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Flood Prevention Projects to Protect Winnipeg

Unless Works Are Constructed to Control Flood Waters of Red River of the North, Next Inundation at Winnipeg May Cause Damage Totalling Millions of Dollars—Reservoirs, Dykes and Channel Improvements Proposed

By DOUGLAS L. McLEAN

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DEVASTATING floods of the Red River of the North in times past have swept over the plain on which the city of Winnipeg now stands, and unless protective works are provided to control or confine these floods in future, the next inundation will cause widespread damage and losses which will total millions of dollars.

The cycle of meteorological conditions which has kept the city of Winnipeg free from these terrible inundations during the recent period of its rapid growth and development, must give place to the natural agencies which, at more or less regular intervals, caused the early floods. While it is not yet possible to predict the actual year in which a flood of given height will occur, yet observations on the Tiber at Rome dating from 413 B.C. to the present, on the Danube at Vienna for the last 1,000 years, on the Seine at Paris for 300 years, and on many European and American rivers for shorter periods, show that floods on any river occur at more or less regular intervals, and while the worst flood may only occur once every thousand years, yet there are

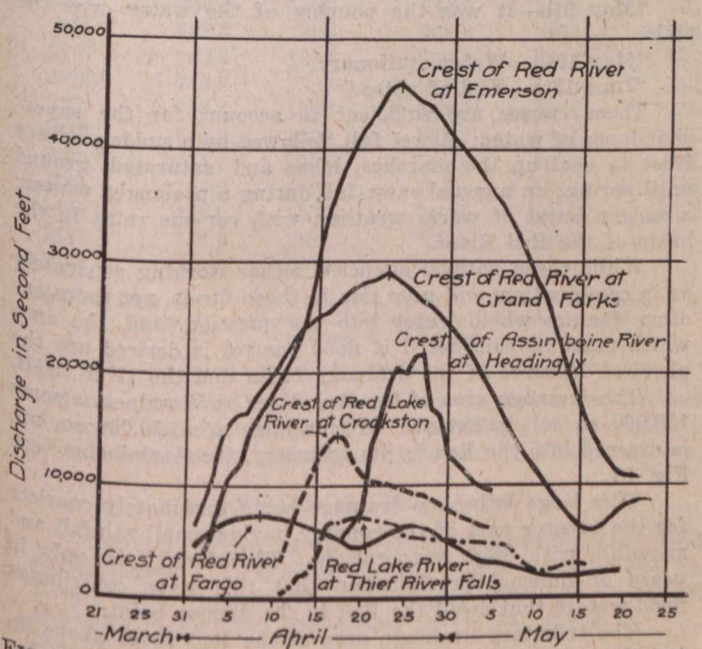


FIG. 1—DIAGRAM SHOWING THE 1916 FLOOD OF THE RED RIVER

other floods which very nearly approach the maximum and for all practical purposes equal it. Such floods as these occur in periods varying from 3 to 100 years.

The records of the Red River show that the plain on which Winnipeg is built has been covered with flood-waters for periods of two weeks or more in the years 1776, 1790, 1809, 1826, 1852 and 1861. There have also been spring freshets or high water, such as that of 1860, 1882, 1897, 1904 and 1916, but these were confined within the banks of the river at the city, though on the upper reaches of the river, much flooding occurred.

While there is record of two floods higher than that of 1852, yet this flood probably gives the best idea of these deluges, as in that year the country was becoming settled and records were better kept. Even to-day, visible records remain, as one can yet see the floor in the Convent Building at St. Boniface, over which canoes floated in May, 1852.

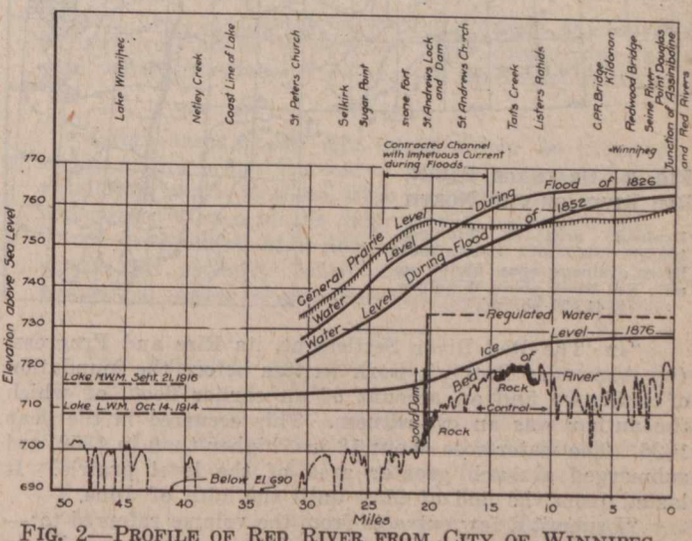


FIG. 2—PROFILE OF RED RIVER FROM CITY OF WINNIPEG TO LAKE WINNIPEG

A very comprehensive description of this flood is given by Sir Sanford Fleming in his report on the Canadian Pacific Railway, 1880, page 265:—

"During my visit to Manitoba, I was favored with an interview with the Archbishop of St. Boniface. His Grace has resided in the country for a long series of years, and has had the advantage of witnessing the annual freshets, as well as several of the inundations. His Grace was good enough to afford me the benefit of his local experience. In the year 1852 the river overflowed its banks and completely submerged the level prairie for several miles on each side. The water rose until it stood at least 3 ft. 6 ins. above the general surface of the ground around the Palace of St. Boniface, and it seemed like a vast lake, extending in all directions. The whole country was submerged from Minnesota north to Kildonan. The site of the city of Winnipeg was completely under water, and the nearest dry land in that neighborhood was at Burke's farm, some four miles

away. The flood remained in this state for more than two weeks.

"After an interval of eight years (in 1860) the river again inundated its banks, covering the level prairie, but the overflow was not widespread.

"The following year (1861) there was another flood, when the water rose to within 2 ft. of the level of the flood of 1852, overflowing to the depth of about 18 ins. a very large area of the prairie.

"Since 1861, there has been an immunity from any serious inundation, but on one or two occasions, the water has risen nearly to the prairie level.

"The Bishop of Rupert's Land, in his 'Notes of the Flood of 1852', estimates the breadth of the inundated country at about 12 miles; mentions that houses and barns, furniture and farm implements were swept away. The settlers took refuge on the nearest elevated ground, Stoney Mountain and Bird's Hill. The bishop, with his household, escaped in canoes, and passed down the river until he reached dry land, in the Parish of St. Andrews, some thirteen miles below Fort Garry. From this point northerly he describes the river as being 'confined within narrow limits,' and with a more impetuous current. The bishop mentions that at the Stone Fort the river was 'running at the rate of eight or ten miles an hour.'

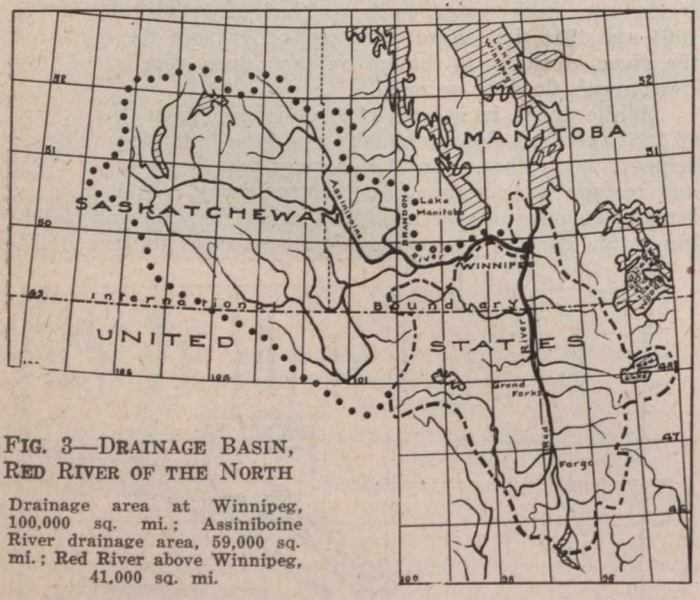


FIG. 3—DRAINAGE BASIN, RED RIVER OF THE NORTH

Drainage area at Winnipeg, 100,000 sq. mi.; Assiniboine River drainage area, 59,000 sq. mi.; Red River above Winnipeg, 41,000 sq. mi.

"In 'The Red River Settlement, its Rise and Progress' (by Alexander Ross), a work written before the inundation of 1852, we find an account of an earlier flood, of which the author was an eye-witness. This occurred in the year 1826. The water rose about 18 ins. higher than in 1852, asd submerged a much greater area of the level prairie. It lasted from the 2nd of May until the 15th of June.

"I submit a few extracts from the volume referred to:—

"'The winter had been unusually severe, having begun earlier and continued later than usual. The snow averaged 3 ft. deep and in the woods from 4 to 5 ft. The cold was intense, being often 45 degs. below zero; the ice measured 5 ft. 7 ins. in thickness. Notwithstanding all this, the colonists felt no dread till the spring was far advanced, when the flow of water from the melting of the accumulated snow, became really alarming. On the 2nd of May, the day before the ice started, the water rose 9 ft. perpendicularly in the 24 hrs.

"'On the 4th, the water overflowed the banks of the river and now spread so fast that almost before the people were aware of the danger, it had reached their dwellings. Terror was depicted on every countenance, and so level was the country, so rapid the rise of the waters, that on the 5th all the settlers abandoned their homes and sought refuge on higher ground.

"'At this crisis, every description of property became a secondary consideration and was involved in one common wreck, or abandoned in despair. The people had to fly from their homes for dear life, some of them saving only the clothes they had on their backs. The shrieks of children, the lowing of cattle and the howling of dogs, added terror to the scene.

"'By this time the country presented the appearance of a vast lake, and the people in the boats had no resource but to break through the roofs of their dwellings and thus save what they could. The ice now drifted in a straight course from point to point, carrying destruction before it, and the trees were bent like willows by the force of the current.

"'While the frightened inhabitants were collected in groups on any dry spots that remained visible above the waste of waters, their houses, barns, carriages, furniture, fencing and every description of property might be seen floating along over the wide extended plain, to be engulfed in Lake Winnipeg. Hardly a house or building of any kind was left standing in the colony.

"'The water continued rising till the 21st, and extended far over the plains. Where cattle used to graze, boats were now flying under full sail.' It subsided, of course, very gradually. It was on the 15th of June that the settlers, for the first time, drew near the sites of their former habitations."

Cause of the Floods

The cause of these floods has been the subject of much speculation and debate. Mr. Ross states with respect to the flood of 1826, that "the previous year had been unusually wet; the country was thoroughly saturated; the lakes, swamps and rivers at the fall of the year were full of water; a large quantity of snow had fallen in the preceding winter. Then came a late spring, with a sudden burst of warm weather, and a south wind blowing for several days in succession; the snow melted at once, and Red Lake, Otter-Tail Lake, as well as Lake Traverse (source of the Red River), all overflowed their banks."

Bishop Anderson, in his "Notes on the Flood of the Red River in 1852," records:—

"April 25th, Sunday—Large masses of ice passed during the evening and the following day. The winter had been unusually fine until the end of February, but through the whole of March, a great deal of snow had fallen.

"May 5th—Towards night heavy rain commenced, the first since the breaking up of the ice; if it brings warm weather it may do good.

"May 9th—It was the pouring of the water over the plain.

"May 19th—Water stationary.

"June 13th—End of notes."

These causes are sufficient to account for the superabundance of water: A wet fall, followed by a sudden, severe frost to seal up the marshes, lakes and saturated ground until spring; an unusual snow-fall during a prolonged winter; a sudden burst of warm weather, with copious rains in the basin of the Red River.

While these natural agencies, either working separately or in combination, will give rise to these floods, yet there are other factors which enter into the question, and the ones which must be considered if flood control is desired are the physical features of the drainage basin and the river itself.

The drainage area of the Red River at Winnipeg is some 100,000 sq. mi. in extent. Of this huge area, 59,000 sq. mi. is drained into the Red by its tributary, the Assiniboine (see Fig. 3).

This large tributary drainage basin fortunately consists for the greater part of the country having small rainfall and snowfall, with high evaporation. Therefore, it is only in years of unusual precipitation that this river contributes flood-waters that swell the Red to the danger point.

The tributary drainage area of the Red River above its junction with the Assiniboine at Winnipeg, extends through a country which has, in general, comparatively flat slopes, but the tributary streams all have steeper slopes than the main river, and thus by bringing the flood-waters down to the main river faster than it can carry them away, tend to increase the frequency of the floods.

Another important factor in the location of this drainage basin is that it drains to the north. Thus, on the south or upper watershed, the snow thaws and the rivers break up

before they melt in the area in the vicinity of Winnipeg. This has the tendency to congest the flow of the water and to bring the flood waters from the south to the mouth of the river just as those in that vicinity are commencing to discharge. This is shown graphically by Fig. 1.

With Lake Winnipeg, the outlet of the Red River, only 40 miles distant from the city, one must look for other causes than the superabundance of water and the flat slopes of the river, to account for such widespread and sustained flooding as ocurred in 1826 and 1852. An examination of the river bed shows that a contracted channel between St. Andrews and Lower Fort Garry is responsible for the holding up of the water. This is shown graphically by Fig. 2. Rock outcrops in the bed of the river at Listers Rapids, 12 miles below the city, and at St. Andrews Lock and Dam, precluding any natural deepening of the channel, while the firm and unyielding nature of the banks through the Parish of St. Andrews to below lower Fort Garry prevent any practical change in the sectional area.

