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The Canadian Engineer

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LONGITUDINAL RAILWAY OF CHILI

A DESCRIPTION OF THE BUILDING OF THE NORTHERN SECTION—A 450-MILE LINE THROUGH THE CHILIAN DESERT FOR PURPOSES OF PROTECTION AND DEFENCE.

By E. H. DRURY, M. Can. Soc. C.E., M. Am. Soc. C.E.,
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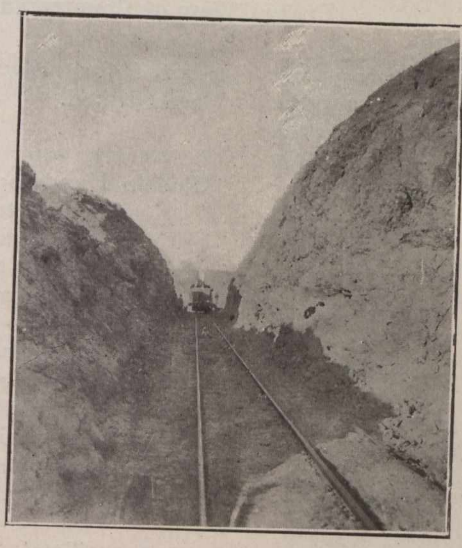
CHILI has long been the most powerful naval republic of any of the South American independencies. After the war of 1879, however, when Peru and Bolivia were despoiled of their territory by right of conquest, which included the vast nitrate beds of the Tarapaca Pampa, it was thought by the Chilian Government and politicians that it would be well to construct a longitudinal railway so that troops could be moved by land to protect their valuable acquisitions, if in the event of war the control of the sea was lost.

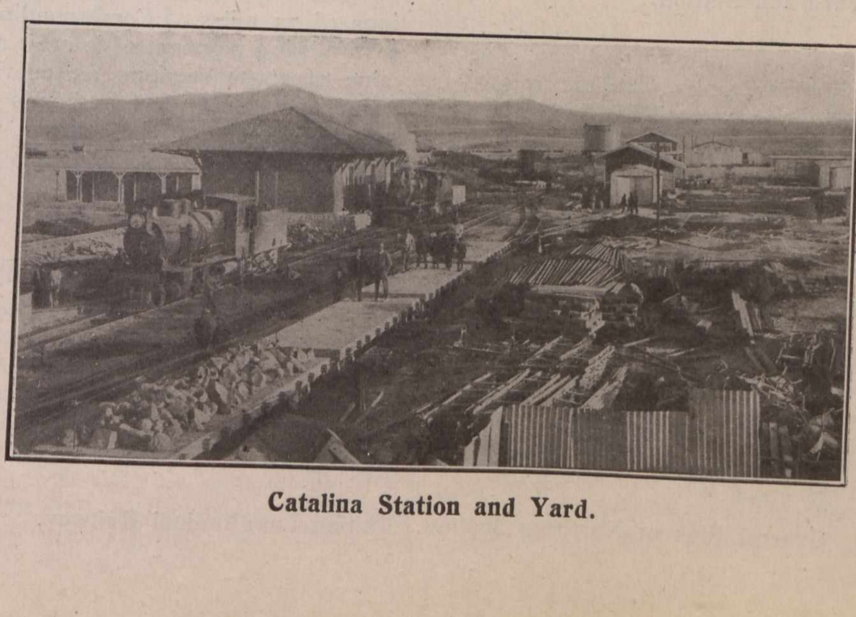
In the year 1888 the then Chilian Government, under the presidency of the late Don Jose M. Balmaceda, brought the issue into prominence by advertising the concession for the building of this railway, and among the contractors seeking the concession was the firm of Ross, Holt, Mann and Mackenzie, Sir Donald Mann and Mr. Holt going to Chili and entering into negotiations for the building of the road. But when everything was ready for the signatures of the contractors, the revolution of 1889 came into existence, and after fierce fighting at Santiago and Valpariso the Balmaceda Government was defeated and deposed, thus delaying the longitudinal railway enterprise for some years to come. It did not materialize again until it was carried into practical effect by the late President Don Pedro Montt, who, considering the railway essential to the welfare and development of the country, never rested until a contract was signed for the building of the north and south sections from Serano to Pintados, a distance of some 700 miles. The northern section was first to be signed and is dated 23rd April, 1910. This contract covers the ground from Pueblo Hundido (which is one of the inland stations of the Chanaral Railway) to Pintados, on the main line of the Iquique Nitrate Ry., a distance of 450 miles. This concession was originally granted to the Chilian Construction Co., Limited, who later transferred their rights to the Chilian Northern Ry. Company, the present holders, and who entered into a contract for the carrying out of the work with Messrs. Macdonald, Gibbs and Macdougall, Engineers and Contractors, New Broad Street, London, Eng.



A Cut Near Pueblo Hundido.

For the purpose of convenience in the construction of the line, this firm decided to divide the work into six sections, each section being connected by railway from the coast, thereby giving a route for the transportation of supplies and material to the work. The sections were as shown in Table I.

It is worthy of note that of all the railways enumerated in Table I. the only one which is of the same gauge as the longitudinal railway, viz., one metre (39.37 inches), is the state-owned Chanaral Ry., the others varying from 2 ft. 6 in. to 4 ft. 8½ in., which involves transshipment at the point of junction in order to reach the ports. The country through which the road was built being a desert, nothing was indigeneous to the soil. All material, supplies, plant, etc., was imported either from England, Canada, Germany or the United States. Chanaral was the

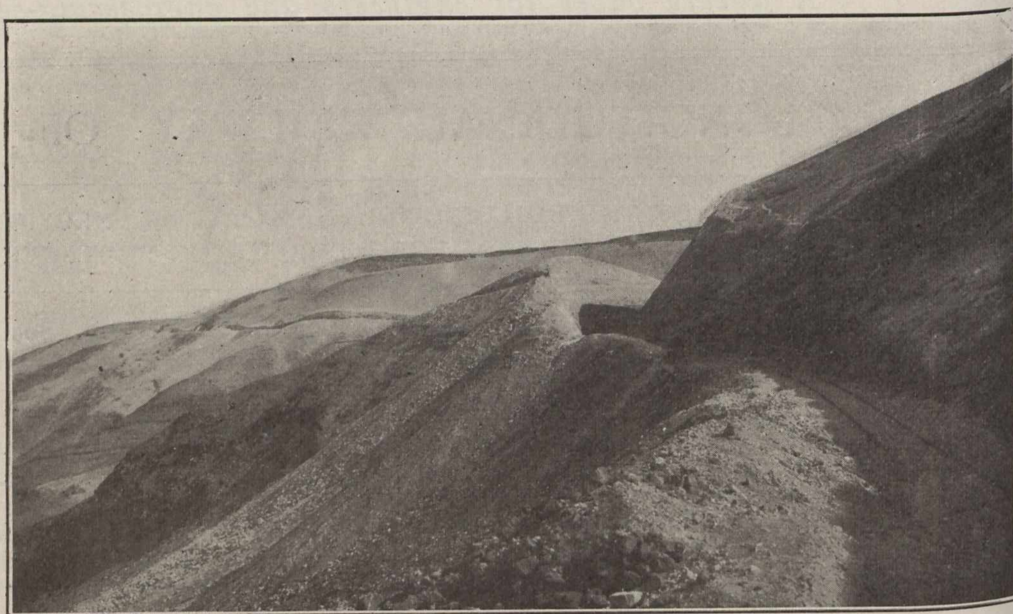


Catalina Station and Yard.

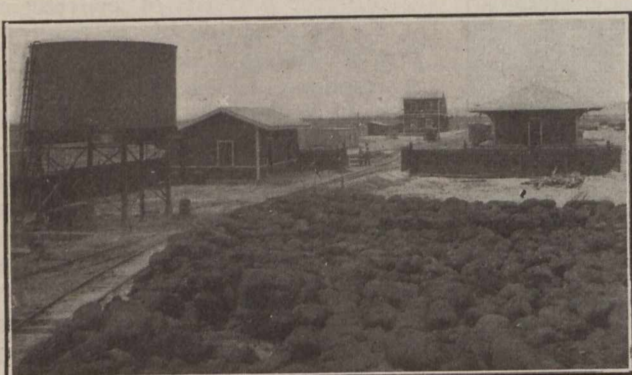
only port at which rolling stock could be landed from steamers, set up and taken direct to the work ready for service. At all other points, engines, cars, etc., were taken in piece-meal and erected at the different material yards established at the junction points by the firm.

Work was first started at El Toco in January, 1911, and the Baquedano section was commenced a week or two later, with the result that the first official train ran from Baquedano station to Toco station on the 16th September, 1911, thus forming an interior connecting link between the ports of Antofagasta and Tocopilla. The line between these points passes over the rich nitrate pampa of Tocopilla, from which industry the railway will derive the largest portion of its freight and passenger revenue.

The Aguas Blancas section was next attacked, and in rapid succession the Pintados, Catalina, and Pueblo Hundido followed. In July, 1913, the rails were joined from the north and south and by November, 1913, the whole of the line was completed and handed over to the original concessionaires. Thus in two years and ten months the total distance of 450 miles of railway was graded, track laid, telegraph lines, tanks, stations, freight sheds, round-houses, work shops, machine shops, car sheds and turntables were erected; and all rolling stock necessary for the equipment of the road delivered and set up ready for operating. The rolling stock included sleepers, diners, 1st, 2nd and 3rd class passenger cars, flats, boxes, open boxes, cattle cars, powder vans, tank cars and 27 engines of different classes. This record for railway building in Chili is absolutely unprecedented.



Typical View of Country and Nature of Work.

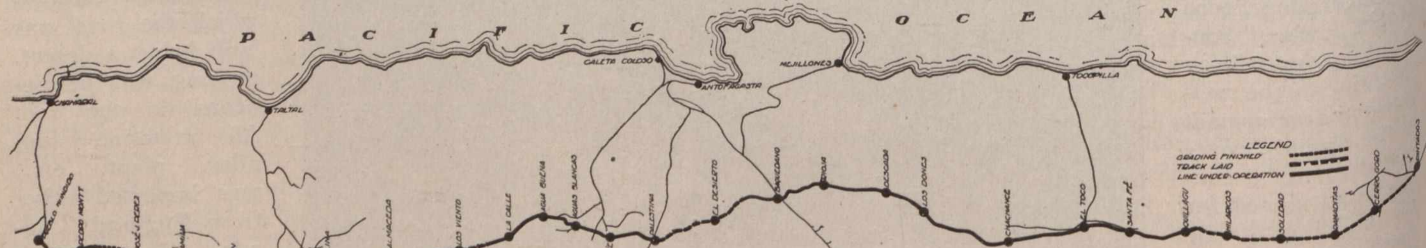


Pintados Yard and Station.

TABLE I.

Pueblo Hundido (Junction with Chanaral Ry. northward to Altimira)	50 miles
Altimira northward to Catalina (Junction with Taltal Ry.)	44 "
Catalina northward to Aguas Blancas (Junction with Aguas Blancas Ry.)	81 "
Aguas Blancas northward to Baquedano (Junction with Antofagasta and Bolivia Ry.)	70 "
Baquedano northward to El Toco (Junction with Tocopilla Ry.)	98 "
El Toco northward to Pintados (Junction with Iquique Ry.)	107 "
Total	450 miles

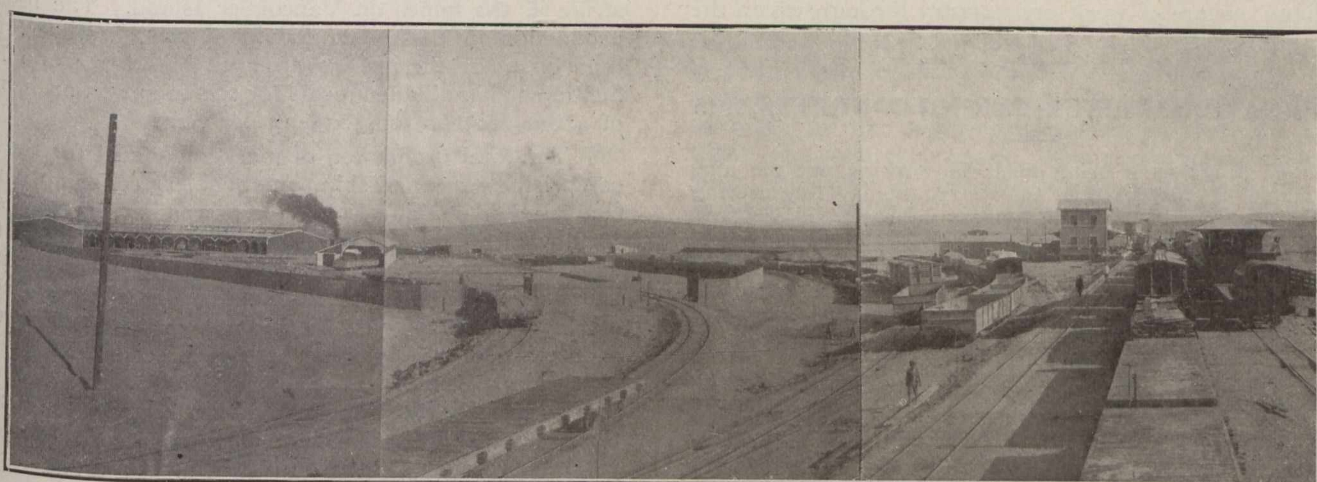
The work was accepted by the Government in sections of 75 miles. Corresponding decrees were issued guaranteeing payment of interest and amortization on the value of these sections as provided by the contract. Based upon these decrees bonds have been successfully issued in London. The contract was to have been completed in April, 1914, and was therefore finished five



General Plan of Northern Section, Chilian Longitudinal Railway.

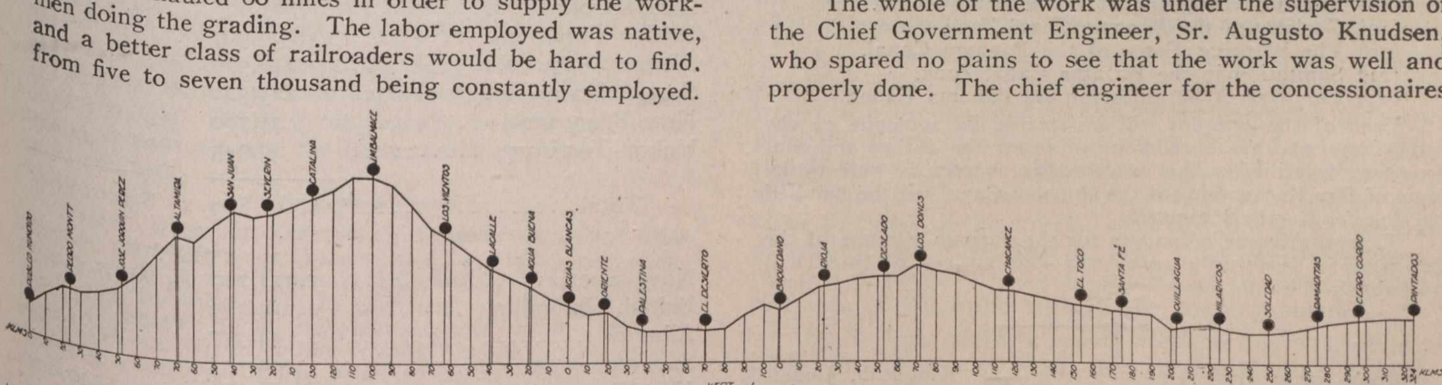
months before date of expiry. Thus by the completion of the Northern section the whole of the great Chilian nitrate districts are now connected by rail with Santiago, Valpariso and Port Montt, the total length of the system being 1,600 miles.

The northern section is built across the great Chilian desert on which for the whole distance of 450 miles one cannot find a blade of grass or a living insect. In fact, it is absolutely devoid of life. Darwin, in his travels, which included the Chilian desert, states: "It is the most perfect desert in the world."



Baquedano Yard, Showing Car and Engine Sheds.

In building the line, the water question was one of the most serious problems, but by hard work in drilling the contractors were eventually rewarded, and secured a good supply from wells at different points on the line. In some places it was found necessary to erect condensers as the only water obtainable was salt. These plants yielded a supply of 15,000 gallons per day, and gave excellent satisfaction. At some of the wells, owing to the hardness of the water it was necessary to erect softeners, the water first passing through chemicals then to the tank for engine supply. During construction water was often hauled 60 miles in order to supply the workmen doing the grading. The labor employed was native, and a better class of railroaders would be hard to find, from five to seven thousand being constantly employed.



Profile of Route of Northern Section.

As nothing grew in the country, all supplies of every sort and description were imported, the majority of the ties, telegraph poles and timber for stations, etc., were obtained in British Columbia, although a few ties, etc., came from Southern Chili. The stations were constructed with timber frame covered with corrugated iron; matched board partitions. This was the rule with all buildings except the main machine shops at Baquedano which were of steel frame covered with corrugated iron. Tanks and softeners were of steel, with steel frame on concrete foundations.

There was only one bridge on the whole line, this being at Quillagua, across the Loa River valley. As it never rains in the country there are no streams to cross.

As the sections were accepted by the Government, and the decree issued, the contractors were obliged to operate these accepted sections. Before the final acceptance of the whole line the contractors were operating 250 miles, on which a large traffic in the haulage of nitrate and supplies to the different nitrate plants along the line was developed. During an outbreak of yellow fever in the port of Tocopilla in the summer of 1912, the road was able to maintain the traffic between the ports of Tocopilla and Antofagasta by the interior connecting link, thus saving thousands of pounds in keeping the many nitrate plants in supplies, thereby avoiding their closing down during the epidemic. Up to this date all supplies had been shipped to Tocopilla by sea and then to the Pampa by the Tocopilla Railway. As the port was in quarantine during the epidemic, ships were not allowed to enter or leave.

The whole of the work was under the supervision of the Chief Government Engineer, Sr. Augusto Knudsen, who spared no pains to see that the work was well and properly done. The chief engineer for the concessionaires was Mr. W. B. Leane, A.M.I.C.E., with headquarters at Santiago. The headquarters of the contractors, Messrs. Macdonald, Gibbs and Macdougal, was in Antofagasta, the chief sea port of Northern Chili. Here they employed a large staff, the heads of the different departments being either English or Canadian. The whole work was under the direct control of the general manager. The partners, Messrs. Arthur C. Macdonald, a Nova Scotian by birth and a graduate of the Royal Military

College of Canada, and Edward T. N. Macdougal, are both well-known engineers and contractors in London and Chili. In the latter country they have carried a number of large and important works to a successful finish.

To more fully give a comprehensive idea of this undertaking, a map is given of the route showing connections with the coast ports, a grade profile showing altitudes which vary from 3,250 to 7,852 feet above the sea, and a number of photographs illustrative of the buildings, nature of work and country through which the railway passes.

INTERNATIONAL ENGINEERING CONGRESS, 1915

Rapid progress is being made in working out the final programme of papers for the International Engineering Congress to be held in San Francisco in 1915.

The first volume of the publication of the Congress will consist of a series of articles descriptive of the various technical features of the design and construction of the Panama Canal. The various topics which will be treated are noted in the following list:—

(1 Introductory Chapter.
(2) Dry Excavation for the Panama Canal.
(3) Dredging in the Panama Canal.
(4) Terminal Works, Dry Docks, and Wharves of the Panama Canal.
(4) Permanent Shops of the Panama Canal.
(6) Coaling Plants and Floating Cranes of the Panama Canal.
(7) Meteorology and Hydrology of the Panama Canal.
(8) Design of Locks, Dams, and Regulating Works of the Panama Canal.
(9) Method of Construction of the Locks, Dams, and Regulating Works in the Atlantic Division of the Panama Canal.
(10) Method of Construction of the Locks, Dams, and Regulating Works in the Pacific Division of the Panama Canal.
(11) Design of Lock Walls and Valves for the Panama Canal.
(12) Design of the Spillways on the Panama Canal.
(13) Gates of the Panama Canal Locks.
(14) Electrical and Mechanical Installations of the Panama Canal.
(15) Emergency Dams above Locks of Panama Canal.
(16) Municipal Engineering and Domestic Water Supply in the Canal Zone.
(17) Reconstruction of the Panama Railroad.
(18) Aids to Navigation of the Panama Canal.
(19) Geology of the Panama Canal Zone.
(20) The Working Force of the Panama Canal.
(21) Sanitation in the Panama Canal Zone.
(22) Purchase of Supplies for the Panama Canal.

Each of these topics will be treated by someone on the canal force who has been responsible for the design and construction described. The introductory chapter as well as the topic of Dry Excavation for the Panama Canal will be handled by Colonel Goethals himself.

The programme of papers for the various sections of the Congress is practically completed and notices of them will be published in the near future.

Buoys of reinforced concrete built for Kingston, Jamaica, weigh each about 5 tons, carry about one ton of ballast, and are said to cost a little less than half as much as steel buoys of the same size. The buoys are cylindrical in shape, with the bottom concaved to give protection to the mooring chain eye bolt. The sides have curved horizontal ribs, with bottom reinforced bars built up inside the shell, and waterproof cement on the outside and inside builds up the total thickness of the sides to 3 inches. The top is a solid slab, with reinforcement extended down the side. A temporary manhole serves for removing the interior centring and for convenience in lowering; but its cover is sealed in place when the work is finished. As water sometimes leaks in during the first few days a buoy is in use, a pump hole with brass screw cap is provided.

COAL AND COKE PRODUCTION IN 1913.

