim of which is to provide the whole Dominion with electricity from the very plentiful supply of water-power resources, estimated at 4,000,000 horse-power. This scheme is thus interesting as an experiment, as well as an example of hydro-electric practice, and its inauguration has attracted considerable attention. It was preceded by others in various parts of the colony, and it is to be followed immediately by more enterprises authorized by Parliament, and by others under private auspices. Mr. W. Wilson, B.E., has an article in the June issue of the Engineering Magazine concerning New Zealand's hydro-electric developments. From it the following is extracted:

New Zealand is for the most part a narrow land, approximately 1,100 miles in length and 94 miles in average width. The South Island, the larger of the two, is nowhere wider than 180 miles, while throughout almost its whole length of 525 miles, a backbone of alpine mountains raises the interior to a height of as much as 10,000 or 12,000 feet. The North Island is slightly smaller, more irregular in outline, and with the exception of several volcanic peaks of about 7,000 feet, the frequent mountain chains rise to heights up to 4,000 feet. Thus it will be seen that the conditions strongly favor an abundant rainfall, and frequent changes in the land-level. Hence New Zealand is exceptionally rich in water-power.

The most numerous and generally the easiest schemes to develop occur among the mountains, where there are a myriad of large and small cataracts and waterfalls. Examples of successful plants in such situations are found at the big Waipori Falls Station, at Te Aroha, at the Holt's Creek and Punchbowl Stations of the Otira Tunnel, and at other places. The best of these have a way of occurring in hardly accessible situations, and the supply is not very constant. Storage is not as a rule easy to provide, owing to the movement of shingle during floods. It is, therefore, from the big rivers and lakes of the lower country that most power is at present being drawn. Lakes are very plentiful all over the Dominion, especially near the borders of the ranges. In many cases a direct fall can be obtained from them by tunneling, as at Lakes Kanieri and Coleridge. In other cases they act as perfect storage reservoirs for the rivers flowing from or through them, as in the case of Lake Taupo and the Waikato River, and of Lakes Rotorua and Ratoiti and the Kaituna. Finally, in the south-west of the colony there is a long stretch of coastline indented with deep fiords—submerged valleys which have been hollowed out by extensive glacier action —so that the tributary valleys are cut back, forming hanging stream-beds from which many waterfalls flow into these arms of the sea. Here the conditions resemble those existing in Norway, and excellent opportunities for cheap power are presented. At present the country surrounding the fiords is more picturesque than useful and is practically uninhabited. So far no development has been undertaken in this region.

Of all these stores of energy the Goverment has primary control and has embarked upon the policy of developing certain large schemes itself, but permits private individuals, companies, or corporations to utilize practically any water-power, subject to an annual payment for the privilege. Until the present Government assumed office in 1911, this favorable state of things by no means existed; their predecessors adopting the extremes, first of over-generosity, and then of almost complete obstruction.

About thirteen years ago a private company applied for rights to use the energy latent in the Waipori Falls, some 30 miles from the City of Dunedin. This request was granted without any payment. Not long afterwards the city corporation wished to take over the project, and purchased from the company the water-rights which had been acquired for nothing. This transaction so acted upon the Government that they switched over to the opposite policy of not parting with their water assets for any reasonable consideration. Instead, they announced, after some delay, their intention of expending £2,000,000 upon eight schemes distributed through the Dominion, at the following places:—

Locality.	H.P.	Cost.
1. Wairua Falls, North Auckland	3,000	£100,000
2. River Kaituna, South Auckland	10,000	320,000
3. Makuri, North Wellington	6,000	200,000
4. River Hutt, South Wellington..	10,000	300,000
5. Lake Coleridge, Canterbury ...	10,000	270,000
6. Kumara, Westland	3,000	75,000
7. Teviot, Otago	10,000	300,000
8. Lake Hauroto, Southland	10,000	350,000

It was proposed to make an immediate start with locations Nos. 1, 4 and 5 at once. The current from all was to be retailed on a basis of 2d. per unit for light, and 1d. for power.