Thus, with the above natural conditions still in operation, the ordinary course of nature may be depended upon to again cause floods of great magnitude.

Frequency

Before the question of controlling these floods to protect the city of Winnipeg can be considered from an economic standpoint, it is necessary to know how often they may be expected to occur. Table 1 gives a record of the flood heights at Winnipeg from the year 1776 to date. In the early years, the great floods were all that were recorded, but later, as the country became developed, records were taken of the height of every spring freshet. Fig. 4 has been prepared from these records to show the probable average frequency of the different floods. This frequency and the amount of probable damage will determine the expenditure that may be economically made to safeguard the city of Winnipeg.

TABLE 1—RED RIVER OF THE NORTH, HIGH WATER ELEVATIONS AT WINNIPEG

Year	Elevation	Year	Elevation	Year	Elevation
1776	761+	1885	742.4	1906	740.4
1790	761.0	1892	750.4	1907	743.5
1809	761.0	1893	750.0	1908	741.4
1826	766.0	1894	745.4	1909	737.4
1852	764.0	1895	741.9	1910	742.2
1861	762.0	1896	748.6	1911	734.3
1875	747.0	1897	750.3	1912	737.5
1876	740.3	1898	746.9	1913	744.3
1877	742.4	1899	733.9	1914	735.4
1878	734.5	1900	733.7	1915	733.9
1880	744.2	1901	742.1	1916	751.9
1881	745.3	1902	746.4	1917	743.3
1882	753.9	1903	740.4	1918	729.9
1883	746.5	1904	752.5	1919	738.7
1884	745.8	1905	737.9		

Records from 1776 to 1875, inclusive, from Sir Sanford Fleming's C.P.R. report. Records from 1876 to 1919, inclusive, by city engineer of Winnipeg

Methods of Flood Control

There are four separate methods of controlling the floods at Winnipeg: (1) Reservoirs in the upper valley of the Red River, in the U.S.A.; (2) improvement of the river channel; (3) reservoirs on the Assiniboine River; (4) dykes.

Reservoirs in Upper Valley, Red River

A $25,000,000 project for the control of the floods in the United States portion of the Red River drainage basin, by means of reservoirs, is now under consideration. Reservoirs of ample capacity, under international control, might do much to protect the city of Winnipeg, but there is also the danger that such works might only retard the flood crest until such time as the flood waters from the Assiniboine were arriving at the city. In the flood of 1882, the Red River crested before the Assiniboine had risen to flood height. If both rivers had reached flood stage at the same time, the waters would have overflowed the banks of the Red and covered the streets of the city.

On the portion of the river above Winnipeg, such reservoirs would probably be of very material benefit in reducing the height of the floods.

Improvement of River Channel

By deepening the river channel and improving its carrying capacity below the city, particularly at the control section shown on Fig. 2, it would be possible to confine even the largest floods within bank level from the city down to the mouth of the river at Lake Winnipeg, This method of improvement and control would necessitate the movement of very large quantities of material from the river bed and would only benefit that portion of the river about Winnipeg.

Reservoirs on Asiniboine River

By holding back the Assiniboine River flood, the Red River would be deprived of a large quantity of flood water at critical periods and the high water could be reduced to such heights as would be contained within the river banks at Winnipeg.

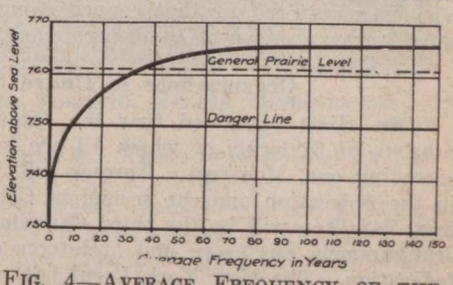


FIG. 4—AVERAGE FREQUENCY OF THE RED RIVER FLOODS AT WINNIPEG

One of the most ambitious of the control schemes contemplates carrying the surplus Assiniboine flood waters into Lake Manitoba west of Portage la Prairie and, by improvements to the Fairford River, discharging this surplus water into Lake Winnipeg via the Dauphin River.

Dykes

Large areas of the city might safely be protected by means of dykes, but the cost of right-of-way and the danger of sliding banks if these were carried close to the river's edge, restrict such means of protection to local areas.

A combination of a number of these different types of works will probably afford the most efficient and most economical means of providing the necessary protection.

The following resolution was adopted without discussion at a recent meeting of the Toronto Branch of the Engineering Institute of Canada: "Be it resolved that this branch of the Engineering Institute request the special committee of the council of the institute to bring their influence and acquired knowledge to bear with the Civil Service Commission to have the minimum salaries of the responsible officers of the engineering staffs made commensurate with those received by responsible officers in equivalent positions in private corporations."

Capt. F. M. Dawson, of Montreal, who is a member of the firm of Monks, Manhard & Dawson, engineers and contractors, Montreal, addressed a joint meeting of the Queen's University Engineering Society and the Kingston Branch of the Engineering Institute of Canada, March 19th, on the "Microscopic Study of Cement." Capt. Dawson claimed that a large percentage of cement does not combine with the mixing water, and that from 70 to 80% of the cement in any concrete mixture does not act as a binder. Alcohol, ether and soap have been added to cement in efforts to improve hydration, but the most successful product for this purpose is one which has a catalytic action between cement and water. This product is a chemical which is added to the clinker before grinding; cement produced by this process is called "super-cement." Capt. Dawson said that the hydration of "super-cement" is more perfect than of Portland cement, and that its concrete is stronger and denser.

TORONTO DRAUGHTSMEN FORM LABOR UNION

MORE than 100 draughtsmen employed in municipal, provincial and private engineering and architectural offices, in Toronto, met last Friday evening in the Sons of England Hall, Toronto, and formed Local No. 40 of the International Federation of Technical Engineers', Architects' and Draughtsmen's Unions, affiliated with the American Federation of Labor.

After formally dissolving the "association," which was organized about a year ago, the draughtsmen proceeded to form a labor union with a charter from the A. F. of L. F. M. Hiatt, a designer in the Navy Department, Washington, who is prominent in the Washington Local, delivered an address and then answered numerous questions regarding the locals in the United States and their organization. An address was also delivered by a district representative of the Trades and Labor Council, in which he extended labor's welcome to the draughtsmen and intimated that they would have the support and co-operation of the Building Trades Council if they could become sufficiently well organized. Enough draughtsmen must belong to the union to enable the Building Trades Council to supply union men wherever and whenever required, or that council cannot enforce a "closed shop" order in respect to draughtsmen.

Organizations in United States

Mr. Hiatt explained that the International Federation consists of 39 locals of which all are in the United States, excepting one, Montreal. Toronto will be the fortieth local in the federation and the second in Canada. It is expected that Hamilton will be the third Canadian local. Over 5,000 draughtsmen, engineers and architects are members of the federation. The New York Local has about 1,400 members and is the largest in the federation. Washington, with about 600 members, is the second largest. Chicago comes third, with about 500, and most of the others have less than 200. The International Federation was formed about 18 months ago, but some of the locals were in existence previously.

The federation's office is in the A. F. of L. Building, Washington. Its affairs are managed by an executive council consisting of the president, three vice-presidents and the treasurer. One vice-president represents each of the following groups or sections in the membership: (1) Men engaged in marine work; (2) government employees; (3) employees of industrial corporations. The vice-presidents and the treasurer are paid nominal salaries and devote only a portion of their time to the work of the federation. The president, A. J. Oliver, is a paid official devoting all of his time to the federation, as is also the corresponding and financial secretary, Mrs. A. H. Miller, who also acts as office manager. There are two paid organizers,—one in New York and one who works in the St. Louis territory.

Wage Scale in Washington

The dues are $1.25 a month, of which 60c. goes to the federation's main treasury and 65c. can be used for local expenses. The Toronto Local, explained Mr. Hiatt, will be free to make its own by-laws, provided that they contain no regulations contrary to the constitution of the federation or of the A. F. of L., or contrary to the local's charter from the A. F. of L.

In regard to wages and salaries, Mr. Hiatt stated that the Washington Local had adopted the award of the "Macy Board" as to salaries to be paid by the the U.S. Shipping Board, and had succeeded in obtaining its general recognition in Washington. Under this award, draughtsmen are divided into five classes—viz., charge men (squad bosses or men engaged on special work), Class A men, Class B, Class C, and copyists. The rate of pay is as follows: Charge men, $12 to $10 a day; Class A (designers), $9.60 to $8 a day; Class B (detailers), $7.20 to $6; Class C, $5.20; copyists, $4.80 to $4. Forty-four hours constitute a week, but the men are paid for six full days each week. Time over 8 hrs. in any day is overtime work and subject to extra pay.

The New York Local has adopted a scale of pay that is considerably higher than the Washington scale. Chicago expects to be able to obtain recognition of a uniform scale this summer and has the support of the building trades in its demands, but no other locals in the International Federation have yet reached the point of seriously discussing wage scales. The federation is opposed to strikes and has declared in favor of arbitration of all disputes.

GRAND FORKS IRRIGATION PROJECT

UNDER the direction of W. J. E. Biker, district engineer, and E. A. Cleveland, comptroller of the Water Rights Branch, Lands Department, British Columbia Government, plans have been prepared for the irrigation project at Grand Forks, B.C. About 25,000 ft. of concrete pressure pipe, 5 ft. 9 ins. in diameter, will be required, also several miles of smaller sizes of pipes, ranging from 6 ins. to 4 ft. in diameter. The maximum head under which the largest pipe will be operated will be 16 ft. The estimated cost per mile of the largest pipe is $34,108, or $6.46 per lineal foot, as follows: Concrete in pipe, 6.4 cu. ft. @ 60c., $3.84; concrete in saddles, 51c.; reinforcing steel, $1.61; excavation and preparation of right-of-way, 50c.; total, $6.46.

ISLE PERROT BRIDGES COMMITTEE

ORGANIZATION of the Isle Perrot Bridges Committee was completed at a recent meeting in Montreal by the election of the following officers and directors: President, T. B. Macaulay, president of the Sun Life Assurance Co., Montreal; vice-president, Brig.-Gen. A. E. Labelle, Montreal; vice-president, Henry Miles, M.P.P., Montreal; secretary, Gustave Boyer, M.P.P., mayor of Rigaud, Que.; adjoint-secretary, Ludger Lemieux, architect, Montreal; treasurer, Lt.-Col. F. S. MacKay, mayor of the town of Dorion, Que. Directors—Senator Arthur Boyer, Montreal; Geo. Summer, president of Board of Trade, Montreal; Eugene Tarte, editor of "La Patrie," Montreal; Adrien Rouleau, mayor of Coteau Landing, Que.; Guisolph Daoust, mayor of St. Anne de Bellevue, Que.; Jos. Wilson, mayor of Hudson, Que.; R. Ouimet, secretary-treasurer of St. Polycarpe, Que.; J. A. Duchastel, city engineer of Outremont, Que.; F. W. Stewart, manufacturer, of Montreal; and a representative of the city of Montreal. Honorary members—The federal deputies for the counties of Jacques-Cartier and Vaudreuil; the provincial deputies for the counties of Vaudreuil, Soulanges and Jacques-Cartier; municipalities and other public bodies joining the commission. Towns—Montreal, St. Anne de Bellevue, Rigaud and Dorion. Parishes—Vaudreuil, Isle Perrot, St. Lazare, Rigaud, St. Marthe, St. Justine, Les Cèdres, Coteau du Lac, St. Zotique, St. Claire d'Assise, St. Polycarpe and St. Telesphore. Villages—Vaudreuil, Como East, Como West, Pte. Fortune, Les Cèdres, Coteau du Lac, Coteau Station, Coteau Landing, St. Zotique, St. Polycarpe and River Beaudette.

The committee has had several meetings, including an interview with Sir Lomer Gouin, who promised to build the bridges provided that the federal government will contribute 50% of the cost and provided that the municipalities of the counties of Vaudreuil and Soulanges will guarantee bonds to the extent of $100,000. The estimated cost of the bridges is $400,000. An interview was then held with the acting prime minister, Sir George Foster, at Ottawa. At the latter meeting a delegation from the city of Kingston, Ont., supported the request of the Isle Perrot Bridges Committee, stating that the construction of the bridges between St. Anne de Bellevue and Isle Perrot and between Vaudreuil and Isle Perrot is of vital importance to both Ontario and Quebec, and that Eastern Ontario would unquestionably derive great benefit from direct communication with Montreal.

PARK ENGINEERING

By Reginald B. Evans
Engineer, Parks Department, Toronto, Ont.

An engineer is sometimes called the man who makes the roads smooth for other people. He gets part of the credit for travelling over the rough ground ahead of the proposed railway, with a pair of shoepacks and an Indian guide, searching for the most suitable valleys and side-hills to keep his railway as nearly level as possible and as nearly straight as practical, so that there will be no heavy grades and no unnecessary curves.

Park engineering seldom requires railways, but roads are often an important factor, as many people use park roads for automobiling, bicycling, sleigh-riding and walking. These roads must be located in scenic parts and must sometimes be on side-hills, often on low ground and occasionally on high lands. In almost all situations the most important work in connection with park roads is to have them well drained. If a road is built over soggy clay and no tile drain is put in, the next winter one is sure to find his road heaved up in spots; and in the spring, when the frost comes out,

Road Construction in High Park, Toronto

there is a soft place into which every wheel drops until a pitch hole is formed and the road ruined.

