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Smooth Rock Falls Power Development

Preliminary Survey Work—Plant Completed and in Operation One Year After the First Concrete Was Poured—Paper Read Before the Association of Ontario Land Surveyors

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THE site of this plant is at Smooth Rock Falls on Mattagami River, thirty miles west of Cochrane on the Transcontinental Railway and three miles north of the track. (Fig. 1.)

Five years ago Duncan Chisholm, of Toronto, secured from the Ontario government the lease for a pulp wood limit of 25 townships on the Mattagami River, between Porcupine and the Transcontinental Railway. It covers an area of 684 square miles and is considered one of the best limits in Ontario.

Preliminary surveys of three falls (one below and two above) were made by our firm during the summer of 1914, and about 18 miles of river traversed by the micrometer and stadia method and rough contours taken. With the data secured, Smooth Rock Falls was chosen as the site of this plant. A direct line was run between Yellow and Smooth Rock Falls to be used in locating a railway spur, the line crossing the Transcontinental Railway about a mile east of the river. On running section lines on that portion between the railway and Smooth Rock Falls, it was found that the line could not be improved on, and this is now the location of the company's spur line.

Fig. 1.—Site of Plant

The general character of the river and banks having been ascertained, some time was spent in taking cross-section and soundings at the various falls, a camp being built for better accommodation (Fig. 2). It was found that lines running parallel to, and at right angles to the river, worked out to the best advantage. These lines were carefully lettered and numbered and permanently established for future reference. Each 100-foot square was then sectioned as the character of the ground and the importance of the location demanded. It was in this manner that the sections were taken at Smooth Rock Falls and the data thus acquired was constantly referred to during the entire design and laying out of the plant.

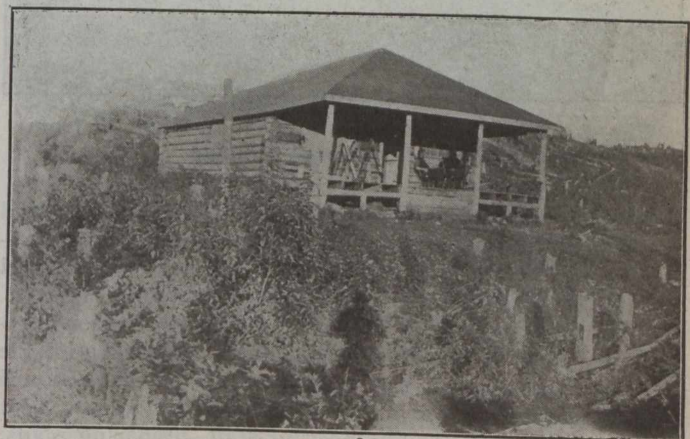

Fig. 2.—First Camp Built Near Site

A slightly different procedure was found necessary in taking soundings but they were done along the parallel lines referred to. A 1½-inch manilla rope was swung across the river above the falls and supported at 100-foot intervals by rafts designed to keep the rope clear of the water, and to let any driftwood pass through. The banks were cleared back for about 50 feet on either side and pickets carefully set and plumbed at 10-foot intervals. A similar line was set half-way down the falls and points set by means of improvised bridges over the east and west channels. Cards were tied to the ropes at 10-foot spaces, thus marking the place to set the lead line when soundings were being taken. A 20-ft. canoe was used with three men, two to handle the lead rope and one to use the sounding rod. The sounding rod, which was a length of drill steel, marked in feet and half feet, was dropped at 10-foot intervals as the canoe came in the range of the pickets placed on the shore. The depth was called by the rear canoeman to the observer on the shore and in this manner over 300 soundings were taken in 2½ hours, the maximum depth of water being 9 feet. Elevations of the water were taken in several places and bottom elevations computed for the soundings. In fairly smooth swift water this method worked successfully, but in surging water, such as was encountered below the falls, it was found necessary to use a large, strongly built raft held in place by three or four lead lines. As few plank as possible were used in making the raft, as it was found that the swells caught them too easily, thus making the raft very unstable and rendering accurate work very difficult and dangerous. A narrow steel tape wound on an improvised windlass and weighted by a lead ball, was used, and worked very satisfactorily.

Some time was spent in looking for gravel deposits and many test pits dug. We were unable to locate sufficient

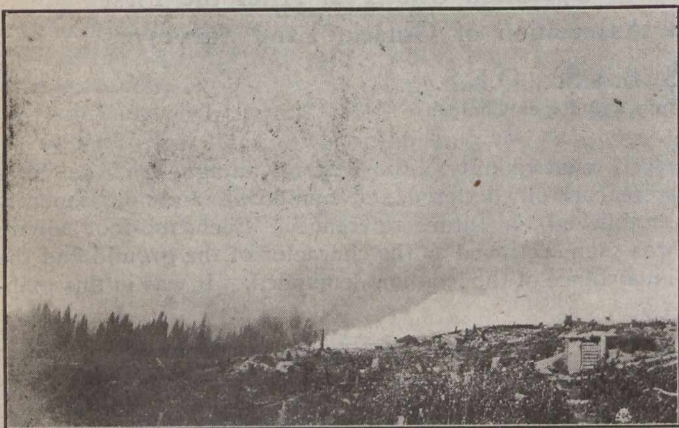

Fig. 3.—Showing Clearing by Which Damage from Forest Fires was Avoided

quantities, so arrangements were made to get sand and gravel from the Buskego pit on the Transcontinental Railway, and it was from this pit that all material required for the job was taken.

The breaking out of the war a few days after our preliminary plans had been delivered, delayed work until the autumn of 1915, when the spur line was cleared, sectioned and staked out. The following winter the writer spent three months with the engineering staff, preparing plans, and the following spring went north in charge of the work.

Morrow & Beatty, Ltd., Peterborough, Ont., secured the contract for mill, dam and power house, and the grading of 3½ miles of spur line, 30,000 cubic yards of earth being removed. The company laid the ties and steel, standard materials being used, while the Canadian Government Railways placed the ballast for our track-lifting gang. One small sink hole developed, requiring 40 cars of ballast, but the line is straight to the townsite and the grades easy. Notwithstanding scarcity of men and material, work was completed in October, and concreting started, sand being hauled from Boskego pit and rock from the power house and tail race excavations crushed at the works.

While the spur line was under construction, 500 acres of land around the mill and townsite was cleared in such a manner as to offer the best fire protection, all merchantable timber being sold to the contractor who installed and operated the company's mill, thus saving the importation of any form lumber.

The contractors erected a splendid set of camps to house 400 men, while the company erected about twenty 8-room houses and larger camps.

Fortunately the great conflagration which swept the north country during that summer had little left on the cleared area upon which to feed, and this condition, together with organized effort and the contractor's temporary water system prevented the loss of any buildings, plant or material. (Fig. 3.) With the completion of the railway, additional men were employed and construction rushed during the severe winter and wet summer following, but notwithstanding all the adverse conditions, in-

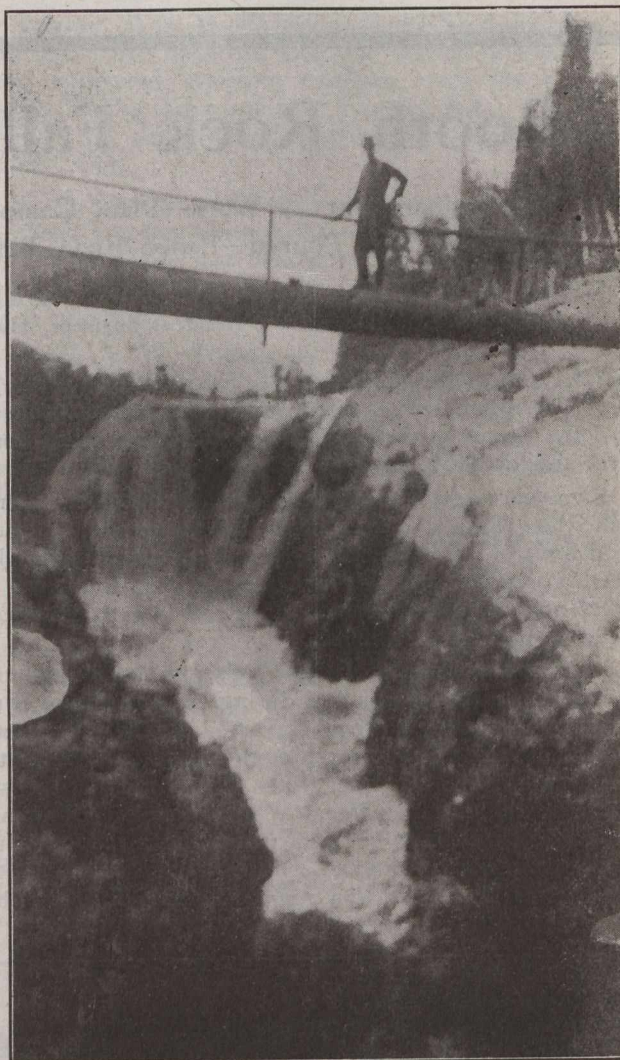

Fig. 4.—Jumping Place Channel on Mattagami River

cluding labor troubles, the plant was completed and in operation one year from the day the first concrete was poured, involving the excavation of 21,000 cubic yards of rock, 57,000 cubic yards of earth, placing 34,000 cubic yards of concrete and 1,000 tons of reinforcing and struc-