However, this extensive programme was not followed. Instead, it was decided to complete No. 5 as soon as possible, and to use the experience so gained in carrying out the others. At the end of nearly four years, the plant mentioned is now in operation, but in the meantime the Government, which had held office continuously for 21 years, was replaced by one whose announced intention was to afford much greater facilities for the use of water-power. At once, a private company purchased, for £150 per annum, the rights to the Wairua Falls, No. 1 on the foregoing list, and their station is fast approaching completion. Other enterprise has taken place on smaller schemes, and is foreshadowed on a larger scale in the near future, though the rapid improvement in the lignite gas-producer has assisted the institution of small local power houses at the expense of the hydraulic central station.

New Zealand farmers are recognizing more and more the great advantages of electricity not only for lighting, but also for shearing, pumping, chaff-cutting, and the host of operations on a farm performed nowadays by machinery. Such plants, driven by hydro-electric current, are established at Kaiwarra, Glenmark, Hawarden, and Temuka, in Canterbury, and in other parts of the Dominion. So far, electric ploughing has not yet made its appearance but this should not be long delayed.

Future opportunities for power development occur over almost the whole country. Practically every one of the numerous lakes is a potential power site of the most satisfactory order, and in spite of the war activity in exploitation should continue. In one of the big schemes now under construction it was found that the electric machinery, though nominally British, was of German manufacture and could not be delivered. However, the deficiency was at once made good by an American firm and the opening will not be delayed by the change. For a long time New Zealand will be dependent upon imported machinery, the local manufacturers being at present restricted to the smaller apparatus, such as low-power transformers. However, with the assistance of plant from abroad, continuous progress must be looked for in things electrical, especially in the districts most endowed with water-power.

HYDRO-ELECTRIC DEVELOPMENT AT FOUNTAIN FALLS, ONTARIO.

During the early part of May, 1914, the Fountain Falls station of the Northern Ontario Light & Power Co., Limited, was put in commission. This plant is located on the Montreal River, 1½ miles below Ragged Chutes. The following brief description of it may be of interest. For it we are indebted to the report for 1914 of Mr. A. A. Cole, mining engineer to the T. & N. O. Ry., on the mineral industry of Northern Ontario.

A concrete dam 400 ft. long diverts the water into a short canal, where it is passed through two 1,500 h.p. I. P. Morris Co., vertical water wheels, operating under a tentative head of 30 ft. These wheels are direct connected to two 3-phase, 60-cycle, 150 r.p.m., 11,000-volt, 1,250-k.v.a. Swedish General Electric Co.'s alternating current generators.