A successful way of draining has been found to dig a ditch along each side of the road about 3 ft. deep, lay a 4-in. tile pipe in the bottom, and fill the ditch with cinders. On a long hill this is not sufficient, but a glazed pipe drain may be put down on one side of the road, say 4 ft. deep, with a brick manhole (and a sump to catch sand) every 100 ft., the top being covered by an iron grating, with the bars running parallel to the road, so that leaves will wash over and will not plug up the grating. A 6-in. glazed pipe should be run from each such manhole across the road to a similar manhole on the opposite side.

Sometimes a piece of land has to be drained for a garden or a ball field. In this case weeping tiles should be laid from 50 to 75 ft. apart and about 2 ft. deep, depending on the soil. They should have a fall of at least 2 ins. in 100 ft. and the material taken from the ditches replaced to within 6 ins. of the surface with cinders. Water pipes are sometimes laid in every second ditch, for watering the grass, etc.

For a bowling green the ground is levelled and 9 ins. of cinders is put on. This is covered with good top soil and seeded. The cinders prevent worms from coming up and destroying the green. Tennis courts are sometimes built of cinders, and often a clay court is built if a good strong clay can be secured from a new sewer or some deep cellar. A cricket crease should be well under-drained with tile pipes and sown with a fine grass seed, including neither rye grass nor clover. About six or eight bushels, or 200 lbe., of seed is required to a an acre.

Open-air rinks are an addition to our parks. These should never be made on grass, as the sun in March, shining through the clear ice, will often burn and kill the sod. The city of Toronto operated 92 free skating and hockey rinks

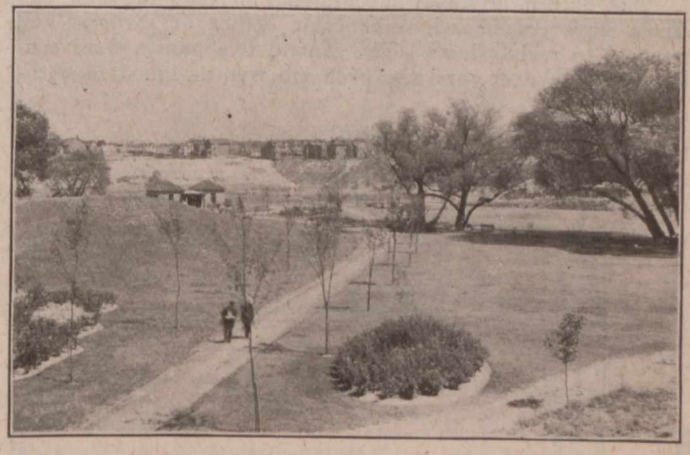
Willowvale Park, Toronto, Before Improvement

during the season of 1919-20. These were flooded by hose connected generally with a city fire hydrant.

At Exhibition Park, where roads are paved and large roofs shed water rapidly, a good system of draining is required, varying from 6-in. pipe to as large as 24-in. where they empty into Lake Ontario.

The Rosedale lacrosse field was under-drained with tile pipe laid 50 ft. apart some 30 years ago, and it is considered one of the best ball fields in Ontario to this day.

Lavatory accommodation is an important feature of park work. Sometimes, when no sewers are at hand, a system of septic tanks and weeping tile are installed, or the Kaustine system if the land is very low, as on an island.



Willowvale Park as it is To-Day

The lavatory buildings should be designed with fixtures concealed as much as possible to discourage rowdyism. Press buttons can be placed in the wall and lights guarded. Two lavatories may be built close together and one main drain placed between to reduce expense. All water and drain pipes should be constructed so that they can be easily emptied in the fall or whenever desired.

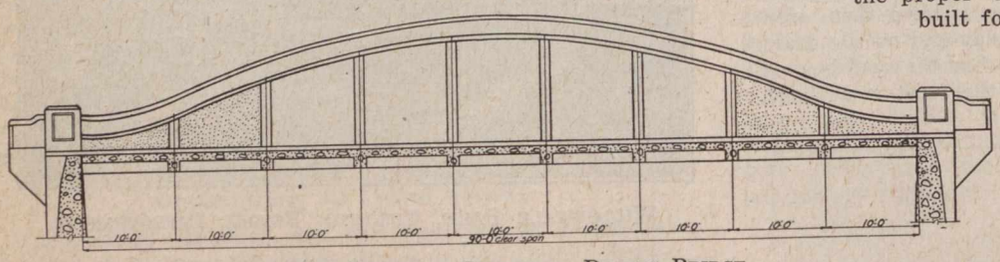
A summer course in civil and mining engineering has been arranged by the University of Toronto, which has bought 75 acres at the northern end of Gull Lake, about four miles from Minden, Haliburton County, Ont., where the students will receive practical training.

PROPOSED DESIGN OF CONCRETE TRUSS FOR DAVIES BRIDGE ON DON MILLS ROAD, NEAR TORONTO

By E. A. James
Chief Engineer, Toronto and York Roads Commission

In connection with the road improvements carried on by the Toronto and York Roads Commission, bridges have been an important item, both as to expense and as to appearance. While the commission have not gone to the extreme of spending funds for appearance only, yet they have planned that works designed for utility shall have a pleasing appearance, and in this regard an attempt has been made to improve the lines as well as the utility of the concrete truss.

The crossing of the Don River by the Don Mills Road, a short distance north of Toronto, required particular study because of the meeting of two streams at the bridge site,



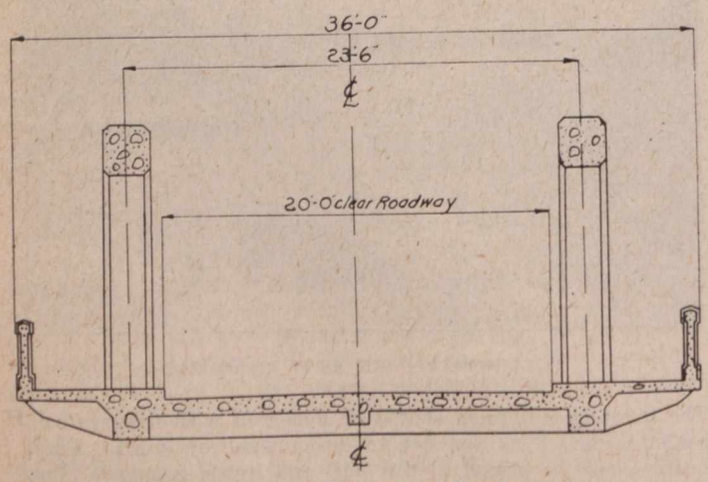
Section Through Roadway, Davies Bridge

and further because the highway at the approaches to the bridge is always submerged at high water.

At this point there is likewise a right-angle turn in the road, and to eliminate this sharp turn and provide sufficient clearance for the water in time of flood, it was necessary that the maximum of clearance be provided with the minimum of height.

Because of the conditions mentioned above, it appeared that a reinforced concrete truss bridge might be the most suitable for this location, and with this in mind the bridge indicated in the accompanying drawings was designed.

The design is somewhat unusual in that the two end panels were considered as concrete beams or girders, and designed to resist shear. The central five panels were considered as an arch, and the arch rib was designed to with-



Section at Centre of Bridge

stand the bending stresses incident to loading, and independent of the stiffness of hangers, bottom chord and floor.

In estimating the cost of crossing the stream at this point, it was found that if a beam bridge with centre pier were to be used, there would be 90 cu. yds. more of concrete required, but upon opening tenders it was found that the truss was 25% more expensive than two 45-ft. girder spans with centre pier.

Letters to the Editor

HIGHWAY CONSTRUCTION

Sir,—The following extract from a recent editorial in a technical publication sounds a timely note of warning that should command the serious consideration of our public officials:—

"Engineers are fully convinced that under normal conditions, expenditures for good highways are investments that yield satisfactory returns to the public, but when costs have risen abnormally, the investor must consider alternative plans for accomplishing the desired results. Last year we had to acquire the habit of considering $40,000 per mile as the proper cost for a road that could have been built for half that sum before the war. This year, if the bids received are a fair criterion, we must decide to pay $60,000 for the identical product. Against an annual interest and amortization charge of $2,233 (interest at 4½% and amortization in 15 years), we now have an annual charge of $6,700, three times as much. No highway engineer who has any sense of values and the significance of figures can fail to set against these annual charges the cost of maintaining a cheaper type of pavement, even though he knows maintenance costs, too, have gone up. Already there is much talk of serious curtailment of highway programs until costs come down to their pre-war level and when the annual charge for the better type of road will again, with a given traffic, be equal to or less than that of maintaining a cheaper surface."

For the past few months, numerous deputations from different sections of Ontario have urged our provincial highway department to build nothing but rigid pavement on our provincial system. The folly of committing the province of Ontario to a road program of $90,000,000 for a small percentage of our total highways must be apparent to anyone who reflects on the situation.

The public at large will welcome the announcement made at the Ontario Good Roads Convention recently, of the policy adopted by the Department of Public Highways for the provincial system. This "pay-as-you-go" policy is particularly appropriate at the present time when labor and material prices are unusually high. Many states in the Union are becoming much alarmed at their rapidly increasing road bond indebtedness for expensive pavements that too frequently must be resurfaced with a suitable wearing surface long before their bonds have matured. The tendency is to build more cautiously by establishing well consolidated macadam bases, thoroughly drained, and surfacing them with bituminous tops. Our engineers who served in France appreciate the traffic-carrying capacity of well maintained macadam roads.

A recent article on "Asphalt Constructed on a Macadam Base" states that 21 miles of the Warnersville-Palmyra road, one of the main thoroughfares of Pennsylvania, were recently surfaced with a 2½-in. asphalt top at 91c. per sq. yd. Another example of economical construction is that of a 2½-in. sheet asphalt surface constructed in Burlington County, New Jersey, in 1917, on a gravel base, at a cost of $1.32 per sq. yd., including the cost of gravel shoulders. Absolutely no maintenance charges on these roads have been incurred to date.

Irving T. Patterson, chief engineer, State Board of Public Roads, Rhode Island, in writing on "Asphalt Macadam Roads." states that "in no case has the maintenance been over $100 per mile, and the average cost of maintenance we estimate to be $50 per mile." Mentioning a two-mile section built under unfavorable conditions late in 1916, Mr.

Patterson states that "it is, however, gratifying to note that the maintenance costs of this road (two miles long) in 1918 and 1919 were $55.03 and $37.33 respectively."

Rhode Island has constructed asphalt macadam on some of its heaviest travelled trunk lines, such as the Post Road from Providence to Westerly, the road between Fall River and Newport, the Putnam Pike, the Hartford Pike and the New London Turnpike. Mr. Patterson states that the Post Road between Providence and East Greenwich carries an average daily traffic of approximately 3,500 vehicles, of which 300 are auto trucks.

These asphalt macadam roads were built at a cost in 1915 of 78c. to $1.10 per sq. yd., including foundation; and in 1916, at 82c. to $1.42 per sq. yd.

The foregoing are typical examples of asphalt construction that are truly economical; being low in first cost and very low in maintenance, therefore, their actual cost to the ratepayers is extremely low.

When these figures are compared with those of a rigid pavement costing from $30,000 to $50,000 per mile, and with annual charges that are certainly no less, the economy of asphalt wearing surfaces on macadam bases is apparent.

K. D. McDONALD,
Asst. Eng'r, Asphalt Sales Dept.,
Imperial Oil Limited

Toronto, Ont., March 16th, 1920.

CONCRETE REFUSE-BURNER

Sir,—I am enclosing a photograph of a concrete refuse-burner that I built for Allen & Norris, of Grand Forks, B.C., six years ago at a cost of only $800. This burner has been in constant use ever since it was completed, and has given, and is giving, entire satisfaction. Sawdust, slabs and all the refuse of the saw-mill are disposed of in this burner quickly and easily and without any danger to the mill.

The burner is entirely of reinforced concrete. It is 38 ft. in height, 16 ft. inside diameter, and is lined with common brick, set on edge, to a height of 10 ft. from the ground. The wall is 12 ins. thick to a height of 3 ft. from the ground, then 8 ins. thick for the next 15 ft. in height, and then tapers to a thickness of 4 ins. at the top.

There are four doors equally spaced around the base of the burner, the grates forming a Greek cross. It was found, however, that the draft was too great if more than one door were opened at a time, it being difficult to keep fire in the burner throughout the day, as the refuse was consumed too quickly. So three of the doors were blocked shut, and the draft is regulated nicely with one door, fire is kept steadily, and the burner has been giving splendid service. The material is fed into the burner by a conveyor at the rear.

Saw-mills, in British Columbia at least, are finding it difficult to get brick and steel at present, and may be interested in this type of construction.

W. J. GALIPEAU,
Manager, Grand Forks Concrete Co., Ltd.

Grand Forks, B.C., February 20th, 1920.

QUARRYING AND CRUSHING*

By T. V. Anderson
Road Superintendent of Lennox and Addington Counties, Ontario

QUARRYING and crushing operations constitute a very important item in the cost of highway construction. In selecting a quarry, rock containing earthy seams, shelly bedding and heavy overburden should be avoided. The quarry that makes for greatest output is one with light overburden, rock in regular beds from 4 to 9 ins. in depth, and an average depth of face of 12 ft.