THE coal mining industry in Canada in 1913 was marked by an increased production in the Maritime provinces of Nova Scotia and New Brunswick and in the Province of Alberta and a falling off in the provinces of Saskatchewan and British Columbia. In the latter province the decrease was entirely due to the continuance throughout the year of the labor strike in the mines on Vancouver Island. The lessened production in these two provinces was, however, more than offset by the increased output in Alberta and Nova Scotia so that the net result for the year was an increase of about 602,260 tons or 4.15 per cent.

The total production of marketable coal for the year comprising sales and shipments, colliery consumption and coal used in making coke, etc., was 15,115,089 short tons, valued at $36,250,311, as against 14,512,829 tons, valued at $36,019,044, in 1912. Nova Scotia shows an increase of 188,839 tons, or 2.4 per cent.; Alberta an increase of 903,800 tons, or 27.9 per cent.; Saskatchewan a decrease of 16,167 tons, or 7.1 per cent., and British Columbia a decrease of 494,548 tons, or 15.4 per cent. The figures for the Yukon represent for 1913 the production from the Tantalus field only, no record having as yet been received of the output below Dawson.

The production by provinces during the past three years, as given in a recent preliminary report by John McLeish, B.A., of the Division of Mineral Resources and Statistics, Canada, is shown in Table I.

Table I.—Production of Coal by Provinces.

Province.	Tons.	Value.
	—1911—	
Nova Scotia	7,004,420	$14,071,379
British Columbia	2,542,532	7,945,413
Alberta	1,511,036	3,979,264
Saskatchewan	206,779	347,248
New Brunswick	55,781	111,562
Yukon Territory	2,840	12,780
Total	11,323,388	$26,467,646
	—1912—	
Nova Scotia	7,783,888	$17,374,750
British Columbia	3,208,997	10,028,116
Alberta	3,240,577	8,113,525
Saskatchewan	225,342	368,135
New Brunswick	44,780	89,560
Yukon Territory	9,245	44,958
Total	14,512,829	$36,019,044
	—1913—	
Nova Scotia	7,972,727	$17,796,265
British Columbia	2,714,449	8,482,653
Alberta	4,144,377	9,462,836
Saskatchewan	209,175	347,685
New Brunswick	70,311	140,622
Yukon Territory	4,050	20,250
Total	15,115,089	$36,250,311

The exports of coal in 1913 were 1,562,020 tons, valued at $3,961,351, as compared with exports of 2,127,133 tons, valued at $5,821,593, in 1912, a falling off of 565,113 tons or over 26 per cent.

Imports of coal during the year included bituminous, round, and run of mine 10,743,473 tons, valued at $21,756,658; bituminous slack, 2,816,423 tons, valued at

$4,157,622; and anthracite, 4,642,057 tons, valued at $22,034,839; or a total of 18,201,953 tons, valued at $47,949,119.

The imports in 1912 were, bituminous, run of mine, 8,491,840 tons, valued at $16,846,727; bituminous slack, 1,915,993 tons, valued at $2,550,992, and anthracite, 4,184,017 tons, valued at $20,080,388, or a total of 14,595,810 tons, valued at $39,478,037.

Thus the increase of imports of coal in 1913 amounted to a total of 3,606,143 tons, or nearly 25 per cent. The increase in the imports of bituminous run of mine being 2,251,633 tons, or 26.5 per cent., increased imports of slack 900,430 tons or 47 per cent., increased imports of anthracite 458,040 tons or 11 per cent.

The apparent consumption of coal during the year was 31,685,456 tons as against a consumption of 26,934,800 tons in 1912. Of the consumption in 1913 about 42.8 per cent. was from Canadian mines and 57.2 per cent imported.

Coke.—The total output of oven coke during 1913 was 1,517,133 tons of 2,000 lbs., made from 2,147,913 tons of coal of which 1,598,912 tons were mined in Canada and 549,001 tons imported. The total quantity of coke sold or used by the producers during the year was 1,530,499 tons, valued at $5,547,694.

In 1912 the total output was 1,406,028 tons and the quantity sold or used by the producers 1,411,229, valued at $5,164,331.

The output by provinces in 1913 was: Nova Scotia, 920,526 tons; Ontario, 411,643 tons; Alberta, 65,104 tons, and British Columbia, 319,860 tons. That of Ontario was entirely from imported coal.

By-products from coke ovens recovered during the year included 10,608 tons ammonia sulphate; 8,371,600 gallons of tar and 3,353,731 thousand feet of gas, and the total value would approximate $866,150.

The ovens of the Acadia Coal Co. and Londonderry Iron and Mining Co. in Nova Scotia, the Atikokan Iron Co. in Ontario, the West Canadian Collieries and Leitch Collieries in Alberta and the Canadian Collieries, Limited, in British Columbia were idle throughout the year. At the end of the year there were 1,720 ovens in operation and 1,325 idle as follows: Nova Scotia, 572 active, 376 idle; Ontario, 110 active, 100 idle; Alberta, 134 active, 233 idle; British Columbia, 904 active, 426 idle.

The exports of coke during 1913 were 68,235 tons, valued at $308,410, and the imports 723,906 tons, valued at $2,180,830. In 1912 the exports were 57,744 tons, valued at $252,763 and the imports 628,174 tons, valued at $1,702,856.

Messrs. Ohrt and Ouistgoord, Danish engineers, have prepared plans and an estimate of cost for a submarine channel tunnel to connect Denmark and Sweden. According to the plans, the railway will be carried along the coast south from Copenhagen on an embankment, and the first part of the tunnel will be under the "Drodg," as that part of the Sound is called which lies between the mainland and the little island of Saltholm. The railway will run across the island above ground and then dip under the Sound again, till it reaches the west coast of the Swedish province of Schonen. The end of the tunnel will be at Limuhamm, which is a little to the south of Malmo. The entire length of the new railway will be about 30 miles, of which nearly 9 will be submarine tunnel. The greatest depth at which the tunnel will run will be about 100 feet, and it is estimated that the undertaking can be completed in 5 years at the cost of about $25,000,000. The tunnel will be worked by electricity, and will have to be driven through the same kind of stratum, grey chalk, as would the tunnel between England and France.

ORGANIZATION AND METHODS OF STREET CLEANING DEPARTMENTS.*

By William H. Connell,
Chief, Bureau of Highways and Street Cleaning, Philadelphia.

The organization and methods of street cleaning is a comparatively new field for the engineer, and in this respect it differs from the other branches of highway engineering, such as the construction and repair of pavements, which have always been—at least in some localities—more or less under the jurisdiction of the engineer, even though only considered seriously by the engineering profession and the public within the last few years. The construction, maintenance and care of pavements is distinctly a highway engineering problem, and the cleaning of the pavements is a part of this work, and the highest point of efficiency will never be reached until it is so recognized.

We all agree that ease of operation is the most important factor to be considered in any organization, and this cannot be accomplished without centralizing the control of all the functions so closely related and interrelated with respect to the different branches of the work that there is bound to be an overlapping of jurisdiction and a certain amount of duplication of work and lost effort if under separate organizations. This is the case where highway and street cleaning work are under separate control, and it is for this, aside from many other reasons, that the cleaning of streets is properly a function of the organization having jurisdiction over the construction and maintenance of the highways. It is obvious, from a business and engineering point of view, that the logical way to handle both of these branches of highway work, in order to attain the greatest economy and efficiency, is through one organization, which would properly be the highway department. Unfortunately, most of the discussions and papers written relating to highway and street cleaning organizations have been confined to an outline of the methods of carrying on the work of existing organizations. A careful review of the ground covered in these articles forcibly suggests that the field cannot be economically and properly covered through separate departments, and that the inevitable solution is the one organization controlling all the branches of the work relating to the highways.

A proper highway engineering organization, composed of a personnel capable of controlling such work, would also be equipped to handle the collection and disposal of ashes, garbage and waste with far less additional expense than through a separate organization, and, as the ashes and rubbish should be collected previous to cleaning the streets, each cleaning and collection schedule bears a relation to the other, and, therefore, the line of least resistance would be to carry on both branches of the work through the one organization.

In Europe, street cleaning work is more generally under the supervision of the engineers than in this country, and it is usually under the control of a department having jurisdiction over the construction and maintenance of the pavements.

In Paris, the street cleaning authorities are charged with the construction and maintenance of streets and sidewalks, as well as with sweeping the streets and sidewalks, sprinkling roadways, collecting house refuse and

* Lecture delivered by Mr. William H. Connell before the Graduate Students in Highway Engineering at Columbia University on January 15th, 1914.

removing dirt, ice, and snow from the streets. The work is done by a branch of the Department of Public Works and is under engineering supervision.

In New York there is a street cleaning department having charge of the street cleaning, removal of snow, collection and disposal of ashes, garbage and rubbish, in the Boroughs of Manhattan, Bronx and Brooklyn. In each of these Boroughs there is a separate department having charge of the construction and maintenance of highways. In the Boroughs of Richmond and Queens the street cleaning, collection and disposal of ashes, garbage and rubbish come under the jurisdiction of the Department of Public Works, as does the construction and maintenance of highways.

In Chicago, the Bureau of Streets embraces street cleaning, collection of ashes, garbage and refuse, the removal of snow, and also street repairs, but not the construction of pavements.

The St. Louis Street Department embraces the construction and maintenance of streets, street cleaning, collection and disposal of ashes, garbage and refuse, and the removal of snow.

In Washington, the street department has jurisdiction over the construction and maintenance of streets, street cleaning, collection of ashes, garbage and refuse, and the removal of snow.

In Philadelphia, the Bureau of Highways has control over the construction and maintenance of streets, street cleaning, collection and disposal of ashes, garbage and refuse, and the removal of snow.

The above mentioned departments also have jurisdiction over other matters which are aside from the subject of this paper and will not be taken up, the object being, first, to point out the necessity for placing street cleaning work, including the removal of ashes, garbage and refuse, etc., under engineering supervision, and second, to combine this work with the general highway work. Of the cities mentioned the New York street cleaning organization—although second only from a point of efficiency to that of Washington—is founded on the wrong principle, inasmuch as it has not been an engineering department and is under separate control from the departments having jurisdiction over the construction and the maintenance of highways. The ideal organization for New York City would be somewhat along the following lines:—

The Bureau of Highways to have jurisdiction over the construction and maintenance of highways and street cleaning for the whole city. This would result in more uniform methods and more efficiency and economy in carrying on the work than exists under separate organizations, each working independently of the others. Of course, each Borough should have a voice in the management, probably through an Engineering Commission, somewhat on the order of the Board of Estimate, but the methods of carrying on both of these branches of highway work should be uniform in all of the Boroughs. New York has been selected to show the absence of engineering supervision in street cleaning and co-operation in both of these important branches of municipal work, simply because it is more in the public eye than any other city, and the generally accepted theory that one central body should control, so far as is possible, any one particular line of work, such as highways and street cleaning, has not been put into effect, even in this progressive municipality.

Cost of Cleaning Different Types of Pavements.—We cannot divorce the construction from the maintenance and care of the pavements, as the fundamental principles that should govern the selection and design of a pavement must necessarily take into consideration, amongst other things, the cost of the maintenance and its desirability from a sanitary point of view; and obviously in this connection the character and cost of street cleaning is a most important factor, as the welfare of the community must be considered, for dirty pavements are not only a great annoyance, but they spread disease, and no stone should be left unturned to combat this evil.

Aside from the financial, which is the first and most important consideration in any undertaking, the two basic principles that should govern the selection of a pavement are the traffic and sanitary requirements. Under these headings the gradient, first cost, cost of maintenance, noiselessness, social and local conditions, street cleaning, etc., may be grouped. In determining upon the proper pavement for the vast majority of streets in our municipalities, we should assume that the public health of the community demands that the pavements be kept clean. Therefore, the cost of cleaning during the life of the pavement is one of the primary considerations, and where the traffic conditions, aside from reasons due to gradient, might call for a stone block pavement, the cost of cleaning during its probable life might make it not only desirable but more economical to substitute an asphalt pavement on account of the lesser cost of cleaning. There is practically no definite data on this subject, but the following quotations from the report of a committee appointed in 1907 by the Mayor of New York City to investigate street cleaning methods, and from the Superintendents' Handbook on Cleansing, by Arthur May, Superintendent of Cleansing in the Metropolitan Borough of Finsbury, London, give a very good idea of the possibilities and value of collating reliable data along these lines for use in computing the cost of the maintenance and care of the pavements.

The following is quoted from the report of the New York Commission:—

"There is a very marked difference between the quantity of dust left upon the pavements of various kinds. Thus, if we call the average volume and weight collected from the sheet asphalt pavements 100, the relative quantities from other kinds of pavements were:—

	Volume.	Weight.
From sheet asphalt	100	100
From block asphalt	130	182
From wood block *	332	145
From granite block	1,081	912

After careful consideration of all the facts available, we estimate the average relative cost of cleaning, equally well, the various kinds of pavements in use in the city under similar conditions of repair as follows:—

Sheet asphalt pavement	100
Wood block pavement (new)	105
Asphalt block pavement	115
Brick pavement	120
Wood block pavement (old)	125
Medina block pavement	130
Granite block pavement	140
Belgian block pavement	150
Cobblestone pavement	3,000

On the assumption of 100 cleanings per year, it may well be shown that the annual cost of cleaning equally

* It should be said that the wood block pavement on which the examination was made is one of the oldest of its kind in the city, and its surface, being uneven, caught and held an uneven quantity of dust. Wood block pavement, when comparatively new, should compare favorably with asphalt block pavement in its freedom from dust-retaining qualities.

a mile of each of the pavements named over what it would be if sheet asphalt were substituted, would be as follows:

Wood block pavement (new)	$ 26.40
Asphalt block pavement (average condition)	79.20
Brick pavement	105.60
Wood block pavement (old)	132.60
Medina block pavement	158.40
Granite block pavement	211.20
Belgian block pavement	264.00
Cobblestone pavement	1,584.00

In speaking of the pavements of London, Mr. May says:—

"The four types of carriage-way pavings that are in general use are asphalt, wood, granite and other stone sets, and macadam. The order in which they are placed is, to all intents and purposes, the degree in which they lend themselves for cleansing, and, although the difference between the first three is not very great, there is no doubt that from a cleansing point of view, asphalt supercedes all others.

The following figures will give some idea of the relative cost per yard of cleansing the four kinds of road surfaces: Asphalt, 12 cents; wood, 76 cents; granite, 83 cents; macadam, $3.

"The above figures represent the cost per annum for the scavenging of one square yard of such roadway under equal conditions.

"It has been found that for every eight loads of slop removed from macadam roads, two loads are removed from granite sets, one and a half loads from wood paving, and half a load from asphalt."

If street cleaning had been more generally under the control of highway engineering organizations it is probable that we would be in possession of more definite data relating to this fixed charge in connection with the maintenance of our pavements.

Day Labor vs. Contract System.—There is one point in connection with street cleaning work that is generally agreed upon, both in this country and abroad, namely, the work involves so much detail, for which there are no definite units, that it can be more economically and better done by labor employed directly by the municipality than by the contract system. Philadelphia is the only one of the twenty-five largest municipalities in this country where the contract system is employed, and in this municipality the excessive inspection charge for the supervision of the work, aside from the fact that the work could be carried on more efficiently by day labor, is sufficient argument for municipal operation.

Uniforming Employees.—It also appears to be generally accepted that the street cleaning forces should be in uniform, and this is the case in the twenty-five largest municipalities in this country. In this respect it is singular that about nineteen years ago, when Col. Waring put the New York street cleaning force in uniform and established a more or less military organization, he was ridiculed by all the local newspapers and a number of others throughout the country. The wisdom of the step taken by Col. Waring, however, is generally appreciated to-day, as it is necessary to have a more or less military organization in connection with work of this character, and the uniforming of the force not only makes the men more conspicuous and permits the public to act as self-constituted inspectors, but raises the standard of the work and has the moral effect of increasing the efficiency through the pride the men take in the work.

Sources of Street Dirt.—Before going into the methods of street cleaning, it will be advisable to consider the origin and volume of street dirt, which is derived from a number of different sources, the principal ones of which may be summarized under the following headings:—

1. The excrement of animals.
2. Material lost by passing vehicles.
3. Dirt swept from sidewalks and thrown from buildings into the street.
4. Dirt from unpaved streets and alleys.
5. Falling leaves.
6. Building construction.
7. Soot and dust from the air.
8. Material originating from the wear of pavements.
9. Dirt due to scavengers picking over refuse placed on the street for collection.

To give an idea of the volume of street dirt collected, the Commissioner of Street Cleaning of New York in his report for 1912 states: "In the collection of the waste for this year we have handled 2,755,897 tons of ashes and street sweepings, 210,652 tons of rubbish, and 340,815 tons of garbage, a total of 3,307,364 tons. This accumulation, if placed in City Hall Park, would completely cover that area (8 acres) with a heap whose top would reach to a height 85 feet above the top of the new Municipal Building (or about 650 feet)."

Preventive Street Cleaning.—In considering some of the principal sources of street dirt, such as material lost by passing vehicles, dirt swept from sidewalks and thrown from buildings into the street, dirt from building construction, it is very evident that our streets could be made very much more sightly and the work of street cleaning carried on at a much less cost, if we had the proper kind of co-operation from the public, as the three principal causes of street dirt just mentioned could be entirely eliminated. This brings up one of the most important problems in connection with street cleaning, which is termed "Preventive Street Cleaning," and deals with the educational and publicity work being carried on to educate the people to use the same degree of care in connection with the streets that they do in their homes.

When Col. Waring was Street Commissioner of New York City he formed leagues of school children to teach their parents the importance of refraining from throwing refuse upon the pavements. At the time this was a novel way to reach the people in connection with preventive street cleaning work, but it is generally accepted to-day as one of the best means of carrying on work of this kind, and in Philadelphia a woman is employed in the Street Cleaning Department just for the purpose of securing this kind of co-operation from the school children, Boy Scouts, and civic organizations. The results from the educational campaign that is now being carried on in the different cities throughout the country will be more in evidence when the children of to-day have grown up, as street cleaning work, conducted on a scientific basis, is comparatively new, and a number of the older people do not show the interest that the growing citizens do in this or other branches of municipal work.

It is purely an educational campaign, but, like everything else, must be backed up by the law, and will often require a few arrests for offences, such as leaky wagons, throwing paper and store sweepings into the street, etc., to drive home the importanct of living up to the laws and ordinances regulating these matters. A good example of the kind of co-operation we want in this respect occurred in Philadelphia recently, when one of the owners of a large manufacturing establishment requested the

Department to help him keep clean the streets in the vicinity of his business by arresting any of his employees found throwing paper or sweepings into the streets, or violating any of the laws or ordinances designed to help keep the streets clean.

Waste Paper Cans or Baskets.—In many of the progressive cities in this country waste paper baskets or cans have been placed at different prominent locations throughout the city. In some cases these are paid for by the city, and in others by civic organizations interested in this work.

Scavengers.—One of the greatest sources of annoyance and unnecessary littering of the streets in many of our municipalities is due to scavengers, a class of people —men, women and children—who pick over the refuse placed on the curb for collection for rags, bottles, paper and other saleable products, and whenever they have an opportunity work in the same manner on some of the public dumps. In the course of their operations they always scatter a certain amount of ashes and dirt, etc., on the street. This trouble is also a source of annoyance in European cities, although they have it more generally under control. In Paris, for instance, there are twenty to thirty thousand scavengers operating in this way. Just before the house refuse is to be collected they go along the streets, spread a square of burlap or other cloth upon the sidewalk and tip the refuse can over on it and overhaul the contents, depositing in a bag the saleable products picked out. Thus they avoid littering the streets, and this is one of the conditions under which they are allowed to operate. The city authorities, however, have apparently been unable to rid the city of them, although they are not as objectionable as they might be, due to being under control.

Standard Methods.—In so far as street cleaning is concerned there is no such thing as standard methods in this country, or, if I am correctly informed, abroad. Each city in this country until only recently has been working independently of the other cities and without profiting by their experience. The report of the Chicago Bureau of Efficiency for 1913 states, in referring to data from other American cities in connection with a very exhaustive investigation carried on relating to street cleaning matters, that: "Inquiries directed to the larger cities of the country as to the methods and systems used in the cleaning and repair of streets and alleys and the collection of municipal wastes brought forward replies from twenty-five of the larger municipalities. The analysis of the information received showed the diversity of methods and conditions and a general lack of uniformity in maintaining uniform records and standards, and it was found impossible to use the same as a basis for comparison."

Referring to the work of the Chicago Bureau of Efficiency, which has been very commendable, both in the scope of the work and the character of report submitted, one cannot help but feel that what is really needed in this country, and particularly at this time— when all our leading cities are conducting investigations relating to all the branches of public works—is an association whose principal membership would consist of the cities and Public Works Departments throughout the country, organized for the purpose of collating data which would be of value to all municipalities, and would enable one to profit by the experience of others, and establish, in so far as the fundamental principles are concerned, standards for all classes of work, subject, however, to modification from year to year through investigations of committees appointed from the different cities and Public Works Departments for this purpose. This would enable all the cities to keep abreast of the times and would result in more uniform methods in all branches of public work throughout the United States. The Association for Standardizing Paving Specifications, which was conducted along these lines, and which accomplished more real work of general value to the country at large in the short period of its existence than any other society organized for similar purposes, has been recently discontinued. This was decidedly a step backward and is to be very much regretted, as this Association was founded on the correct principle, and its work was made a part of the work of the municipalities. It would appear to have been a wiser policy to have enlarged the scope of this Association to embrace all branches of public work.

Street Cleaning Methods Abroad.—In speaking of conditions abroad, it was recently said by an engineer, who has made an extensive study of street cleaning methods, that, taking into consideration the number of years they have been at it, the cost of labor and appropriations made, it might be expected European cities would be much further advanced than they are to-day. This is borne out by the following extracts from articles on street cleaning, from which it would appear they are not as far advanced as we would be led to suppose through comments of different citizens who have visited European and continental cities.