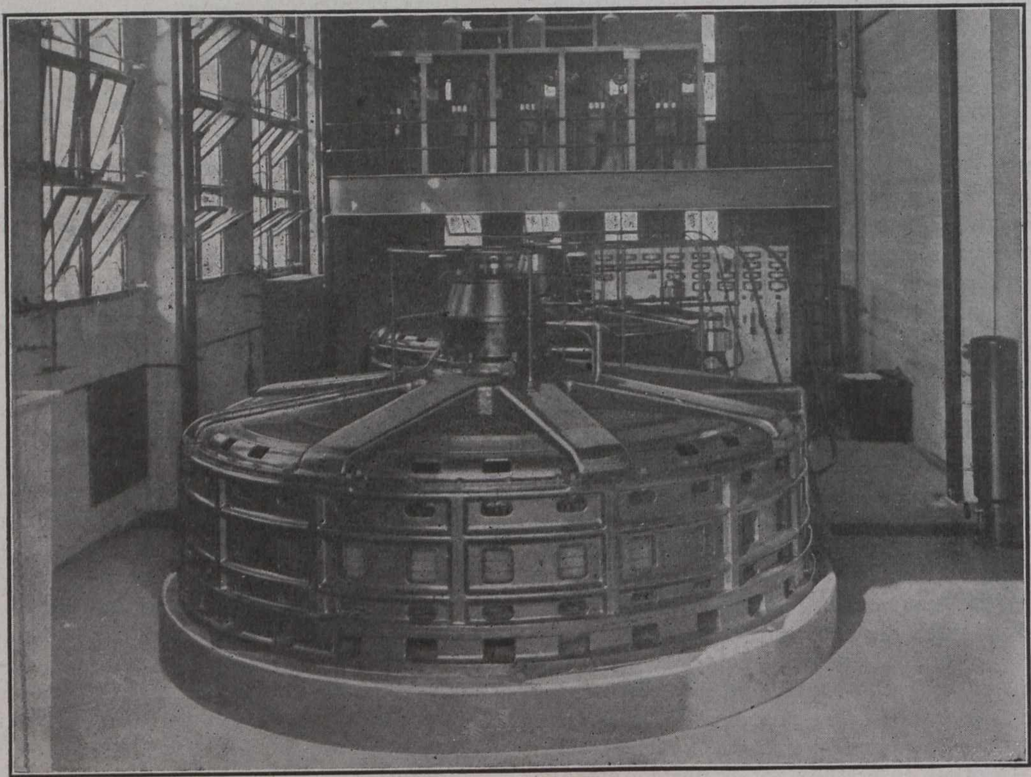


Fig. 1.—Interior of Fountain Falls Generating Station, Northern Ontario Light and Power Co., Ltd. (Switchboard and Galleries at Rear.)

Power for the excitation of these generators is supplied by two 52-kw., 220-volt, 1,200 r.p.m., motor-driven generators. Power for these exciter sets is being supplied through four 40-k.v.a. oil-insulated, self-cooled, single phase, 60-cycle transformers, which step the voltage down from 11,000 to 220 volts.

Speed control on the generators is obtained by Pelton, type "G," oil pressure governors, shaft driven from the generator shaft, and direct connected to the turbine gates. Each governor is equipped with a tachometer and a motor for switchboard control.

The dam is constructed of a combination of Cyclopean and reinforced concrete, and is of the Ogee type. It has an average and a maximum height of 12 ft. and 15 ft. respectively, to which are added 4 ft. of flash boards. It rests on solid rock foundation throughout its entire length.

The head gates, sheltered by an overhang from the power house as shown, are motor-driven. The gate house equipment comprises also stop-logs and racks. A concrete weir wall placed 10 ft. in front of the racks and extending 9 ft. below the operating water level prevents the entrance of ice and logs and damage to the racks. The gates themselves are 14 ft. 8 ins. by 9 ft. 8 ins. They are equipped with steel roller bearing surface. These gates close quickly and properly when the water wheel is operating with a full gate. They are the design of Viele Blackwell and Buck, consulting engineers, New York, who were in charge of the development.

The water wheels are of the Francis single-runner down-discharge type. They are installed in a scroll chamber of reinforced concrete with concrete draught tubes. They are each equipped with a lignum vitae guide bearing.

The sub-structure of the power house is a combination of Cyclopean and reinforced concrete. The superstructure, 26 by 66 ft. in plan and 78 ft. high, is a steel frame, with reinforced concrete walls and tile roofing, covered with tar and fine pebbles, and is equipped with a 20-ton travelling crane, with electrically operated hoist. Ninety steel frame windows, with wire reinforced glass, operated from the generator floor, together with a large ventilator on the roof, give the power house all necessary light and ventilation.

The switch-board is located at the north end of the plant, together with the motor generator exciter sets. The oil switch and disconnecting switch gallery is directly above, while above that again is the lightning arrester and transformer gallery.

This station operates in parallel with the Hound Chute, Ragged Chutes, and Matabitchouan stations belonging to the same company.

The Northern Ontario Light and Power Co. was organized in 1911 to take over the properties of the Cobalt Power Co., Limited, and its subsidiary companies, and the Cobalt Hydraulic Power Co., Limited. The company also acquired the property of the Cobalt Light, Power and Water Co., Limited, and, on October 1st, 1912, took over the business of the British Canadian Power Company. The company serves a population of about 20,000 people in the municipalities of Cochrane, Haileybury, Timmins, Sturgeon Falls, New Liskeard, Porcupine, South Porcupine, Cobalt, and the surrounding mining district, with electricity for power and lighting. It owns and operates a hydraulic air compressor plant on the Montreal River of about 5,000 h.p. under the Taylor hydraulic air compressor patents, for which system it has exclusive rights within a radius of 20 miles of Cobalt. Its hydro-electric developments consist of four plants with a total capacity of about 18,500 h.p. in addition to a number of steam-driven plants aggregating about 1,250 h.p. The system is served by about 170 miles of transmission lines.