Cost of Drilling

The first matter to be considered in opening a quarry is the removal of the top earth, or overburden, which usually costs from 50 to 80c. per cu. yd. For quarrying rock the steam drill and jackhammer are most commonly used. A good drill runner and his assistant will easily average 75 ft. of hole per day of 10 hours, and the cost will be approximately 16c. per ft., made up as follows:—

Wages of drill runner	$3.50	Rent of engine	$2.00
Wages of assistant	3.00	Depreciation of drill	.65
Fuel	2.00	Oil	.25
Sharpening steels	.75		

In quarrying where the rock is comparatively solid, the jackhammer is a very useful tool. Owing to its light weight it can be readily moved from place to place by one man, and large sections of rock that have been blown out may be quickly drilled and broken into smaller pieces; but where rock is inclined to be shelly, the jackhammer is rather difficult to operate, owing to small pieces of stone dropping in the drill hole and clogging the drill.

Crushing Costs

A crusher with a jaw opening of 10 by 20 ins., set to 2 ins., will easily average 95 cu. yds. of crushed stone per day. In operating the crusher it is advisable to employ a man to level the stone in the bin, to see that the teams hauling away the stone are quickly and uniformly loaded, and also to keep a record of the number of yards and trips each team makes. The daily cost of crushing is, approximately, 38 to 40c. per cu. yd., including the following items:—

Engineer	$4.00	One bin man	$3.00
Two feeders	7.00	Oil	.50
Fuel	5.00		

The following is a summary of the cost per cubic yard of stone ready for the road:—

Drilling per cu. yd.	$ .33	Crushing	.38
Explosives	.30	Supervision	.05
Quarrying, sledging		Contingencies	.12
Hauling to crusher and loading	.15 .42	Total	$1.75

These prices are for limestone quarries and conditions as they are found in Eastern Ontario.

Location of Holes

In placing the holes they should usually be about three-quarters of the depth of the hole from the face, extending about the same distance apart across the quarry. After the holes have been charged they should be fired by use of a battery. An ordinary battery will fire up to 30 holes at once. Much more can be accomplished by firing a series of holes simultaneously than individually.

In limestone quarries it will require from three-quarters to one pound of explosive of 50% dynamite per cubic yard of rock. The quantity of explosive to be used depends largely on the depth and length of face of the quarry.

*Paper read at the recent conference of county engineers and road superintendents of Ontario.

In moving the stone from the quarry to the crusher, the common wagon, dump wagon or dump cart are usually employed. Where the haul is short, one team will haul to the crusher 45 cu. yds. per day. The cost will run about 15c. per cu. yd. For quarrying, sledging and loading into wagons, the cost will average 42c. per cu. yd.

Crushing

The most commonly used crusher for highway work is portable and of the jaw type, and preferably with a jaw opening of not less than 10 by 20 ins., with an elevator of sufficient length to discharge the crushed stone into a revolving screen mounted on a 20 or 30-ton bin, with compartments separating the various sizes of stone. When the product of the quarry is principally of uniform size, or what is termed one-man stone, the unloading platform, or driveway, should be of such a height that the bottom of the wagon will be a few inches higher than the crusher opening. With stone of this size, two men will have no difficulty in keeping the crusher full.

When the product of the quarry is small, or principally shovel stuff, it is preferable to load it in dump wagons or carts. A platform with approaches built over the top of the crusher, and provided with a trap door, can be used to advantage. The contents of the waggon or cart may be dumped directly over the opening of the crusher. This method saves much time of both teams and men, and will save many times its cost of erection.

ADVOCATES PROVINCIAL RESEARCH LABORATORY

IN a letter to the editor of "The Winnipeg Free Press," Prof. John W. Dorsey, of the University of Manitoba, urges the establishment of an industrial research laboratory for that province. He says that special research in the reduction of the cost of electrical power would alone warrant the establishment of such a laboratory. Means are available, states Prof. Dorsey, for decreasing the cost of transmission of electrical power which require only further experimental development to become commercially successful; it takes only the discovery of a single new principle to revolutionize current industrial practice. The principle of consigning electrical reasearch to a few large laboratories in the United States can hardly be supported from a national point of view, says Prof. Dorsey. He sees no reason why Manitoba should not support the best electrical research laboratory in Canada. By neglecting research the province will fail to develop research men, continues Prof. Dorsey, and it will fail to encourage men whose object is the advancement of science. The two essentials for research work are brains and money, and the province should furnish the money in order to retain the brains and prevent their being attracted to other fields.

The Engineering Corporation, of Vancouver, B.C., is conducting inquiries as to the possibility of central heating systems for Winnipeg, Calgary, Edmonton and Regina.

The Canada Metal Co., Toronto, has purchased from Steel & Radiation, Ltd., the latter firm's large plant on Fraser Ave., Toronto. It is understood that the price paid, plus the expenditure that will be necessary before the premises are occupied by the Canada Metal Co., will mean an outlay of $250,000 by that company.

Claiming that war conditions and alleged faulty soundings made by the Toronto Works Department had resulted in a loss of $45,000 for his firm on a sewer contract, Wm. Godson, of Godson & Sons, contractors, Toronto, appeared before the Board of Control of that city recently and asked for reparation for the firm's loss. Mr. Godson said that he did not know whether he had a legal right to reparation, but he felt that he certainly had a moral right. Mayor Church replied that the city is anxious to treat contractors fairly, and said that a conference would be held with Works Commissioner Harris.

EARLY EXPLORATIONS AND SURVEYS IN THE CANADIAN NORTHWEST

By Roger Fyfe Clarke
Dominion Land Surveyor, Ottawa, Ont.

(Continued from last week's issue)

IN its search for new fields of trade, the North-West Co. developed other great explorers. The most notable of these was Simon Fraser, a native of Glengarry. He was sent by the company in 1805 across the Peace River Pass into the country west of the mountains, which then began to be called New Caledonia. He was to make further explorations and establish new posts. Two years later he went down the Fraser River and reached its mouth July 1st, 1807. In the course of this journey, he discovered the junction of the Thompson with the Fraser River.

Records Incomplete and Inaccurate

In the case of all of these explorers, from the Sieur de la Verendrye, down to Fraser, while they ventured into unknown regions, established posts and opened up the way for others to follow them, still their records of the country explored were very incomplete and inaccurate. It remained for David Thompson to really make the first map of the whole of the Northwest. Thus, while he did a good deal of actual exploring, particularly throughout the valley of the Columbia river, his chief title to fame is that he accurately surveyed and mapped all the principal topographical features of the Canadian West, chiefly, of course, the rivers and lakes. Mr. Tyrrell regards him as one of the greatest land geographers the world has produced and says of him: "Thompson was not a spasmodic explorer; with him surveying was his chief pleasure and life work."

Thompson came to America in 1784, at the age of 14, as an apprentice in the Hudson Bay Co. Among the subjects on the curriculum of the Grey Coat School in London, where he received his small amount of education, was that of navigation. Even so, the instruction he received on this subject must have been very elementary. On his arrival at Hudson Bay, he spent a year at Churchill under Samuel Hearne, one of the few Hudson Bay Co. officials who had shown any enterprise in going inland from the bay. In 1770 Hearne had crossed on foot from Fort Churchill to the mouth of the Coppermine River. He had also ascended the Saskatchewan and established Cumberland House in 1774.

Thompson's Surveys and Map

Thompson began his surveying on the Saskatchewan and Hayes rivers in 1789. He spent the winter of 1789-90 at Cumberland with Philip Turnor, the principal surveyor of the Hudson Bay Co. at that time. During that winter they made observations for latitude and longitude. Thompson probably obtained valuable instruction and experience. From this time he appears to have formed a broad plan for the prosecution of his surveys. From then on, wherever he went, he made a careful traverse notes of the routes followed, and by making latitude and longitude observations at the various posts where he stopped, he was able to accurately tie in his compass traverses. In writing to a friend he speaks of his sextant as his constant and loved companion. The accuracy of his observations with this simple instrument is marvellous. With all the refinements of modern methods for these determinations, the error in his location of points has never been found to exceed a few minutes of arc. Furthermore, his traverse notes were so complete that he was able from them to draft his map of Northwestern America after he retired from the country in 1812, fully twenty years after some of the notes had been made.

In 1796 Thompson explored the route from the Churchill river northward through Deer and Wollaston lakes to the east end of Lake Athabaska. A year later, having received so little encouragement in his work from the Hudson Bay Co., he left them and joined their more enterprising rivals, the North-West Co.

From that time until 1812, Thompson remained with that latter company, serving them as a trader, but chiefly interested in making surveys wherever he went. From 1805 onward, his efforts were chiefly devoted to the Columbia River district, which he reached from Rocky Mountain House at the head of the North Saskatchewan. He returned from the Northwest in 1812. During the following two years he made his map of that country from the notes he had collected during the previous twenty years.

It was at this time that the Earl of Selkirk secured a controlling interest in the Hudson Bay Co. and had them cede him a large tract of land in the Red River valley for the purpose of founding a colony. It is unnecessary to restate the details of all the misfortunes which followed that colonizing effort. The settlement became involved in the savage conflict between the North-West and Hudson Bay companies, as well as suffering from misfortunes of natural origin which overtook it. In spite of these difficulties and repeated set-backs, by 1821, when the two rival companies were finally united, the colony had become firmly established. Its population was largely augmented at that time by the settling there of many of the employees of the two companies whose services were no longer required when they became one.

Red River Settlement

As already stated, the Red River settlement was formed on a large tract of land ceded by the Hudson Bay Co. to Lord Selkirk in 1811. It became known as the District of Assiniboia. Its government consisted of a governor appointed by Selkirk (or afterwards his executors), and a council (called the Council of Assiniboia), composed of the leading citizens of the settlement.

In 1835 the land rights were returned to the Hudson Bay Co. and continued under their control until purchased by Canada in 1868. Under the jurisdiction of the company, the Red River settlement was governed by a governor and a council, both appointed by the company, although the council consisted largely of the leading men of the settlement.

As surveyors, we are chiefly interested in this first settlement in the west in connection with the surveys of the lands occupied by the settlers, and the men responsible for those surveys. These men were really the pioneers in the work upon which we, as Dominion land surveyors, are engaged.

Fidler's Experiences and Surveys

One of the earliest surveyors connected with Selkirk's colony, was Peter Fidler. Like Thompson, Fidler came to America as an employee of the Hudson Bay Co., probably arriving at York Factory about 1793. But he remained in their employ as a trader and surveyor.

An interesting incident regarding him is given by the Abbé Dugas. In 1809 he was sent with 18 men to open a trading post at Isle á la Crosse in opposition to the North-West Co. The first winter there he was fairly successful in trading. But the North-West Co. did not approve of the mild methods of their agent at Isle á la Crosse which allowed Fidler this measure of success. They sent Duncan Campbell to take better charge of the North-West Co. interests in that region. Campbell immediately asked for more men and built a house a few rods from Fidler's post. Here he installed a gang of particularly bold and lawless men to interfere with the Hudson Bay Co.'s trade and to harass the company's men. Their firewood was stolen, their fishing lines were carried off at night, they were bothered if they went out to hunt, and they found their fishing nets, their main source of livelihood, cut to pieces. Finally the North-Westers became so bold that they came to Fidler and his men and ordered them in a formal manner not to stir out of their fort again. Being overpowered by their superior numbers accompanied by such acts of violence, Fidler was compelled to leave Isle á la Crosse, and the North-West Co. burned down his fort a day or so after he had gone.

Fidler appears to have gone to the Red River district soon after this incident and to have made an early map of that region. Lord Selkirk, in his instructions in 1811 to Miles MacDonell regarding the founding of the colony, refers to a certain point on the Red River as marked in Fidler's survey. He seems to have been connected with the settlement almost from its inception. In the summer of 1814 he was employed by Miles MacDonell in laying out lands. He made the survey of the boundaries of the District of Assiniboia and a map of the Selkirk settlement. In 1814, in writing to Selkirk, Miles MacDonell says: "We require to have a permanent surveyor that would keep a regular office, and Mr. Fidler might answer the purpose. His Indian family is some objection to him. He is far from being a well-polished man and is not well liked by the people, but I think him a well-meaning man. I set off to-morrow for York. Mr. Fidler takes charge of matters here until my return."

Fidler was a member of the Council of Assiniboia for some time. He died at Norway House in 1822. During his life he accumulated a small library, which in 1848 was incorporated in the public library of the Red River settlement. Vol. 69 of the Selkirk papers contains his journals and his meterological journal and astronomical observations.

It is interesting to note the instructions for surveying contained in the memorandum of guidance made by Alexander MacDonell as agent for Selkirk's executors in 1821. They set forth that in laying out lots a base line ought to be taken and marked out parallel to the general course of the river without reference to the points or bends; and the boundary lines between lots drawn at right angles to this base line to the river on one side and to the extent of the Indian grant, or two miles back, on the other; all lots to have a front of 8 chains on this base line.

Kempt's Early Town Planning

Another surveyor connected with the early days of the settlement was William Kempt. He came out from Scotland as surveyor for the colony at £100 per annum and took up the work where Fidled had left it. In 1882 he laid out lots on Image Plain, and the following year drew a plan of a village on the Assiniboine River. Thus, at this early date, we find an example of the practice of town planning, or possibly an attempt to solve the problem of a community settlement.

Governor Bulger wrote of Kempt: "He is surpassed by no man I have ever known in zeal and industry in the performance of his professional duties." During the period of two months from Governor Bulger's departure until the arrival of Governor Pelly, Kempt was assigned the nominal charge of the colony. He subsequently returned to Scotland and resumed his profession there.