Commenting upon street cleaning in Paris, Soper, in his book on "Modern Methods of Street Cleaning," published in 1909, states: "Paris is universally conceded to be one of the cleanest and most beautiful cities. Many of its streets have been built in accordance with wise and comprehensive plans, a fact which has contributed substantially to its successful development."

Two years later the "Surveyor" for 1911 (an English publication) stated: "The following extract from an official report shows that Paris has somewhat fallen from its lofty heights, and, while the English towns have rapidly improved, the city of Paris has quite lost its supremacy:—

"The upkeep of the streets and roadways of Paris (the correspondent of the "Times" states) costs 600,000 pounds sterling ($3,000,000), and 5,000 men are employed in this branch of the municipal service. Although it is contended by French critics, Paris spends an enormous sum—which is far more considerable in proportion than the expenditure for this purpose in other great cities —the streets of the once renowned "Ville Lumiere" have fallen into a chronic state of deplorable neglect. The reporter of the Municipal Budget, who is unsparing in his condemnation of the filthiness of Paris, attributes the evil to want of organization on the part of the responsible services. Public works are executed at haphazard, without regard for promptness or uniformity. A single roadway is torn up time after time for one purpose or another, and no attempt at co-ordination is made. With regard to the actual cleaning of the streets, M. Dausett bitterly remarks that 'When all is said and done, the rain remains the great cleanser and scavenger of the Paris streets.' "

Referring to the same subject, "Cleansing Superintendent" for 1911, also an English publication, states:—

"It is certainly singular that the Paris Municipality has suffered matters in relation to the maintenance and cleaning of the public thoroughfares to go from bad to worse. They might usefully study the methods adopted in English cities, which are rarely excelled."

And the following quotation from the "Superintendents' Handbook," by Arthur May, likewise gives some idea of the estimation of the English of French methods:—

"Much has been written and said of the extreme cleanliness of Paris and its modern methods, yet anyone with a critical eye cannot be impressed with the puny methods employed.

"Thirty years ago Paris was no doubt to the fore, but it has apparently been standing still for some years; consequently to-day it is very much behind many other continental cities, and has a lot of headway to make if it is to compete seriously with these and the large English towns. Even their own Chief Magistrate, in his report this year, seriously deprecates the inefficient means adopted to cleanse the city, and strongly urges for a responsible department to take control of this work. Channel and gutter swilling appears to be the important feature of street cleansing. The water is obtained from hydrants placed in the footways, and these emit the water on to the outer edge of the curb, so that when turned on it runs along the gutter in the direction of the gradient. Should the flow not be sufficient a dam is made by using heavy pieces of sacking, and the same process is applied should it be desired to cause the water to flow one hundred feet a minute, gathering up enroute dust and light articles. The operation is assisted by a man with a broom, who sweeps all refuse within reach into the flowing stream.

"In summer the roads are hand-sprinkled with a 2-inch rubber hose, and to those who have watched the operation there is no doubt that the men so employed are masters in the manipulation of this hose. Generally the refuse is washed into the sewers."

From these extracts it is evident that the English consider their methods par excellence. This, however, we have often heard disputed, the general consensus of opinion being that German cities are further advanced in this branch of municipal work, which might be implied from the following description from the cleansing method in Berlin by Mr. Arthur May:—

"The city of Berlin is undoubtedly one of the most advanced in methods of street cleaning, as is also the plant in use. Modern science and education have been brought to bear in a very marked degree upon the scavenging of the city. The streets are flushed regularly by water vans, and at present they have in use a machine which undoubtedly represents the highest success yet obtained in street cleansing appliances. The machine is electrically driven, and consists of a street watering van with a machine broom behind. The water is distributed at the front and sides of the vehicle, and the whole operation of machine sweeping and street watering is accomplished by one man in one act. The delivery of water is so controlled that pressure, obtained by compressed air, may be applied in its distribution; thus street swilling and brushing may be effectively carried on even during the busiest part of the day. Many continental cities have in use a new type of apparatus in the form of a watering cart, to which is attached a rotary squeegee, fashioned somewhat after a rotary machine broom. The effect of this combination is that a street may be washed and left practically dry afterwards, the apparatus being worked by one man only."

We must, however, refrain from relying too much on these statements if we are to judge from the following quotation from the "Superintendents' Handbook," by Arthur May, referring to the street cleaning in New York:—

"Wonders may be expected from this hustling city in its street cleansing operations, yet the only factor which strikes one from the official data is that the Chief Commissioner, who is the head of the Street Cleaning Department, appears to get a salary of about $7,500 a year, and in this respect New York is certainly a shade in advance of the English capital. This official, however, only holds office so long as the Mayor for the time being holds his.

"The streets are swept by hand, by order of the authorities, and the methods adopted are somewhat ancient. A short-handled broom, a scraper and a pan-carrier are the tools used. The can is like a barrel mounted on two wheels, being upright, with an open top.

"Length-sweeping is adopted, each man being allotted a length of street from 400 feet to a mile, according to the width, and he is expected to keep this section clean. The refuse made is placed in the receptacle, or can, at other times into bags, these in their turn being emptied into vans, which ultimately deposit their loads into barges. The whole of the work is done during the day time. No water can precede the sweepers, but flushing with a hose is practised somewhat extensively, as is also swilling by the water-can.

"The refuse is tipped upon low-lying land."

At the time this book was written, New York was advanced according to present-day standards in street cleaning, and there was apparently very little difference in the methods used in New York and foreign cities, which illustrates the danger of laying too much stress on the point of view of an individual in the absence of definite data.

(To be continued.)

A most favorable report was issued in February at Montreal by the Nova Scotia Steel and Coal Company for the year ending December 31, 1913. The net earnings amounted to $1,255,955.84, being an increase of about 25 per cent. over those of 1912, and being equal to 11.14 per cent. on the outstanding capital of $6,000,000. These earnings compare with $1,000,609.93 in the previous year, which were equal to 8.43 per cent. on the capital.

The progress made in the surveying of the province of British Columbia during 1913 has established a record, according to the report of the Surveyor-General, which is included in the annual report of the Minister of Lands, presented to the Legislature recently. One million acres of crown lands have been surveyed by the Government, and the greater part of this vast area has been subdivided into lots varying from 40 to 160 acres in extent; 400 miles of district boundaries have been run; explorations have been carried out in Cassiar and Peace River districts, and a commencement has been made on the de-limitation of the eastern boundary of the province in conjunction with the Governments of the Dominion and of the province of Alberta.

The recently published report of the Surveyor-General included in the annual report of the Minister of Lands shows that in British Columbia, in the matter of private surveys, the outstanding feature of the year is the quantity of timber lands surveyed. It is probable that when all returns are received it will be found that 1,500,000 acres of land held under special timber license have been surveyed, which equals the combined area surveyed in 1911 and 1912, and amounts to, practically, 30 per cent. of the timber land held under license and unsurveyed at the beginning of the year. On the other hand, the area of land surveyed privately is under 600,000 acres, or only about 50 per cent. of that surveyed in the preceding year, the shrinkage being due to the decrease in the area of unsurveyed land held under application to purchase. The area of mineral claims surveyed is well above the average. The area of surveyed coal licenses and leases in general is about the average. The area of land surveyed by the Government is practically double that of 1909, notwithstanding the fact that the expenditure of this year represents survey of land in all parts of the province, including the most difficult and dangerous sections.

SOME FEATURES OF HIGHWAY SURVEYING

A TREATISE DEALING WITH BOTH THE PRACTICAL AND THEORETICAL PHASES OF THE WORK—THIRD OF A SERIES OF ARTICLES ON THE SUBJECT.

By DANIEL J. HAUER
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IN a former article, highway engineering was described and commented upon up to the time of plotting the field notes.

Plotting Notes.—The plotting of the transit line and the surveyed area can be done on regular drawing paper, and afterwards a tracing made of it in ink to be sent to the chief engineer to have blue prints made from it. A better method than using ordinary drawing paper is to plot the alignment on profile paper. For this a sheet or roll of Plate A paper should be used, the upper half being used for the line and the lower half for the profile, or vice versa. Then, in the same horizontal scale, viz., 1 block, (or 2½ in.) = 100 ft., the line and profile run along in regular order and quick reference and comparison can be made of each. The vertical scale for the profile can be made 10 ft. to 2½ in. or one block. It is possible to shorten up this scale, but the plotting is not so easy and the paper thus saved will not equal the enhanced value of the drawing on the scale given.

Tracings of the plan and profile can be made on plain tracing linen, but better results can be obtained by using profile tracing linen, Plate A. From this tracing, blue prints can be made in the main office for office and field use. The importance of each party in the field plotting up the line and profile has already been stated, and if only this drawing work is done by the field party, a draughtsman is not needed. The making of all standard plans should be done in the office of the chief engineer.

The plotting of the alignment should be carried on each day, putting in on the plan all side measurements, the location of fences, property lines, where necessary, town and country lines, and showing the magnetic course of each. Culverts, bridges and waterways of all kinds should be shown, and the cross roads, private driveways, buildings and other features should be plotted. It may, at times, be necessary to locate telephone and telegraph poles, and the trolley poles for electric roads. It is sometimes necessary to move some of these poles, and so they should be properly located. Trolley tracks along a highway should always be located, and at times it is well to locate and plot on the map streams and other bodies of water that may be within several hundred feet of the highway.

Railway crossings of all kinds on the highway should be surveyed, and enough of the railroad line should be drawn to show how dangerous the crossing may be for rapidly moving vehicles. Changes of alignment of the highway should be made, if possible, to eliminate dangerous crossing. When money is available, and it is possible by legislative enactments to have the railroad share in the expense, grade crossings of the highway on the railroads should be eliminated, as under all conditions they are dangerous, but the elimination of such crossings is very expensive and few highway commissions have the necessary funds to do such work at present.

In plotting, each station on the sheet should be numbered in consecutive order. This is necessary as many men, such as foremen and supervisors, who are not accustomed to reading plans, will use the blue prints. The station numbers should be placed at the bottom of the plan, but all pluses should be noted in plain figures along the centre line.

At frequent intervals distances to the side of the road, to fence lines, and to buildings close to the highway should be shown. Care should be taken not to make the plan one mass of figures, but all important distances should be marked down. Too many plans lack essential measurements.

Buildings of different kinds should be shown by different symbols, and the various lines on the plan should likewise be shown by different kinds of drawn lines. A key of these symbols and lines given on one end of the plan allows each to be recognized without printing many words on the drawing.

The stations for the profile should be shown, but it is not necessary to reproduce the plus stations for these can be read from the plan. The elevations of the lines on the profile plate should be marked for every 10 ft. of elevation, and should be reproduced horizontally every 1,000 ft. The elevations should be marked at every change of the established grade together with the rate of the grade and whether plus or minus, on the grade line. The line of profile plotted should be the transit line. All culverts and bridges should be shown in a graphic manner, and with the elevations and plus stations marked on the profile.

The profile line is made with black ink, and the grade lines in red. It is sometimes a help in deciding on the many questions that arise, to plot the centre line and the two sides of the road. If these are only for office use and it is not considered necessary to have them show on the blue prints, these lines can be made in colors that will not readily blue print, as orange and yellow. If different colors cannot be used, and it is desired to have the lines show on the blue print, then various kinds of dotted lines can be used, a different line to show each profile.

The cross-sections taken can be plotted on the profile, or only special or typical sections need be plotted at convenient blank spaces. Outside of the typical sections, which should be on the profile, it is better to plot all the sections on regular cross-section paper, thus having a permanent record of the sections taken. In many cases these can afterwards be made useful, with replotting, in calculating the quantities of excavation and filling.

Whenever possible, there should be uniformity in all drawings and plans. For this reason, all standard plans showing cross-sections of road, and structures to be built, should be made in the office of the chief engineer and should be made the standard for all work to be done.

Trial Lines.—Trial lines or diversion of the road should be surveyed to make possible improvements in the alignment and gradient. As to the advisability of such changes being made many considerations govern, besides the money available for such purposes. The money consideration is exceedingly important, for it is evident that if the amount of money is limited, but little of it can be expended for grading of new roads, if there are surfaces of old highways to be improved. However, if permanent improvements and betterments are to be made, to the end that good roads, admitting of economical hauling, are to be obtained, then it is manifestly wrong to improve stretches of roads that have poor and dangerous alignment and gradients that prevent fair loads being hauled.

Crooked highways with sharp curves are dangerous for automobiles, and more so for horse-drawn vehicles. A farmer with his wagon heavily loaded, meeting an automobile on a narrow road at a sharp turn, runs greater risk of being injured than does the party in the automobile. He, too, will be slower in getting out of the way. A steep hill means limitation of load. A team hauling a load 5 miles cannot carry any more than can be pulled up the steepest hill, even if it is a short one. This is an all-important fact to remember. Good roads not only mean good wearing surfaces, but also good grades, if we are to reduce the cost of hauling per ton-mile.

Thus, as a basis of any road improvement, sharp curves and heavy grades should be eliminated, so that money spent in the future for improving the surface will be upon a permanent highway. Money spent temporarily with a view of bettering the surface, only to change the line a few years afterwards is, to a great extent, money wasted; yet the amount of money appropriated for a certain highway may compel such makeshift work.

Even if a small amount of money, the importance of a close study of road changes is shown. Most country roads to be improved must be widened. This widening means extra grading, so that a decision as to relative costs of improving the old line or adopting a new one must be reached only after a close study of alignment, profile and cross-sections.

This study must, to some extent, be made in the field, but only careful and close study of these features can be done from the plotting of these notes. This is another reason for the field party to plot up their notes. Then the work of running side lines or trail surveys can be done knowingly. For this work, the importance of both field and map study can hardly be overstated, even if a man has an exceptional "eye for country."

In making betterments, distances must be considered, but a larger load can be hauled a slightly greater distance at less cost than a smaller load over a steep hill. The distance travelled by a vehicle over a very steep hill is always more than the horizontal measurement. This may mean that a hill can be circled without a greater distance being travelled than in going over it.

In starting a trial line some point is selected on the transit line on the road and the new line deflected from it by turning an angle to the right, as frequently explained in making the survey. These lines are either numbered or lettered to distinguish them. A complete survey of the line is made, and all features of value in determining the cost of the work should be noted. Connection with the original transit line is made at some convenient point and again the full angle to the right is turned.

Levels are run over these trial lines and a profile made of each, and enough of the original line is plotted to show how the grade can be worked up.

Not only should crooked roads have trial lines run to better the line and grade, but every steep hill should have a line run around it. In the past too much money has been spent improving poorly located highways, instead of first bettering the location. Through well-populated improved country it is not always possible to better the alignment, but through unimproved country and open fields this feature of highway betterment should always be carefully considered. However, it should be remembered that long tangents are not necessary, for sweeping curves are not a detriment, but rather add to the beauty of a highway. Heavy gradients should always be avoided.

Traffic Records.—The cost of all highway improvements must be gauged, not only by the money available, but by the traffic that goes over the highway. Many laymen, who are road enthusiasts, advocate the building of first-class roads in all sections. These are much to be desired, but it is an unwise policy to expend large sums of money on by-roads, when we have so many heavy traffic roads to rebuild. The following of this practice is seen in the laws enacted for road betterment. In some sections, in order to obtain money from the provincial or state government to improve local roads, these highways must be made a certain width, cannot have greater than a specified grade, and must conform in other ways to a high standard. Through this kind of folly, the writer has seen roads that had less than a dozen vehicles pass over it in a day, made 24 ft. or more in width, when the old road was not more than 10 ft. wide. On the other hand, he has seen roads, built under the same laws, with excessive travel on them, to the point of being dangerous, built the same width.

Traffic records are essential to make knowing decisions as to highway improvements. Such records should show the number of vehicles moving over the road during the daylight period, these observations varying to suit the conditions as found. It is not enough to make such studies only as surveys are being made. Records should be kept for a longer period, and should show both summer and winter traffic. Sunday records should be kept, as many pleasure vehicles are out on that day when the weather is fair. The records should show the size and kind of vehicle, the load carried, the average length of trip and the extreme length of some trips, thus showing local and through travel.

With complete records of this character it is possible to decide upon the width of road needed, the kind of road surface to be built, and the need of bettering the line and grades. Many roads can be made from 14 to 18 ft. wide with a hard surface in the middle 10 ft. in width, and answer every need of the traffic. It is a manifest waste of money to go beyond this in a large number of cases.

Geology.—Geological conditions, as well as those called for by the traffic, must be considered in these matters. The cost of work will vary with the geology of the country. In making the survey, all geological features should be observed and recorded. The character of the soil, the location of rock and its character, should be noted for every station. The quarries, sand and gravel pits, and clay banks along the highway should all be located and shown on the plan. This should be done also on the trial lines. Frequently a road is expensive to maintain, due to the character of the soil, when a parallel line within a short distance can be kept up at half the cost. Likewise, it is expensive to cut down hills, with large boulders out-cropping, or ledge rock, in order to improve grades. To widen many roads in their present location, means to get into rock and rough ground, that the original locaters avoided with a narrow road.

Adopting New Lines.—With surveys completed, trial lines run, traffic and geological records made, and the amount of available money known, the engineer and highway official are ready to decide upon the line to be improved. To obtain all of this information may have cost some money, but it is an expenditure well justified and one that will save a much greater sum in the end. This, though, is at variance with the practice of many engineers and highway officials, who first decide upon the line to be improved and then have surveys to find out what work is to be done. Such surveys are needed, but the other records and considerations do not enter into the problem; yet they too are obtained, and boasted of by those in authority, although it is money wasted, as far as any good obtained from them is concerned. This practice is only to be condemned.

It is not possible to give any rules for deciding upon alignment and grades. The information obtained from the surveys and records mentioned must govern the selection, based upon sound judgment gained from experience. The engineer should be the one to make the final decision, but even a layman, with such information before him, can assist in deciding upon the proper line.

Laying Down Grades.—Although the alignment of a road decidedly affects the cost of highway construction, yet the establishing of grades is a more potent factor. A few tenths in elevation does not greatly affect vehicle traffic, yet if they mean the blasting out of rock by hand methods, an excessive cost is entailed.

The limit of gradients should be set by the vehicle traffic records. Generally 5% should be the maximum grade, as with such fair loads can be carried and rapid-moving vehicles have no trouble in climbing. But, if the traffic is light and such grades mean excessive cutting, then gradients up to 8% may be used.

The establishing of new grades alone may mean the changing of a line. Thus it may be cheaper to build a new road on easy grades than to cut down hills to the maximum grades.

Care must also be taken not to make grades too decided and long, as is done in railroad construction. Many engineers, experienced in railroad work, entering the highway field, make this mistake. There is no need in highways of long straight lines with grades causing deep cuts and high fills. These cuts mar the beauty of the country, obstruct the traveller's view, and mean a great cost in building and maintaining the road. High fills are dangerous, must have guards on each side to prevent accident, and are washed badly by summer showers or in flood periods. As with the alignment, the grades can be sweeping curves, so as to keep down the cost of construction, yet keeping in view the traffic to be carried. It is even possible to have short raising grades to go over various obstacles, as small knolls, bridges and railroads, care being exercised in not making them too steep and short and with the proper view for approaching vehicles. This prevents long, high embankments.

In establishing grades care must likewise be exercised in preventing the top of a grade from being so sharp that vehicles cannot see one another in approaching. All changes of grade should be made with vertical curves. The value of proper drainage can hardly be overestimated, but drainage to some extent is dependent upon the laying down of proper grades.

Deciding Upon Improvements.—The next question to be considered is that of how improvements are to be made, the width of road, the surface to be laid and the method of doing the work.

One prevailing idea is to do as many miles of work as possible with a given sum of money, expending some in each town or road district, that is, not to build a good road of some particular type, but rather to repair the roads as they may be at present. This means to do little work that is permanent, giving only passable roads for a season and possibly taking out a few bad curves and grades. It is a wasteful procedure and defeats the object of any legislative act to improve roads. Nevertheless, it is a popular method, as it means the expending of some money in each community, the so-called "pork barrel" distribution of public funds. The roads on the North American continent need rebuilding and not just repairing as a bit of political jobbery to curry favor with the unthinking classes.

The second method is to decide upon the kind of road to be built in a given section, the width, alignment, grade and surface to suit the traffic and local conditions, taking into consideration the money available. Then build the very best road possible under these governing factors. Thus, wherever work is done good highways are obtained, and if properly maintained, a permanent improvement is made, the taxpayers receive full value for their money, and with the benefits that accrue to the community from the use of such roads, there is a demand for a greater mileage and the public gladly acquiesces in making financial arrangements for additional work. This scheme should be advocated by all those desiring to have good roads.

Even with this method, short sections of roads are built in different districts. This is a political aspect of the subject and, unfortunately, it is necessary to follow out this system to some extent, as otherwise many communities, feeling they are being slighted and deriving no direct benefit from the expenditure of the road money, will vote against future bond issues, although by so doing they are cutting themselves off from enjoying the benefits of future improvements.

As far as possible, long stretches of roads should be improved at a time. Economic reasons make this imperative. Small contracts mean high prices. The cost of plant for road construction is high, much higher than for many other classes of work, and so the plant charge against a small job is much higher than for a larger undertaking. As the road building season is short, especially in the north, a job should be large enough to keep the forces and plant busy for a season, without being moved. All of these and many other considerations will mean more road built for the same money.

Contract Work.—There are two methods of having the construction done on roads. One is by day labor forces, that is by men, machines and teams employed by the day, working under the directions of the road engineer and his assistants. The other is to let the work by contract, the contractor doing the work under the supervision of the engineer.