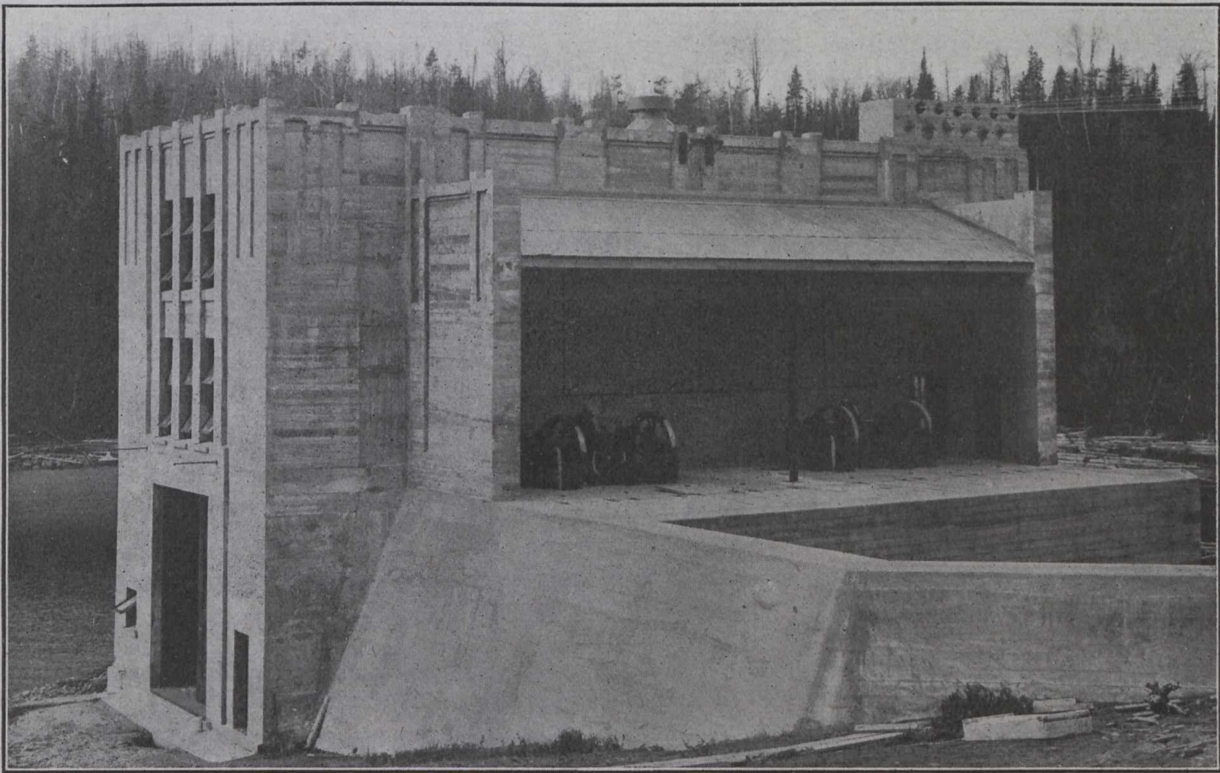


Fig. 2.—Power House, Forebay and Motor-operated Intake Gates at Fountain Falls, Ont.

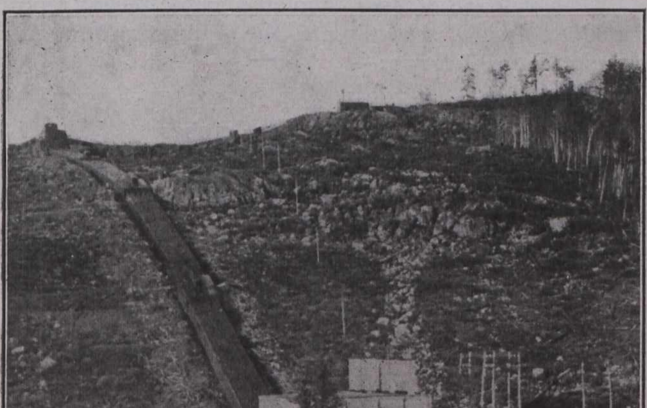


Fig. 3.—Matabitchouan Power House and Penstocks, Northern Ontario Light and Power Co., Limited.