In the records I have had an opportunity of consulting no further surveyors are mentioned in connection with the settlement until 1841, when George Taylor became surveyor and superintendent of works at a salary of £12/10 under the Board of Public Works. It seems probable, however, that before this time there must have been a surveyor constantly in the colony. The office to which Taylor was appointed was abolished in 1844.

Other Surveyors at Assiniboia

For some time after that there appears to have been no regular surveyor at the Red River, for in 1854 the council of the settlement applied to the Hudson Bay Co. for the appointment of a good surveyor. In the following year the council resolved "That a public land surveyor be appointed with a salary of £25, and that he shall be authorized to charge not more than 7s. 6d. each day he is employed by private individuals." William Inkster was appointed.

Mr. Inkster's appointment does not seem to have proved universally popular. The Canadian population were dissatisfied with him, as they could not understand him. He was, therefore, warned that his services under the agreement above mentioned should cease at the end of May, 1856. There must have been some further objections to his work as a surveyor, however, for, when on the 27th May, 1856, it was agreed by the council that two surveyors should be appointed, Roger Goulet was appointed to that part of the settlement south of the Assiniboine River, while it was left to the governor to appoint one for the north side of the river. Apparently, the council at the same time considered they had been

rather too liberal to the surveyor under the old arrangement, for now the surveyors were to receive no salary from the public funds, although they were allowed to charge up to ten shillings a day for their services. No mention is made of what surveyor was appointed for the remainder of the settlement until 1860, when Herbert L. Sabine was given permission to engage in surveying upon the same terms as others employed in that work.

During the following 10 years Goulet played quite an important part in the affairs of the settlement. Whether he continued the practice of surveying along with his other duties and responsibilities, seems uncertain. In 1862 he was appointed collector of customs at Upper Fort Garry, with a salary of £25 a year. He became a member of the council in 1866, and two years later was made a justice of the peace. He appears to have been regarded as something of an engineer, too, for in 1869 he was a member of a committee to consider the possibility of constructing a floating bridge across the Assiniboine River at the forks. During the disturbed conditions in the autumn of that year he was entrusted by the council with the difficult mission of proceeding to the camp of the party who were determined to prevent the entrance of Governor MacDougall into the new province. Goulet was to endeavor to procure the peaceable dispersion of this party. In this, unfortunately, he was not successful. Afterwards, when Riel formed his provisional government, he endeavored to have Goulet accept office under him. Goulet, as a result of his refusal to do so, had the unique experience of being imprisoned for refusal to accept a government office.

Limits of Pre-emption Rights

One other point of surveying interest in connection with the Red river settlement is a resolution of the council, dated February 27th, 1860. This provided that in case of difficulties arising between persons who take land outside of the part of the colony already surveyed, the magistrates were authorized to act on the principle that 12 chains should be the limit of pre-emption rights arising from occupation. According to William Pearce, this was the width allowed to many of the lots laid out in the settlement. How long the earlier regulation of a lot 8 chains wide on a base line was in force, and whether it was superseded by the 12-chain lots without the intervention of any other systems, I have not been able to determine.

As soon as the Canadian government had consummated the transfer of the lands in the West from the Hudson Bay Co., Col. J. S. Dennis was sent out to commence surveying operations around the Red River. He was stopped in his work by the insurgents in 1869, and subsequently played no small part in the events which took place during the Red River Rebellion. It was he who worked out the first system of surveys in the West, a complete history of which may be found in the report of the Department of the Interior for 1891.

Explorations in Other Parts

While I have followed the surveys of the Red River settlement from its inception until it became a province of the Dominion, I have neglected to mention explorations which took place in other parts of the West during this period.

Even after Thompson, and the explorers who preceded him, completed their surveys of the Canadian West, there were still some regions which were very little, if at all, known. These were particularly the districts between Great Slave Lake and Hudson Bay and those parts which now comprise Northern British Columbia and the Yukon.

The region to the west and north of Hudson Bay was first penetrated by Hearne in 1771. No further explorations are recorded until 1819, when Sir John Franklin made his jonrney from York by way of the Saskatchewan, Churchill and Athabaska rivers to Great Slave Lake, and from there down the Coppermine River to the Arctic Sea. He was accompanied in this expedition by Sir George Back and Sir John Richardson. They appear to have been the first to explore the whole course of the Coppermine and parts of the coast around its mouth.

Sir John Franklin made another expedition in 1825-7, going from Canada to the Athabaska, Great Bear Lake and down the McKenzie River to the Arctic and thence along the coast eastward to the Coppermine, returning to the Athabaska by that river. Sir George Back commanded an expedition from 1833-5 to search for Sir John Ross, who was then supposed to be lost in Arctic lands. He proceeded from Canada to the Athabaska and Great Slave Lake. He built Fort Reliance at the east end of Great Slave Lake, and, using that as a depot, struck out to the northeast, discovering the Great Fish or Back River. He followed it to the sea and returned by the same route.

Northern British Columbia and Yukon

This northeastern region of the Canadian West was largely explored, as we have seen, by expeditions sent out from England. The district at present comprising Northern British Columbia and the Yukon was, on the other hand, opened up as a result of the desire to further extend the fur trade. When the North-West Co. became merged in the Hudson Bay Co. in 1821, it seems to have infused some of its enterprise and energy into the older and more conservative organization. At any rate, the following 20 years was a period of great activity on the part of the Hudson Bay Co. in seeking new fields for trade. They also appear to have been very ready and liberal in their assistance to the expeditions of Franklin, Back and Richardson. In addition to giving every assistance to these explorers, about 1837 they sent an expedition of their own, under Chief Factor P. W. Dease and Chief Trader Thomas Simpson, to the Arctic coast. These men successfully outlined unknown portions of the Arctic coasts to the east and west of McKenzie River, continuing their efforts for two or three years.

Before this time, John Bell, another Hudson Bay Co. employee, crossed the Rocky Mountains from Peel's River, near the mouth of the McKenzie. He discovered the Porcupine river, and descended it to its junction with the Yukon, where he established Fort Yukon.

About 1835, John McLeod ascended to the head waters of the Liard River, passing through the Rocky Mountains. From there he discovered the sources of what was then named Pelly's River, now known as the Yukon. McLeod's discovery was followed up by Postmaster Robt. Campbell, who showed great enterprise and determination in explorations in this region. Campbell finally succeeded in crossing through the mountains from the Liard to Pelly's River, which he descended to Fort Yukon at its junction with the Porcupine River. By these successful efforts Campbell won the name of "The Livingstone of the Northwest."

Enquiries Regarding Railway Possibilities

I have endeavored to outline the course of the discovery and exploration of all the great river systems of what was then the northwestern hinterland of Canada. Owing to the restrictions imposed by nature on the mode of travel, these early explorations and surveys were almost entirely confined to the water courses. As the conception began to dawn upon the people of Canada and Great Britain that this vast stretch of country might be of some value other than as a great fur reserve, other explorations were instituted to determine the possibilities of the country for wider colonization, and for the establishment of communications to and within the territory. Even in the fifties, the possibility of a railway across the country to the Pacific was considered by a few of the more far-seeing statesmen. Efforts were being made to build such a line in the United States. In both Canada and Great Britain another incentive to exploring and occupying the West more fully was the fear that, with the American settlements extending westward so rapidly, they might occupy the country. Furthermore, the people of the Red River were raising many complaints regarding their position under the Hudson Bay Co., and were particularly eager for better communications between their settlement and the outside world.

During the latter part of the fifties, all these influences combined to create a very lively interest on the part of the people of Canada and Great Britain in the possibilities of the western country. This interest was evidenced in en-

quiries by both governments to collect more accurate information from people familiar with the country, and by the sending out of expeditions to more fully explore the country and report upon it. There was an enquiry instituted by the legislature of Canada, and in England there was the Select Committee on the Hudson Bay Co. In the period from 1857 to 1861 three important expeditions were sent out: Captain Palliser, by Her Majesty's government; and S. J. Dawson, C.E., and H. Y. Hind, M.A., F.R.G.S., by the Canadian government.

The expedition under Captain Palliser was sent out in 1857 to explore the country between Lake Superior and the Rocky Mountains, and also to ascertain whether any practicable passes available for horses existed across the mountains south of that known as the Boat Encampment Pass, the one first used by Thompson. Owing to the limitation in this last clause, Palliser did not, of course, investigate the best passes which lay to the north of the limit imposed on him. As a result, after four years of work, he reported very unfavorably upon the project of a line of communication across the continent entirely within British territory on account of the difficulties to be encountered, both between Superior and Red River and through the Rocky Mountains.

Dawson and Hind Expeditions

About the same time the Canadian government sent out S. J. Dawson particularly to examine the country between Lake Superior and the Red River, with the view of opening up a line of summer communication on British territory between Canada and the western settlements. Mr. Dawson reported in 1859 on a combined road and boat route, following much the same course as that used by the old North-West Co. The principal difference was that wagons were to be used from Lake of the Woods direct to Winnipeg, instead of going around to the north by the Winnipeg River. The Canadian government placed the sum of $20,000 per annum for five years at the disposal of the North-West Transit Co. for the purpose of developing this communication. It became known as the Dawson Route.

The Canadian Red River Exploring Expedition was sent out from Canada in 1857 under H. Y. Hind. The following year Mr. Hind extended his investigations westward as far as the south branch of the Saskatchewan. He covered all the country from the Red River westward to the south branch and northward to the main Saskatchewan. He was to report on the geology of the country, its possibilities for agriculture, and the possible development of means of communication.

Finally, when Canada bought out the Hudson Bay Co. rights in the West, there were the numerous explorations and surveys made under Sanford Fleming, engineer-in-chief, to determine a route for the Canadian Pacific Railway. But these expeditions belong to the succeeding period of Canadian control in the Northwest.

Works of Reference

The following historical works have been consulted in the preparation of this sketch:—

1. Report from the Select Committee of the British House of Commons on the Hudson Bay Co., together with the proceedings of the committee, minutes of evidence and appendix. Ordered to be printed August 17th, 1857.

2. "The Canadian Northwest: Its Early Development and Legislative Records." Publication No. 9, in two volumes, of the Canadian Archives. Edited by Prof. E. H. Oliver.

3. "History of Canada," for the High Schools of Ontario, by Prof. W. L. Grant.

4. "The Canadian West: Its Discovery by the Sieur de la Verendrye; Its Development by the Fur Trading Companies Down to the Year 1822." Translated from the French of Abbé G. Dugas.

5. "Thompson's Narrative of His Explorations in Western America, 1784-1812." A publication of the Champlain Society. Edited by J. B. Tyrrell.

6. "MacKenzie's Journal." Edited by Sir Alexander MacKenzie, himself.

7. Narrative of the Canadian Red River Exploration Expedition of 1857, and of the Assiniboine and Saskatchewan Exploring Expedition of 1858. In two volumes, by Henry Youle Hind.

8. "Ocean to Ocean." Sanford Fleming's expedition through Canada in 1872. By the Rev. George M. Grant.

Wm. Pearce, D.L.S., kindly permitted me to read also the draft of a treatise he was preparing on "Titles to Land in the Three Prairie Provinces."

I regret that I did not have the opportunity nor the time to consult any of the following valuable books of reference on this subject:—

1. "Saskatchewan and the Rocky Mountains," by the Earl of Southesk.

2. "History of the Northwest," by Begg.

3. "The Remarkable History of the Hudson Bay Co.", by Byrce.

4. "The Hudson Bay Co. Land Tenures," by Prof. Archer Martin.

5. "The Journals of Captain Palliser's Explorations," published by Her Majesty's government.

6. "A History of the Red River Settlement," by Prof. Archer Martin.

7. "The Search for the Western Sea," by Lawrence J. Burpee.

B. C. ARCHITECTS' BILL GIVEN BETTER RECEPTION THAN WAS ENGINEERS' BILL

SECOND reading was given without opposition to the bill to incorporate the architects of British Columbia, recently introduced in the legislature of that province. The bill met with considerably better reception than did the similar measure introduced a few weeks ago on behalf of the engineers of British Columbia. David Whiteside, who introduced the architects' bill, said that he was a little diffident about doing so after the "rough and ready" reception of the engineers' bill, but he thought that some people in the legislature assumed a professional knowledge that they did not possess. This bill by no means aimed at a closed shop, he declared. One had only to look around at the public buildings in Victoria to recognize the importance of architecture in securing harmony and beauty. While the bill was brought in at the request of 70 architects in the province, there was no desire to build a high board fence around the profession. The bill had been carefully considered by the private bills committee, the objectionable features had been eliminated, and the contractors had withdrawn their opposition.

Pig iron production in Nova Scotia totalled 334,000 tons during 1919; steel ingots, 374,500 tons; and coke, 518,713 tons.

One of the events of the past year in Nova Scotia was the discovery of salt at Malagash. Drilling revealed salt underlying an area of 5,000 sq. ft. and with a depth of approximately 350 ft.

More than 5,000,000 tons of coal were mined during 1919 in Nova Scotia, of which approximately half was consumed in that province. Shipments via the St. Lawrence River totalled 344,662 tons and to the United States 75,813 tons.

City Engineer Gray, of Hamilton, Ont., has recommended to the city council that they accept the offer of the Dominion Geodetic Survey to prepare a complete topographical map of the city of Hamilton. The cost of this map will probably be about $40,000, of which the Dominion Government offers to pay 60%.

The city of Chatham, Ont., desires to undertake this year all of the work allotted to it in the suburban areas. The city council has passed a resolution asking the Ontario government to permit it to devote two mills of the city's tax-rate to this purpose, instead of one mill, which is the maximum which can be devoted under present legislation.