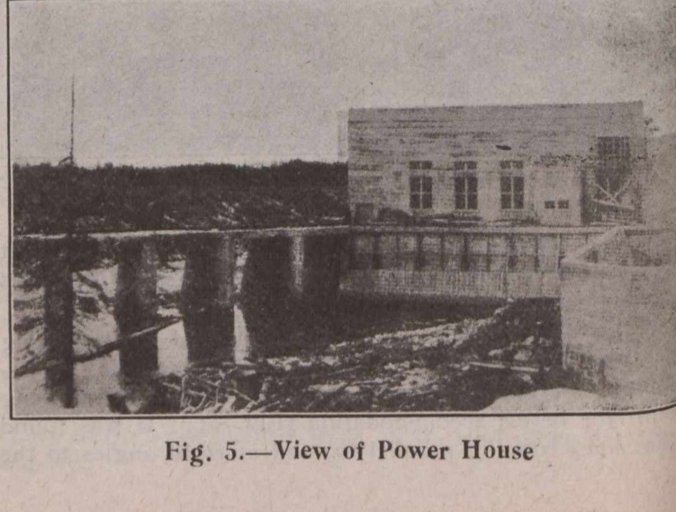

Fig. 5.—View of Power House

tural steel, as well as the sawing, moving and placing of 1½ to 2 million feet of lumber, besides other material incidental to building construction.

The rock formation at the dam is grey laurentian granite with intrusions of black basalt, two of which have been decomposed by the action of frost and water resulting in an east and west channel with a smooth island of granite in the centre, which gave the place its name. The west channel for a distance of 50 feet or more is only about 5 feet wide and possibly 40 feet in depth, and as the east channel goes dry in low-water this place has the distinction of being the only point on the Mattagami River where a man can jump over, and accordingly has been called the "Jumping Place" by the Indians. Fig. 4 shows this channel in August, 1914, when the discharge was only 750 c.f.s., although it will take care of 1,300 c.f.s. without overflowing. The lower portion of the east channel also is 30 feet in depth but much wider, while the upper portion at the break is shallow and narrow.

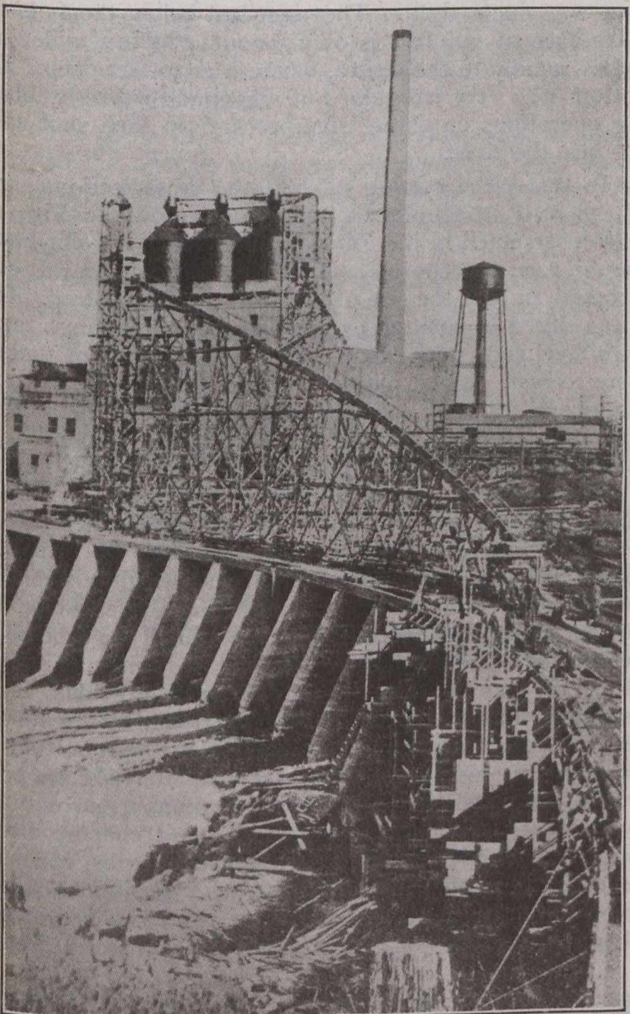

Fig. 6.—View of Dam Which Had a Radius of 333 Feet on the Upstream Surface

Fig. 7.—The First Coffer-dam Being Removed

It was therefore decided for the following reasons to build a circular dam, starting from the west side above the break in the west channel, curving over the extreme top of the island with the toe of the dam slightly above the break in the east channel, the apron being carried over the gorge on a reinforced concrete arch, while the dam terminated in the power house situated on the east side and below the falls.

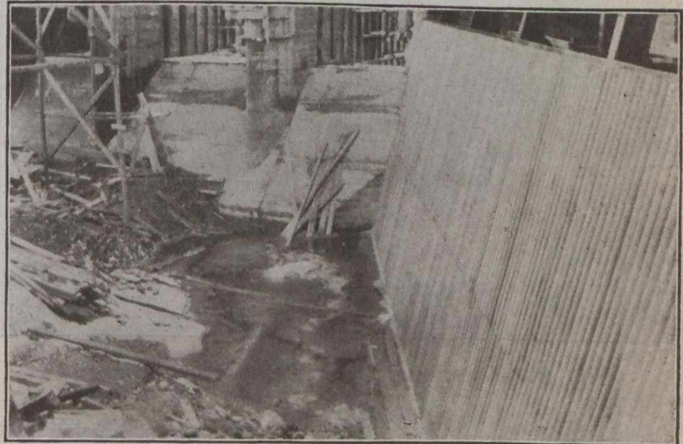

Fig. 8.—Completed Sluiceways

In the first place, without dewatering it was impossible to ascertain the depth of the west fissure, which might prove exceedingly difficult to seal, hence our decision to keep above the falls. Furthermore, high rock on the west side above the falls made an excellent place to terminate the end abutment. By following the crest of the island, excellent facilities for construction were provided, mass concrete in the base being reduced to a minimum of 4 feet in thickness under sills, and sloping both upstream and down made a natural and ideal approach and discharge, in design, character and efficiency.

It was desirable on the east side to leave sufficient cross-sectional area between the dam and shore to insure a low velocity of approach to headworks of power house. (Fig. 5.) By placing the power house at the bottom of the falls, less rock excavation was required, and a deeper section provided in front of the racks, permitting the dam at the same time to approach more closely to the shore without reducing the section. For the above reasons, and on account of tremendous spring freshets, of which there had been no accurate measurements taken, it was considered advisable to obstruct the river as little as possible and provide as many and large sluiceways as the location would permit of. It was found that a circular dam 448 feet in length, consisting of 18 piers, 19 sluiceways and the two abutments, as shown in Fig. 6, with a radius of 333 feet to the upstream surface, met all conditions. The base of the dam is of mass concrete in the proportion of 1:3:6, while in the upper part in which the stop-log sills are embedded and anchored together with the piers, a 1:2:4 mixture was used.

The piers are spaced 21 feet centre to centre at the stop-log guides and are on radial lines. From nicely rounded noses they increase to a maximum of 5 feet in thickness at the stop-log guides and taper to 38¼ inches at the downstream end, leaving a minimum sluiceway of 16 feet in width.

The piers are covered with a reinforced concrete deck 25 feet in width, the upper surface of which is 25 feet

Fig. 9.—After the Forms Had Been Removed

above the sill. This large surface is necessary to take care of 20 British Columbia fir stop-logs 12-in. x 12-in. for each sluiceway. They are bolted together in pairs and raised and lowered by means of an electrically driven travelling stop-log hoist. Two sets of stop-log guides set 2 feet 6 inches apart, were provided to meet the requirements of the Hydro-Electric Commission.

The method of constructing the dam followed closely the facilities offered by natural conditions. The east channel, which discharged a less amount of water than the west, was first cut off by means of an L-shaped cofferdam, terminating on the east edge of the west gorge, thereby throwing all water clear of the island and permitting not only the construction of seven piers on the island, but rock work on the power house, which had to be completed before the headworks and first piers of the dam were built. No difficulty was experienced with the upper cofferdam, as the bottom was smooth and hard and the water shallow, the result being that the cribs were well lined up and the sheeting well fitted to the bottom. The crib at the corner of the L was sheeted on three sides so that when the west channel was to be cofferdammed it would act for it also. Timbers in the corner were left projecting a short distance so that in placing they lapped over the adjoining crib, thus being held solidly in position.

Before the spring freshet of 1917 the eastern gap was entirely closed, the headworks of power house and dam being well above high-water. The first cofferdam was removed (Fig. 7), the filling being used by the company to load their retaining piers for the spring drive.

After the spring freshet the west channel was closed, the water turned through the completed sluiceways (Fig. 8) and the balance of dam completed.