The first is generally an extravagant method; men do not work their best under such conditions, nor is the character of the work done of the best. Under the contract system the contractor is responsible; he requires men to work well, he is made to live up to the specifications and contract, and the unit cost of the work is known as soon as the contract is let.

The contract system can also be used for highway maintenance. Specifications can be drawn up for such work and it can be paid for by various units, according to the character of the work. Space will not permit of a further discussion of this subject, but the better method is to build and maintain highways by contract.

Road Surfaces.—A decade or two ago there were only a few kinds of road surfaces in use, while to-day they are numerous. Many of the patented surfaces and some of the newer types have not been in use long enough to definitely learn their advantages and disadvantages, but every road engineer should make a close study of all the different types. In some cases chemists must be consulted.

In deciding upon the surface to be used, the governing factors must be the amount and character of the traffic and the materials that can be obtained for the money available. This may necessitate the use of local materials, and the engineer should know enough about the various kinds of surfaces to select the best. Too frequently poor results are obtained from a lack of knowledge of this part of highway engineering. Only recently the writer saw a young engineer stop the use of beach gravel on a road, because of a lack of binding qualities of the gravel, and compel the use of a rotten rock from a pasture, which was ground up into mud within 6 months. Had he had some of this rock mixed with the beach gravel, and a small per cent. of suitable clay, he would have had a fairly good wearing surface, and the money would not have been wasted. This, too, would have cut down the cost of maintenance for some years to come. In deciding upon all surfaces, the ease and cost of maintenance should be considered as well as the adaptability of that particular kind of surface. Then, too, the cost of some materials may seem prohibitive, but this may be offset by the low cost of maintenance.

Locating the Road.—After all of the foregoing matters are decided the proper location of the new centre line is made. This location should be laid out on the ground. To do so, a new transit line is run, in the manner previously described in making the survey. Where the line has not been changed the same transit points and reference hubs can be used. This new line should be well referenced, and the stakes marked "L" showing that it is the located line. Then, new levels should be run over this transit line. The side levels are not necessary. From these levels a new profile is made, and then the work can be cross-sectioned.

All cross-sections should be calculated and payment for the work made on them alone. A standard section of the road should be made, and this should be followed in carying on the work.

Drainage.—Too much attention cannot be paid to the drainage of highways. Water is a sure detriment to all road materials. Roads should have ample subdrainage as well as surface drainage. Ample drainage should also be provided to prevent water from going onto road surface. It is easier to do this than to drain off the water after it has gone upon the highway.

Ample waterways, made of the most permanent materials, should be provided under the highways. To-day, in both Canada and the United States, millions of dollars are being wasted in maintaining flimsy, out-of-date culverts and bridges on highways. It is evident that if these could all be replaced with permanent structures, the money that is being spent each year for maintenance could be expended on the road surfaces.

RAILWAY TUNNELLING.

(PART II.)*

By Leonard Goodday, C.E., M.E.,
Late of the British Admiralty.

THE cost of driving a heading of the size outlined in Part I. of this article (January 15th issue) can be estimated only approximately, as it varies with the nature of the ground. In good shale, and where water does not prove a serious obstacle, conditions are most favorable to economical construction.

To arrive at an approximation of the cost per yard one must include excavation, timbering and supplies, operating expenses, percentage for engineering and contingencies, etc.

If the head-tree be 10 in. and side trees 8 in. in diam., with poling all around the excavation, per yard forward will be 10 ft. 7 in. x 8 ft. 6 in. x 3 ft. = 10 cu. ft. This may be let piecework, lineal, to include timber setting, but not to include pumping, power for hoist, or foremen and timekeepers.

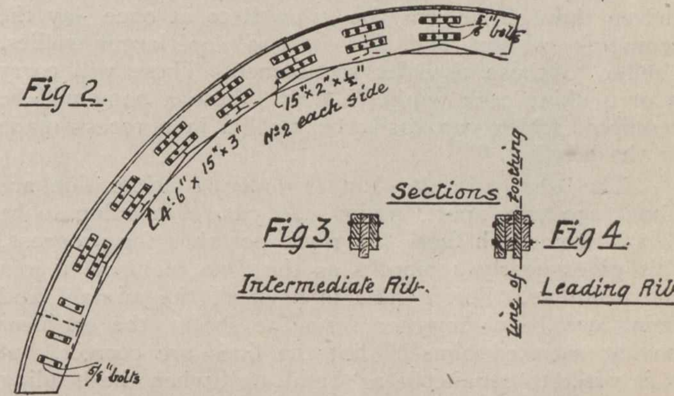
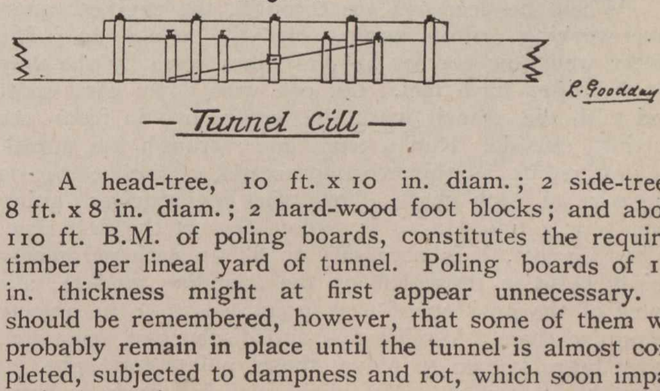


Fig 5.



— Tunnel Cill —

A head-tree, 10 ft. x 10 in. diam.; 2 side-trees, 8 ft. x 8 in. diam.; 2 hard-wood foot blocks; and about 110 ft. B.M. of poling boards, constitutes the required timber per lineal yard of tunnel. Poling boards of 1½ in. thickness might at first appear unnecessary. It should be remembered, however, that some of them will probably remain in place until the tunnel is almost completed, subjected to dampness and rot, which soon impair their strength.

From the shafts sunk at either end of the tunnel, a heading may be driven back through the cuttings leading up to the tunnel's mouth until it reaches the face at which the cutting excavators are working. "Shoot-holes" can then be driven upwards from the roof of the heading to the surface of the ground; strong trapdoors are then fixed in the bottom of each hole at the level of the heading roof and opening downwards. Tip-wagons can be run under the holes, the doors opened, and the earth shovelled down from the top. In good ground, indeed, in almost any ground, 2 men at the hole will do as much as 4 filling in the ordinary way.

*Part I. appeared in Jan. 15th, 1914, issue.

This method does not work so well in a wet, or rock cutting, as the water naturally drains into the wagon, and by the time the latter has got to the tip-head, its contents are slurry; another drawback is that rock falling down the holes breaks the doors and wagons.

If the slope of the ground is about 1 to 1, the distance between these shoot-holes will be twice the depth of the cutting at these points. With 5 shafts, there will be 2 working faces at the cutting headings, or 10 in all. If the work is to proceed rapidly, 20 gangs will be required, including day and night shifts; so that for a gang of 2 miners and 4 laborers, 40 miners and 80 laborers will be the total strength. A boy for every 2 gangs, for fetching tools, etc.; a hanger-on at the bottom of each shaft to attend to skips and ring the signal-bell; and on the bank at least 2 banksmen for landing and tipping the skips would make up the staff.

As the heading progresses, light rails of about 15 or 20 lbs. per yd. are laid with a gauge of 2 ft. 6 in., on which small trollies operate, similar to those required on the bank. On these are carried the skips, each of which has a capacity of about ⅓ cu. yds. If it is intended to get tip-wagons into the heading when it is driven through, it may be as well to at once lay the temporary wagon road, and on it to place larger trollies, similar to those used by sectionmen. These will carry 3 or 4 skips each trip. To draw these a pony will be required, which can easily be stabled in a recess made in the heading.

The shafts in the tunnel under consideration are about 440 yds. apart, giving 220 yds. of heading to be driven from each face. At 1 yd. per shift for progress, this gives nearly 4 months as the time required to join the headings. Before this is finished, the mining and lining can be commenced from the shafts, the engineer having satisfied himself that the lines are correct, but it is wiser to commence a "break-up" when the heading is through, at least between any 2 shafts. A break is generally made midway between 2 shafts, and, consequently, at or about the point where the headings from the shafts meet.

When the headings are through, the engineer must give working centres again. He will be able to judge pretty well how correct his first lines were by the way the headings have met. Let one wire down each shaft and with the transit work the centre line in from the cutting outside. Run a trial line through the tunnel, leaving points as this work proceeds, and checking on the wire at each shaft. This trial line requires going over 2 or 3 times, as it is seldom correct the first time. When correct, it is necessary to fill up with permanent points between those left on the trial line, and to take notes of the position of each point, so as to be able to recognize them. Mischievous and discharged men, etc., have been known to move these points for spite or through ignorance. Establish plainly marked Level B.M.'s all along the heading at Rail Level.

When driving these headings water may be tapped, which must be conducted to the sumps under the shafts, so that it may be drawn off at certain intervals. A large barrel, holding 40 or 50 gals. and called a "landing barrel," is required for drawing this water up the shaft. Unless water enters in large quantities, this will serve all through the work. Otherwise a steam pump will best get rid of it. The former outfit must be complete in every way, with the trunnions on which it turns below its centre of gravity, so that when the catch is released it will tip easily and without disconnecting it from the winding-rope. Over 2,000 gals. per hr. can be raised by this means.

The contractors should see to the provision of a large supply of strong larch forbars for supporting the mined length, poling boards, brick, etc.

With respect to brickwork, if brick is used, an ordinary tunnel for a double line, without an invert, with walls and arch 2¼ ft. thick, and of the dimensions shown on the figure, will contain 17¼ cu. yds. of brickwork per yd. of length. If each length turned is 5 yds. long, this amounts to 86¼ cu. yds. If 350 bricks, 9 x 4½ x 3, are reckoned per cu. yd., a length will then require 30,000 bricks, and with 5 shafts, in 2 of which one length each per 10 days is to be turned (work only progressing in one direction from them), and 3 shafts, 2 lengths each per 10 days, one in each direction, are to be turned, there will have to be provided sufficient for 8 lengths in the course of each 10 days, or 240,000 bricks—a quantity hardly obtainable in most localities. Even if available, there might not be adequate means of transportation. Supposing the locality to be surrounded with brick works and the average distance to be 1 mile, a horse would make 5 journeys per day and bring 300 bricks per journey, or 1,500 per day. As 240,000 are wanted in order to keep up the supply, 16 horses and carts and 2 extra horses and carts for continual work would thus be needed. Besides these 18 horses there are all the others required for general work. An alternative worthy of first consideration, if the facilities for the operation are available, is the manufacture of brick at the site.

The section of the tunnel and thickness of lining having been decided upon, 26 ft. clear between the walls is the minimum for a double line. This width will depend upon the type of car and locomotive which the cross-section was designed to allow. It must be remembered that when a tunnel is on the curve, the cant of the outer rails causes the corners of the car to project. Therefore, keeping the same total width, the wall on the inside of the curve should be a few inches farther from the centre line than that on the outside. The centre line is still the centre line, between the rails, but is not that of the tunnel. This little difference can easily be adjusted when the curve enters the straight again.

We have supposed 5 shafts, 3 of which have 2 faces, one working each way, the other two shafts having one face each. Between each two shafts, a breakup is to be formed, which gives another 2 faces to each breakup. There will be 4 breakups in this case, and, consequently, 8 faces. Thus there are 8 faces due to 5 shafts, and 8 more due to the breakups, or 16 in all. In an organized tunnel, a length will be mined in 8 of these faces, and the bricklayers will at the same time be lining the 8 others.

For supporting the arch of a 5 yd. length, at least 3 ribs are required, 2 of them called intermediate, the other, "leading." A the ribs should always be left standing in 1 length until the next at the same face is keyed, it follows that 4 intermediates and 2 leadings are required per face, giving 96 ribs in all. These must be ready, with a few to spare for breakages, when the brickwork is commenced. Fig. 6 shows the curve of the arch beginning at about 6 ft. above rails, it being the real springing point of the arch. A scaffold is needed for this work, and it is advisable also to lay the finishing courses of the walls from this scaffold. Generally, centres are set at about 9 ft. above rails, and which point is called the springing.

The ribs should be built on a good, level platform, on which the soffit line, full size, is accurately described, with 2½ in. allowed below it for lagging. The tunnel being a heavy one, the ribs must be of well-seasoned ash or elm, and built up of pieces called sweeps; each one being

4½ ft. long, 1¼ ft. deep and 3 in. thick; for an intermediate rib 3 thicknesses of sweep, or 9 in., will be sufficient. One edge of each must be neatly adzed to the soffit line; keeping the full depth of the sweep at the middle. Fasten all together at every joint with 4 iron plates about 15 in. x 2 in. x ½ in., bolted completely through with No. 4 ⅝ in. bolts, having all bolt heads on the same side, as by keeping the heads all on one side, the rib can be more easily dragged about on the tunnel scaffold.

A leading rib is constructed in the same way, but with 4 thicknesses or layers of sweeps, one of the 2 inside layers projecting 2½ in. above the others, or equal to the thickness of a lagging. This rib is set at the leading end of the brickwork to be built, and remains in place. When the arch of the next length is ready for turning, the laggings find a bearing point on this rib on the other side of the rim. It also keeps them from slipping. Figs. 2, 3 and 4 show an elevation and sections of a rib.

support but that of the centres. The pressure must be very slight to allow such a condition.

When the ground is heavy and pressure great, the arch and length cannot be left without support, and the contractor cannot afford to leave bars bricked in above the brickwork in every length. Drawing-bars are introduced, bars so placed that the arch can be keyed in under before they are drawn out endways into the next length to be mined and used again.

The crown, i.e., the top bar, and 2 others on each side of it, 5 in all, form a set of drawing-bars. Those on each side the crown bar are called "third bars," because when in place, there are 3 bars in; the next 2 are called fifth bars, next 2 seventh, etc. The crown, third and fifth are all of a size, and, in a 5 yd. length, must be 21 ft. long at least. In heavy ground they should be not less than 16 in. diam. at the small end. They must be straight, free from knots, and should taper uniformly.

All the bars carrying the roof are supported upon a top sill, placed about 9½ ft. from the underside of the

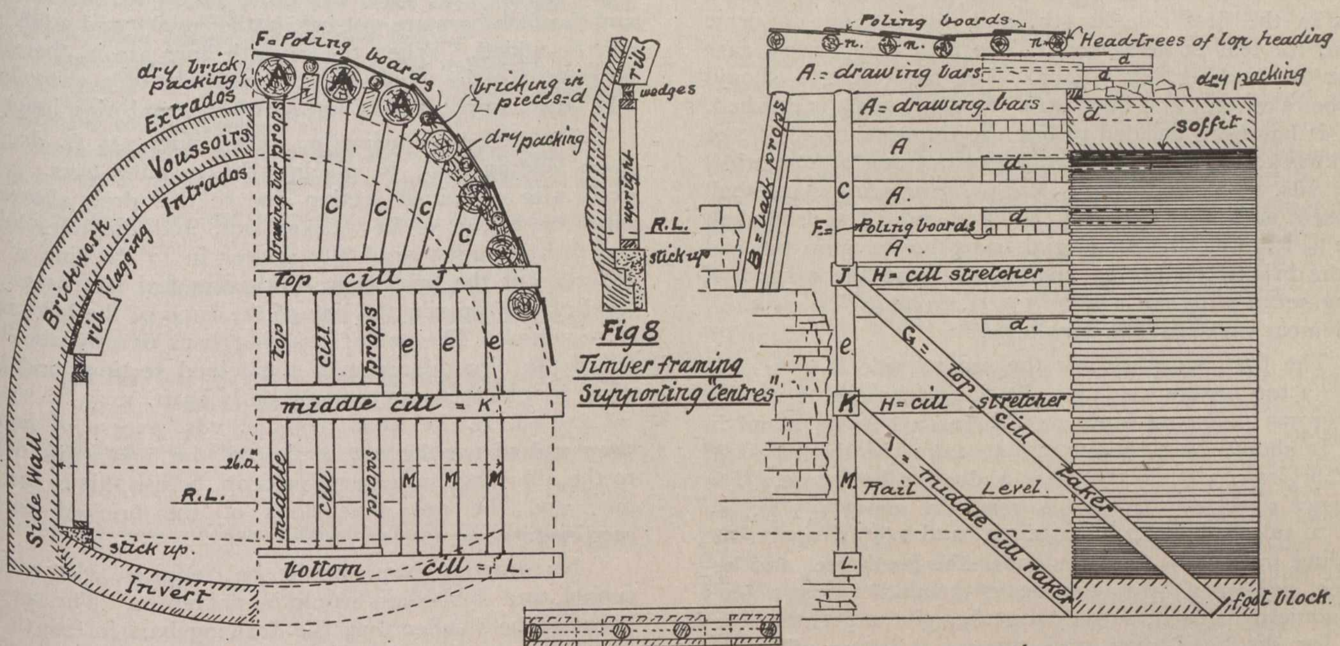


Fig 6. Fig 8 Timber framing Supporting Centres. —Plan of Fig 8— —Fig 7—

Mining and Timbering.—The excavating and building-in of a tunnel is done in lengths, one length being mined and lined completely before much work is done in the next.

The extent of a length is determined by the probable weight which must be supported on the bars until the brickwork can be placed; also upon the size and quality of the timber procurable for bars. A length is seldom more than 6 yds., and is sometimes reduced to 3 yds. In a light tunnel all bars carrying the roof can be taken out as the brickwork is built up to them. The ground is excavated and mined as nearly as can be to the exact shape of the extrados of the lining. Therefore, the back of the bars supporting the ground is just even with the back of the lining, excepting 5 or 6 of them at or near the crown of the arch, which are kept up a few inches to compensate for settlement and sag. When the walls are built and the arch is under construction the bars are removed one by one as the work proceeds until the arch is keyed. It will be obvious that when the arch is within about 4 ft., measuring transversely, of completion, the crown, or top bar, must be taken out, and that the ground and incomplete arch are thus left without any

crown bar, and stretching horizontally across the tunnel at that level, just at the leading end of the brick work to be built. This top sill should be 13 in. square and 27 ft. long. (See Fig. 5.) The roof bars are all propped from it, and it is again supported, by props from another or middle sill, which should be yet stronger and 33 ft. long. The top sill cannot be put in place until the ground is excavated down to its position, and the ground cannot be mined without support from bars. The bars, in their turn, must be temporarily supported until the top sill is in place, so they must be long enough to allow of their being propped off firm ground, ahead of the length under construction. The roof bars should be 21 ft. in length.

The best timber for bars is larch. They should not be stripped of the bark as the timber then becomes slippery in damp places, and difficult to handle. They should be neatly scarfed for 5 ft. to make a sill. The top and bottom of the scarf should be faced with an iron plate about 6 in. x 4 in. x 1¼ in., and the 2 plates bolted together through the sill and enclosed by 4 iron glands. On the top of the scarf is placed a timber saddle the full width of the baulk, 6 in. x 9½ in., the whole being secured by 5 additional glands, made out of 2½ in x ½ in. flat bar.

The section of timber to be encircled by these glands is 13 in. x 13 in. for the sill proper, and a 13 in. x 6 in. saddle, making 13 in. wide x 19 in. high. The gland is made in 2 parts, one formed into 3 sides, to take the bottom and the 2 sides of the sill and saddle. On the ends of the 2 sides which are made to project beyond the 19 in. required, are formed good screws with nuts. The top side of the gland is then made separately, and long enough to provide for a hole in each end to fit over the screwed ends of the other piece, and the nuts screwed tightly down. The sill must be scarfed as it has to be longer than the width of the tunnel. As a sill should serve all through the work and will be taken to pieces many times, it should be well made. (See Fig. 5).

The first side length, next the shaft, let us suppose to be in and lined; this operation being similar to the following, except that sills must be used at both ends of it. But if bad ground has been encountered in sinking the shaft it will be safer to brick the crown, and third bars in the first side length, and not attempt to draw them, for fear of settlement. The fifth bars in this case must be "taking out" bars. The shaft length should not be taken out and lined until the shaft work is finished.

It has been decided to line the tunnel with 2½ ft. of brickwork. The lengths, to be got out one by one, shall be 5 yds. To support this length, 5 drawing bars shall be used, each 2 ft. diam. at the thick end. The drop shall be 1½ ft., i.e., the small end being borne upon the end of the brickwork of the last length, and the other end being set at a higher level by 1½ ft. to allow for sagging, settlement and possible breakage.

The first operation for the second side length is to drive a top heading 21 or 22 ft. long (enough to receive the crown bar) and high enough for a man to stand in it. It should be wide enough to take the thick end of the bar, say, 3 ft. in the clear under the head-tree. The distance apart of the bars is generally about 1½ ft., so that to take 2 bars, 2 ft. in diam. and 1½ ft. apart, the heading must be 6 ft. wide under the head-tree, and between side-trees. In very heavy ground 2 crown bars are sometimes used, as they together give a greater bearing for the head-trees, and support it better when the side bars are put in, or taken out. The heading must be supported by settings of head and side-trees about 1 yd. apart, and strong enough to bear the weight for 10 days or so. The heading should be poled all round.

The crown bar must be got into this heading by means of a crab and tackle.

As the top sill (Fig. 7) will be placed at about 6 ft. below the soffit of the arch, the ground at the far end of the top heading should be excavated across the heading down to a little below this level. In the bottom of this, foot blocks should be placed, on which will stand the long back props, supporting the bars until the top sill is in position. These back props should be 10 to 12 in. diam. and up to 9½ ft. long. Their length varies, of course. All props should be "collared," i.e., on two opposite sides at the top end cut off about 1 in. and run out about 9 in. down the prop; and then hollow out the top of the prop to receive the round side of the bar, which will give a good bearing surface, and prevent the outside from splitting. The props should be set with a sprag.