CONCRETE MIXTURES IN ALKALI SOILS

Field and Laboratory Tests Covering 39 Different Mixtures—Gunite, Powders and Paints to be Tested—Observation of Buildings and Experimental Walls—Paper Presented at Recent Annual Meeting of Engineering Institute's Saskatchewan Branch

By C. J. MACKENZIE
Professor of Civil Engineering, University of Saskatchewan

BRIEFLY the known facts concerning the effect of alkali waters on cement and concrete mixtures are as follows:—

1. By laboratory experiments it has been conclusively proved that magnesium and sodium sulphates, which are the predominating salts in our so-called alkali waters, will attack cement chemically; and under certain conditions of intimate mixture, completely disintegrate same. (See Montana Agricultural College Bulletin, No. 81.)

2. In laboratories it has also been proved that if a porous concrete be saturated and dried alternately, using a solution of soluble salts found in our alkali soils, that the process of crystallization will exert a force which will cause a splitting of the concrete. (Bureau of Standards Paper, No. 12.)

3. In practice, many cases have been observed where structures of concrete, as well as those of chemically inert and porous materials, such as brick, sandstone, etc., where exposed to alkali waters, have become disintegrated, suggesting that the mechanical force of crystallization is the action obtained.

4. Also numerous cases have been observed where the concrete exposed has become soft, pasty and bulged, with the total loss of its cementing value, suggesting a chemical action on the binding material.

5. In practice also we find structures of apparently the same grade of concrete exposed to the same conditions, one of which may be badly attacked with pitting and disintegration, while another appears unaffected.

According, therefore, to their personal experiences, there are those who hold that the action is entirely mechanical, due to the crystallization of the salts of the alkali water, and that, therefore, all required is a dense concrete. There are engineers and chemists who are attacking the problem from the purely chemical side. There are also a few engineers who hold that there is no effect from the alkali waters at all; that the trouble is entirely due to poor concrete, and the disintegration found in our western areas of alkali waters would have occurred similarly in the East and been accredited there to the action of the weather, etc., on a poorly fabricated concrete.

Seeking the Danger Zone

It follows, then, that, accepting the facts above stated, we may say that, while cement can be disintegrated by intimate action of alkali solutions in laboratories, and also that concrete of porous character can be disintegrated by the mechanical forces of crystallization under ideal laboratory conditions of saturating and drying, these ideal conditions will seldom, if ever, be found in practice, and consequently, deductions from laboratory experiments must be interpreted with a great deal of caution.

In practice the alkali water is not permitted the intimate contact with cement; nor do we find the rapid saturating and drying, and in addition, we have the extremely important problem of what effect the surface coating may have.

It would seem, then, that the most feasible method of attacking this problem is by actual field tests of concrete in the form of and under conditions found in practice. It is my opinion, and we have outlined our own experiments on this basis, that the most practicable way to approach the problem for the present is to subject, not a few mixtures to numerous varieties of water, but a number of widely different mixtures to conditions where disintegration is known to have taken place, and in this way, we may hope to get some idea as to which mixtures will stand the action of a typical alkali water and which will not. If we could establish even a danger zone, we would have accomplished something practical, and later the effect of other concentrations and the determination of just what chemical or mechanical action takes place when concrete fails could be undertaken.

The only published records of field tests of this nature being conducted at present, with which I am familiar, are those of the Bureau of Standards, Washington. Their experiments were initiated in an endeavor to determine the action of sea water on concrete, which we now know is of a similar nature to that of alkali action. Their first published report in 1912 covered an account of experiments conducted in the laboratory and a few field tests in the sea. This report proved only the theory of mechanical action by crystallization under laboratory conditions.

Bureau of Standards' Tests

The second report, published in 1917, is devoted to an account of the field tests made on various reclamation projects in the American West to determine the effect of alkali waters on concrete. The major part of the work covered by this report deals with cement pipe, but there are also the results of a year's experiments on block concrete. The results show nothing conclusive. The tile pipes were taken up and crushed, and from their installation in 1914 till 1916 it may be stated generally that all pipes showed increases in strength in alkali waters, although there were some cases of total failure of individual tiles, and even some of the tiles showing increase in strength were slightly pitted and attacked. It is very likely, however, that the future examinations will throw light on this subject. The only conclusions drawn are that richness of mixture alone will not prevent disintegration, and that poor tamping in several rich mixtures showed up much worse than lean mixtures in a well-made concrete.

The blocks were only in one year before inspection, and, with the exception of two cases, there was no effect noticed other than a slight pitting. The failure of two of the projects indicates that material and proper workmanship are of the greatest importance, but no conclusions of far-reaching effect are drawn at present.

The most encouraging aspect at present, to my mind, is not due to any of the results of direct experiment along this line, but to the great steps in the understanding and interpretation of concrete mixtures which have taken place within the past 18 months.

The question that concerns us chiefly as engineers to-day is, let me repeat, "Which mixtures, if any, will successfully withstand the action of the alkali waters as found in our western provinces?" This naturally demands that we must first have an intimate and complete knowledge of mixtures, and then investigate the action of alkali on a wide range of mixtures, and determine, if possible, which are suitable and which are unsuitable for our local conditions.

New Light on Design of Mixtures

I firmly believe that the principle reason we have obtained no definite conclusions up to the present is due to the fact that for the past years we have known practically nothing about the science of the design of concrete mixtures. How could we expect to obtain any definite information as to which mixtures would be suitable and which would not when we knew nothing more about the results of our mixtures than that they were mixed in the proportions of 1:2:4

or 1: 3: 5, as the case might be, without any definite knowledge as to the final results of the concrete made?

A mix of, say, 1: 6, as is common with us, tells absolutely nothing about the finished concrete. The strength and character may vary several hundred per cent. on the same job, to say nothing of the variation in mixtures on different jobs using different materials and mixed by different men and different methods. (I make this statement advisedly as the result of actual tests made from concrete poured on various jobs.)

Mixing Concrete with Eyes Shut

For years we have been simply mixing concrete with our technical eyes shut. Certainly some engineers and some firms have been making concrete of the very best quality, while others, working to the same specifications and with the same materials, have been making concrete of an altogether different character. The thing that has troubled most of us is, I think, the fact that if we were given the ingredients in any case, including cement, sand, gravel and water, we could not calculate the strength of the finished product with any degree of assurance, although many men of mature judgment and wide experience could form a very good opinion.

Personally, I have done what was called sand and gravel analyses for several years. I have plotted the results on properly ruled paper along with Fuller's "ideal curve," handed the results along to clients, and even charged good money for it; but I tell you truthfully, the analysis never meant anything to me, and I am absolutely sure that it meant nothing to most of those to whom I sent it. All the time I prayed that someone would do something to clear up the meaning of gravel analyses.

During the years 1918-9 two independent experimenters accomplished what I consider to be the biggest step towards placing the mixing of concrete on a scientific basis that has been made for years. The names of the experimenters are Prof. Abrams, of the Lewis Institute, Chicago, and Capt. Edwards, until recently of the Department of Works of the city of Toronto.

At the risk of covering ground familiar to all, I wish to mention these methods, as we have mixed all our concrete for experimental purposes on these theories, and we have tested their value on various jobs in Saskatoon during the year and have found them very satisfactory and enlightening.

Great Advance in Scientific Proportioning

Prof. Abrams proved from the results of about 50,000 tests that the strength of concrete depends only on the ratio of water to cement for all ordinary workable mixtures. The aggregate functions only in determining how much water must be used to make the mix workable. He worked out a method of stating this property of aggregate in terms of a concrete number which he calls the "fineness modulus," and which is readily obtained from a screen analysis. Thus, if we observe the amount of water being used per bag of cement on any job, it is always a simple matter to calculate the strength of the resulting concrete. Or, if we are given an aggregate and we obtain its fineness modulus, we can calculcate how much water will be necessary for any mix and what the strength will be; or, if we wish to make concrete of a certain strength out of a certain aggregate, we can easily calculate the amount of cement required and the necessary water. By this method we have a means of comparing in actual figures of strength, and also of dollars and cents, the value of different aggregates.

Capt. Edwards, on the other hand, attacked the problem from an altogether different viewpoint, and concluded that, always providing the concrete mixture is of normal consistency or workability, the strength of concrete depends on the ratio of cement to the surface area of the aggregate. He worked out tables which, when applied to the mechanical analysis of an aggregate, will give the surface area per pound of the aggregate. And by this method also mixtures may be analyzed and designed as above.

While these two methods at first glance seem quite different, and even contradictory, they are almost identical in practical results, and have both been found to give satisfaction on actual work.

The scope of this paper does not permit of a thorough discussion of these methods, but if there are any engineers who are not familiar with these theories, I would strongly urge a serious study of them.

In outlining the experiments carried out in conjunction with the Committee on Concrete of the Saskatchewan Branch, Engineering Institute of Canada, it would be well to state that we recognized that the problem was a very large one, and that with the funds and facilities available at present, it would be better to confine our work to one particular district, and if results of any value are obtained, further grants might be secured for a complete survey of the province and test blocks placed in all the different localities where conditions of ground water, soil and available concrete aggregate differ.

We started with the premises as set forth in the opening paragraphs of this paper, and accordingly decided to undertake our work under three divisions: (a) Field tests; (b) observation of buildings under construction in areas known to be troublesome; (c) laboratory tests, both chemical and physical.

Field Tests

For the present we are devoting the major part of our time to the field tests, and to date we have placed in the ground specimens representing about 39 different concrete mixtures.

It was decided, in view of the fact that the pressing problem, in Saskatoon at least, is in connection with foundations and walls and not with tile, to make up our test blocks in cubes, with sides of 12 ins., thus approximating the conditions of walls. Each block is moulded in our laboratories, and a wrought-iron rod with anchor plate is inserted. The portion protruding forms a loop for handling, and has encircling it a brass identification disc.

The site for placing the test blocks was selected after a thorough investigation of the city, and is in the centre of the most troublesome area and is surrounded by buildings which have been affected.

Contiguous buildings were inspected to ascertain at what depth the most serious disintegration occurs, and we found that this was at a depth of 6 ft., where a small gravel seam, about 2 ins. in thickness, runs through the clay. This depth was used for our blocks.

The test blocks made to date are in six series, as follows:—

Series A—This series consists of thirteen blocks, ranging from a heavy, strong, well-graded, dense concrete to a very weak mixture of poor, pit-run gravel, so weak that it was impossible to even handle without knocking the corners off.

Blocks Nos. 1 to 5 were made with an aggregate of washed gravel and crushed stone. This aggregate is a good approximation of Fuller's curve. Its fineness modulus (according to Abram's method) is 5.5, and the surface area per gram (calculated by Capt. Edwards' tables) is 2.44. Mixtures by volume of 1: 2½, 1: 3.7, 1: 5, 1: 6.2 and 1: 7½ were used.

The ratio, volume of water to volume of cement, runs from 0.62 to 1.31, while the grams of cement per square inch of surface area of aggregate varies from 7.3 to 22.

Blocks Nos. 6 to 10 were mixed with a pit-run gravel as aggregate, the fineness modulus of which was 3.8; and the surface area per gr., 3.9 sq. ins.

The same mixes were used as in blocks Nos. 1 to 5, but the ratio, volume of water to volume of cement, varied from 0.82 to 2.4, and the grams of cement to surface area, from 11.7 to 35.1.

Blocks Nos. 28 to 30 were mixed with a pit-run gravel of a better grade, the fineness modulus being 4.8, and the surface area, 2.51 sq. ins. per gr.

The water-cement ratio varies from 0.81 to 1.59; the grams of cement per square inch of surface area, from 8.7

to 22.6. Thus we have in this series, concrete from the best to the worst practicable. We have a well graded aggregate and a poorly graded aggregate of various mixes; range in water ratio from 0.62 to 2.4 and a variation from 1 gr. of cement to 7.3 sq. ins. of surface area, to 1 gr. to 35.1 sq. ins., which gives a range in crushing strength from 3,800 lbs. per sq. in. to 300 lbs. per sq. in.

Complete records of the analysis of the cement and aggregate mixing water have been kept, while from a test hole at the site, a log of the ground water level with the corresponding chemical analysis of the water is being recorded in order to check the variation in concentrations with the water table. The weights of the various ingredients as well as the moisture content of the gravel were kept, of course, and it might be interesting to note that the best block (No, 1) weighed 147 lbs. per cu. ft., while No. 10, the poorest, only weighed 131 lbs. per cu. ft.

To be Photographed Periodically

Before placing in the ground, a photograph was taken of the blocks, and it is proposed that each time the blocks are dug up for inspection, photographs will be taken for comparison and record.

It is believed that from this preliminary series, we shall be able to obtain at least the danger zone of mixtures for this particular locality, and thus cut down the range for future experiments and indicate the value of the different factors in combating disintegration in this locality.

Series B—Blocks Nos. 11 to 19, 25 to 27 and 31 to 33 (15 blocks in all). This series was designed for the purpose of testing a few commercial water-proofing and alkali-proof products. Each compound was applied according to the manufacturer's specifications to each of the three blocks corresponding exactly to either blocks Nos. 11, 12 or 13, or Nos. 28, 29 or 30, in constituents, mix and consistency.

Four general types were used: An integral powder mixed with the cement; a compound mixed with the water; an alkali-proof paint applied on the surface; and tar applied to the surface.

Series C—Blocks Nos. 20 to 22. These blocks were made of the same aggregate and mix as Nos. 11, 12 and 13, but the consistency was made as wet as possible in order to see if the excess water decreases the resistance of a concrete to alkali just as it decreases its strength.