Waterproof expansion joints of the lead and asphalt type were placed every third pier. The greatest portion of the concrete was poured hot in a temperature many degrees below zero, with little protection save for forms. Before pouring started on the previous day's work, the frozen surface and laitance was thawed out with steam and removed. The removal of forms during the summer months revealed most excellent results, as will be seen by Fig. 9, the concrete being extremely hard, free of blisters or bad joints.

During the time the dam was under construction, work was being rushed on the power house and tail race, the latter being held up to some extent until the lower coffer-dam was made tight. The river-bed below the falls for a distance of 300 feet is only about 180 feet wide, but slopes rapidly to the centre, where it is 50 feet deep. The bottom was very irregular but was made worse by blasting operations on shore, some rock from each shot spilling into the river.

In this place cutting off half the cross-sectional area of the river, the tail race coffer-dam (shown in Fig. 10) was constructed in the following manner: A point below the tail race was chosen as a starting place and a raft constructed, in plan the size of the largest crib required. This was secured in position by guy lines and soundings taken with steel rods over every foot where the bottom timbers were to rest. Short pieces of round timber were then cut and placed together on shore, conforming with the bottom. This was then slid into the water and other timbers drift-bolted on them in the regular manner, until such time as it was considered advisable to place ballast floor. This is one of the fine points in coffer-dam work and depends on depth of water, strength of current, size of crib and material used. One-man stone was then wheeled in barrows and dumped into the crib until it rested on the bottom or required more timber, the crib all the time being held in the same position as the raft. In this manner crib after crib was built, sunk and permanently loaded, being so placed that it rapidly curved upstream into water 46 feet in depth and resting in places on a rough bottom inclined at an angle of 30 degs. Unfortunately, at the point where the water was deepest the maximum current was encountered, the deep fissure in the west channel directing a heavy under-tow directly against the cribs, requiring several large cables to retain them in position. These cribs were 50 feet x 20 feet with three ballast floors. Double sheeting made from 2-inch seasoned and dressed

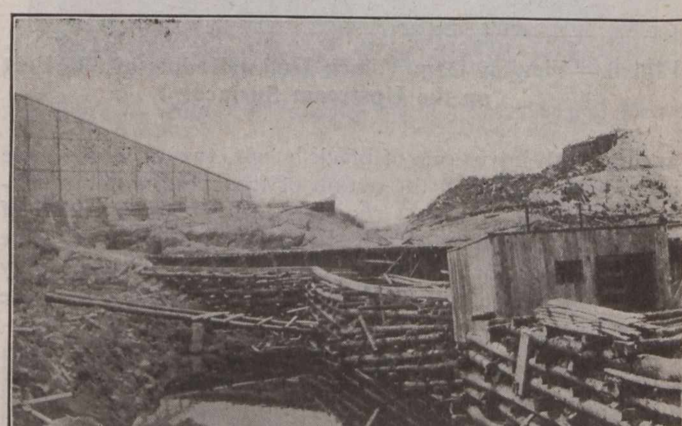

Fig. 10.—Tailrace Coffer-dam

spruce plank was then placed by the divers in the order in which the cribs were sunk, the force and direction of flow helping to hold the sheeting in position in the same manner as it kept the cribs tight against each other. Water-soaked logs were continually being driven in between the timbers of the crib, requiring much time and effort to keep the face clear for sheeting. Electric lights and telephones were, however, used in the deepest place, greatly expediting the work. While this work was under way is was observed that logs driven by the force of the current were smashing the sheeting, so a break-water was constructed in a similar manner to that of the cribs, except that it was built in two pieces only, cross-timbers being left projecting 6 to 7 feet on the side next the coffer-dam to support break-water and leave a place for clay toe, of which several thousand yards were used. Heavy canvas had previously been placed on the outside of the sheeting, particularly where the sheeting was difficult to fit properly. Two small centrifugal pumps housed in on top of the coffer-dam were sufficient to lower the water back of the coffer-dam to the required level.

As the depth of the tail race was decreased as it approached the river its width was increased, thereby maintaining the same, if not a larger, cross-sectional area, the maximum tail race velocity being not more than 3 feet per second with full gate openings.

The lower section only of the coffer-dam was removed, the balance being increased in height and strengthened, forming a breakwater during the spring freshet and thereby lowering the elevation of the tail water about 2 feet.

The power house is 98 feet in width by 74 feet in depth, constructed entirely of heavily reinforced concrete and is considered the most modern and efficient hydro-electric development in New Ontario.

The installation consists of two wheels of the vertical type rated at 4,500 h.p. each under 45 feet of head, each unit being direct connected to a 3,125 k.v.a. 3-phase, 60-cycle, 575-volt generator. A 60-kw. motor generator exciter is again direct connected to each of the large units, but the Lombard governors are belt-connected to the turbine shafts. (Fig. 11.)

The lubricating system for these units consists of three direct connected motor-driven pumps, compressor, drain, and filter tanks. The compressor supplies air for oil pressure and power for operating brakes.

The draft tubes and scroll casings are constructed entirely of concrete, the latter being exceptionally heavily reinforced, and are so designed as to offer the least amount of resistance. At the outlet the tubes are oval in shape, 22 feet wide by 15 feet in height, and gradually change to

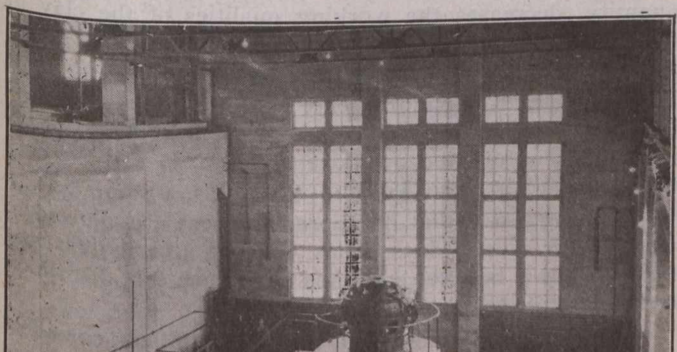

Fig. 11.—Interior View of Power House

a true circle, being 9 feet in diameter under the wheels, no two sections having the same radius of curvature or diameter of section.

Immediately back of the large units a hollow breast wall is so constructed that any possible seepage is readily drained, while back of this again, in order, are placed steel gates, each 24 feet in width, covering openings to wheels, each gate being connected to a worm-gear lifting apparatus, operated by motor or hand, singly or together, ice racks and emergency stop-log guides, and in front of the power house, supported on a structural steel framework, inclined at an angle to the normal direction of inflow, are placed the coarse wooden ice-racks calculated to stop all submerged logs, driftwood, ice, etc., which can readily be sluiced through the first and adjacent opening in the dam. A reinforced concrete deck covers this ice-rack structure and is at the same elevation as the deck of

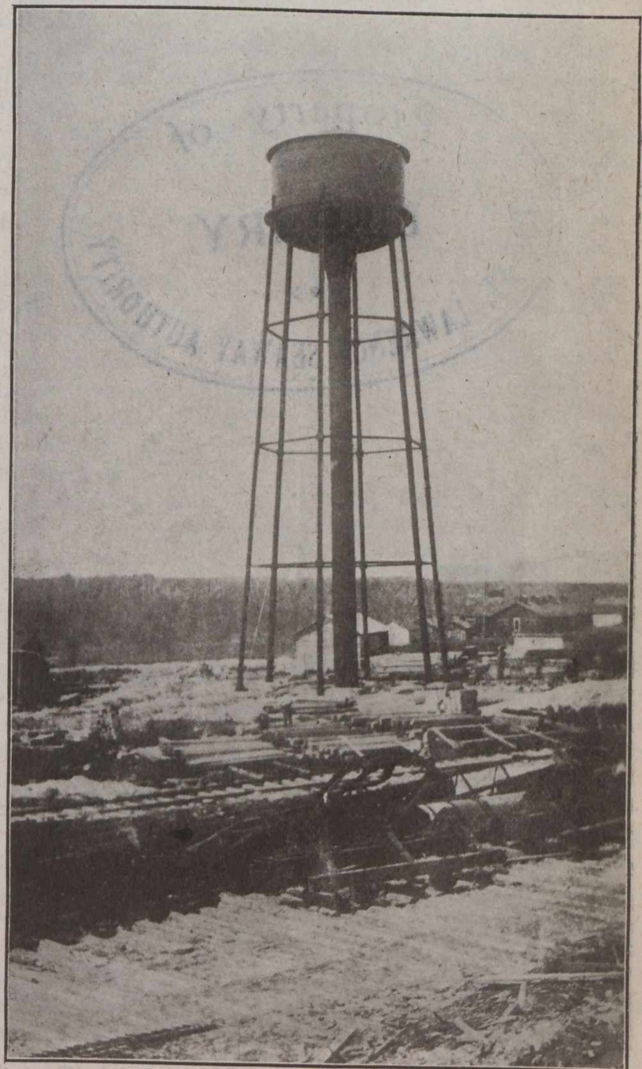

Fig. 12.—150,000-gallon Water Tank

dam and floor of gate house. A 10-ton crane is installed in gate house and a 25-ton crane in power house proper.