The crown bar being in and back propped, the next necessity is to get in the third bars, but as they must follow the curve of the arch, they are not quite so high above rail level as the crown bar. Widening out for these bars can be commenced by removing the side-trees of the heading, and the poling boards, and then excavating from the sides. When the third bars are in, short stretchers must be put in between the bars spaced about 5 ft., strutting one bar against the other, so as to distribute the pressure. Dog-headed spikes, or brobs, must be driven into the bar round the head of all props, four to a prop, to prevent slipping. When this excavation is done, poling boards must be placed transversely to the bar. The proper way, when the face of the excavation is straight, is to insert the board above the last bar put in, and hammer it into place; but as the excavation here is curved, it is sufficient if the ground be removed from behind the bar on the underside, and the board hammered upwards, until held by the bar.

The fifth of the set of drawing bars is now put into position. They hold the lower ends of the poling boards, and must be back-propped similarly to the others.

With an occasional helping hand, 2 miners and 3 laborers will get the crown and third bars into place when driving the top heading. As space widens out, and the fifth bars are got in, another miner and 2 laborers can be added. When the seventh bars are in there will be room for the whole gang, consisting of a gang boss, who must work as a miner, 3 miners, and nine laborers.

The fifth bars being in, spaced with 1½ ft. drop at their leading end, in placing the seventh bars. The extra size of mined section due to this drop allowance must be begun to be worked out, and the bars below the fifth brought gradually nearer in to the line of the extrados of the brickwork, until at a few feet below the level of the top sill, the line of the back of the brickwork is regained. The set of drawing bars occupy about 15 ft. of the circumference of the mined section, and in a 5-yd. length there are consequently 15 ft. x 15 ft. x 1 in. = 225 cu. ft., or about 8½ cu. yds. excess of mining over and above the net section of the brickwork owing to the allowance necessary for drop, before this is worked out, and the net dimensions of the bricked section regained.

No drawing bars would be required with a light tunnel, and this excess would be prevented. The seventh bars can be smaller than the drawing bars in length and diameter, as they are not under strain so long. They must, of course, be longer than the actual length to be lined, as they require back propping until the sill is in.

When the length is mined down to the top sill, which must then be got in. The front or side of it facing the length must be a little more than 15 ft. from the last toothing which extends horizontally across the length, and 2 ft. into the ground on each side behind the proposed brickwork. Working this 2 ft. is called driving the sill hole. It is an expensive piece of work in hard ground, and dynamite will be found expedient in doing it. Bring the sill into the tunnel in halves with saddle and glands loose, the ground or sill bed being levelled and the sill holes driven. Place one half in its position and level it well before slipping on half of the glands, with screwed ends pointing upwards. Set up the remaining glands in about the position they should occupy on the other half sill, and drop this half into place, fixing it over the scarf with the plates. If from wear, etc., the glands do not all fit tightly, tighten them up with wedges. Prop all the bars of this sill, taking care to collar the props and drive brobs in at both top and bottom. The back props, which have up till now been supporting the bars, may be taken out.

(To be continued.)

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CONTENTS OF THIS ISSUE.

SEWAGE TREATMENT IN SASKATCHEWAN.

The Bureau of Public Health of the Province of Saskatchewan will shortly issue a number of official suggestions respecting the design of sewage treatment works for municipalities of that province. In issuing the bulletin the Commissioner of Public Health places before the people of Saskatchewan an interim outline of the more important considerations in the design of plants for the treatment of sewage. It will be found of vital and immediate importance in the conservation of the purity of water, and will doubtless be followed by others, in an aim to supply the municipal engineers of the province with a knowledge of the records and data which experimental plants on this continent and in Europe are contributing.

These suggestions, appearing on another page of this issue, are being submitted without intention of limiting in any way tendencies toward originality of design or of discouraging the incorporation of new features. To avoid mis-interpretation in this respect Dr. Seymour is making it plain that, under certain conditions, sewage treatment works designed at variance with the suggestions which are being presented, may be approved of by him, and conversely, that sewage treatment works designed strictly in accordance with these suggestions may not be approved of. It may be necessary to make such modifications as the requirements of local conditions justify.

EFFECT OF TAR ON ROAD SURFACES UPON FISH AND PLANT LIFE.

From a late reference to the subject in the London Financial News one would infer that the conclusion appears to have been arrived at on the European Continent that the use of coal tar from gasworks for the treatment of road surfaces has a number of drawbacks, not the least of which is that all vegetation in the vicinity of roads which have been tar-sprayed suffers heavily. Another of almost equal importance is that it appears to be impossible for fish to live in those streams which receive, either directly or indirectly, the drainage from their surfaces.

Engineers in America and Great Britain do not agree with the contention, and a number of facts have been tabulated which appear to show that the conclusions have been altogether of too sweeping a character. The "Journal of Austrian Gas and Water Engineers" recently published some information on the subject, and it is interesting to note that M. Griffon, a Parisian engineer, has made careful investigations as to the effect of coal tar on neighboring vegetation, and finds that it has little or no effect, thus upsetting the conclusions of Herr H. F. Fischer in this regard. As an example of this it may be mentioned that in Bordeaux one of the principal streets has been tar-sprayed for a number of years without a single tree suffering. As the point might be raised that the trees in the vicinity might have been of a specially hardy species, he is careful to mention that among them were such varieties as maples, silver poplars, lindens, and walnuts, all of which are known as being of a particularly sensitive character. At Montpellier all the macadam roads have been sprayed with gasworks tar for several years, and the plane trees in the vicinity are in much better condition than was the case before the treatment was adopted, owing to the absence of dust under the improved conditions. At Alexandria, in Egypt, the engineer responsible has found that the treatment of the roads by crude tar has had no effect on the vegetation in the neighborhod, and he gives details of many informative tests which he had carried out before finally committing himself to that opinion.

As regards the effect on fish life, however, all the evidence obtainable appears to show that there is much in the contention, and it would appear to be advisable to construct all roads of one or other of the tar-macadam systems at present available than to adopt a spraying method, which, after all, can only be considered as a palliative, and so ensure a lasting road surface which will withstand the exigencies of modern vehicular traffic.

CONSULTING ENGINEERS AND CONTRACTORS.

At the annual meeting of the American Institute of Consulting Engineers, Inc., held January 20th, 1914, the following report was made and adopted by the meeting:—

"The committees on Professional Practice and Ethics and Relations held a joint meeting at the Railroad Club on January 2nd, 1914, to discuss the resolution adopted by the executive committee of the General Contractors' Association on August 6th, 1913, which resolution was referred to our two committees at a meeting of the Institute on October 31st, 1913. Your committees have the honor to report to the Institute as follows:

First: In respect to charging a fee for the use of plans, it is our opinion that, when contractors are invited to bid upon any work, the necessary plans should be furnished to them by the engineer without charge. If, however, the work is to be publicly let, there should be some limitations made with regard to the number of plans to be furnished free by the engineer. We believe that in such case the public or advertised invitation for bids should provide that the plans be on view at one or more places where all bidders can conveniently call and examine them. If prospective bidders ask for the use of plans under this last condition, we believe that the engineer should require a deposit for them, which deposit may be in an amount sufficient to insure the return of the plans, and that when such plans are returned to the engineer, after the award is made, the engineer should return the amount of the deposit.

Second: We are of the opinion that a sufficient number of plans for the execution of a contract should be furnished the contractor without charge. As to the number of sets of such plans, we are unable to make any definite recommendation other than that we believe the engineer should furnish sufficient for all reasonable construction purposes, and for any number in excess thereof he should charge the cost of reproduction.

Third: We believe that the engineer employed by a private client should lend his influence against the requirement of a deposit of a certified check by a contractor bidding upon his work.

Fourth: We are of the further opinion that it would be advisable in the interest of all concerned that the subject matter of the General Contractors' resolution be discussed by a joint committee composed of equal representation from:

(a) American Institute of Consulting Engineers, Inc.
(b) American Institute of Architects.
(c) General Contractors' Association.

We therefore recommend that the secretary of the American Institute of Consulting Engineers, Inc., be directed to invite the other two associations in interest to join them in the appointment of a committee which may take up this subject to the mutual benefit and interest of all."

CANADIAN CEMENT PRODUCTION AND CONSUMPTION IN 1913.

The Department of Mines, Canada, has issued a preliminary report compiled by J. McLeish, B.A., chief of the Division of Mineral Resources and Statistics, in which it is officially stated that the financial stringency during 1913 had an immediate effect in the restriction of building operations of all kinds and its results are shown in the statistics of production and consumption of structural materials. In the case of cement, while a very substantial increase in production is shown, this has seemed chiefly to displace imported material, the increase in consumption being only 4 per cent. as against an increased production of 24 per cent. Canadian mills supplied over 97 per cent. of the consumption in 1913 as against 83 per cent. in 1912. The industry has been marked by the extension of old and the completion of new plants, the latter west of the great lakes. The total capacity of completed plants at the end of the year being about 50,000 barrels per day as compared with 36,500 barrels at the end of 1912. New plants were placed in operation at Winnipeg, Marlboro west of Edmonton, Princeton, B.C., and at Tod Inlet, Vancouver Island, B.C. The plants of the Imperial Portland Cement Company at Owen Sound and of the Crown Portland Cement Company were not operated during the year.

The total quantity of Portland cement, including slag cement and natural Portland made in 1913 was 8,880,983 barrels, an increase of 1,739,979 barrels or 24 per cent. over 1912. The quantity of Canadian cement sold or used was 8,658,922 barrels, valued at $11,227,284, or $1.29⅔ per barrel, an increase of 1,526,190 barrels or 22 per cent. and $2,120,728 or 23 per cent. in total value. The total imports of cement were 889,324 cwt., equivalent to 254,092 barrels of 350 pounds each and valued at $409,303, or an average of $1.61 per barrel, as compared with imports of 1,434,413 barrels valued at $1,969,529, or an average of $1.37, in 1912. The total consumption of Portland cement, therefore, neglecting a small export, was 8,913,014 barrels as compared with a consumption of 8,567,145 barrels in 1912, an increase of 345,869 barrels or only 4 per cent.

Detailed statistics of production during each of the past three years are shown in Table I.

TABLE I.

	Barrels. 1911.	Barrels. 1912.	Barrels. 1913.
Portland cement sold	5,692,915	7,132,732	8,658,922
Portland cement manufactured	5,677,539	7,141,004	8,880,983
Stock on hand Jan. 1	918,965	894,822	866,138
Stock on hand Dec. 31	903,589	903,094	1,088,199
Value of cement sold	$7,644,537	$9,106,556	$11,227,284
Wages paid	2,103,838	2,623,902	....
Men employed	3,010	3,461	....

The average price per barrel at the works in 1913 was $1.29⅔ as compared with $1.28 in 1912 and $1.34 in 1911 and 1910.

The imports of cement in 1913 included 77,356 barrels from Great Britain, 172,298 barrels from the United States, 3,443 barrels from Hong Kong and 995 barrels from other countries. The average price per barrel was $1.61 as against an average of $1.37 on imports in 1912.

Annual Consumption of Portland Cement.—The consumption of Portland cement during each of the past five years was as shown in Table II.

Table II.

Year.	—Canadian— Barrels.	%	—Imported— Barrels.	%	Total. Barrels.
1909	4,067,709	97	142,194	3	4,209,903
1910	4,753,975	93	349,310	7	5,103,285
1911	5,692,915	90	661,916	10	6,354,831
1912	7,132,732	83.3	1,434,413	16.7	8,567,145
1913	8,658,922	97.1	254,092	2.9	8,913,014

SEWAGE TREATMENT WORKS IN SASKATCHEWAN.

THE following suggestions with reference to the design of sewage treatment works are formulated upon principles of sewage treatment which are in accordance with present day practice, and are about to be issued by the Bureau of Public Health of the Province of Saskatchewan to serve as a guide to those preparing schemes for municipalities in the province.

Screening.—(*a*) That where sewage is to be pumped, provision be made for screening, cleaning the screens at regular intervals, and for removing and disposing of screenings.

(*b*) That where works are of a character producing a large quantity of screenings, mechanical means must be provided for their removal.

Grit Chambers.—(*a*) The function of grit chambers (or detritus tanks) being to arrest the heavier mineral particles carried in suspension, the construction of such tanks is, generally speaking, unnecessary in this province, where the majority of sewerage systems are designed on the "separate" principle.

(*b*) That in special cases where sand or other mineral particles cannot be kept out of the sewerage system, it is advisable to introduce grit chambers.

(*c*) That these be constructed in multiple compartments to take care of the varying volume of flow.

(*d*) That a lineal velocity of one foot per second be aimed at, calculated to retain the heavy mineral, but not the organic matters.

Pumping.—(*a*) That where it is necessary to raise the sewage at the works, it is advisable that all machinery be in duplicate with alternative forms of power in case of failure.

(*b*) That appliances for raising sewage be specified with reference to efficiency in dealing with solids.

Sedimentation.—(*a*) That there be at least two sedimentation tanks.

(*b*) That such tanks be so constructed that the precipitated solids are automatically and continuously removed from that portion of the tank in which precipitation takes place, and that a tank or chamber combined with, or separate from, the sedimentation tank, be provided, into which the precipitated solids may pass by gravitation immediately following settlement.

(*c*) That consequent upon the modern requirement of the continuous removal of sludge as above stated, all base slopes of sedimentation tanks be made as near to the perpendicular as is practicable, relative to general construction.

(*d*) That the tank capacity be equal to one-fifth of the dry weather flow in twenty-four hours, or equal to three hours' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(*e*) That the cross sectional area of the tanks provide a velocity of flow of not more than .05 foot per second, while lower velocities are preferable. Flows may be either vertical or horizontal.

(*f*) That consideration be given to the design of the inlets and outlets with a view to ensuring uniformity of flow throughout the breadth of the tank, and the absence of stagnant sections; and that all channels and parts of the tanks apart from the sludge storage area, be so constructed that no solids are retained.

Sludge Storage.—(*a*) That the overall depth of the sludge storage chamber from the surface of sewage in sedimentation tank be generally not less than fifteen feet. Greater depths may be adopted, producing a more concentrated form of sludge.

(*b*) That in deep tanks, wherever possible, provision be made for breaking up the sludge at the inlet to the sludge removal pipe.

(*c*) That the capacity of the sludge storage chamber be equal to at least four months' precipitation of sludge, containing 85 per cent. of water. Greater storage capacity is preferable as septic action is delayed in winter months. The cubic capacity of the sludge storage chamber shall be taken as only that space which is below the level of the deepest point of the sedimentation tank. In general, the average accumulation of sludge may be taken as three and a half cubic yards per million gallons of sewage on the above basis of dilution.

(*d*) That ample provision be made for the escape of gases from the surface of the sludge storage chamber.

(*e*) That pipes for the conveyance of sludge be of an internal diameter of not less than eight inches and that the inclination of such pipes, where the sludge is discharged by gravity, be at least 3 per cent. and preferably 5 per cent.

Biological Filtration.—(*a*) Where a dosing or siphon chamber is constructed to regulate the flow of the sewage over the surface of filter beds, that the capacity of such chamber does not exceed a ratio of two gallons of sewage to each square yard of filter surface. For instance, if the area of the filtering surface be two hundred square yards, the capacity of the dosing chamber should not exceed four hundred gallons, representing a dose of one-half inch depth of sewage over the whole surface of the filter.

(*b*) That the depth of the filter media be not less than four feet and preferably seven feet.

(*c*) That the filter media for effluents from the above form of tank be composed of hard broken stone or other suitable material, broken from one-inch to two-inch cubes.

(*d*) That the surface area of filtering media for domestic sewage be in proportion to the population using the sewers, i.e., in proportion to the amount of oxidizable matter present in the sewage.

Where a high degree of oxidation is required, the ratio of population to surface area of filter media should be approximately 17,500 persons to the acre (or 275 square yards per 1,000 population).

This corresponds to a rate of filtration of 1,750,000 Imperial gallons per acre per day, or 155 Imperial gallons per cubic yard per day (assuming depth of filter media to be seven feet) at a per capita flow of 100 Imperial gallons per day.

The efficiency of filters will not be materially affected by increasing the rate of filtration during periods of storm to, say, three times the above stated rate, provided that the increase in volume is due to clear water.

In cases where the volume of dilution at the point of final discharge exceeds twenty times the volume of the sewage effluent, higher rates of filtration may be adopted.

(*e*) That the method or apparatus adopted for the distribution of liquid over the filter bed, shall ensure a uniform distribution over the whole surface.

(*f*) That all filter beds be drained at the base by tile pipes or preferably by means of a false floor over the entire base of the filter.

(*g*) That sufficient provision be made for ventilation to allow of oxygen being present at all times and in all parts of the filter bed.

Humus Settling Tanks.—(*a*) That it is generally advisable to provide settling tanks for the removal of the humus which is unloaded by the filter beds from time to time.

(*b*) That such tanks be constructed in every case where disinfection of the final effluent is adopted.

(*c*) That humus tanks have a capacity equal to one forty-fifth of the dry weather flow in twenty-four hours, or equal to twenty minutes' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(*d*) That it is desirable that such tanks have separate storage compartments as in the sedimentation tanks above described.

Disinfection.—(*a*) That where chloride of lime is used for the disinfection of the final effluent, provision be made for weighing, measuring and storing the disinfectant in a dry covered building.

(*b*) That the period of contact between the disinfectant and the sewage be not less than fifteen minutes. An open pond or lagoon will serve this purpose.

Effluent Pipe.—That the effluent from the works be discharged into the watercourse or lake in such a manner as will ensure a maximum amount of dispersion.

Housing of Tanks and Beds.—(*a*) That all parts of the works containing sewage under treatment be housed to conserve the latent heat of the sewage during low temperatures and to prevent fly nuisance in summer.

(*b*) That such covers be designed to enclose the minimum amount of space, at the same time giving room for accessibility and inspection.

(*c*) That with properly designed covers the introduction of artificial heat is unnecessary in sedimentation tanks, and may be obviated in filter beds.

(*d*) That provision be made in all covers for the access of light and for efficient ventilation.

Laboratory.—That wherever the size of a municipality or other circumstance warrants its construction, a small laboratory be provided and equipped in which simple tests may be made of the sewage and effluents.

Laying Out the Surrounding Grounds.—That provision be made in the specifications and estimates for laying out, grading and improving the appearance of the surrounding grounds by terracing and seeding the slopes.

The Sanitation Corporation, 50 Church Street, New York City, has been organized to take over the sewage disposal interests of the T. A. Gillespie Company, the East Jersey Pipe Company, and the D'Olier Centrifugal Pump & Machine Company. The new concern will also control for the United States and Canada certain German sewage apparatus and processes, including the Riensch-Wurl screen. They will specialize in apparatus for the clarification and purification of sewage, the reduction of water content in sewage sludge and the recovery of by-products from sewage sludge.

CONTRACTION AND EXPANSION OF CONCRETE ROADS.

On February 13th, 1914, Mr. R. G. Wig, of the United States Bureau of Standards, as chairman of the committee on the contraction and expansion of concrete roads, of the National Conference on Concrete Road-building, held in Chicago, February 12th to 14th, presented a report which, among other things, brought out clearly that water as well as heat plays a vital part in the varying length of a road. The following is an abstract of the report:—

The effect of contraction may be finally evidenced by cracking and that of expansion by crushing, spalling or buckling. The engineer is interested in this subject only so far as it affects the integrity of the road. The chief causes of expansion and contraction are: (1) Changes in the temperature of the concrete; (2) variation in the moisture content of concrete; (3) variation in the condition and character of the sub-base; (4) excess loading by traffic.

Effect of Temperature Changes in the Concrete.—It is generally considered that the variation in the temperature from season to season tending to cause a change in length, combined with unequal frictional resistance between the concrete and the sub-base, is the primary cause of cracking. The change in the length of concrete due to temperature is free to move ranges from 0.00000805 to 0.000004355 per degree F. per unit length, the accepted value being about 0.000006. Assuming a normal change of temperature of 90° F., the movement which would occur without restraint is about 0.00054 per unit of length.

In practical work, however, several elements enter tending to modify the temperature effect. A reduction in the moisture content of concrete would cause a contraction, while an increase would cause expansion, thus aiding or counteracting the effect of temperature. The friction on the sub-base in the case of a road will always reduce the movement. In some recent experiments made by Henry S. Spackman upon experimental slabs of 1:2:3 concrete 18 in. wide, 6 ft. 6 in. long and 6 in. thick, on a clay sub-soil, a total movement of 0.00017 per unit length was observed under a change in temperature of 65° F. between July and November. The theoretical temperature movement for this range would be 0.000384 per unit of length.

Measurements made on a concrete road by the Bureau of Standards, covering a period from October, 1912, to October, 1913, and others from June to October, 1913, show that the linear change in the concrete is not in accord with the temperature change. These measurements were made by stretching an invar tape, graduated to meters, along the road spanning several slabs and reading every second meter, the figures recorded as slab changes represent changes between the points nearest the ends of the slab. Readings were recorded to hundredths of a millimeter (0.00039 in.) There was an elongation from November to April, when it reached a maximum, followed by a shortening until August, and this is followed by an elongation until October. During this period there was a mean temperature range from 16° to 84° F.

Considerable rain fell during the later part of March and the early part of April. The contraction from April to August is contrary to the condition which should result from a rise in temperature, and this can only be explained by a drying out of the concrete sufficient in amount not only to overcome the expansion due to a temperature increase of 20° F., but also to show a substantial contraction. From August to October the slab shows expansion, which again can be explained by an increase in moisture content as there is no rise in temperature.