SEWAGE DISPOSAL SCHEMES FOR EDMONTON.

Edmonton is considering four different sewage disposal schemes, prepared by the city engineer, Mr. A. J. Latornel, and involving expenditures varying from $588,000 to $761,000. Three of the schemes, estimated to cost $613,000, $675,000 and $761,000, provide for four plants at different points on the river (North Saskatchewan) for receiving and treating the sewage. The fourth scheme calls for three plants, and for a tunnel under the river to carry the South Side sewage to the North Side plants for treatment. All four schemes propose a plant on the river bank at the foot of 101st Street, to cost $50,000 on property owned by the city. This plant will likely be the first to be constructed as it is common to all schemes under consideration. Its immediate construction has been recommended by the public works committee.

SUGGESTIONS FOR THE YOUNG ENGINEER.

PROFESSOR IRA O. BAKER, of the School of Civil Engineering, University of Illinois, is quoted to have said that the chief reason why the engineer does not attain to the position in the public estimation which he might occupy is because of wrong ideals. The representative engineer magnifies the importance of technical matters; in college he is insistent upon acquiring a so-called practical education. He desires to specialize and to take only the subjects immediately connected with his chosen profession. As a consequence, he lacks breadth of view and is weak in knowledge of non-professional matters. Too often he has sought to perfect himself in technical details to the neglect of a knowledge of political procedure, of business methods, of labor conditions, or of social problems. Further, he is often seriously deficient in the ability to use correct language.

The suggestions which Prof. Baker offers to the young engineer who desires to prepare himself for a wider usefulness and a greater success, are these:

By continual care and practice, cultivate the ability to express yourself in writing and in oral speech in clear, concise, correct English. There is nothing more necessary to the young engineer who desires to attain more than a mediocre success.

Extend your horizon by reading and study of industrial and political history, political and social science, economics, labor problems, principles of banking, rate regulation, and other vital subjects.

Do not become a man of technical details nor a man of books to the exclusion of a knowledge of affairs. The successful engineer must buy materials; therefore he must have a knowledge of market conditions and of business methods. A successful engineer directs the labors of others; therefore he must know much of the motives that influence men, and must understand the point of view of organized labor, and should have at least some knowledge of the advantages and disadvantages of the different methods of payment. An engineer is frequently called upon to report upon projects; therefore he should be able to foresee all the industrial, commercial and financial conditions involved in the project, and should be able to accurately discriminate as to the relative importance of the various conflicting factors. The engineer writes specifications and makes contracts; therefore he should know something of the intricacies of the law.

LOW-TENSION TRANSMISSION LINES OF THE ONTARIO HYDRO-ELECTRIC POWER COMMISSION.

ON October 31st, 1914, the Hydro-Electric Power Commission of Ontario had completed or under construction 800 miles of low-tension transmission lines of voltages varying from 46,000 volts to 2,200 volts. This figure includes 16.43 miles of steel lattice pole line. The mileage of these lines is distributed among the various systems as follows: Niagara system, 609.68 miles; St. Lawrence system, 60.77 miles; Simcoe system, 80.15 miles; Wasdell's Falls system, 49.19 miles.

In the construction of these lines, 5,600 miles of wire weighing 3,450,000 lb., 33,000 wood poles and 383 steel towers were used. On the transmission line poles 685 miles of a single circuit telephone line has been erected for use in operating the system.

During the year 17 gangs were employed, two of which, under the direction of a forestry expert, were employed solely in trimming trees. These gangs constructed 243 miles of transmission line as well as distribution systems in 19 towns and villages and rural lines in 8 townships.

For the above lines about 200 crossing plans were prepared, and submitted to the telephone and railway companies for approval.