The large units occupy 66 feet on the river side of the power house, the remaining 32 feet containing below the level of the main generating room, a 200-kw. alternating generator belt-connected to a 250-h.p. horizontal double-runner wheel, connected to the head works by a steel flume 54 inches in diameter and 40 feet in length.

This unit was installed early last summer and supplied power for slashing and storing the winter supply of pulp wood and also furnishing light for the entire works, including the townsite. It is still used for lighting purposes and for small machines on Sundays, when the large units are shut down. The balance of the floor space beside the flume contains two 2,500-gallon-per-minute motor-driven pumps, supplied by a 20-inch suction pipe under a head of 18 feet with pond level at 740. These pumps discharge through eight pressure filters and provide an ample supply of good water for manufacturing purposes, each ton of pulp requiring 500 tons of water.

The first floor above contains the switch-board apparatus, while the second, overlooking the generating room, contains the switch-board panels, from which place the whole plant is electrically controlled.

The contract, beside the dam and power house, included building the 150-ton sulphite mill and the wood-

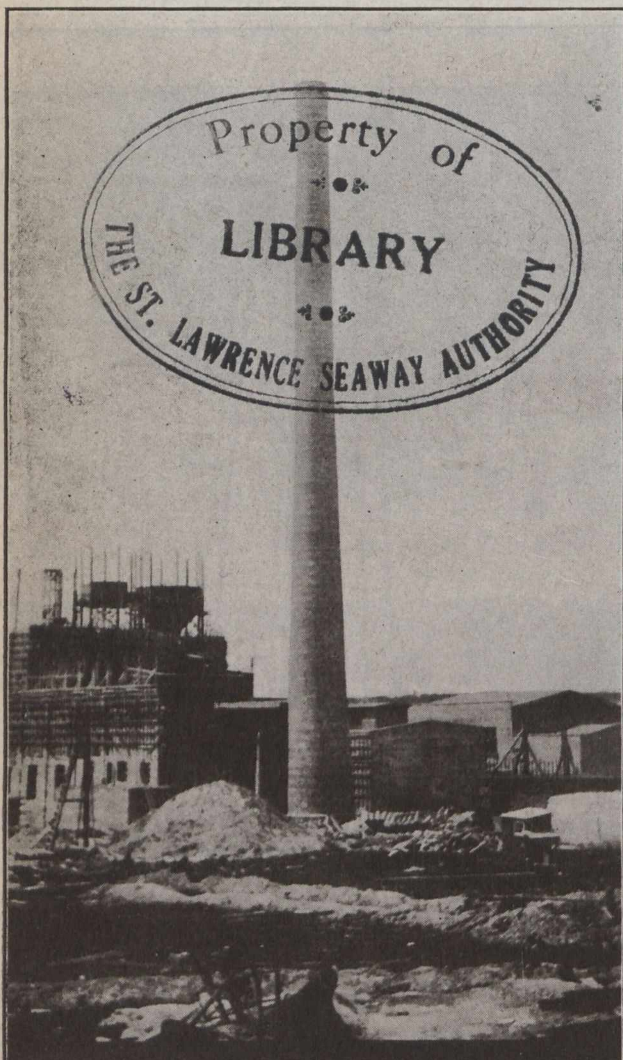

Fig. 13.—250-foot Brick Chimney Completed in Twenty-five Working Days

preparing room, the company erecting all buildings, conveyers, etc., in connection with wood storage. All townsite construction, office buildings, sewers and waterworks were also constructed by the company, while the Chicago Bridge and Iron Works erected the 150,000-gallon water-tower (Fig. 12), and the M. W. Kellog Co., of New York, the 250-foot brick smoke stack, completing same in 25 working days (Fig. 13).

All the electrical equipment was supplied and installed by the Canadian General Electric Co., of Toronto.

Wm. Kennedy, Jr., of Montreal, was consulting engineer and was represented at Smooth Rock Falls by A. E. Loignon.

The contractors, Messrs. Morrow and Beatty, of Peterborough, and their engineer, James Dick, were on the ground during the entire construction.

The present town of Smooth Rock Falls is a great credit to the Mattagami Pulp and Paper Co. With its fine residences, well-graded streets, sewers and waterworks, it is an up-to-date example of what a large corporation can do along this line. The company have also erected a fine hotel and school and are supplying all their employees with free electric light and water. Taxes are a minimum and every effort is being made to attract the best class of labor to the new industry. Duncan Chisholm, of Toronto, is president of the company; S. R. Armstrong, general manager, and J. G. Mayo, local manager at Smooth Rock Falls.

VITRIFIED CLAY SEWER PIPE*

By A. R. Duff

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THE clays used in the manufacture of sewer pipe in Ontario are confined chiefly to the district east of Hamilton, principally in the vicinity of Waterdown station on the Grand Trunk Railway. The clay is obtained from two sources in this locality, either the weathered and softened top of the Queenston (formerly known as Medina) shale, or from a transported clay, consisting chiefly of this material.

The weathering action of the shale is twofold; softening and leaching. The softening increases the plasticity of the shale very considerably, the leaching decreases the lime content.

Both processes are essential in producing a clay for sewer pipe, as smoothness of surface and the ability to take a salt glaze are obtained by using the weathered clay. These qualities could not be obtained in the finished product by using the hard unweathered shale.

The sewer pipe clay is a mixture of the weathered blue and red shale and sand, and is liable to contain certain impurities, such as small pebbles of limestone, or streaks and lenses of sand and silty clay having a high lime content. These impurities are harmful, as the limestone pebbles burning to quick-lime cause soft white spots on the pipe, and the sand or silt, if present in any appreciable quantity, decreases the working qualities of the clay in the raw state and prevents the formation of a salt glaze, at the final stage of manufacture.

The method of winning clay is as follows: The surface sod is removed by scrapers after a shallow plowing. This is followed by a deeper plowing, and the clay thus loosened is shovelled into carts.

It is suggested that if exposed surfaces are allowed to weather for several days before winning a clear demarcation is shown between clay and high lime streaks which can readily be taken advantage of.

The clay as it comes from the fields contains considerable moisture, depending on weather conditions. To pass the clay through the screens it is necessary to have it quite dry (not more than 10 per cent. moisture) and for this purpose a large drying floor built of concrete and heated by steam pipes is provided.

All operations from the field to the pipe presses help to insure a thorough mixing of the clay and a more uniform quality of product from the factory.

Belt conveyers take the clay from the drying floor to the dry pans where the clay is ground very fine. It then falls through the perforations of the pans after which it is elevated and made to fall over piano wire screens set about ten to the inch. That which goes through the

*Abstracted from 1916 Report of the Provincial Board of Health, Ontario.

screen is elevated to a storage hopper and the coarser material chutes back to the dry pan to be re-ground.

The wetting or tempering of the clay is the next step in the process. The tempering pan is fed from the storage hopper with dry-ground clay. Water is added to each charge and the mixing continues until the clay has the correct plasticity. It is then spaded from the constantly revolving pan to a belt which conveys the carefully prepared material to a hopper situated over or near the pipe press. This prepared clay cannot be stored in large quantities because its water content is liable to change due to evaporation. The behavior of the clay in the pipe press is largely dependent upon a variation not greater than 1½ per cent. in its water content. If too much water is added the clay will leave the press in a very smooth condition, but will not have sufficient strength to permit of handling on the drying floor. On the other hand, if insufficient water is added the clay is not sufficiently plastic and does not go through the die readily and is apt to cause laminations in the pipe.

The safest method of controlling the proportion of water in the tempered clay would be to use some instrument or machine that would give an accurate measure of the behavior of the water content. Laboratory tests made with the Olsen needle penetration machine showed that a difference of one-quarter per. cent. of water in the mix could quite easily be detected.

For very large pipe the clay is required not so stiff as for smaller sizes.

The greatest possible percentage of water without weakening the pipe would be the ideal condition for compact homogeneous wares.

To obtain pipes that are compact, dense and capable of being handled before firing without deformation it is necessary to apply pressures ranging from 250 to 600 pounds per square inch as it leaves the press.

In adjusting the cutter and the dies, allowance is made for the 10 or 12 per cent. shrinkage the green clay undergoes on drying and burning, so that the final product shall be of given size.

The bell, if thinner than the body of the pipe, dries more rapidly. The shrinkage from loss of water causes the outer rim to contract faster than the more moist body and when the clay lacks the necessary cohesion and strength the bell cracks. This might be overcome in the larger pipe by enriching the more doubtful sandy clays by adding some very plastic tough clay. Any pipe in which flaws develop are scrapped and returned to the raw clay drying floor.

Each pipe from the cutting platform is placed on a wooden pallet and carried on trucks to the drying floors, where it is placed bell end up.

Immediately after placing the pipe on the floor, workmen supplied with damp pads or pieces of canvas slick up any rough spots. A little more care in this operation would go a long way towards producing a better looking pipe.

In drying, care must be taken to dry all sides of the pipe evenly to avoid warping and cracking. For this, the advantage of a careful control of drying floor temperature and air humidity and the value of the hygrometer and hygrometric charts should be appreciated.

After the very careful selection of clay in the field, the most important step in pipe manufacture is the thorough and correct vitrification of the wares.