There are no data available to indicate the expansion which might be expected in green concrete due to a rise in temperature brought about by chemical action during setting. Several of the curves of results obtained would indicate that this setting heat might be effective in causing expansion. Temperature measurements have been taken in a number of cases, and the temperature increases were noted to range from 17° F. to 108° F. in less than 18 hours after mixing. Such a great increase in temperature as these, it is believed, would have some effect, but its magnitude can only be determined by further investigation.

A variation in the quality of the concrete may also cause a variation in the thermal co-efficient of expansion, and it will, of course, affect the movement which takes place, as the modulus of elasticity of the concrete does change with a change in the quality.

Effect of Variation in Moisture Content of Concrete.—It has been definitely established that with an increase in moisture content there is an expansion of the concrete and with a decrease in the moisture content a contraction. This phenomena is apparently true for all concretes at all ages. The magnitude of this change is not definitely known, but experiments show:—

(1) Neat cement hardening under water expands + 0.15 per cent. by volume, and the increased volume is approximately 0.08 per cent. for a period of from 30 days to five years. The maximum expansion obtained at one year is nearly as great as at five years.

(2) Neat cement hardening in air contracts 0.25 per cent. by volume in from 16 weeks to five years.

(3) Cement-sand mortars change in like manner but to a lesser degree.

Experiments by the University of Michigan show the following results:—

(1) Neat cement hardening in air has an average unit linear contraction of —0.00109 at 7 days; —0.00190 at 28 days; —0.00236 at 6 months; —0.00270 at 1 year; —0.00289 at 2 years; —0.00322 at 4 years.

(2) That neat cement that has been hardened under water for three years will expand 0.0011 per unit of length, and if then exposed to air for 60 days will contract 0.0005 per unit of length less than the initial length, and will, therefore, show a total linear contraction of 0.0016 per unit of length.

(3) That neat cements under water show a linear expansion of from 0.0007 to 0.0015 per unit of length at the end of one year, and after that a very slight additional expansion.

(4) That neat cement alternately exposed to air and water will show results if platted that will form a regular saw-tooth curve.

(5) That 1.3 mortars show linear changes in the same direction as those of neat cement, but to a lesser degree. Submerged bars show a linear expansion in the first few weeks of as much as 0.0005 per unit of length, but decrease slightly after that, and then expand later to a length greater than the maximum expansion of 0.0005. Bars of 1.3 mortar in air shrink in length to an average of 0.0008 per unit of length within three months.

(6) Experiments with sections of a top coat of a cement walk which had been laid 20 years showed that it expanded when immersed 0.0005 per unit of length and contracted the same amount when again dried.

(7) Experiments with a section of stucco two years old, from a brick house showed a linear expansion when immersed of 0.0008 per unit of length in four days, and a return to its original volume when dried.

(8) Experiments with a section of cement walk in which a sample of both the top course and base were bound together showed that upon immersion the base reached its maximum expansion in 15 minutes, while it took the top coat three days to reach the same expansion.

This is interesting, partly because of the evidence of alternate bending stress in the concrete due to the more rapid expansion of the lower layer and partly because of the ultimate agreement in expansion of the top and bottom portion. This cement sidewalk was in good condition after 20 years' service.

The results of experiments made by the Bureau of Standards are shown in Table I.

Table I.—Linear Expansion of Neat Cement Stored in Various Manners.

Test piece (1 in. by 1 in. by 13 ins.) neat cement prisms.

No. of cements.	Manner of storing.	Age of test piece.	Change in length per unit of original length.
6	In water	30 days	+0.00095
8	In water	30 to 60 days	+0.00105
4	In water	120 days	+0.00113
20	In water	6 to 9 months	+0.00152
6	In air	30 days	—0.00150
15	In air	30 to 60 days	—0.00167
4	In air	120 days	—0.00211
40	In air	6 to 9 months	—0.00285

It was noted that prisms which had been stored in air, when placed in water at practically any age, began expanding, the expansion proceeding in manner similar to prisms placed directly in water after moulding. Similarly, prisms stored in water contracted when removed and kept in air.

Note.—The original reading was taken on removal from damp closet 24 hours after moulding.

Investigations have not been extensive enough to form final conclusions on the effect of moisture on expansion and contraction, but the following statements may be made, which are in part applicable to concrete roads:—

All of the tests quoted above show expansion of neat cement and of mortar and concrete when the samples are hardened under water. The results show the extent of this expansion to be greater with neat cement and to decrease when the addition of sand or coarse aggregate is made.

These tests also show that neat cement mortar and concrete will contract when hardened in air and that the contraction of neat cement is the greater, while that of mortar or concrete varies with the amount of sand and coarse aggregate used in the mixture.

They show that to an age of 20 years, and possibly for all time, these changes may be looked for in concrete.

They show that the condition which would provide for a decrease in moisture content when the temperature increases and an increase in the moisture content when the temperature decreases would be an ideal one.

All these tests indicate that the effect of moisture content is very much greater than the effect of temperature change, and may be sufficient to cause a stress in the concrete opposite to that which would be caused by a normal temperature change.

A variation in the quality of the concrete will cause a variation in the tendency to expand and contract with change in moisture content, as dense mixtures absorb water less rapidly than porous mixtures.

If concrete of two qualities in a road were exposed to an equal amount of moisture for a short period, the more porous of the two would have a tendency to expand the most and would have the less strength to resist the stresses set up. Assuming only a slight change in temperature and that the frictional resistance on the sub-base was uniform, the more porous concrete would have to move the greater distance, higher tensile stresses would be set up upon drying out, and it would be the more liable to crack.

If 1-course work concrete of two qualities in the same slab in a road were similarly exposed, the same tendency would be exhibited, and this may, in certain cases, be sufficient to cause a separation of the two concretes or may cause a number of small cracks.

If in 2-course work the base is of a more porous concrete than the top, the tendency would be to have unequal expansion and contraction in the slab, due to different moisture content in these mixtures causing the bottom to move more than the top or vice versa. Also, if the concrete road is subject to a heavy rain for a considerable length of time the bottom will be exposed to moisture in the ground for a longer time than the surface and the surface will be more or less dried, due to exposure to the sun, and, consequently, the top would tend to contract while the bottom would still be expanding.

Effect of Variation in Condition and Character of Sub-base.—The condition and character of the sub-base would affect the support of the road; the amount of moisture transmitted to and from the concrete; the action of frost; and the friction on the bottom of the slab. All of these factors affect the expansion and contraction of the concrete.

If the slab of concrete is not uniformly supported, sections may be stressed, causing tension or compression in an amount sufficient to exceed the strength of the concrete, resulting in cracking. A condition illustrating this point may be found where a concrete road is built over an old stone road-bed of less width than that of the concrete slab. The foundation at the sides, which is not so compact as that at the centre, will settle more, causing expansion in the surface of the concrete slab possibly sufficient to cause a crack. While there is no experimental data available definitely establishing this point, it is believed the longitudinal cracks noted in one of the roads under examination may be thus accounted for.

The amount of moisture transmitted to and from the concrete through the sub-base depends upon the porosity and density of the material in the sub-base. The action of frost can only occur in a sub-base containing moisture in localities in which the temperature gets sufficiently low to freeze to a depth of the sub-base. This action is, therefore, dependent upon the porosity and capillarity of the sub-base material and the depth of the water table below the concrete. The effect of freezing and thawing is to place the slab in stress which may cause cracking.

From observations made it would appear that the cracks usually occur during a thaw rather than during a frost, and this may be explained by the fact that the heat may be transmitted more rapidly through the shoulders than through the centre of the road, causing unequal settlement. If the heaving action of frost does cause cracking it is usually due to raising the edge of the road, which will probably crack the lower side, which may not be apparent until the slab returns to its original position, when the crack will appear on the upper surface.

The friction on the bottom of the slab is dependent upon the condition of the sub-base. The effect of this friction is to restrain movement in the concrete; therefore, the tendency to volumetric change due to change in moisture content and thermal change would be restrained. This restraint would set up stresses in the concrete probably proportional to the restraint. This is shown in the experiments made by Mr. Spackman. Referring to these results and considering only the effect of temperature, there should have been a theoretical movement of 0.000384 per unit length, and yet only a movement of 0.00017 per unit length was obtained. An inspection of the movements recorded in Figs. 1 to 3 also shows that the movements were not in accordance with theoretical requirements. The change in moisture content is not known, and most probably had something to do with the discrepancies. Thus, the actual movement observed by Mr. Spackman due to temperature may have been greater or less than that indicated by the figures.

The longitudinal grade of the road would affect the friction on the bottom of the slab. On a 5.2 per cent. grade a slab 30 feet long was observed to have moved down hill, the joint at the upper end of the slab being decidedly open while the lower end of the slab slid upward on the adjoining slab. The joint in this case was not perpendicular to the slab. Measurements also substantiate the above conditions. This sliding may have been assisted by changes in the thermal and moisture content of the concrete.

Effect of Traffic.—The expansion and contraction of concrete is probably the least affected by loads brought upon the road by traffic than by any of the above mentioned causes. The effect is, however, not to be neglected, particularly when it acts in conjunction with an uneven settlement of the sub-base, similar to that heretofore mentioned of a slab being placed over an old stone road of less width than that of the concrete. The result would be cantilever or beam action and the consequent throwing into tension the top of the slab, which may cause cracking.

[Note.—The balance of the report dealing with the application of present knowledge to the prevention of cracks; the value of reinforcement; the effect of joints, and of character and condition of the sub-base on cracking, will follow in next issue.—Editor.]

BELL FILTRATION COMPANY SUES THE EX-MAYOR OF OTTAWA.

The Bell Filtration Company of Canada, Limited, have entered suit against ex-Mayor Ellis, of Ottawa, Ont., for $10,000 damages. Mr. Ellis, who is now an alderman of Ottawa, was defeated in the mayoralty contest early this year by Mayor McVeity.

Alderman Ellis is a strong advocate of the Gatineau Lake water scheme for Ottawa, while Mayor McVeity prefers filtration. Interviews and other matter published in the Ottawa papers tending to have an influence on the plebiscite which was to have been taken March 9th, are the cause of the suit.

The Bell Filtration Company contend that the cost of a filtration plant for Ottawa plus the capitalized cost of operation, is far less than the cost of the Binnie or Gatineau Lake scheme plus the cost of operation. It was in opposing these arguments and urging the people to vote for the Binnie scheme, evidently, that the former Mayor made statements which led to the institution of the suit for damages.

The Cleveland Bridge and Engineering Company has secured from the Argentine Government the contract for the erection of a great new reservoir at Caballio, in connection with the water supply of Buenos Ayres. Leading American, Belgian and German structural engineering firms submitted tenders.

THE CONTROL OF STREAM POLLUTION.*

By Paul Hansen,
Engineer, State Water Survey, Urbana, Ill.

IN uninhabited or even rural districts the evil results of stream pollution are practically negligible, but in urban districts streams are rendered exceedingly foul by the enormous quantities of sewage and industrial wastes poured into them from city sewers. These streams become totally unfit for pleasure purposes, the land along the banks is depreciated in value, and public water supplies drawn from the streams may be grossly contaminated and constitute an extreme danger to public health. An enormous toll in human lives is annually exacted as a result of polluted streams, not to mention the economic loss due to depreciation in property values.

To prevent the evils of stream pollution gaining too great headway, central governmental control backed by an intelligent public opinion is essential. The molding of an intelligent public opinion is, however, a rather difficult matter, for even among persons who have given considerable thought to sanitary subjects, there exist gross misconceptions as to the logical and practicable way to treat the problem of stream pollution. There has been a tendency to permit sentimentality to get the upper hand, and this has resulted in giving wide currency to some extravagant demands that are wholly impracticable. There is, however, a group of sanitary engineers who have come into intimate contact with actual problems relating to the prevention of stream pollution, and among these engineers there has gradually come about a unanimity of opinion regarding certain essential factors relating to the stream pollution problem. It will be the object of this paper to present these opinions, and the statements made will be largely based upon recent careful inquiries among sanitary engineers and others interested in sanitation.

The subject may best be treated by first considering in a broad way what the functions of a stream really are. Having reached a satisfactory conclusion upon this point, it will be possible to consider certain special uses of streams with respect to stream pollution.

General Functions of Streams.—The proper conception of a stream recognizes the dual function of watering and draining the country through which it passes. Some pollution of streams is inevitable; for with increased density of population, increased cultivation of the soil and increased numbers of urban communities, it is practically impossible to prevent the discharge of all deleterious matter into streams. It is only reasonable to require that the pollution of streams be maintained at less than a certain fixed maximum, and this permissible maximum pollution must vary according to the character of the stream, the population along the banks of the stream and the uses to which the waters of the stream are placed.

Streams Used as Sources of Public Water Supplies.—Since streams in the ordinary course of events must receive more or less contamination, it follows that public water supplies drawn from surface streams must of necessity be polluted, and should not be delivered to the consumers unless the water is first adequately purified. One exception may be made to this general rule, namely, in the case of water supplies derived from streams draining comparatively small watersheds. In such cases it is sometimes feasible for the water supply authorities to own the entire watershed and control it in such manner as to make contamination of the water courses impossible. But in general we have this question to contend with: How much pollution may be permitted to enter a stream before the water thereof is polluted to a point beyond redemption by water purification methods? This is a question that taxes the greatest ingenuity of sanitary experts, and it is always necessary for any specific problem to be considered on its particular merits in order to obtain what is the best and most economical solution.

Notwithstanding the great difficulty in defining that degree of pollution which is permissible in streams which are to be used as public water supplies after purification, there would seem to be an advantage in attempting to approximate a general rule for the control of such streams. A rule has been formulated in the light of the present available evidence, but it must be admitted that this rule is not based upon any very scientific data and it can, therefore, only be put forward tentatively, with the expectation that it will be modified from time to time as more and more experience is acquired. This rule may be stated as follows:

The time in hours required for the passage of a particle of water from a sewer outlet to the point of waterworks intake during high water multiplied by the dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers should equal a constant and this constant should not equal less than 40. This may be expressed mathematically as follows:—

$$T + D = C.$$

In which T = time in hours required for the passage of a particle of water from the sewer outlet to the waterworks intake at high water;

D = dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers; and

C = constant which it is recommended be not less than 40.

The above formula applies to streams in which there is no appreciable increase in volume of flow between the sewer outlet and the point of waterworks intake. In the case of streams which receive the discharge of large tributaries between the point of sewer outlet and the point of waterworks intake, the formula must, of course, be modified. Generally it will be merely necessary to assign a value of D, which represents the mean of the quantity of water flowing past the sewer outlet and that flowing past the waterworks intake. If the factor of safety proves to be more than 40, purification of the sewage will not be necessary for the protection of the water supply. If the factor of safety is less than 40, some form of purification will be necessary, and this may vary all the way from plain sedimentation to intermittent sand filtration followed by sterilization.

The formula, of course, is intended to be used merely as a rough guide, and it is conceivable that there are instances where it will not apply. Take, for example, the case of a very large stream, where a sufficiently large factor of safety may be obtained with the sewer outlet at a very short distance above the point of waterworks intake, and on the same side of the stream; here it is manifest, due to the impracticability of securing a mixture of the sewage with the entire volume of the stream, that the sewage must receive treatment or the waterworks intake must be extended to a point above or, at

*From a paper read at the 1913 convention of the Illinois Academy of Science.

any rate, beyond the influence of the sewer outlet. As a rough guide, however, such a formula may serve a useful purpose in narrowing down the widely divergent practice of the present time.

Streams for Recreation Purposes.—Of recent years growing importance is attached to the maintenance of our streams for pleasure purposes. Every summer there may be found scattered along the streams within a radius of fifty miles or more of our large cities numerous camps. This form of summer vacation is a comparatively cheap and normally a healthful means of recreation. It ought to be regarded as one of the means of improving the health tone of our urban communities, inasmuch as it is within the means of so great a number of people.

Under this head may be asked how high a degree of purity should be demanded in a stream which is extensively used for recreation purposes, but not for public water supply? Within the last few years much emphasis has properly been placed upon the purification of sewage by dilution, which, after all, is purification by oxygenation in which a natural resource is utilized instead of an artificially constructed purification works. It has generally been held—and in most instances rightly held—that the degree of dilution necessary is merely that which will prevent a nuisance, having reference primarily to unsightly floating matter and bad odors. For most rivers and many of the smaller streams of the country, this requirement as to the cleanness of the waters is all that is necessary.

There is, however, a certain class of streams which, because of the beauty of the country through which they flow and their specially favorable location, become highly prized for camping and recreation purposes. It is a striking circumstance, in fact, that recreation seekers nearly always look for the stream valleys, which illustrates the craving of man for a combination of land and water, by means of which nature presents her most alluring and most picturesque aspects. These streams, as a rule, have no large cities upon their banks, but merely here and there a small town or village. The sewage from such small towns and villages may not be sufficient to produce a visible contamination except possibly throughout a very short distance below the sewer outfalls. Such contamination does offend the esthetic sense, however, and undoubtedly does add some danger to public health, for the reason that, when a stream is used for recreation purposes, it will be used for boating and bathing and as a domestic supply to some extent among campers, though it may not and should not be used for drinking water. It seems to the writer that such streams as these deserve greater protection against contamination than merely to prevent nuisance.

No definite rules to apply to all cases can be laid down, but as a general principle it may be said that if such a stream is not polluted to any material extent by storm water and street wash, such as would obtain in the case of a city of considerable size located upon its banks, it would seem perfectly feasible to purify the sewage to a point where it will give no evidence of its existence even in the vicinity of the outlet. Furthermore, the sewage effluent should be sterilized by the cheap and satisfactory means of using bleaching powder, so as in large measure to guard against dangers to health among vacationists which may result from boating, bathing and domestic uses of the stream other than for drinking.

Fish and Shell Fish.—Many streams are valuable to the community on account of their fish life. It may be said, in general, that there is rarely necessity for so polluting a stream as to endanger fish life, though there are some circumstances where the continuance of certain liquid-waste-producing industries injurious to fish is of so great importance to the general welfare that fish life in certain streams must be sacrificed.

The maintenance of fish life does not necessarily imply an unpolluted stream. It is merely necessary that the alkalinity of the water be maintained and that the pollution be not so great as to absorb the dissolved oxygen in the water to an extent that will suffocate the fish. The fact is that a moderate degree of pollution favors fish life, in that it favors the growth of microscopic aquatic organisms which constitute valuable fish food. Certain difficulties have been encountered in the contamination of fish by polluted water which causes the fish to decay rapidly and become unfit for human consumption. The danger of infection of human beings with specific disease through eating fish taken from polluted streams is almost negligible, for the reason that, in this part of the world, at any rate, fish are not eaten raw. With shell fish, however, the case is quite different, because they are very frequently eaten raw. It has been a common practice along the coast to float oysters in shallow polluted waters, which causes them to become bloated and appear fat. Such an oyster perhaps makes a more delectable morsel of food, but in it may be lurking the germs of typhoid fever or some other water-borne disease. The problem of protecting the shell fish industry is a very complicated one, and all its intricacies have not been worked out. Here, again, the services of experts are needed to study each zone of shell fish pollution in the light of diverse local conditions.

Discharge of Manufacturing Wastes Into Streams.—Many of our important industries, such as paper mills, woolen mills, dye works, starch factories and tanneries require large volumes of water to carry on their industrial operations, and they also produce large volumes of waste which are capable of undergoing offensive putrefaction. The discharge of these wastes into streams often causes unsightly and malodorous conditions; yet, with the exception of tanneries, these waters do not menace the public health, since they do not contain the specific infections of disease. (Tannery wastes may contain anthrax bacilli.) In fact, some of the processes are such that the wastes are quite inimical to the existence of disease germs. In some cases it is practicable to treat the wastes so that offensive conditions in a stream may be in part or wholly relieved, but for certain industries such treatment of the wastes is prohibitively expensive.

Enjoining industries against causing objectionable stream pollution may, and in some instances actually has, necessitated the shutting down of works. It is conceivable, in the case of large industries upon which are dependent a considerable population, that an order to cease stream pollution, which is virtually an order to shut down the works, might result in great hardship without adequate returns accruing from the cleaner conditions of the stream. There may be instances, therefore, where a limited few of the streams of the country may legitimately be turned over to the manufacturing interests. Now that the stream pollution problem has become more acutely an issue and the disadvantages of filthy streams are better understood, it would not seem wise to permit waste-producing industries to be located upon any but very large streams which have an ample volume to dilute the wastes to an inoffensive condition. That is to say, the streams which are now clean should be maintained clean, for the reason that we have an ample number of large streams which can effectually take care of wastes from waste-producing industrial plants for an indefinite period in the future.

Legal Control Over Stream Pollution.—A discussion of stream pollution would not be complete without some consideration of legal control. As already indicated, the cleanness of streams cannot be conserved unless under a central governmental supervision. If left to individual communities, very little could be expected in the way of results. Communities are not likely to be altruistic enough to spend large sums of money for sewage purification works to protect neighbors on the stream below, unless such altruism is induced by damage suits which render sewage purification the cheapest way out of the difficulty. But law-suits are costly if long drawn out, and the results are often unsatisfactory.