Series D—The purpose of this series is to check our assumption that the maximum disintegration takes place at a depth of 6 ft. These specimens were made 6 ins. by 6 ins. by 6 ft., and were placed upright so that one end is exposed to the air while the other is well under the ground water level. If we find that the 6-ft. level is not the worst, we will be able to change the position of the other blocks and make all future tests accordingly.

Series E—Blocks Nos. 34 to 36. In this series the pit-run gravel was first screened and divided at the No. 4 screen and then re-mixed. The mixtures by volume correspond to Nos. 28, 29 and 30. This series was designed to ascertain the economy, if any, of screening and remixing the gravels for concrete aggregate.

Series F—Blocks Nos. 37 to 39. The blocks in this series are of the same mix as Nos. 28, 29 and 30, but the mixing water was the alkali water taken from the ground where blocks are placed. At the time of making up all blocks of the series, small blocks for compression tests were made up for testing after 28 days in water in order to check, if possible, the alkali-resisting properties of concrete against its strength. With blocks Nos. 25 to 39, nine compression blocks of each mixture were also buried, to be tested three per year.

Observation of Buildings

This phase of the work consisted of an inspection of all known cases of disintegration in the city for the main purpose of defining the troublesome areas and gathering all the information and evidence possible. Added to that we have outlined a scheme for inspecting all buildings being erected in these areas and personally observing the concrete being put in, the mix, consistency, aggregate, etc.

Our inspection shows that the down-town section of about ten city blocks contain the greatest amount of affected concrete, and information gathered from a reliable source indicates that before the city was built this area was known as an "alkali slough." Accordingly, this section was selected for our tests and observations.

Various contractors and builders were interviewed, and some evidence obtained as to the probable mixes of the cases of failure, but little reliance can be placed upon the verbatim information generally, as was proven in many cases where we, ourselves, were able to check up. The following is a typical experience:—

1:5 or 1:9 Mix?

One owner informed us that he realized the danger of alkali, and in his new building, which he was then putting up, he was using a 1:5 mix. The contractor interviewed said he was using a 1:6. The foreman on the job said he was putting in a 1:7, and our personal observation showed that what was really going in was a 1:9. The same sort of vagueness seems to be prevalent generally and our own experiences have led us to accept nothing not seen personally.

On new buildings we take records of the conditions of the excavation, including an analysis of the ground water, a mechanical analysis of the aggregate, and data as to the mix and water used. On several buildings we got permission to put in a section of the wall of a very much stronger mix than was used for the rest of the work, and it is our desire to get a wall poured with about six different mixes, but up to the present time we have not succeeded.

On one old wall which was uncovered when extensions were being made, a very interesting thing was observed. Two distinct layers of disintegration were noted: The ordinary one at the 6-ft. level, and another at the ground level, suggesting that perhaps there had been disintegration by crystallization at the surface and direct chemical action at the 6-ft. level.

Laboratory Tests

Laboratory tests are being conducted as an aid to and for the purpose of throwing light on the results of the field tests, and not as primary tests themselves, as it is felt that conclusions drawn from laboratory tests are not always reliable when applied to field conditions.

For the present, the chemical work consists of a survey of ground waters, and analysis of the mixing waters and of the aggregate, etc. As we get results from our field tests, laboratory tests to clear up certain points will, no doubt, be necessary.

New Series This Summer

The above is a summary of the work done during the past summer, and while a great deal of actual labor has been done, we are, of course, unable to present any conclusions at present, although we hope that even by next summer we may be able to report at least some indications.

We intend extending the tests of the various series next summer and adding from time to time new series dealing with other phases such as admitting air to blocks at the 6-ft. level; application of "gunite" to the surface, etc. Concretes found immune to our local conditions will then be subjected to other concentrations of alkali in the hope that eventually we may be able to specify the mixtures for different conditions of alkali waters just as we do for other external forces.

Frank Barber, consulting engineer, Toronto, addressed the Toronto Branch of the Engineering Institute of Canada last Thursday evening on concrete bridges. He predicted that within a few years concrete will have replaced steel almost entirely for bridge construction. He stated that most of the bridges in Canada are too light for the traffic which they have to bear and in many cases are decidedly dangerous. "Beauty in architecture combined with utility is the ideal in bridge construction," declared Mr. Barber, "and the future of bridge building will depend a great deal upon the architect, with whom the engineer must co-operate more closely."

HOUSING AND TOWN. PLANNING*

By James White
Deputy Head, Commission of Conservation

DURING the past year, as previously, it has been a constant problem to keep the town planning work of the Commission of Conservation within the limits of the staff available and, at the same time, render the practical services essential to the development of proper town planning in the various provinces. The following resumé indicates the scope and character of the work undertaken:—

Legislation

An Act was drafted for Quebec province which passed a first reading during the last session and is still under consideration of the government before being re-submitted.

A special draft was also prepared for revising the Ontario Act to meet the needs of the large cities and towns. A draft Act was prepared for British Columbia and has been submitted to the government. Different sets of regulations under town-planning legislation have been prepared or reviewed during the year. Provisions of St. John and Halifax town-planning schemes have been revised and are now about ready for presentation to the provincial governments.

Proposals have been made to the cities of Edmonton, Calgary, Lethbridge and Medicine Hat as to the special provision necessary to deal with their somewhat unique conditions under town-planning schemes.

Housing Legislation and Administration

Our town-planning adviser has continued to assist the Housing Committee of the Cabinet in the administration of the federal housing loan of $25,000,000. A large part of the time during the past year has been given to this work with the assistance of a special staff appointed by the Housing Committee of the Cabinet.

General Town-Planning Schemes

General advice has been given to the cities all over the country in connection with proposals to prepare town-planning schemes. Meetings have been held or visits paid to cities in all the provinces. Considerable progress has been made with plans for several cities, including St. John, Halifax, Borden (P.E.I.), Hamilton, London, Ottawa (housing schemes), Calgary and other smaller cities.

Studies, Investigations and Educational Work

A housing report has been advanced toward the stage of being nearly ready for publication. A report on regional planning is completed. A report on industrial decentralization in large cities is under preparation, after a considerable amount of research in Toronto and Montreal, by Capt. Ferguson.

Reports have also been prepared on the surveying of curves, by H. L. Seymour, and on comparative conditions of assessment and taxation in different cities, by A. G. Dalzell, and on several incidental questions, such as sunlight engineering.

Expert Advice to Government Departments

During the past year the town-planning adviser has been in an advisory capacity to the Department of Public Works in connection with the planning of the sites for public buildings in Ottawa. The branch has prepared plans of houses and has been considering the planning of Jasper and other towns for the Dominion Parks Branch, Department of the Interior.

Designs for houses have been prepared, including a special design for soldiers suffering from tuberculosis, and one for a farm house for the Soldiers' Settlement Board. A report has been made to the Department of Trade and Commerce on the question of erecting wooden houses in England.

We have been in consultation with the Canadian Air Board regarding the preparation of aerial maps of cities and towns, and with the Geodetic Survey regarding preparation of topographical maps.

Work for Present Year

The work for the coming year will be almost entirely a continuation of the foregoing activities. The particular projects which require to be carried forward may be summarized as follows:—

Town planning covers a continually extending field of work because of the large number of elements that enter into the growth of cities and towns, and the new factors that are constantly arising. Hence, it is necessary to keep legislation up to date and to confer with the provinces regarding improvements and amendments needed. Apart from Ontario, Quebec and British Columbia, we have up-to-date legislation in Canada. In the other provinces, while legislation exists, it is necessary to continue to advocate for its effective administration and to give assistance in drafting regulations and advising municipalities.

In all this work, the town-planning adviser is acting in co-operation with the provincial governments and has avoided anything which would have the appearance of interfering or forcing their hands.

Studies and Investigations

Investigations have been begun this year by Capt. Ferguson into the industrial developments of the largest cities in the country and the tendencies towards industrial decentralization. These investigations will provide valuable information regarding the direction in which population is becoming distributed and regarding the factors which are causing industries to move from one district to another.

The town-planning branch is also taking a leading part in promoting a movement to develop regional plans for industrial areas such as the area comprised in the Niagara district, which centres round the power developments of Niagara Falls.

Other research work during the coming year will include further investigations into assessment and taxation, particularly in the western cities, where acute problems are arising in connection with these matters.

In order to obtain definite information regarding the condition of four miles of the Shoal Lake Aqueduct, the Greater Winnipeg Water Commission is sinking test holes at 100-ft. intervals.

Hon. F. C. Biggs, Minister of Public Works and Highways of Ontario, introduced a bill in the Ontario legislature last week providing $2,000,000 as a fund from which loans may be made to the townships of Ontario for road improvements. The loan will be repayable without interest within a period not exceeding five weeks. These loans are to be in addition to the regular grants. No loan is to exceed ten mills on the assessment of the township. Township debentures will be accepted as security and these will not require the approval of the electors. The bill also establishes a grant to be made in connection with suburban area roads, 30% of the cost of which is to be paid by the county, 30% by the city and 40% by the province.

George Clark, designing engineer of the Toronto Harbor Commission, addressed the Toronto Branch of the Engineering Institute of Canada March 18th, explaining the plans which are being followed by the commission and reviewing the work that has been done to date. Mr. Clark said that during the four years of war and the period of reconstruction following the war, the Toronto Harbor Commission had acquired 257 acres by patent from the federal government, 74 lineal feet of water rights by negotiation with the railway companies, and 795 acres for industrial purposes and 280 acres for recreation purposes by reclamation; and have constructed six miles of concrete wharves, retaining walls, breakwaters, etc. One hundred acres of reclaimed lands have been leased to 22 industries capitalized at $50,000,000.

*Excerpt from address at the recent annual meeting of the Commission of Conservation.

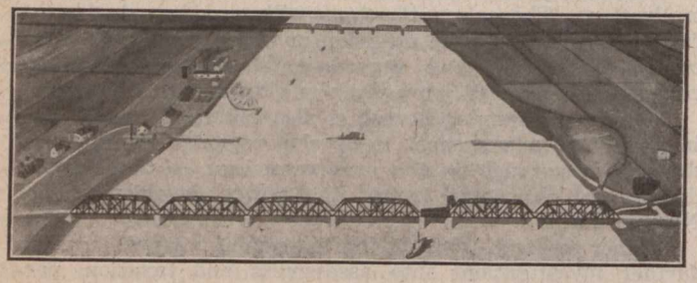
STEEL BRIDGE REPLACES BATISCAN FERRY

By F. Benoit Painchaud

Assistant Chief Engineer, Department of Public Works and Labor of Quebec Province

WHEN contracts were awarded recently to the MacKinnon Steel Co., of Sherbrooke, for the superstructure, and to Jos. Gosselin, Ltd., of Levis, for the substructure, approaches and concrete floor for a new steel bridge across the Batiscan River at St. Francois-Xavier de Batiscan, in Champlain County, Que., a definite step was taken toward closing the last gap in the Montreal-Quebec Highway. The bridge will replace the hand-operated ferry, which is now the only means of transportation across the river, excepting when the stream is ice-covered. The nearest bridge to the highway is at Ste. Genevieve, six miles away, therefore a 12-mile detour must now be made by all traffic when the wind is too strong or the water level too high for the operation of the ferry. The accompanying photograph is of a painting by which the writer has endeavored to present a bird's-eye view of the proposed bridge; while this painting is acknowledged to be far from a masterpiece of its kind, it may interest engineers throughout Canada, in that it gives a fair idea of how the structure, when built, will appear.

From face to face of abutments, the total length of the bridge will be 1,211 ft. The superstructure will consist of six through trusses, each 192 ft. long overall, and one plate-girder bascule span, of Strauss type, 65 ft. long. The leaf is necessary as the Batiscan is a navigable river. There will be six concrete piers and two concrete abutments, built on wooden piles. The upstream sides of the piers will be protected by steel plates against impact of logs or ice. The piers will be from 25 ft. to 37 ft. 4 ins. high. They will be 6 ft. wide at top, excepting the piers for the bascule span, one of which will be 7 ft. and the other 8 ft. wide.



Bird's-Eye View of the Batiscan Bridge Now Being Built by the Quebec Government

From painting by F. B. Painchaud. C.P.R. bridge in background. Present hand-operated ferry is shown between the two bridges.

The bascule span will be floored with 4-in. planks, carrying a wooden wearing surface 1½ ins. thick, but the other spans will be floored with a reinforced concrete slab 6 ins. thick at the curbs and 7½ ins. in the middle. The clear width of the roadway will be 18 ft. No sidewalks will be provided at present, as the pedestrian traffic will be practically negligable.

The bridge floor will be 34.22 ft. above mean sea level. This is rather high compared with the level of the surrounding territory (the approaches will be 6% grade), or compared with ordinary high water level, but it was desired to place the floor above the reach of even such floods as occurred in 1865, 1885 and 1896, which were caused by ice jams across the St. Lawrence River above Quebec. The Batiscan flows into the St. Lawrence a short distance downstream from the proposed bridge, which, by the way, is about a half mile downstream from the Canadian Pacific Railway bridge. The accompanying photograph shows the C.P.R. bridge in the background, and, between the two bridges, the present hand-operated ferry. It will be noted that the bridge will be built a short distance downstream from the ferry crossing.

The trusses for the fixed spans will be of the Pratt riveted type, with "curved" top chords and sub-divided panels. These trusses have been designed in accordance with the specifications of the Department of Public Works and Labor, Province of Quebec, and of the Engineering Institute. No electric power is now available at the bridge site, so the Strauss span will be hand operated, but the machinery will be so arranged as to permit of conversion to electric operation at any time.