The expert burners use three methods for following the course of the burning: (1) An electric thermo-couple placed in the kiln, is attached to a recording pyrometer which draws a chart of the temperatures in the kiln. (2) Seger cones placed at strategic points in the kiln and extracted at regular intervals also give a record of the temperatures and show the point at which vitrification is complete and the pipes ready for salt glazing. (3) Small samples of the same clay as the pipes are put in similar positions to the Seger cones and by extracting these samples at correct intervals the course of the burning is followed.

There are four distinct steps in the burning of the clay products, the water smoking, burning, salt glazing and cooling.

In burning sewer pipe the term "water smoking" usually refers to that period during which any residual moisture from the drying floor process and water of crystallization is driven off.

The water present as moisture could be driven off at about 220 degrees F. or a little over boiling point, but the water of crystallization or combined water in the clay would not be completely removed till a temperature of 1,200 or 1,300 degrees F. had been reached. Speeding the process usually results in poor colored, scummed and blistered pipes. The forced drying seems to leach out to the surface soluble salts that otherwise would remain in the body of the pipe.

Depending upon the size and thickness of the wares, water-smoking takes from one to two days.

The temperature is gradually rising during the process and when water-smoking is complete the operator can see the floor from the peep-hole in the dome of the kiln and the fires have been built well upon the grates. Just so soon as the contents are red-hot from top to bottom there is little danger in raising the temperature. At a higher temperature the carbonates present in clay decompose and give off carbon dioxide. At this stage there has been very little knitting between the grains of clay and the clay is quite porous.

As the temperature rises, a point is finally reached when the edges of the clay grains start to soften. This is called incipient vitrification. At a still higher temperature the clay fuses and becomes liquid. This would be the point of fusion. Now, somewhere between the points of incipient vitrification and fusion is the correct place to stop the burning. The temperature range between these points is called the range of vitrification of the clay.

With some clays this "range" or interval between the temperatures of incipient vitrification and fusion is quite wide, say, 200 or 300 degrees F., while with other clays the range is so narrow that a burner could not possibly control his fires sufficiently to thoroughly vitrify his wares.

To determine the suitability of a clay it is important that its behavior for each step in the process of manufacture be closely studied in the factory.

Complex silicates are formed in well-vitrified clay pipe which are quite chemically inert and are not affected by the action of acids or alkalis even at boiling temperature.

Soft burned pipe will absorb as much as 14 per cent. of water, while a pipe burned to the point of fusion would have no absorption. It would be as dense as glass. The absorption then is taken as a measure of the vitrification, and a pipe is said to be vitrified when the absorption does not exceed 5 per cent. The burner of Ontario clays, to get very hard, non-porous, well-vitrified wares, must burn them as close to the point of fusion as he dares. As a general statement, it can be said that the Ontario pipes are not burned quite as hard as they might be. Some excuse for this lies in the fact that Ontario clays have a narrow range of vitrification and require very careful burning. It is not to be assumed from this, however, that Ontario pipe is either porous or has considerable absorption; as a matter of fact it is one of the best vitrified pipes on the continent.

Care in burning but one size or thickness at a time and in keeping the floors or flues in good repair are points to be watched in sewer pipe manufacture.

Vitrification requires about sixteen hours and is followed by the salt glaze process. The salt glaze that is formed on the surface of sewer pipe is a complete sodium iron aluminum silicate that forms at a temperature of 1,800 degrees F. or over. The salt is thrown onto the fire boxes of the kiln and dissociates into sodium and chlorine. The chlorine goes up the flue and the sodium combines with the red-hot (almost liquid) clay surface to form a glass-like silicate. The higher the percentage of sand in the clay, the more readily and better does this glaze form.

When three hours have elapsed, the damper is closed and the kiln left for about twelve hours. During this time the fire doors may be opened to partially cool the kiln, then the fire boxes are completely blocked up and the kiln is left to cool slowly. This cooling and annealing takes about three days.

Annealing is a very important step in the process, as on it depends the cohesion of the pipes.

If the Ontario manufacturers are careful to produce clean glazed, good colored, well-formed pipe, we should have here pipe absolutely second to none.

ANNUAL MEETING OF ASSOCIATION OF ONTARIO LAND SURVEYORS

The 26th annual meeting of the Association of Ontario Land Surveyors was held at the Engineers' Club of Toronto, February 19th, 20th and 21st.

The morning session of the first day was devoted principally to business matters. At the afternoon session, the chair was occupied by the president, James J. MacKay, O.L.S., who in opening his address referred with pride to the fact that out of a membership of 245, the society has a representation of 39 overseas, two of whom have made the supreme sacrifice. Mention was also made of the fact that the society has already passed its silver jubilee. The president also touched on the immense work which awaits the surveyor in the coming reconstruction period. The land surveyor, he said, should be a leader in the various fields of activity; in the era of road-building which is just commencing a great opportunity is presented, and in the town-planning and developing act are opened new fields of endeavor. The opportunity for men of the surveying profession in the development of our natural resources and water powers made necessary by the lack of coal, wood and power, so forcibly shown this winter, was also pointed out.

The alleged prejudice against land surveyors which exists among engineers, was alluded to by F. N. Rutherford, chairman of the committee on engineering, who suggested that this might be overcome if a higher degree of qualification such as graduation from the faculty of applied science at any recognized university, were enforced.

J. W. Pierce, O.L.S., read an instructive paper on "Survey Monuments," which showed the shortcomings of the present system. A committee of eleven was named to wait on the provincial authorities to point out the value of permanent markings for all survey work.

In the evening, H. S. van Scoyoc, chief engineer of the Toronto and Hamilton Highway Commission, gave an interesting account of the work on the recently completed highway. An amount of local improvements and the large county and town bridges still remain to be built, he said. "The Road Development of Ontario" was dealt with by C. R. Wheelock, O.L.S., who traced the roads from the time they were mere trails until they developed into the present provincial highways. George Hogarth, O.L.S., chief engineer of the Ontario Highways Department, delivered a report on "Roads and Pavements."

On Thursday morning, the detailed business of the Council of Management was chronicled in a report by the chairman, T. B. Speight. E. T. Wilkie's report of the Committee on Land Surveying discussed some of the problems met in surveying, and Wm. W. Perrie, O.L.S., gave an instructive paper on "Problems Met With in Practical Surveying." R. R. Grant, O.L.S., gave a talk on "Descriptions," and E. W. Neelands, O.L.S., discussed the Smooth Rock Falls power development which was constructed by the Mattagami Pulp and Paper Company, of which he is resident engineer, to supply power for the 150-h.p. sulphite mill.

A very interesting paper was read by J. F. Whitson, O.L.S., commissioner of the Northern Development Branch, on "Development in Northern Ontario," dealing principally with the work of the past six years.

In the afternoon, a report of the committee on drainage was given by W. G. McGeorge, the chairman. George F. Henderson, K.C., of Ottawa, the drainage referee, was present, and threw light on a number of legal matters dealt with in the report.

Seven were given credentials during the year as Ontario land surveyors, according to the report of the Board of Examiners. The board recommended the reappointment of Thos. Fawcett and T. B. Speight to the Board of Examiners for a term of three years.

The evening session took the form of an informal dinner at the Engineers' Club.

The election of officers and the nominations for councillors took place at the last final session on Friday morning. For 1918, the officers are: President, Herbert J. Beatty, of Pembroke; vice-president, C. Fraser Aylesworth, of Madoc; and secretary-treasurer, L. V. Rorke, of Toronto. Two councillors will be elected by letter ballot next month. Those nominated are: T. B. Speight, Toronto; James S. Dobie, Thessalon; C. J. Murphy, Toronto; F. N. Rutherford, St. Catharines; Charles R. Wheelock, Orangeville, and E. W. Neelands, New Liskeard. D. D. James and John Van Nostrand, both of Toronto, were named as auditors, and R. R. Grant, of Toronto, was appointed as representative on the Joint Committee of Technical Organizations.

Among those who attended the convention were E. T. Wilkie, F. B. Speight, L. V. Rorke, Geo. Hogarth, R. B. Laurel, J. G. Ransom, T. D. LeMay, R. S. Code, E. Fitzgerald, K. Huffman, A. P. Walker, N. A. Burwash, M. M. Gibson, H. T. Routley, John Van Nostrand, A. F. Ward, W. S. Gibson, P. A. Jackson, of Toronto; J. J. MacKay, W. W. Perrie, J. E. Jackson, of Hamilton; G. A. McCubbin, W. G. McGeorge, of Chatham; C. R. Wheelock, W. W. Christie, of Orangeville; E. W. Neelands, H. W. Sutcliffe, of New Liskeard; A. C. Young, Haileybury; E. D. Bolton, Listowel; J. W. Pierce, Pembroke; L. A. Kinnear, Port Colborne; F. N. Rutherford, St. Catharines; Jas. Dobie, Thessalon; C. R. McColl, Windsor.

CANADA'S FUEL PROBLEM*

By Joseph E. Armstrong, M.P.
Petrolea, Ontario.