For successful solution it is essential that specific problems relating to stream pollution be placed in the hands of experts. It is, therefore, necessary, or at least strongly advisable, that every state have an expert commission. Among many there is a strong prejudice against commissions, inasmuch as the multiplication of commissions is looked upon as a delegation of legislative and executive powers to others than direct representatives of the people. This need not necessarily be so, however, for a law may be framed requiring in general terms that streams must be maintained in an inoffensive condition and that they shall not be detrimental to health. This leaves to the commission not arbitrary powers, but the simple function of determining points of fact within limits prescribed by prior legislative enactment. That is to say, the commission will determine when a stream is in danger of being made offensive and when it is in danger of being made detrimental to health, and thereupon decide what purification of sewage and industrial wastes is necessary, whether water supplies may or may not be taken from streams and to what extent they must be purified. Such a commission should be supplied with ample appropriations to enable it to obtain all necessary information for its guidance, whether this consists in maintaining laboratories or in carrying on experimental and research work. As even the best of commissions may at times grow arbitrary or become unduly biased in its views, there should always be made provision for ready appeal from the decisions of a commission to an independent special arbitration board of experts, and, of course, there must exist the inalienable right of appeal to the courts.

The Berlin Elevated and Underground Railway, Berlin, Germany, has recently completed, at a cost of over $2,000,000 and has opened for public service, an extension from Wittenbergplatz in Berlin to the fashionable suburb of Dahlem.

One of the most wonderful structures of its kind, and one that is said to be the only large-span bridge in the world designed for four lines of railway traffic, is the Hell Gate steel arch bridge now under construction at New York. The Long Island abutment pier is well under way and the foundation for the Ward's Island pier is complete. Fabricated steel work is already being received and the erection of the arch will probably be under way before the end of the summer. The structure will be notable for the magnitude of its chord sections. Each single section will have a weight equal to twice that of the heaviest erection parts of the great bridges already existing. The weight of the structure will average about 38,000 pounds steel and 53,000 pounds total per lineal foot. The great weight is due to the large live-load capacity provided. When it is in operation there will be a constant succession of the heaviest freight trains passing back and forth over the structure.

THE MINERAL PRODUCTION OF CANADA, 1913.

THE preliminary report on mineral production in Canada in 1913, prepared by John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics, shows a total value of production in the year of $144,031,047. Although estimates have been made in some cases where complete returns were not available it is probable that the final record will be a revision upward. The total value of the production in 1912 was $135,048,296 compared with which the 1913 output shows an increase of $8,982,751, or 6.65 per cent. In view of the large increase over all previous years made in mineral production in 1912 and the general trade depression and industrial restriction experienced during the latter part of 1913, the industry would appear to have made in the aggregate very satisfactory progress. The average production per capita in 1913 was $18.57 as against $18.27 in 1912 and $14.93 in 1910.

The record of annual mineral production in Canada since 1886 shows the rapid growth of the industry; not only has the total output increased from a little over $10,000,000 in 1886 to its present output, but the average production per capita has increased from $2.23 per capita to $18.57, or eight times the rate shown by the first record. This is shown in Table I.

Table I.—Annual Mineral Production in Canada Since 1886.

Year.	Value of production.	Value per capita.	Year.	Value of production.	Value per capita.
1886..	$10,221,255	$2.23	1900..	$ 64,420,877	$12.04
1887..	10,321,331	2.23	1901..	65,797,911	12.16
1888..	12,518,894	2.67	1902..	63,231,836	11.36
1889..	14,013,113	2.96	1903..	61,740,513	10.83
1890..	16,763,353	3.50	1904..	60,082,771	10.27
1891..	18,976,616	3.92	1905..	69,078,999	11.49
1892..	16,623,415	3.39	1906..	79,286,697	12.81
1893..	20,035,082	4.04	1907..	86,865,202	13.75
1894..	19,931,158	3.98	1908..	85,557,101	13.16
1895..	20,505,917	4.05	1909..	91,831,441	13.70
1896..	22,474,256	4.38	1910..	106,823,623	14.93
1897..	28,485,023	5.49	1911..	103,220,994	14.42
1898..	38,412,431	7.32	1912..	135,048,296	18.27
1899..	49,234,005	9.27	1913..	144,031,047	18.57

The continuance during 1913 of the labor strike at the mines of the Canadian Collieries (Dunsmuir) Limited, and its extension to the other collieries on Vancouver Island, seriously restricted the coal output from that district. The total value of the metals was also somewhat smaller than it might otherwise have been because of the slightly lower average prices obtained for copper and silver. A restricted demand was also reported during the latter part of the year for brick and other clay products and structural materials. While these are some of the influences that have tended to curtail the mineral output during the year, there have been, on the other hand, important increases in the production of gold, nickel, lead, amongst the metals, in asbestos, natural gas and many of the other lesser valuable non-metal products and in cement, resulting in the net increases already shown.

The production of the metals and minerals of special importance to engineers, contractors and manufacturers of their supplies is shown in Table II., in which the figures are given for the two years 1912 and 1913 in comparative form, and the increase or decrease in value shown.

Of the total production in 1913 a value of $66,127,821 or 45.9 per cent. is credited to the metals and $77,903,226 or 54.1 per cent. to the non-metallic products. The increase over the value for 1912 in metallic products was $4,955,068 or 8.1 per cent. and in non-metallic products $4,027,683 or 5.45 per cent.

Mineral Production by Provinces, 1912 and 1913.—The record of production by provinces given in Table III. shows the relative importance of the several provinces in practically the same order as last year with the exception that Saskatchewan replaces New Brunswick in last position due to a falling off in the coal and structural material production in the former province and an increase in the coal, gypsum and natural gas production in the latter. Ontario has the largest output with a value of $58,697,602, or 40.75 per cent. of the total, a slightly higher proportion than in 1912. British Columbia is second with a value of $28,529,081, or 19.81 per cent. of the total, a relative falling off; Nova Scotia takes third place with a total production of $19,305,545, or 13.4 per cent.; Alberta fourth, with $13,844,622, or 9.6 per cent.; Quebec fifth, with $13,303,649, or 9.24 per cent.

Table II.

	—1912— Quantity.	Value. $	—1913— Quantity.	Value. $	Increase (+) or decrease (—) in value. $
Pig iron ....(Short) Tons.	1,014,587	14,550,999	1,128,967	16,540,012	+1,989,013
Lead ....Lbs.	35,763,476	1,597,554	37,662,703	1,754,705	+ 157,151
Nickel ....Lbs.	44,841,542	13,452,463	49,676,772	14,903,032	+1,450,569
Asbestos and asbestic ....Tons.	136,301	3,137,279	161,086	3,849,925	+ 712,646
Coal ....Tons.	14,512,829	36,019,044	15,115,089	36,250,311	+ 231,267
Gypsum ....Tons.	578,458	1,324,620	639,698	1,477,589	+ 152,969
Natural gas ....M. ft.	15,286,803	2,362,700	20,345,763	3,338,314	+ 975,614
Petroleum ....Bbls.	243,336	345,050	228,080	406,439	+ 61,389
Salt ....Tons.	95,053	459,582	100,791	491,280	+ 31,698
Cement ....Bbls.	7,132,732	9,106,556	8,658,922	11,227,284	+2,120,728
Clay products	....	10,575,869	....	9,673,067	— 902,802
Lime ....Bush.	8,475,839	1,844,849	7,671,381	1,605,812	— 239,037
Stone	....	4,726,171	....	5,199,204	+ 473,033

There was an increased production of each of the metals except copper and silver, the most important increase being in gold with 28 per cent. Pig iron increased 11.3 per cent. in tonnage, lead 5.3 per cent., and nickel 10.8 per cent. The falling off in copper was only 1.1 per cent. in quantity although 7.6 per cent. in total value, and for silver 0.6 per cent. only in number of ounces and 2.3 per cent. in value, slightly lower average prices having been obtained for these metals.

Amongst non-metallic products increases are shown in all the important products except clays and lime. The largest increase was in natural gas with 41 per cent. in value. The cement output was greater by 21 per cent. in quantity, asbestos 18 per cent., coal 4 per cent., gypsum 10.5 per cent., salt 6.04 per cent. In the case of petroleum there was a falling off of 6 per cent. in quantity but on account of higher prices an increase of nearly 18 per cent. in total value.

The decreases in clay products and lime were respectively 8.5 per cent. and 12.9 per cent.

Table III.

	—1912— Value of production. $	Per cent. of total. %	—1913— Value of production. $	Per cent. of total. %
*Nova Scotia ..	18,922,236	14.01	19,305,545	13.40
New Brunswick.	771,004	0.57	1,049,932	0.73
Quebec	11,656,998	8.63	13,303,649	9.24
Ontario	51,985,876	38.50	58,697,602	40.75
Manitoba	2,463,074	1.83	2,211,159	1.54
Saskatchewan ..	1,165,642	0.86	899,233	0.62
Alberta	12,073,589	8.94	13,844,622	9.61
British Columbia	30,076,635	22.27	28,529,081	19.81
Yukon	5,933,242	4.39	6,190,224	4.30
Dominion ..	135,048,296	100.00	144,031,047	100.00

*Includes a small production of lime from Prince Edward Island.

Increases are shown in each of the provinces with the exception of Manitoba, Saskatchewan and British Columbia. The largest increase—36 per cent.—is exhibited by New Brunswick. The increases in the other provinces were respectively: Alberta, 14.7 per cent.; Quebec, 14.1 per cent.; Ontario, 12.9 per cent.; Yukon, 4.3 per cent.; Nova Scotia, 2.0 per cent. The decreases were Saskatchewan nearly 23 per cent.; Manitoba 10 per cent., and British Columbia 5 per cent.

It should be remembered in dealing with these comparisons that Nova Scotia in the above record is given no credit on account of the large iron smelting and steel making industries at Sydney, New Glasgow, etc. The pig iron made here is entirely from imported ore and naturally is not credited as a Canadian mine output. The same remark applies to a large percentage of the pig iron production in Ontario as well as to the production of aluminium in Quebec.

A resolution was passed by the Canadian Mining Institute at Montreal on March 6, directing the attention of the Dominion Government to the fact that the iron industry was greatly handicapped because extensive deposits of the same high grade as were found in the United States, Newfoundland and Cuba had not yet been located in Canada, although it was believed that they existed, and that they could be found should endeavours be made. The Institute, therefore, urged the Government to take such means through the proper channels, either by a geological survey or by a special committee of experts, as would determine the extent and value of Canada's iron resources, a procedure which would add immensely to the economic wealth of the Dominion.

Coast to Coast

Edmonton, Alta.—It has been reported at Edmonton that the total deficit in 1913 for the street railway department amounted to $190,000.

Guelph, Ont.—The Fire and Light Committee at Guelph are asking the city council for an appropriation of $31,471, which is in excess of the largest amount ever requested previously.

Halifax, N.S.—At the session of the Nova Scotia government on March 4th, it was announced that during the last fiscal year there had been a total expenditure in the roads division of the department of public works of $408,090.37, the largest expenditure in any year since the organization of roads division.

Halifax, N.S.—The report on provincial railways recently submitted in the Nova Scotia legislature showed that the increase in total earnings of the subsidized railways in the province for the fiscal year 1913 was $126,835.71, or about 8 per cent. over the total earnings of 1912. Except for 2 miles of new railway built by the Dominion Coal Co., Limited, there has been no railway construction during the past year over which the province had jurisdiction.

Winnipeg, Man.—It is estimated, according to a statement presented at a recent meeting of the administration board of the Greater Winnipeg water district, that the sum of $1,332,-906.29 will be spent by the end of the year on the scheme to bring Shoal Lake water into the city. The estimated expenditure by months is as follows: To March 1, 1914, $108,799.34; to April 1, $138,046.04; to May 1, $168,816.04; to June 1, $221,026.04; to July 1, $334,110.29; to August 1, $501,580.29; to September 1, $690,395.29; to October 1, $814,815.29; to November 1, $1,057,466.29; to December 1, $1,293,606.29; to January 1, 1915, $1,332,906.29.

Vancouver, B.C.—It is stated that more than 1,000 feet of the "pioneer" bore, being driven by the C.P.R. in connection with the excavation of a 5-mile, double-track tunnel through the heart of the Selkirk range, have been completed. Good progress is also being made with the cross cuts and side drifts leading into the main shaft which has already been started from the east end. Work on the "pioneer" shaft from the west side of Mount Macdonald, will most likely be started at an early date. The right-of-way at the west portal has been completed and 47 per cent. of the excavation has been done from the east side. Work on the trestles and the grading for the lines on each side of the mountain is well advanced.

Edmonton, Alta.—Compilations made by the Edmonton Industrial Association show that at least 3,000 miles of railway will be built in Alberta before the close of 1915. The C.N.R. will construct 1,000 miles, most of which will be in the northern half of the province; though it will also complete its main line in western Alberta. The C.P.R. will continue the Calgary-Edmonton line northward into the Peace River country and other northern and central sections, as soon as a survey is approved. It is stated by the president of the Edmonton, Dunvegan and British Columbia Railway Company that 125 miles of the 283 miles of road from Edmonton to Fort McMurray will be ready for grading early in May. Also work is to begin this year in the three western provinces on a line from the Ness River on the Pacific Coast, to Prince Albert, Sask., by way of Northern Alberta.

Victoria, B.C.—A settlement has been reached with the Canadian Northern Pacific Railway and the Franco-Canadian syndicate for the lease of the six acres required at Cooper's Cove to the Pacific Lock Joint Company for the purpose of drying out the pipe to be used on the waterworks flow line. The company's agents are assembling material and supplies at the Cove and this contract, the largest and most important of those to be carried out in connection with the waterworks, will be under way in a short time. Meanwhile the city is pushing the work on the trestles, which have to be made of a permanent character before the pipe is laid upon them. At present frame structures carry the track across creeks and ravines, except Sooke River, where a steel span is necessary.

Calgary, Alta.—In addition to the plans recently submitted by the City Engineer of Calgary upon the bridge at Centre Street, plans have also been provided for bridges known as Louise Bridge and Mission Bridge. The plans for the former call for a reinforced concrete bridge to replace the present structure, 600 feet long, landing just east of the present structure so that it debouches into 9th Street, at a cost of $167,000; or for a duplicate of present steel bridge, but two feet wider, to be placed directly alongside and coupled up with the present bridge, making a double steel bridge, one for north-bound and the other for south-bound traffic. This is estimated to cost $55,000. The plans for the Mission bridge are for a reinforced concrete structure, with 46-foot roadway and two 8-foot sidewalks, estimated at $77,600; or for a steel lattice girder bridge, with ornamental railing, estimated at $67,000.

Calgary, Alta.—Three separate plans and estimates have been furnished by City Engineer Craig, of Calgary, for a bridge at Centre Street, and these are now being considered by a special committee of the city council. Mr. Craig has arranged all three plans so that the south approach can start from either Centre Street or First Street West. Alternative plans are also provided for the North Hill approach. These will be either through an open cut running back into the hill some distance and bridged over at street crossings by overhead bridges, or else the approach in the north hill can be tunnelled for a short distance through the hill. The difference in cost between the tunnel and the overhead bridges will be about $3,000 in favor of the bridges, according to the engineer's estimates. The plans for all the bridges provide for length of 900 feet. The plans also provide for 40-foot roadways with two 8-foot sidewalks.

Woodstock, N.B.—Preparations for the spring work on the St. John Valley Railway are in progress. It is announced that Messrs. Kennedy and McDonald, who have an option on the section from Centreville to Grand Falls, but which contract has not been let, will have a new 100-ton steam shovel on the work by April 1st, to supplement the smaller shovel which has been used between Woodstock and Centreville. Ballasting south of Woodstock will commence on May 1st. The Dominion Bridge Company is constructing the overhead crossing at Woodstock, which is an 80-foot span, and will soon commence work on the Meduxnakik Creek bridge, which is 380-foot span, and which will probably be finished by the middle of April. The brick station at Woodstock will have a concrete foundation, and will be 140 feet long by 40 feet deep. The tenders are now in and the contract will be given and work commenced as soon as the frost is out of the ground.

Ashcroft, B.C.—One of the most difficult bridges from a construction point of view on the Canadian Northern Pacific Railway in British Columbia is approaching completion. The viaduct spans the Black canyon, a narrow gorge on the Thompson River, a few miles below Ashcroft, and 189 miles east of Port Mann. It had to be built without the aid of false work; and the fact that the railway entered a 1,300-foot tunnel after spanning the canyon greatly increased the engineering difficulties experienced in its erection. An abutment was built on the tunnel side and the massive steel girders were placed in position by means of a huge derrick, which swung over the gorge. The main span of the bridge is 210 feet long, the total length of the structure being 245 feet. It rests on a pier which is nearly 100 feet down to rock; and it is built of truss girders and of the most substantial type. At low water the railway will cross the canyon at a height of about 80 feet.

Vancouver, B.C.—The preliminary work in connection with the dock upon which construction has commenced for Messrs. McNeill, Welsh and Willson, of Vancouver, consists of the erection of a wharf 308 feet long by 176 feet wide, a roadway approach, and the reclamation of a tract between the proposed dock and the railway bridge. The plans which have been prepared by Messrs. J. R. Matheson and Sons for the sheds and warehouse buildings to be constructed provide for two large structures 204 feet long by 75 feet wide, which will flank a central roadway and "gridiron" landing slip for scows. Additional loading facilities for barges will be provided on the western side of the wharf, and the reclaimed area between the eastern edge of the dock and the railway bridge will be utilized for trackage purposes. A strip 50 feet wide will be filled in, to connect the dock with the bridge. The warehouses will be of substantial construction and covered with galvanized iron. The roadway and the scow landings will also be enclosed. The dock will be approached by a driveway 200 feet long. A feature of the sheds will be the absence of pillars, massive trusses being used to support the roof.

Brandon, Man.—A joint power committee was formed in Brandon on March 5th, and at its session on the following day passed three resolutions, the first proclaiming that the committee recognized the importance to Manitoba of the preservation of the water powers on the Winnipeg River, and that it be represented to the government of this province that it is necessary in the provincial interests that the province vigilantly guard the rights of the province in the matter of the water flow on the said river. The second motion proposed that it be respectfully represented to the government of the province that is is expedient in the interests of this province that the matter of the distribution of electrical energy to the towns and villages, and as far as possible to the rural municipalities of this province, be made the continuous study of those experts in hydraulic and electrical engineering, and that it be represented that the matter may be a fit one upon which to invoke the continuous thought and attention of the engineering branches of the Manitoba university. The third resolution provided for securing an itemized statement of the power used between Portage and Carberry, and the same information regarding Carberry.

Victoria, B.C.—The report of the first year's work of the Water Rights Branch of the Provincial Department of Lands was given recently in the British Columbia Legislature by the Hon. W. R. Ross, Minister of Lands. He stated that a definite order of work was adopted and followed throughout the season in all the water districts into which the Province has been divided on the following basis:—Engineering investigation of old records; systematic and continuous work in stream measurement; a study of the proper duty of water; the prevention of wasteful use of water; the policing of streams; the economic distribution and delivery of water; the inspection of cisterns to determine their efficiency and safety; the determination of storage possibilities; and the investigation of water powers; also the chief draughtsman of the Water Rights Branch reports that a series of standard water rights maps, on a scale of 20 chains to the inch, has been inaugurated, and 228 of these have been drawn in 15 of the new water districts, each showing about 35 square miles, making a total of 8,000 square miles covered. Reports of engineers of the several districts are also submitted together with a series of valuable tables dealing with hydrographic stream measurements and a number of maps and diagrams showing the work of the department.

Montreal, Que.—During last summer about 60 miles of the 132 miles of macadamized road which the Quebec Government is building between Charlemagne and St. Augustin on the north side of the St. Lawrence River was levelled, and this year Mr. H. Beauregard, general contractor for the work, expects to have that district entirely completed. By next fall, it is expected that the completed road will extend as far as Berthier, which will exceed the 30 miles stipulated in the contract by 3½ miles. Mr. Beauregard has sub-let the eastern portion of his contract to Messrs. Massicotte and Gagnon, and is supervising personally the western section, or that which extends from Charlemagne to within 3½ miles of Berthier. The line for the greater part of the distance will be in full view of the St. Lawrence. Generally speaking, the old high roads are utilized, but where the grade is somewhat heavy the line deviates, the land being expropriated by the department having charge of the important work. Hundreds of gullies and ravines have to be crossed, but the statement was made yesterday by Mr. Beauregard himself that the remarkably favorable grade of 2 per cent. would be maintained throughout the entire road except a short distance near the Jacques Cartier River on the lower end of the contract. Besides the 30 miles from Charlemagne or more which the contractor expects to hand over this fall he will also level and additional stretch and everything will be done so as to secure the certainty of a completed road by the fall of 1915, the time specified in the contract.

Victoria, B.C.—The bill giving further aid to the Pacific Great Eastern Railway Company has passed its second reading in the Provincial Legislature. It provides for 30 miles of railway at $35,000 a mile, constituting an additional mileage over the 450 miles named in the original agreement between the Government and the company. This extra mileage is due to the fact that a deviation in the route was made by the engineers in the neighborhood of Clinton, as the route along the Fraser River was found not to be a feasible one, and the new alignment opened up a new section for settlement. It also provides for an increase of $7,000 per mile over the entire mileage of 480 miles, thus raising the guarantee to $42,000 a mile over the entire distance; and for 330 miles at $35,000 a mile into the Peace River country. The average cost of the Pacific Great Eastern is over $58,000 per mile, according to the estimates recently prepared by the engineers. This brings the total cost to about $27,840,000. If the guarantee is raised to $42,000 per mile, it will leave $16,000 a mile to be found by the Pacific Great Eastern, or an aggregate of $7,680,000. The whole length of the line between Vancouver and Clinton is of very heavy construction. The cost from the head of the sound to Clinton, a distance of 164 miles, has been over $61,000 per mile, or a total of something more than $10,000,000. The 44½ miles from Vancouver to the head of Howe Sound has been at the rate of $103,500 per mile, owing to expensive right of way in North Vancouver, and heavy rock excavation along the shores of English Bay and Howe Sound. The balance of the line, from Clinton to Fort George, has been of lighter construction, thereby reducing the average cost to $58,000 per mile.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice. THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

DOMINION LAND SURVEYORS.