The bridge will be built and paid for by the provincial government as a part of the Montreal-Quebec Highway. Four structural steel companies submitted bids on the superstructure and seven general contractors tendered on the substructure. In both cases the contracts were awarded to the lowest bidders. The bridge will cost approximately $250,000. It will be constructed under the direction of Ivan E. Vallee, chief engineer of the Department of Public Works and Labor, Province of Quebec.

CANADIAN GOOD ROADS CONVENTION

SPECIAL efforts are being made by the executive of the Canadian Good Roads Association to ensure the success of the Seventh Annual Good Roads Convention, which will be held June 1st to 3rd, inclusive, in the Royal Alexandra Hotel, Winnipeg, because this will be the first convention that the association has held west of Ontario. The program, which is now in course of preparation, will be arranged to appeal specially to the western municipalities. Apart from the general papers on different methods of paving, there will be addresses dealing particularly with road conditions and problems in the prairie provinces.

The lieutenant-governor of Manitoba, Sir James A. M. Aikins, has been invited to formally open the convention, and invitations are being extended to the premiers of every province and their ministers of highways.

The deputy ministers of highways from all the provinces are being specially invited, as it is intended to hold special meetings for them for the purpose of discussing road laws, traffic regulations, automobile taxation, systems of construction and maintenance of highways and similar problems, with a view to arriving, so far as possible, at a uniform system of regulations for the whole Dominion. Representatives of the federal government will also be present at this conference, which will commence on the second day of the convention and proceed concurrently with it.

Information has already been received by the association's secretary, George A. McNamee, that delegations will be sent from the Ontario Good Roads Association, Eastern Ontario Good Roads Association, Good Roads League of British Columbia, New Brunswick Automobile Association, Halifax Good Roads Association, Quebec Automobile Club, Automobile Club of Canada, Central Canada Colonization and Highways Association of Fort William, Pacific Highway Association of Maryhill, Wash., and other organizations. Special Pullman cars are being arranged at all the big centres for the conveyance of delegates to the convention. Ladies are being invited to join the party, and the railway companies are arranging several trips from Winnipeg to points of interest in the west.

The annual meeting of the Canadian Automobile Association will be held at Winnipeg during the convention, and will be attended by representatives from all the recognized automobile organizations in the Dominion.

In future the Toronto city architect's department will be known as the Department of Building, and the city architect as the Commissioner of Building.

Hamilton newspapers state that it is the intention of draughtsmen in that city to follow the lead of the Toronto draughtsmen and organize a labor union. W. H. West, organizer for the unions, states that he will call a meeting of the draughtsmen at the earliest date that the labor hall is available.

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PRINCIPAL CONTENTS

FLOOD CONTROL AT WINNIPEG

FLOOD control becomes more and more a problem of the moment as a community becomes settled and property values increase. The article in this issue by Mr. Douglas McLean on proposed flood prevention works near Winnipeg deals with a matter of great importance to that western metropolis and of real concern to the entire country on account of the vast interests dependent upon Winnipeg's welfare.

On the portion of the Red River in the United States, the occurrence of a flood on the average of every six or seven years is a very serious matter both to the large areas of valuable agricultural lands that are inundated and to the many towns and villages situated along the banks of the river. In 1916 the flood damage was estimated at approximately $20,000,000 in the states of Minnesota, North Dakota and South Dakota. As a result, North Dakota has a Flood Control Commission, a Tri-State Flood Control Association has been at work for the past four years, and the United States government made investigations during the past season and has approached the Manitoba and Dominion governments with a request for Canadian co-operation.

Next year, the year following, or any year may mark the end of the fortunate cycle of meteorological forces which have kept Winnipeg safe from great flood damage during the past 60 years. In addition to the value of the records of past floods which have been accumulated by Mr. McLean during the past 10 years, there is a possibility that his article may anticipate, by a comparatively short period of years, a very serious inundation that will be of more than local interest unless some of the proposed flood prevention works are constructed upon a large scale and in the near future.

FORMER G. T. R. CHIEF NOW A. R. E. A. PRESIDENT

WHEN Mr. H. R. Safford was selected three years ago by the nominating committee of the American Railway Engineering Association as a candidate for the office of second vice-president, that committee intended that his probable subsequent elevation to the presidency of that association would afford Canadian members their periodic representation in that office. Circumstances have prevented the presidency being held this year by a resident of Canada; nevertheless, the many friends whom Mr. Safford acquired during his long residence in Montreal, will still feel that he represents them.

It is a coincidence that Howard G. Kelley, the man who is responsible for Mr. Safford's appointment on the staff of the Grand Trunk, was also at one time the president of the American Railway Engineering Association.

Like many of his predecessors, the new president of the association has grown beyond the limitations of a chief-engineership. His ability to grasp the broader phases of railway transportation is partly natural and partly the consequence of an excellent training in the Illinois Central's engineering department. Mr. Safford has always given freely of his time to engineering associations, both in Canada and the United States, and his election as the new president of the A.R.E.A. is as deserved as it will be popular.

ADOPT THE INSTITUTE'S SCALE!

EMPLOYING engineers and other employers of engineers will be well advised to adopt the schedule of salaries advocated by the Toronto Branch of the Engineering Institute of Canada. While the suggested increases in compensation may apparently involve considerable sums in certain cases, it is believed that the extra expense would be more apparent than real, as it is safe to assume that through a restoration of morale and consequent increase in efficiency, through the weeding out of incompetents, and through the certain savings that would result from better design and construction, the total expenditure of any employer for engineering services would be no greater (and perhaps even less) than under the present conditions of generally inadequate salaries.

PUBLIC DEMANDS GOOD ROADS

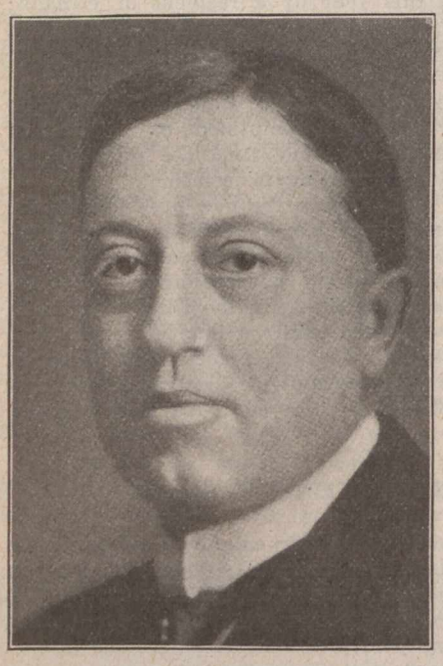
REPORTS reaching the Federal Highway Council of the United States from all sections of that country show the extent to which the people of this continent are committing themselves to a definite policy of highway development. Despite shortages of both materials and labor, there is no tendency to slow down in plans to place highways upon a higher plane in the system of transportation. Thanks to the automobile, the public has been permanently "sold" on the idea of constructing highways that will release rather than restrict traffic, and the taxpayers are dismissing labor and material problems with curt reminders to their officials that it is "up to them" to deliver the roads. The experiences of the past decade have caused the people to have unbounded faith in the desirability of good roads.

A curious fact in connection with road construction problems at present is that the building of roads is seriously hindered by the same evil which they are designed to remove, namely, lack of transportation. According to authoritative information, production is halted to a greater degree by inadequate transportation facilities than by labor shortage. At least this is true, it is claimed, in the production of materials for road building.

As a result of the divergence between the service highways are called upon to render, and their ability to render that service, the highway from an educational standpoint has become a subject of much greater importance than heretofore. Highway officials are now placing great reliance upon the educational phase of highway work in securing effective and practical co-operation from the public, particularly in rural communities.

PERSONALS

HARRY ROBINSON SAFFORD, who was recently elected president of the American Railway Engineering Association, is well known in Canada, having been chief engineer of the Grand Trunk Railway for seven years. Mr. Safford was born in Madison, Ind., and educated in civil engineering at Purdue University. He joined the engineering staff of the Illinois Central Railway in 1895 and was with that company for 15 years, being successively rodman, instrumentman, assistant engineer of construction, division roadmaster in charge of maintenance, principal assistant engineer, assistant chief engineer and chief engineer of maintenance-of-way. In 1910 he was appointed assistant to the president of the Edgar Allen American Manganese Steel Co., but returned to railway work within a year, as the chief engineer of the Grand Trunk system, which position he held until 1918, when he was appointed by the United States Railroad Administration as engineering assistant to the regional director of the central western region. When the United States government returned the railways to private ownership, Mr. Safford became assistant to the president of the Chicago, Burlington & Quincy Railroad. He is a member of the American Society of Civil Engineers, and was until recently one of the seven members of its committee on development. He is also a member of the Engineering Institute of Canada, and from 1916-8, inclusive, he was a councillor of the institute.



C. B. SMITH has been appointed roads inspector of Sherwood Municipality, Sask.

J. B. FRASER has been appointed chairman of the Ottawa improvement Commission, succeeding Sir Henry Egan.

J. B. TYRRELL, of Toronto, has been retained as consulting engineer by the National Mining Corporation, Ltd., of London, Eng.

ERNEST SMITH, of Edmonds, B.C., has been appointed municipal engineer of Burnaby, B.C. There were five applications for the position.

A. M. WEST, city engineer of North Vancouver, B.C., has resigned in order to enter business on his own account. Mr. West's resignation will take effect April 15th.

H. A. GOLDMAN, who has been acting secretary-treasurer of the Toronto Branch of the Engineering Institute of Canada since the resignation of W. S. Harvey, has been elected permanent secretary-treasurer.

M. N. MCDOWALL, street commissioner of Owen Sound, Ont., recently celebrated his thirtieth anniversary in that position. Mr. McDowall succeeded his father as street commissioner. The town council commemorated the anniversary by granting Mr. McDowall an increase in salary.

WILLIAM K. SANDERSON, chairman of the St. Thomas Hydro-Electric Utilities Commission, was elected president of the Ontario Municipal Electric Association at the recent annual meeting of that association. JAMES E. BANWELL, manager of the Winder "Hydro," was elected first vice-president.

MAJ. E. G. M. CAPE, contractor, of Montreal has been nominated by the Montreal Administrative Commission as one of its two representatives on the Montreal Charter Commission. The latter commission is being formed by the provincial government to report on the most advisable form of civic government for Montreal.

ROY M. WOLVIN, vice-president and managing director of Halifax Shipyards, Ltd., was last week elected president of the Dominion Steel Corporation and of its subsidiary companies, succeeding Mark Workman, who recently resigned. Mr. Workman becomes chairman of the board of directors of the company and a member of the London Advisory Committee.

HENRY J. CAMBIE, chief engineer of the Esquimault & Nanaimo Railway, has retired from active work at the age of 84, and after a railway engineering career of more than 60 years. Mr. Cambie was born in 1836 in Ireland. In October, 1852, he entered the engineering office of the Toronto & Guelph Railway, which was later absorbed by the G.T.R. From 1853-9 he was with Gzowski & Co., contractors on the G.T.R., and for the two following years he explored Northern Ontario and surveyed land for the provincial government. From 1863-9 he surveyed for the Intercolonial and Annapolis railways, and from 1870-3 was engaged in Intercolonial Railway construction. In 1874 and 1875 he was engaged in land surveys in British Columbia and for the following four years was in charge of surveys in that province for the C.P.R. From 1880-3 he was in charge of C.P.R. construction in the Fraser River canyons, and in the following two years he built the Savona section of the C.P.R. From 1886 to 1903 Mr. Cambie was in charge of maintenance of the main line and all branches of the C.P.R. in British Columbia. From 1905-7 he supervised the construction and maintenance of subsidiary lines, and since 1908 he has held the position from which he now retires. Mr. Cambie is a member of the Engineering Institute of Canada and of several other societies, and upon five different occasions he was elected a councillor of the institute.

OBITUARIES

ALEXANDER DAVIDSON, of Davidson Bros., contractors, Winnipeg, died last week at the age of 68. Mr. Davidson was born in Leeds, Ont.

CESAIRE LEMAY, contractor, of Montreal, died last week at the age of 74. Mr. Lemay was formerly an alderman of Montreal. He was born at St. Jean Deschaillons, Lotbiniere County, Que.

GEORGE CRAIN, of Beamsville, Ont., died last week in Brockville after a stroke of paralysis. He was born March 29th, 1841, at Maitland, Ont. For a number of years Mr. Crain was a building contractor in Ottawa until 1884, when he moved to Brockville and formed a partnership with the late John Mix. The firm of Crain & Mix built many of the most important factories, stores, etc., in Brockville. Mr. Crain took an active interest in civic affairs and at one time was a member of the Brockville council.

Hon. J. D. Reid tabled a report in the House of Commons last week, dealing with the Canadian National Railways, which showed that $5,929,790 had been expended during 1919 in construction work on 16 different sections.

W. G. Chace, chief engineer of the Greater Winnipeg Water Board, presided last week at a meeting held in the Olympia Hotel, Winnipeg, for the purpose of discussing the desirability of the establishment of a provincial research bureau. Speeches were made by Mayor Gray; Prof. Dorsey, of the University of Manitoba; L. H. Carter, president of the Board of Trade, and others. All speakers agreed that a research bureau should be established without delay and preferably in connection with the university. A committee, with Mr. Chace as chairman, was appointed to discuss the suggestion with the board of the university and, if necessary, to interview the provincial government.