LAST winter every great city in Canada was within 48 hours of starvation owing to lack of fuel. In recent years we have had two coal famines, first in 1901-2, the year of the coal miners' strike, and secondly, this year, when the severity of the weather and the extraordinary prosperity in the United States caused an unprecedented congestion of freight. A survey of conditions in the United States demonstrates that in the future there will be more coal famines than in the past, and that they will occur at shorter intervals. A recent issue of "Coal Age," of New York, says that the reserves of coal usually held over by the big companies are completely exhausted.

The people of Canada just now are gaining an impression, at considerable inconvenience, of what it would mean were the United States for any reason to cut off Canada's coal supply. Presumably there are insufficient facilities and motive power for coal transportation. Cities and towns in Canada are keeping fires alight with practically a day-to-day supply of coal, and the time may come when the United States may deem it expedient to reserve her supply of coal for her own use.

About three years ago the head of the Geological Survey Department of the United States sent a strong recommendation to Congress urging that the export of anthracite coal out of the United States should be stopped, giving as a reason that about two-thirds of the deposits of anthracite coal in the United States had already been exhausted, and that the people of the United States were facing a condition which if carried on at the present rate of consumption of this coal would deplete the mines available for this supply of coal within the next hundred years. This statement has been discussed with a great deal of emphasis in different parts of the United States. It has been favorably commented upon by many prominent men, and the condition is such as to warrant our immediate attention.

If the United States were to place an export duty on their coal to Canada, we would be then compelled to do what we ought to do to-day, to look about for a source of supply of fuel to take care of our great requirements in this regard. We would then begin to realize that some effort should be made for the development of the poorer grades of fuel that are available almost at our very door.

The attention of geologists and mine owners, also the general public, especially during the past year, have been directed to the questions of the coal supplies and reserves in Canada, and on the Continent. The large increase in the consumption of coal in recent years makes this question of vital importance to this country. Only last year, for instance, we imported $42,000,000 worth of coal into Canada. Considering the constant increase in our imports I think that this matter should receive our closest attention.

Canada Has Coal Supply

Canada has large supplies of coal situated in the Atlantic and Pacific regions; in the mountains of British Columbia and in the plains regions of the central interior. On the Atlantic and Pacific seaboards, bituminous coals are extensively mined. The interior fields supply coals of various kinds, the coals of the mountains being the most important and of the highest grade. The province of Alberta forms Canada's largest coal reserve. The coal areas of Canada have an estimated total surface extent of 109,168 square miles.

In summing up the reports of the coal deposits in the world, Canada stands second among the nations in regard to her deposits. Canada has 1,234,269 millions of tons available; the United States has 3,838,659 million tons available. Great Britain has only 189,000 millions of tons; Germany has 423,000 millions of tons available. At Pictou, N.S., coal fields show an actual available supply of 390 million tons. In addition to this, the small fields and the estimated coal area in Nova Scotia will amount to 400 millions of tons. The present output of coal for Nova Scotia is about 3,000,000 of tons per annum. The coal is largely consumed in the east, much is exported, and a large quantity goes to Montreal.

We have only two deposits of anthracite coal worthy of mention in Canada. One is located in the Rocky Mountains, and the other in the Yukon. Neither of these is easy of access, nor capable of very great development. We use anthracite in our homes because of less smoke and smell. In the West they manage to keep fires in the houses all night with low grades of coal. If our furnaces were changed to consume the smoke, we could use the lower grades of coal with comfort. Mr. Dowling, Canada's coal expert, says this can be done, and we can use $5 coal instead of $8 or $10 coal and get more heat units per ton out of it by adapting our furnaces and heating appliances to its use. From Brandon, Manitoba, east to the Atlantic coast, we are almost entirely dependent upon the United States for our anthracite coal for cooking and heating purposes.

"Scotia" Coal for Ontario

The anthracite coal deposits of North America are fast becoming exhausted. The Americans admit that they have used two-thirds of their total supply, and so we must expect that anthracite will increase in value as the years go by. We must, therefore, investigate more closely our soft coal deposits and make every effort to develop them economically. We must also induce our people to make use of the tar-products taken from soft coal which are most valuable. One of the principal products taken from soft coal is ammonium sulphate, which is used extensively as a fertilizer. We are now making a lot of toluol from Canadian soft coal taken out at Sydney Mines. This same firm has been making coke for the steel plants for years past. Soft coal can be transported from two ports in Nova Scotia, namely, Sydney and Pictou. This coal could go through our canals up the lakes to Port Arthur, and might be able to compete in price with the soft coal brought from the United States, which is delivered to the ports along our inland waters. This subject requires immediate investigation. Should an embargo be placed on coal coming into Canada from the United States this seems the most feasible way of supplying the cities on our inland waters. The government should inquire into the feasibility of handling grain east and coal west.

To obtain coal of a similar grade to that mined in Nova Scotia we have to go to the Rocky Mountains eight hundred miles west of Winnipeg. For lower grades of soft coal, nearly the whole of the province of Alberta and the southern part of the province of Saskatchewan can be called one immense coal field. Some districts in southern Saskatchewan contain soft coal from ten to thirty feet in thickness, but it is of such a nature that when it is exposed to the air it dries to a powder.

Some definite effort should be made to develop the immense soft coal area in southern Saskatchewan. The Department of Mines know where seams and exposures are

*Address in the House of Commons.

located in the bulk of this immense coal field. Experiments have been made in Ottawa by the Mines Branch within the past few years which have gone to show that lignite coal similar to that located in Saskatchewan, when used in a gas producer, can be as economically handled as regards power as if it were anthracite, provided it is used in the localities where the coal is produced.

Electricity has given tremendous assistance in conserving our coal. It is said that if the electric power already established in Canada were dispensed with it would be necessary to import twice as much coal as is at present consumed in order to supply our people. By developing electricity we have made enormous savings in fuel, and we should investigate at once and see how much farther we can go in this regard. If we nationalize our railroads the government may feel justified in electrifying large portions of our main lines, and in this way conserve the coal for other purposes. The Chicago, Milwaukee & St. Paul Railway hauls by electric power freight and passengers over 440 miles of its road, and is at present electrifying an additional 250 miles.

The ordinary growth of our provinces calls for cheaper power and cheaper fuel; and the development of our western provinces will depend to a large extent on the supply of cheap fuel and power. For, notwithstanding the existence of the enormous deposits of coal in the extreme eastern and western portions of Canada, certain of the provinces are dependent on foreign sources for their supply. Conditions, however, may not continue as they are to-day. They may change suddenly and we may find ourselves deprived of fuel from the United States without warning. For such an event, we have made no provision; we have accumulated no extra store to meet such an emergency, but import only what is needed annually.

The Peat Bogs of Canada

It may be safely said that there will be no permanent reduction in the price of coal; rather it is reasonably certain that there will be a gradual but steady increase. Fuel will become higher as the years go by. The cost of development of heat from water power, in addition to maintenance and management, does not encourage us to believe that we will be able to use electricity as a poor man's fuel for many, many years to come. The price of anthracite and other coals is advancing largely because of exhaustion of the thicker beds, and increased costs of working, freight and transportation facilities. Anthracite coal is fast becoming the fuel of the rich.

In addition to this, manufacturing establishments are bound to increase and the coal consumption for power purposes will likely develop more rapidly. As coal becomes dearer, the difficulty and uncertainty of the supply becomes more accentuated, and the importance of a substitute fuel becomes more urgent. If, therefore, the great peat bogs of Canada could be successfully converted into fuel which would be cheaper than wood or coal the advantages thus conferred upon the future inhabitants of Canada and the United States could hardly be overestimated. The difficulties to be overcome do not appear to me to be very great when the attendant benefits are taken into consideration. The kinds of fuel available in Canada are: The wood still standing, our oil deposits, the oil contained in oil shales, gas, lignite coal, water powers (or white coal), anthracite coal, bituminous coal, and our peat deposits.

Peat is incipient coal. It is made up of the more or less thoroughly decomposed and carbonized remains of plants accumulated under conditions that have prevented their complete transformation into gaseous and mineral matter. The successive stages in the process of carbonization, as it is reported in nature, is first peat, then lignite coal, anthracite and graphite, a form of carbon. For centuries, peat has been extensively used for domestic fuel by the peasantry of northern Europe. An important source of additional fuel for the more immediate future in Canada exists in our extensive peat bogs. These, and the great lignite areas of the northwest occupy a middle ground between coal on the one hand and such vegetable fuels as wood, etc., on the other.

Peat Gave Satisfactory Service

For many years past efforts have been made to develop the peat areas in Ontario and Quebec. A large amount of money was frittered away by careless and useless endeavors to produce this material in a manner in which it might be marketable. However, some six years ago the government decided to make a practical investigation into the peat producing areas of our country, and, if possible, demonstrate the advantages to be derived from peat production. They sent representatives to Holland, Sweden, Denmark, Germany and Russia to gather data and material that could be utilized to advantage in Canada. On the return of these representatives the government purchased 300 acres of the peat bog at Alfred, about forty miles out of Ottawa, and prepared to demonstrate the commercial feasibility of the manufacturing of peat fuel by the employment of a process which is well known in Europe, and which was the only process for manufacturing peat economically. The government manufactured 2,000 tons of peats in that bog; they sold this peat in Ottawa and vicinity to householders and manufacturers for the purpose of introducing that form of fuel to the public and to obtain expressions of opinion regarding this fuel for domestic purposes. The various users of this fuel almost invariably expressed their satisfaction with peat as fuel. They further expressed their keen desire to continue the use of this fuel. I have 150 letters from people who used peat as fuel, and, with the exception of two or three, all speak in the highest terms of its heating qualities, its economy and efficiency.