Low-tension distributing systems were constructed by the Commission in the towns and villages of Thamesford, Thorndale, Creemore, Cannington, Gamebridge, Brechin, Woodville, Sunderland, Elora, Fergus, Ayr, Drumbo, Plattsville, Princeton, Lucan, Embro, Woodbridge, Milton and Bolton, and rural lines in the townships of E. Flamboro, Waterloo, Norwich, Toronto, Etobicoke, York, Grantham and Brant.

The mileage of lines tabulated in the recent report of the Commission, according to the voltage and number of circuits, is as follows:—

	—Single Circuit Totals—			—Double Circuit Totals—			Single and Double Circuits Totals		
Voltage	Total, Oct. 31, 1913.	October 31, 1913, to Oct. 31, 1914.	Total, Oct. 31, 1914.	Total, Oct. 31, 1913.	October 31, 1913, to Oct. 31, 1914.	Total, Oct. 31, 1914.	Total, Oct. 31, 1913.	October 31, 1913, to Oct. 31, 1914.	Total, Oct. 31, 1914.
46,000	1.93	.....	1.93	15.50	....	15.50	17.43	......	17.43
26,400	....	94.50	94.50	59.50	7.17	66.67	59.50	101.67	161.17
22,000	89.99	16.00	105.99	63.90	....	63.90	153.89	16.00	169.89
13,200	161.77	96.25	258.02	115.79	....	115.79	277.56	96.25	373.81
6,600	6.52	.....	6.52	5.79	....	5.79	12.31	......	12.31
4,000	22.80	29.67	52.47	.....	....	......	22.80	29.67	52.47
2,200	10.35	.75	11.10	1.61	....	1.61	11.96	.75	12.71
Totals ..	293.36	237.17	530.53	262.09	7.17	269.26	555.45	244.34	799.79

The new furnaces of the Granby Company at Hidden Creek, B.C, will be ready to be blown in by July 1st, permitting of continuous operation of at least three units. This will increase the treatment facilities to approximately the same as those at Grand Forks, making possible a blister copper output at the two plants of between 30,000,000 and 40,000,000 pounds of blister copper monthly.

British Columbia occupies a length of 900 miles in the Cordillera belt extending through North and South America. This belt in the United States and Mexico has yielded close upon $4,000,000 per lineal mile. The economic geology of British Columbia is similar, and it may reasonably be expected that a similar wealth in mineral values exists in that portion of the belt within the confines of the province.

NEW RECORDS IN MIXING AND PLACING CONCRETE.

Further records for the mixing and placing of concrete with half-yard mixers were made by the forces of the Division of Terminal Construction on the south wall of dry dock No. 1 at Balboa on April 19, as reported in the Canal Record.

The regular mixer battery on the south wall consists of 4 half-yard mixers, working in units of two. One of the mixers in one of the units was closed down and the two crews of the unit fed the other mixer. During the 8-hour day, the double-crew mixer mixed approximately 321.94 cubic yards of concrete, as calculated on this basis: The total place measurement of the output of the three mixers was 655 cubic yards, mixed in 1,005 batches. Each batch averaged, accordingly, .6517 cubic yards. Of the 1,005 batches, the double-crew mixer mixed 494, which, on the basis of the average for all batches, may be taken to mean 321.94 cubic yards.

The time charged to this mixer was as follows:

	Hours.	Cost.
1 foreman	4	$ 2.71
1 subforeman	8	2.00
1 mixer runner	8	1.04
1 mixer helper	8	1.04
1 lever man	8	1.04
1 man cleaning runway	8	1.04
2 men carrying cement to hoppers	*8	2.08
2 men wheeling cement	*8	2.08
2 men in cement car	*8	2.08
18 men handling wheelbarrows	*8	18.72
1 helper on wheelbarrows	8	1.04
Total labor cost		$34.87

*8 hours for each man.

During the 8-hour period 30 minutes were lost while the chutes for the mixed concrete were being washed, and 1 hour and 15 minutes were lost in waiting for forms. The actual working time was, accordingly, 6 hours and 15 minutes. The half-yard mixer, therefore, made a record of mixing 321.94 cubic yards of concrete in 6 hours and 15 minutes, at a cost of $34.87, or $.108 per cubic yard.