The eighth annual meeting of the Dominion Land Surveyors was held in the Carnegie Library, Ottawa, March 3rd and 4th. Lectures of a scientific and practical nature were delivered by eminent members of the profession.

First Day.—Morning Session.—The President of the Association, Mr. C. F. Miles, D.L.S., was not present, as he is at present inspecting surveys in Northern Alberta. In his absence, Mr. J. J. McArthur, Assistant Commissioner of Boundary Surveys, acted as chairman.

A paper by H. G. Dixon, D.L.S., on the proposed transfer of natural resources to the western provinces provoked considerable discussion at the morning session. The western provinces having made a move to take over the management of their own natural resources, the Dominion Land Surveyors, in whose hands the work has always been, are afraid that they will lose some of their status—and, in fact, their jobs—if the provincial authorities achieve their desire. A committee was appointed to conserve the Association's interests in this matter.

Land surveying is apparently a healthy occupation. One member is 75 years of age and is still actively engaged in the rigorous duties even during the severe winter months. J. J. McArthur referred to this and pointed out what a healthy profession land surveying proved itself to be.

A paper on Arctic and Antarctic research was read by J. N. Brownlee, D.L.S., of Vancouver.

The report of Secretary-Treasurer Hubbell showed that the Association had made good progress during the year, and has a satisfactory financial balance. There are now 233 members. Motions of condolence were passed on the deaths of two of the members, J. K. McLean, D.L.S., and C. E. Johnston, D.L.S.

Afternoon Session.—A most interesting lecture, illustrated by photos and blackboard diagrams, mathematical formula, etc., was given on Tuesday afternoon. Dr. Otto Klotz, D.L.S., Chief Astronomer of the Dominion Observatory, was the speaker. The subject of the lecture was the "Seismograph" in its relation to earthquakes. While he did not deal with the causes of earthquakes, he expanded upon the results of phenomena. He mentioned an experiment which is being instituted at the Dominion Observatory to determine the physical tides of the earth, Ottawa has been selected, with three or four other points in the world, one in Germany and one in Africa, for the conduction of this experiment. A huge pit was now being dug in which the seismograph would be placed, and the experiments of the future continued. He fully explained the intricate and physical technique of the seismograph.

A useful paper on the transportation problem for survey work in the Canadian North was given by F. C. Herriott. This subject was considered of great importance, and two other papers bearing on this same subject, were read and discussed on the following day. Mr. Herriott gave many suggestions as to the best means of transportation for survey parties operating in the northern sections of Western Canada, many miles from civilization, which makes supplying the commisariat a most difficult problem. In summer there are canoe, and man-packs, while in winter months these give place to the dog-teams, or, in sections where the snow is not too deep, the pack-horse. Mr. C. F. Aylesworth, D.L.S., vice-president, occupied the chair.

Annual Banquet.—The annual banquet of the Association was held at Chateau Laurier in the evening. There were present the Minister of the Interior, Hon. Dr. Roche, Dr. Thompson, M.P., Yukon; M. McNutt, M.P., Saltcoats; H. S. Clements, M.P., Como-Atlin, B.C.; J. D. Taylor, M.P., New Westminster; Senator Casgrain, Dr. King, Director of the Dominion Observatory, and nearly a hundred Dominion land surveyors.

Among the speakers were Hon. Dr. Roche, Dr. Deville, Surveyor-General, and Senator Casgrain. The Senator is an old surveyor, by the way, and brought greetings from the Quebec Land Surveyors' Association. He was glad, he said, to have had some of his reward for his land surveying by his elevation to a body that went on for ever, and one that nothing could alter—the Canadian Senate.

Mr. George Mountain, Chief Engineer of the Railway Commission, told of his saving the Senator's life while in the wilds of Northern Quebec in a surveying party, sharing his small residue of food, when otherwise there would be no Senator Casgrain. Other interesting speeches were given during the evening by Dr. Otto Klotz, Messrs. Taylor, McNutt and Clements.

Second Day.—The attendance on Wednesday was even better than the first, a large number of the employees of the Topographical Surveys Branch, who are nearly all surveyors or assistants, were present, and the hall was again filled to overflowing.

The first paper was, "Goedetic Results and their Practical Meaning," by Mr. William Tobey, Dominion Topographical Surveyor. Another interesting paper was, "The Survey of River Lots in Manitoba," by Mr. Wm. Pearce, D.L.S. These papers elicited a lot of discussion by Mr. Thomas Shanks, Assistant Surveyor-General, Mr. A. E. Aylesworth, Mr. E. W. Hubbell Dr. Deville and others.

Several excellent papers were delivered later in the day. A paper on "Chaining," by Mr. A. H. Hawkins elicited much interest. Mr. Hawkins preferred the four-chain tape and the lighter tapes rather than the heavier. He impressed upon the surveyors present the vital importance of good chaining, and threw out many hints and suggestions for its further improvement. Several papers on "Pack Trains" had been prepared, two of which were read, one by Mr. J. M. Aitkens, D.L.S., and another by Mr. Hawkins. Transportation is one of the most important features of the surveyor's work, as he is often forced to work as much as 200 miles from railway and steamboat terminals depending on pack ponies, dog-trains, canoes and packers for the transport of the food supplies and paraphernalia. There was a lot of discussion. Messrs. J. E. Dodge, A. Milliken, Chas. Ways, Dr. Deville, E. W. Hubbell, Thomas Shanks, A. H. Hawkins, and others, participating. The laboratory for testing of chains and other surveying instruments, at Ottawa, in charge of the Topographical Surveys Branch, was described by Mr. Ways, Mr. Milliken described how the accuracy of azimuth and precise chaining was arrived at by calculation in the Topographical Surveys office.

Mr. Speight, O.L.S., brought greetings from the Ontario Land Surveyors' Association, and also described the work of base-line surveying in Northern Ontario.

The closing session in the evening was, by the kind invitation of Dr. King, held at the Royal Astronomical Observatory, when Mr. N. J. Ogilvie, D.L.S., delivered an address on "South Eastern Alaska Boundary." The surveyors had the privilege of bringing their lady friends to this meeting which they gladly accepted. All were cordially invited to inspect the instruments in use at the observatory. This was the most pleasant session of the series. The election of officers resulted as follows:—Honorary president, Dr. King; president, Mr. C. F. Aylesworth; vice-president, A. H. Hawkins, secretary-treasurer, E. W. Hubbell, Chief Inspector of Surveys, Ottawa. Executive committee: Messrs. D. H. Robertson, E. M. Dennis, A. H. Nelles, J. H. Wallace, and D. H. Dennis.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The luncheon which the Toronto Branch of the Canadian Society held on Thursday, March 12th, was attended by over 100 members and friends. The chief speaker was Mr. Geo. G. Powell, Deputy City Engineer of Toronto, who gave a short address on "The Municipal Engineer," outlining the responsibilities associated with that official's work, his relation to the municipality as compared with the relation of the consulting engineer to his client, the difficulties to be surmounted in municipal service, etc. His address concluded with an optimistic plea to the young engineer, to investigate the possibilities that lie before him in the field of municipal engineering, claiming that it gives greater opportunity owing to the diversity of work within its scope, than does any other engineering field. The growing immensity of problems connected with water supply, pavements, railways and sewerage work and sewerage disposal, etc., were of such a nature as to demand a diligent search by municipal corporations for men with an up-to-date technical knowledge and experience that would qualify him as an expert in such work.

After the address had been tendered a hearty vote of thanks, the ensuing discussion involved the status of the student member among professional men in the Society, and it was generally felt that more recognition and greater opportunity for meeting those on a higher professional plane than he should be tendered him.

Mr. Hugh Lumsden, of the Transcontinental Railway, and Mr. A. L. Hertzberg, Division Engineer of the Canadian Pacific Railway, were the guests of the Branch. Prof. P. Gillespie occupied the chair in the absence of Mr. A. F. Stewart.

UNIVERSITY OF TORONTO ENGINEERING SOCIETY.

The University of Toronto Engineering Society held its annual elections on March 13th. The officers for the ensuing year are as follows:—President, E. D. Gray; Vice-President, F. T. MacPherson; Chairman of Civil Club, C. R. McCort; Chairman of Mining Club, J. M. Muir; Chairman of Mechanical and Electrical Club, K. O. Jefferson; Chairman of Architectural Club, T. Stewart Graham; Chairman of Chemical Club, J. E. Breithaupt; Fourth Year Representative, W. R. McCaffrey; Third Year Representative, J. H. Eastwood; Second Year Representative, Mr. Honeywell; Treasurer, H. A. Babcock; Corresponding Secretary, R. W. Downie; Recording Secretary, T. W. McLelland; Curator, R. S. Bothwell.

The annual event had associated with it a change in the constitution of the Society whereby, for the better representation of the various branches of engineering followed at the university, the three sections; viz., electrical and mechanical, civil and architectural; chemical and mining are superseded by five clubs. This will facilitate the problem of a more suitable classification of the student membership of the Society in the presentation of technical papers.

MINING SECTION, CANADIAN SOCIETY OF CIVIL ENGINEERING.

The mining section of the Canadian Society of Civil Engineers met in Montreal on Thursday, March 12th. A paper of unusual interested entitled, "The Electrical Driving of Winding Engines and Rolling Mills," prepared by Mr. C. A. Ablett, A.M.I.C.E., and H. M. Lyons, A.M.I.E.E., was read by Mr. Ablett. The paper was an interesting description of numerous electrical installations at various mining and milling centres in different countries. It was illustrated by numerous lantern views showing Canadian, English and South African installations.

Mr. R. A. Ross, Vice-President of the Society, presided at the meeting.

THE AMERICAN PEAT SOCIETY.

It is announced that the American Peat Society will hold its 8th annual meeting at Duluth, Minn., on August 20th, 21st and 22nd, 1914. The address of the Secretary is 17 Battery Place, New York.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, P.A.

AMERICAN PEAT SOCIETY.—Eights Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

PERSONALS.

JAMES SHEPPARD, of Queenston, was recently appointed good roads superintendent of Welland County.

WARD CURLEE has been appointed City Engineer of Swift Current, Sask., to succeed Geo. D. Mackie, now of Moose Jaw. Mr. Curlee was previously assistant engineer to Mr. Mackie.

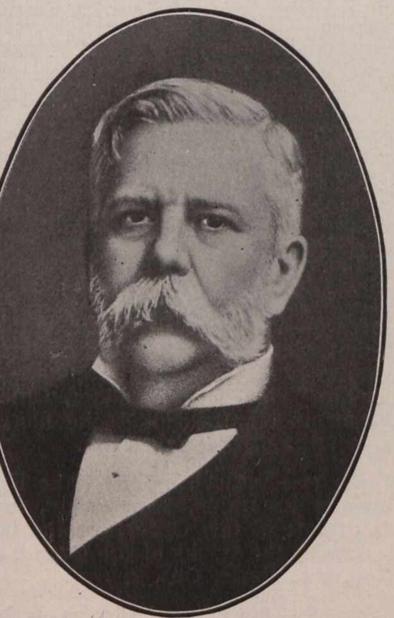
J. L. G. STUART, B.A.Sc., of the City of Toronto Roadways Department, is contemplating an extended trip through Europe for the purpose of studying transportation facilities of the principal cities and towns, and general municipal engineering practice. Mr. Stuart will leave about May 1st, going by way of the Mediterranean, and north through Greece and Hungary. Three months will be spent on the study of European municipal methods.

J. H. LARMONTH, who for some time has been engaged in private practice as a consulting engineer in Toronto, has been appointed superintendent of the Edmonton street railway, to succeed Mr. W. T. Woodroofe, resigned, on April 1st. Mr. Larmonth is a graduate of McGill University. He has had considerable previous experience in electric railway construction and operation, having had charge of the construction of, and later the management of, the Peterborough street railway. He was general manager of the Electric Power Company before opening an office as consulting engineer.

OBITUARY.

The death is announced of MR. GEORGE WESTINGHOUSE, engineer and inventor, who expired from heart disease at his New York residence on March 12th.

Mr. Westinghouse, whose inventions have for many years had a world-wide reputation and use, was himself the son of an inventor. He was born in 1864 in the State of New York. Before he was 15 he had invented and constructed a rotary



The Late Mr. Geo. Westinghouse.

engine, and at an early age he became an assistant engineer in the U.S.N. In 1865 he invented a device for replacing railway cars upon the track.

The Westinghouse air brake, for which he is famous, is the product of a series of improvements upon what was first intended to be an automatic brake attached to the couplers. This was found unsatisfactory. The application of steam also proved unsuccessful, but was followed in 1869 by the use of compressed air and immediate success leading to manufacture. The many changes and improvements which have been made since that time have been practically all the result of Mr. Westinghouse's own investigation.

In 1880 his interest was directed toward the operation of railway signals and switches by compressed air, and the development and patenting of a system followed shortly.

In 1886 the company for the manufacture of electric lighting apparatus was organized, and in 1891 became the Westinghouse Electric and Manufacturing Company, which now employs over 22,000 people.

In connection with turbine development Mr. Westinghouse brought out the mechanical reduction gear for reducing the inherently high speed of a turbine to the slow speed of a ship propeller or d.c. generator. In other important phases of power development, such as alternating current transmission; use of natural gas; electric railway apparatus, etc., Mr. Westinghouse has played an important part. Owing to his many achievements he has been the recipient of numerous honorable distinctions, among which might be mentioned, the Scott medal of the Franklin Institute, the Edison gold medal, and the Grashof gold medal of the Society of German Engineers.

We regret to record the death of MR. ALEC. J. McMILLAN, of Victoria, B.C. Mr. McMillan, formerly a native of Pictou, N.S., has been engaged for a number of years in railway construction in Canada and the Western States. At the time of his death he was Chief Engineer of Construction for the British Columbia Mills and Timber Company, Vancouver, B.C.

The death is announced in England of MR. JOHN SCOTT, chief electrical engineer of the Commercial Cable Company, and one of the pioneer submarine telegraph engineers.

The death is announced at Boston, Mass., of MR. CHARLES MARSH CLAY, who for some time was engaged in Civil Engineering in Manitoba and the Canadian West. Mr. Clay was connected with early railroad construction in Western Canada.

PRIZES FOR HIGHWAY STUDY.

To encourage investigation of methods and materials for road and street construction and to interest engineering students in highway problems, the Barber Asphalt Paving Company has offered prizes of $100 for the best paper written by a member of the graduating classes of the leading engineering schools.

The title suggested is "Asphaltic Materials for Highway Construction." The paper and its conclusions may be based upon service tests and the lessons of experience; the physical qualities or chemistry of asphalt; or it may combine any two of these lines of investigation. The length of the paper is limited to 3,000 words and all manuscripts must be received not later than June 1, 1914.

The purpose of this prize offer is to turn the attention of engineering students to street and road construction as a field of work in which there is great need and great opportunity for trained men.

BACK COPIES WANTED.

Copies of July 21st, 1910, and November 3rd, 1910, issues of *The Canadian Engineer*, are required to complete a volume for binding. Any subscriber who has one or both of these copies for sale will please communicate with the Editor.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, is minus the following copies: July 21st, 1910; November 17th, 1910; May 11th, 1911; May 3rd, 1912, and August 1st, 1912, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these copies, and who do not care to keep them, kindly send them to this office, and we will see to it that they are put into the hands of the party interested.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21442—March 4—Relieving, for the present, G.T.R. from providing further protection at Goodwillin's crossing, 1¾ miles west of Georgetown, Ontario.

21443—March 3—Directing that Kootenay and Alberta Ry. Co., grade west approach to bridge, in Sec. 7, Tp. 6, R. 1, W. 5 M., Alta., for a distance of about 300 ft., and extend guard rail for a distance of about 150 ft.; work to be completed by June 15th, 1914.

21444—March 4—Directing that, within 60 days from date of this Order C.P.R. install improved types of automatic bells at crossing of Kyle and Queen Sts., city of Port Moody, B.C., and thereafter maintain bells at own expense. 2. 20% of cost of installing each of bells be paid out of "The Rly. Grade Crossing Fund," and remainder be borne by Railway Company.

21445—March 4—Authorizing Municipality of Tp. of Nepean, at its own expense, to construct highway crossing over C.P.R. where same intersects Second Avenue, said Twp. of Nepean, County of Carleton, Ontario.

21446—March 5—Approving and authorizing clearance, as shown on C.P.R. plan, between Co.'s standard coal sheds and rail of its side tracks.

21447—March 6—Amending Order No. 17264, dated August 21st, 1912, by striking out word "South" before word "Half" where it occurs in recital and operative parts of Order, and substituting therefor word "East."

21448—March 6—Authorizing C.P.R. to construct Swift Current Northeasterly Branch Line across highway between Secs. 5 and 6-23-27, W. 3 M., Sask., at mileage 98.47.

21449—March 5—Approving revised location of C.P.R. Bassano Easterly Branch Line, from a point of its main line in Sec. 17-21-18, W. 4 M., at mileage 0.0, thence in an easterly direction to a point in Sec. 21-22-8, W. 4 M., Alta., at mileage 72.07.

21450—March 7—Authorizing G.T.R. to reconstruct bridge No. 49, mileage 123.75 from Black Rock, 20th Dist., over public road between Lots 5 and 6, Con. 1, Tp. Fullarton, Co. Perth, Ontario.

21451—March 6—Directing that the G.T.P. Ry. forthwith appoint a regular station agent at Cudworth Station, Sask.

21452—March 9—Authorizing Rural Municipality of Usborne, No. 310, Sask., to open up crossing over C.P.R. Pheasant Hills Branch at mileage 260.8, on East Boundary, S.E. ¼ Sec. 34-33-23, W. 2 M., Sask.

21453—March 9—Declaring that the land applied for (at Tappen, B.C., in Little Shuswap Indian Reserve, No. 5), is required by C.P.R. for railway purposes, and is land which, were it the property of a private owner, could be taken without consent of owner.

21454—March 9—Authorizing C.P.R. to reconstruct bridge 37.6 over Saugeen River, on Walkerton Subdivision, Ont. Division, Ont. And rescinding Order No. 20604, dated September 25th, 1912.

21455—March 9—Approving location C.P.R. station at Cadillac, in N.W. ¼ of Sec. 8-9-13, W. 3 M., Sask., on Co.'s Weyburn-Stirling Branch.

21456—March 9—Authorizing G.T.R. to use and operate two (2) bridges—namely, No. 12, mileage 48.98, 30th Dist., P.Q., and No. 13, mileage 49.20, 30th Dist., Quebec.

21457—March 9—Authorizing C.P.R. to use and operate four (4) bridges—namely, No. 24.1, Eastern Div., St. Guillaume Subdivision, P.Q., No. 22.5, Eastern Div., Newport Subdivision, No. 32.6, Eastern Div., Ottawa Subdivision, Ont., and No. 44.7, Eastern Div., Ottawa Subdivision, Ontario.

21458—March 9—Authorizing the C.P.R. to construct spur for T. W. Murray across gravel road and part lots 1, Con. 7, West of Yonge St., Twp. Vaughan, Ont.

21459—March 10—Approving location C.P.R. station at Shaunavon, Weyburn-Sterling Branch, Sask.

21460—March 9—Approving revised location of portion of Kootenay Central Ry. from mileage 91.85 to mileage 94.81, and authorizing applicant to cross with tracks of said line of railway Laurier St. and Borden St., in town-site of Athalmer, B.C.

21461—March 9—Directing C.P.R. forthwith to re-open station at Dunkirk, Sask., and re-appoint a station agent at that point.

21462—March 9—Relieving for the present the Pere Marquette R. from providing further protection at its crossing over public road just west of Renwick Station, Ont.

21463—March 10—Authorizing the V.V. and E. and Nav. Co. to construct a spur to the premises of the British Columbia Milk Condensing Co., Limited, at Guichon, B.C.

21464—March 9—Authorizing the C.P.R. to construct its Weyburn-Sterling Branch across highways between mileage 232.523 and 253.34 (23).

21465—March 10—Approving revision of grades and alignment between certain points on the Webbwood Subdivision and Algoma Subdivision of the Lake Superior Div. of the C.P.R.

21466—March 9—Ordering the C.P.R. within ninety days from date of this Order, to install improved type of automatic bell where its railway crosses the highway known as the White Lake Road, in the Village of Pakenham, Ont., and that all switching movements on the sidings be flagged over said crossing by a member of the train crew.

21467—March 11—Authorizing the Lake Erie and Northern Ry. to operate its trains, temporarily, for a period of ninety days from date of this Order, for the purpose of construction only, across the tracks of the Grand Valley Ry. Co. at station 372.60, near Paris, Ont.

21468—March 12—Amending Order 21345 by striking out the word "reconstruct" in the recital and operative parts of the said Order, and substituting therefor the word "construct."

21469—March 12—Approving locations of C.P.R. stations Notukeu and Pontiex on its line of railway in the Province of Saskatchewan.

21470—March 10—Extending the time within which to complete siding to and into the premises of Messrs. Whiteside and Arnold, on Lots 2 and 3, south of Tiffin St., in the town of Barrie, Ont., for a period of ninety days from date of this Order.

21471—March 12—Authorizing the G.T.R. to use and operate its trains over the bridge 168 across the Thames River, immediately west of London, Ont., at mileage 121.24 on the 17th Dist. of its line of railway.

21472—March 11—Authorizing the G.T.R. to use and operate the bridge carrying its line of railway across Elgin St., in city of Brantford, at mileage 67.94 on the 20th Dist. of its line of railway.

21473—March 12—Authorizing the G.T.R. to use and operate bridge No. 30, at mileage 83.60, 20th Dist., crossing River St., Paris, Ont.