After the completion of their experimental work, the Mines Branch felt that they had accomplished all that they should do, *i.e.*, the demonstration that this peat could be manufactured at a low cost and transported economically, and that as a fuel it was satisfactory. The Mines Branch felt that further development should be left to private individuals. They disposed of the plant and acreage to a firm who commenced the development of the industry. The private individuals then made some improvements to the plant, and during the year 1914 expected to carry on extensive developments. They were well under way with this work when the war broke out, but being supplied with a limited capital, they were seriously handicapped, and were compelled to close down their plant for lack of money to continue its operation. I regret to say that the plant is now in the hands of a receiver.

From the government's development of the peat bog at Alfred, it was proven conclusively that peat could be manufactured into blocks suitable for use in industries and in private homes at an actual cost of $1.75 per ton.

That was the price manufactured on the ground. Indeed, this was the actual cost of the production of the 2,000 tons of peat referred to. The railway charged one dollar per ton for its transportation to Ottawa, a distance of forty miles.

However, the peat was delivered at $5 per ton to manufacturers and householders, and from many sources I have obtained definite information sufficient to assure me that for residential purposes, in grates, in cook-stoves, in the ordinary heater, this has proved to be an ideal fuel. This is a practical demonstration of what can be accomplished, and a good reason why the government should act. It is true that anthracite coal has more heat units per ton, but the use of anthracite coal entails greater wastage, owing to incomplete combustion, and a larger percentage of ash. This is not necessary in the consumption of peat. Peat fuel is easily lighted, and it is not necessary to use a greater quantity than is required for cooking or heating at one time, while, on the other hand, anthracite undergoes very great wastage in this regard.

Russia Uses Peat

The sale of machines for the manufacture of peat in Russia in the years 1912 and 1913 shows an increase of 400 per cent. It is estimated that Russia is producing annully ten million metric tons of peat fuel, out of which seven million tons are manufactured in the seven central Russian provincial governments. The United States, exclusive of Alaska, is estimated to have 11,200 square miles of peat bogs, averaging nine feet in depth, and containing nearly 13,000,000,000 tons of fuel, worth, at $3 a ton, $39,000,000,000. Canada has 37,000 square miles of known peat bogs, but these form probably but a small fraction of the total, constituting a potential national asset of enormous value. The peat resources of Canada exceed those of any other country with the exception of Russia. During the period from 1908 to 1914 the Mines Branch in Canada located, mapped and investigated 140,000 acres of peat bogs in Ontario, Quebec, Nova Scotia, Prince Edward Island and Manitoba, all convenient to railways and markets, estimated to be capable of yielding 115,000,000 tons of fuel and 10,500,000 tons of peat moss litter. Why do we not make use of the information obtained by our government experts? Seven Ontario bogs within convenient shipping distance of Toronto will yield 26,500,000 tons of fuel. Four bogs within a few miles of Ottawa are estimated to contain over 25,000,000 tons. Seven bogs in the Montreal district could furnish that city with 23,500,000 tons of fuel. Five bogs along the St. Lawrence, below Quebec and convenient to that city by water, could supply 16,250,000 tons of fuel and 5,750,000 tons of peat moss litter. Nova Scotia bogs examined in Yarmouth, Shelburne and Lunenburg counties will produce 6,250,000 tons of fuel and 500,000 tons of litter. Six bogs investigated in Prince Edward Island can furnish 1,250,000 tons of fuel and over 1,000,000 tons of litter. Seven bogs examined in Manitoba will produce 2,000,000 tons of fuel and 2,500,000 tons of litter.

As to the comparative heating value of peat fuel as delivered to the consumer, it may be said that, comparing the actual heating values, one ton of hard coal is equivalent to 1½ tons of peat with a moisture content of 25 per cent.; but, in order to arrive at a fair comparison, it is necessary to understand and carefully consider certain factors which, under certain conditions, would turn the scale in favor of peat fuel. As a fuel for cook-stoves, ranges, etc., peat fuel will prove more economical than anthracite, since, with coal, the fire must be burned continuously, and, moreover, the refuse, *i.e.*, ash, contains a very large proportion of combustible matter.

The manufacture of sulphate of ammonia is a matter of great importance to the people of Canada. Our peat bogs in Canada are high in nitrogen, running about two per cent. In Italy they are running their peat bogs with a little over one per cent. of sulphate of ammonia. Ammonia sulphate is a very valuable artificial fertilizer, for which there is a continually increasing demand in almost all parts of the world, and a ready market could be found for all the sulphate of ammonia that could be produced in Canada.

At a time like the present when stock is being taken of the natural resources of the country, the importance of these investigations will be readily recognized. The estimated yield of 19 bogs in Ontario and Quebec, if used to produce ammonium sulphate, would give a production of 81,696,416 tons of fuel. With a production of sulphate of ammonia amounting to 4,025,525 tons at a valuation of $65 per ton, which is a very low estimate, the value would amount to $261,659,775.

Intense agriculture has filled the granaries of the world, but fertilizers have become absolutely necessary. Soil fertility is urgently demanded. Appetite has come with eating and our demands and wants are increasing day by day. Inoculation of soil has become an established success. Bacterized peat has been used most successfully as a medium for this purpose. Experiments in England made by Professor Bottomley, Botanical Laboratories, University of London, Kings College, as described in a book entitled "Spirit of the Soil," written by C. D. Knox, shows that treated peat gives as much as 50 to 80 times greater results than the best rotted stable manure, that it is free from smell, dust, weeds, disease spores and insect pests, is clean and pleasant to handle. After seven years of experiments, the American Board of Agriculture are distributing a similar preparation to farmers and recommending its use. Bacterized peat opens a field for every farmer and gardener to undertake important scientific work, in order to increase the yield from the land.

In addition to this, Dr. Eugene Haanel, the head of the Mines Branch, makes the following estimate:

That the gas available in working the large Teefield bog for sulphate of ammonia would produce 4,000 h.p., continuously for 86 years, a total of 344,000 h.p. The total power gas available in conjunction with the utilization of all the bogs in Canada would amount to over 5,000,000 b.h.p.

Peat burns with a much smaller air supply than coal, consequently less heat is wasted than with the greater draft required to burn coal.

The Duty of the Government

I believe it is the duty of this government to take over certain peat bogs and lignite mines and furnish the material at cost to our people. Greatly increased prices for the coming winter must be expected, and unless some immediate action is taken, great hardships are bound to ensue. The peat bog at Alfred, Ont., is capable of immediate development, and at least 1,000 tons of peat per month could be manufactured in this bog during the summer and fall. After the material is manufactured, it is up to the municipalities to purchase the peat and see that it is delivered at cost.

In the western provinces, lignite coal should be made available for distribution and I believe that a sufficient quantity of soft coal should be brought from the mines at Sydney or thereabout, up the St. Lawrence, and distributed to the municipalities, if for no other reason than as an experiment. The day may soon come when elevators will be built in Sydney harbor and boats carry coal west and wheat east. I cannot urge too strongly on the government the need of immediate attention to this whole fuel problem.

The Hunttting Lumber Company mill site on False Creek, Vancouver, embracing 425 feet of valuable water frontage, has been purchased by John Coughlan and Son, to serve as an addition to their steel shipbuilding plant.

CENTENARY OF THE INSTITUTION OF CIVIL ENGINEERS

The Institution of Civil Engineers, the pioneer engineering society, celebrated its centenary last January 2nd. It was on January 2nd, 1818, that it was established by eight young men, who met for that purpose in the Kendal coffee-house in Fleet Street, London, England. It was fortunate in securing as its president, two years after its birth, Thomas Telford, the foremost engineer of his day and one of the leading engineers of all time. Holding the office until his death in 1834, he devoted much of his time during his life to furthering its interests, and at his death bequeathed a sum of money for the establishment of the Telford Medals and Premiums, which have ever since served to encourage the presentation of original communications at its meetings. It was in his time also, in 1828, that its position was established by the grant of a Royal Charter, which contains the famous definition of civil engineering as being: "The art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." The growth of the membership was not very rapid. More than thirty years were required before it reached 1,000, and another thirty before it was 5,000; the highest point was attained just before the war, when the roll contained 9,266 names.

1916 REPORT OF PROVINCIAL BOARD OF HEALTH OF ONTARIO

The following facts with respect to sewer extensions in the province of Ontario and the extent to which typhoid fever has been eliminated as a result of use of chlorination, are taken from the report of the Provincial Board of Health for 1916:—

Applications approved by the Board relating to sewerage and waterworks systems and extensions thereto, amounted in the year to the sum of $2,010,070.42 (estimated costs) and are summarized as follows:—

	Applications.	Estimated cost.
Sewer extensions	123	$1,226,260.90
Sewage disposal works	7	97,872.00
Waterworks extensions	56	369,035.42
New water supplies	4	316,902.10
Totals	190	$2,010,070.42

An effort has been made to prepare standards for municipal records, proposal for bids and estimates, bid and estimate, bond, contract and specifications for sewer construction together with certain standard details of construction. With uniform methods it should be possible for a government inspector to deal directly with the interpretation of the specifications and with the contractor. Under existing conditions the matter has to be referred back to an engineer whose responsibility frequently terminated with the acceptance of the plans and letting of contracts.