The yardage of gravel used is about the same as the yardage of concrete mixed. The 18 men trundling the wheelbarrows handled, therefore, in the 6 hours and 15 minutes about 321 cubic yards of gravel, an average of 17.8 yards per man. This is equivalent to 2.85 cubic yards, or about 76.9 cubic feet per hour. As the gravel as handled at the dry dock weighs about 115 pounds to the cubic foot, each man was handling about 8,840 pounds, or 4.44 tons, per hour of working time, which is an average of over 147 pounds per minute.

A novel power plant for supplying electric lighting has been put in operation in Australia. The water power is derived from an artesian well from which the water issues under great pressure. When shut down this pressure reaches 270 pounds; and the working pressure of the jet is 190 pounds. This pressure is utilized in two Leffel wheels, which drive two dynamos, each of 10 kilowatts capacity, which supply current to a d.c. system, comprising eighty 50-candle-power metal filament lamps, the number of consumers being twenty-five, and the voltage at consumers' terminals 200 volts.

COAST TO COAST

Mimico, Ont.—The council agreed to accept the terms of New Toronto for the supply of water from the latter's new system.

Penticton, B.C.—The Kettle Valley Railway, owned by the C.P.R., has been completed for a distance of nearly 400 miles between Midway and Spence's Bridge.

McLeod, Alta.—The C.N.R. has started construction work on the McLeod branch, a large outfit of the Northern Construction Co., under Superintendent Fraleck, arriving on May 24th.

Regina, Sask.—An experimental sewage plant designed by R. O. Wynne-Roberts is now in operation and efforts are being made to devise an economical method of treating the city's sewage.

Montreal, Que.—The board of control is considering a proposal to guarantee the Montreal Tramways Co. the amount required for the construction of some new lines in the outlying parts of the city. The expenditure is estimated at about a million dollars.

Calgary, Alta.—It is stated that the extensive railway construction carried on by the Mackenzie and Mann interests to the south, and the McArthur interests to the north of the province, is practically eliminating the unemployment problem, as thousands of men are now engaged on construction work.

St. Malo, Que.—A new line of railway is being built to provide a connection between the main line of the Transcontinental and the Leonard shops. It includes the construction of a half-through steel span 100 ft. in length, resting on concrete foundation. Messrs. Cavicchi and Pagano are the contractors and have a staff of about 125 men on the work.

Toronto, Ont.—Excavation commenced last week for the new station at North Toronto to be used jointly by the Canadian Pacific and Canadian Northern Railways. Messrs. Darling and Pearson are the architects. The building will cost about $2,000,000, according to report. P. Lyall and Sons, of Montreal, are the general contractors

Vancouver, B.C.—The Joint Sewerage Commission of Vancouver has obtained from the Provincial Government the control of Burnaby Lake levels, in connection with the deepening of Brunette River, which will give better drainage to the upper end of Burnaby Lake and Still Creek. It is planned to construct a dam at the lower end of the lake to keep it at constant level the year round.

Le Pas, Man.—It is reported that the Armstrong Lake bridge on the Hudson Bay Railway was partly destroyed recently by overloading. The structure is 900 ft. long and the foundations are supported by piling. The reconstruction of the damaged part has been commenced. It is stated that the contractors suffered a loss of $54,000, including an engine, a pioneer track-layer and a number of cars of rails and ties.

Vancouver, B.C.—It is understood that the Vancouver Harbor Commission will acquire the control and use of the Kitsilano Indian Reserve. Plans for its improvement were prepared by A. D. Swan, harbor engineer, who was sent out by the Dominion Government several years ago. According to his scheme, the property will be entirely utilized and suitable provision made for the berthing of large and small ocean steamers. Provision has been made on the reserve for a large grain elevator.

Vancouver, B.C.—Grant, Smith & Co., contractors, are suing the Kettle Valley Railway Co. to recover $699,608 on the construction of the line from Penticton to Hydraulic Summit. The contractors maintain that the cost of the construction was $2,804,168.73, which, when added to the contractors' 10 per cent. profit, brings the sum to which they are entitled up to $3,084,585.60. Of this they acknowledge payment of $2,384,976.61 and sue for the balance, which is the sum mentioned in the writ.

Vancouver, B.C.—The new Government dock on the south shore of Burrard Inlet, near Salisbury Drive, is being rapidly proceeded with, and the last crib, of which there are twenty-three, was launched a week ago. A portion of the wall has been built and filling has been started at the southwest corner of the shore end of the dock. The foundations for the cribs have been practically prepared, and the remainder will be installed at an early date. Fifteen of the cribs are already in place. The design of this dock was described in *The Canadian Engineer* for April 15th, 1915.

PERSONAL.

P. W. ELLIS, of Toronto, succeeds the late Mr. J. W. Langmuir as chairman of the Queen Victoria Niagara Falls Park Commission.

E. V. BUCHANAN, new general manager of the Public Utilities Commission of London, took over the duties of office last week, succeeding Mr. H. J. Glaubitz. Mr. Buchanan was previously electrical engineer for the Commission.

H. A. FIFE has been appointed electrical inspector for Peterborough, Ont.

V. W. HORWOOD, provincial architect of Manitoba, has placed his resignation in the hands of the Minister of Public Works, Hon. T. H. Johnson.

L. J. STREET, A.Can.Soc.C.E., has been appointed manager of Algoma Steel Products, Limited, with offices at Winnipeg. The Algoma Steel Products, Limited, are general sales agents for the Algoma Steel Corporation. Mr. Street is well known to engineers throughout Canada, having been for many years the Ontario manager of the Canadian Inspection and Testing Laboratories. For the past couple years Mr. Street has been chief assistant to J. P. McNaughton, the sales manager of the Dominion Iron and Steel Company, having charge of the sales of the merchant mill products.

MALCOLM R. MELDRUM, general manager of Herbert Morris Crane and Hoist Co. of Canada, Limited, is on an extended tour of Western Canada and Western United States, accompanying Mr. Herbert Morris, Jr.

OBITUARY.

The death occurred in Woodstock, Ont., on June 1st of Mr. Charles Frederick Dibble, C.E., at the age of 75. The deceased was a well-known railway engineer and contractor. He had been in ill health for a year or more, and had not been engaged in engineering work since the completion of several contracts he had on the Transcontinental Railway. Two of his sons, H. B. and H. M., are also railway engineers and are both associate members of the Canadian Society of Civil Engineers.

PROFESSIONAL DEGREES GRANTED BY THE UNIVERSITY OF TORONTO.

The following engineer-graduates of the University of Toronto received the degree of Civil Engineer (C.E.) at the recent convocation: G. A. Bennett, J. B. Challies, A. E. Davison, Angus Smith and D. S. Stayner.

The degree of Mining Engineer (M.E.) was conferred upon Messrs. A. D. Campbell and B. Neilly.

Mr. A. M. Campbell received the degree of Mechanical Engineer (M.E.), and Mr. C. E. Palmer, the degree of Electrical Engineer (E.E.).

The new academic degree of Master of Applied Science (M.A.Sc.) was conferred upon Messrs. C. R. Avery, N. F. Parkinson, C. S. Robertson, O. Rolfson and G. E. Treloar.

The Boiler Inspection and Insurance Company's scholarship for general proficiency in mechanical engineering for the third year was awarded to Mr. L. L. Youell.

C.P.R. STAFF CHANGES.

As announced in these columns last week, Mr. George Hodge, previously general superintendent of the eastern lines of the C.P.R., became assistant to the general manager, eastern lines, on June 1st. Mr. Hodge was succeeded by Mr. A. E. Stevens, who was previously general superintendent of the Calgary division. Mr. Stevens was succeeded at Calgary by Mr. J. M. Cameron, formerly superintendent at Medicine Hat, later at Vancouver. Mr. W. A. Mather succeeds Mr. Cameron at Vancouver and Mr. C. D. Mackintosh, division engineer at Moose Jaw, succeeds Mr. Mather at Medicine Hat.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

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.

In electric-furnace work the cost of electrodes is a variable item that may, in successful processes, range from 3 to 25 per cent. of the total cost of treatment, or may even mount so high as to make a process entirely unprofitable.