The question of regulations governing the installation of plumbing and sanitary conveniences in the province of Ontario has been considered and a tentative proposal has been prepared. A standard specification for soil pipe is suggested regulating the sizes, dimensions and weights of soil pipe. This will doubtless control fittings in the eastern portion of the Dominion.

The situation with regard to water-borne typhoid fever in the larger towns is very satisfactory. The accompanying table shows a gradual elimination of typhoid during the past two years. With municipal support in continuing the dosage of chlorine required, it is possible to eliminate typhoid as a serious factor in our vital statistics.

Table No. 1.—Rate Per 100,000 Population

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908-16	Treatment, Source of Supply.
Brantford	53	24	72	77	17	24	11	11	24	34.7	Chlorination, 1914.
Fort William	....	....	....	35	33	30	21	22	9	25.0	None, Loch Lomond.
Galt..............	43	11	42	31	19	27	17	0	25	23.8	None, Springs.
Guelph	21	69	27	13	6	6	12	12	0	18.4	Chl. 1915, Springs.
Hamilton..........	19	16	15	24	8	14	7	6	4	12.5	None, Lake Ontario.
Kitchener	15	15	43	7	19	6	11	5	0	13.4	None, Wells.
London............	12	6	4	17	10	3	9	0	2	7.0	None, Springs & Wells.
Niagara Falls.....	....	....	....	....	...	....	....	9	27	18.0	Chl. 1913, Niagara R.
Ottawa............	31	24	28	....	....	19	17	24	18	23.0	Chl. 1912, Ottawa R.
Peterborough	18	6	29	17	10	10	25	14	14	15.9	Chl. 1916, Otonabee R.
Port Arthur	....	....	....	....	....	....	....	5	21	13.0	Chl.1913, New source, '14
St. Catharines ...	....	24	24	71	22	27	6	0	22	21.7	Chl. 1914, Welland Canal
St. Thomas........	49	34	20	19	19	50	0	29	29	27.6	Chl. 1913, Filters, Wells
Stratford.........	14	34	34	13	20	6	6	17	12	17.3	None, Wells.
Toronto	21	25	46	24	14	13	9	2	7	17.8	Chl. 1909, Filters 1912-16
Woodstock	32	21	21	42	30	10	0	10	28	20.6	None, Springs.
Average by years	25.2	23.7	31.1	30.0	17.4	17.5	10.0	9.8	13.4	19.8	

The above rates do not appear to be greatly influenced by water supply.

Table No. 2.—Rate Per 100,000 Population

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908-16	Treatment of Water Supply.
Belleville..........	71	40	50	19	37	18	17	63	81	44.0	Chlorination 1916
Chatham	49	68	39	38	44	58	16	8	46	40.6	Filters 1895
Fort William	111	106	83	Protected.						10.0	New Source 1910
Kingston	31	31	78	26	32	25	43	28	5	33.2	Chlorination 1912
Niagara Falls	84	26	60	90	44	85	34	protected		60.4	Chlorination 1913
Ottawa..............	....	....	....	101	108	Protected.				104.5	Chlorination 1912
Port Arthur	138	164	178	121	163	146	50	protected		137.1	New Supply and Chlorination 1913
Sarnia	110	82	101	148	139	45	26	34	60	82.7	Chlorination 1913
Sault Ste. Marie ...	68	90	154	280	85	127	84	24	31	116.6	Chlorination 1913
Windsor	63	56	49	34	38	10	27	35	29	37.8	Chlorination 1913
Average by years.	80.5	73.6	88.0	102.1	76.6	64.7	37.1	32.0	42.0	66.2	

The above rates appear to be influenced by infected water supplies.

WOULD PROHIBIT USE OF ELECTRIC POWER FOR DOMESTIC HEATING

In order, if possible, to prevent the more extended use of electricity for purposes of heating, and in the desire to conserve electric power more specifically for essential work in connection with the manufacture of munitions, the city council of Niagara Falls, Ont., has passed the following resolution:—

"That, owing to the shortage of electric power needed for the making of munitions and other commodities used for the prosecution of the war, in the opinion of the council, heating by electricity should be prohibited for these economic reasons:

"That it is used in the months when the peak load is the highest and when power is produced under adverse weather conditions, owing to ice forming at the source of supply.

"That, with electric current at one cent per kilowatt, power is four times the cost of coal at present prices."

SUPPORTING STRENGTH OF SEWER PIPE IN TRENCHES

FOR some time past the Iowa Experiment Station at Ames, Iowa, has been conducting a series of experiments on the supporting strengths developed by sewer pipe and drain tile in actual shallow ditches, with different methods of laying the pipe. A bulletin has recently been issued in which the results of these experiments are set forth. Extracts from this bulletin follow:

First—The "ordinary supporting strengths" (which are those developed with the "ordinary" pipe-laying method) are equal, with close approximation, to the cracking loads in laboratory tests with standard "sand" bearings.

Second—The supporting strengths developed with the "first class" pipe-laying method may be set safely at least 20 per cent. greater than the "ordinary supporting strengths" of the same pipe.

Third—The tests at Ames, Iowa, have shown that it is possible to design and build concrete-cradles of reasonable cost which will increase the cracking supporting strength of sewer pipe and drain tile 100 per cent. or more above their "ordinary supporting strengths." However, a large amount of experimental investigation (by bedding pipe in concrete-cradles of different designs and loading to destruction) is still needed to determine the best designs for concrete-cradles. This work will be prosecuted at Ames as rapidly as resources permit.

It was formerly thought that the effects of differences in pipe-laying conditions upon the supporting strengths developed by sewer pipe and drain tile in ditches must be so great as to make hopeless any attempt to systematize the subject in a scientific manner. Extensive tests of sewer pipe and drain tile in recent years, however, have demonstrated conclusively that the effect of differences in pipe-laying conditions upon the supporting strengths developed in actual ditches is much smaller than had been supposed.

Data from the Ames tests show that even such extreme variations in conditions affecting the supporting strength of sewer pipe as those between distribution of the pressures at top and bottom fairly uniformly over 71 per cent. of the total diameter, through standard "sand" bearings and concentration practically on the centre lines, by "three-point" bearings, affect the cracking loads only to the extent of about 30 per cent. of the "ordinary supporting strengths." Extensive data published in Bulletin 36 of the Iowa Engineering Experiment Station show the same percentage of effect on drain tile, also.

Since the effect of such extensive variations in loading conditions is so small, it is quite apparent that there is comparatively little difficulty, after all, in dividing pipe-laying conditions systematically into a small number of classes, and in ascertaining the relations of each class to the supporting strengths developed by sewer pipe and drain tile in actual ditches.

The classes of pipe-laying methods frequently encountered and their relations to the supporting strengths developed by sewer pipe and drain tile in ditches are as follows:

"Impermissible" pipe-laying methods are those in which the bottom of the ditch is not suitably rounded to fit the underside of the pipe, or in which hub-holes are not properly dug, or in which the refilling material is not placed to fill all around the pipe, or in which other impermissible defects of similar general character occur. Impermissible pipe-laying methods should never be tolerated. They weaken the supporting strength of sewer pipe and drain tile very seriously.

The "ordinary" pipe-laying method is that in which the underside of the pipe is carefully bedded on soil for 60 to 90° of the circumference, suitably rounding the bottom of the ditch for this purpose and digging hub-holes for all pipe with hubs, and in which the pipe is surrounded by soil placed with ordinary care.

"Ordinary" pipe-laying is used extensively in constructing large tile drains under the direction of drainage engineers, and in constructing pipe sewers in villages and small cities. There are many variations in the wording of specifications for pipe-laying methods which should be classed as "ordinary," but the effect of minor variations in the method is not great upon the supporting strength developed in the ditch.

The largest sewer pipe and drain tile show not more than 1/50 in. movement outwards of the extremities of their horizontal diameters under cracking loads, which is not enough to develop sufficient side resistance to affect the cracking load materially, even when the ditch filling is thoroughly tamped, as with "first class" pipe-laying. Nevertheless, all spaces around the pipe should be completely refilled with ditch-filling material, for even untamped refilling between the sides of the pipe and the sides of the ditch is of great value in preventing the collapse of pipe sewers after they crack. Many miles of cracked pipe sewers and large tile drains are still rendering good service for this reason.

The loading conditions on sewer pipe and drain tile laid by the "ordinary" methods are closely reproduced by the standard "sand" bearings for laboratory tests of supporting strength. In fact, the standard "sand" bearings were devised after a careful study of ditch loading conditions, in an attempt to reproduce them as far as practicable. The field tests at Ames demonstrate conclusively that:

The "ordinary supporting strength" of sewer pipe and drain tile is equal, with close approximation, to the cracking load in laboratory tests with the standard "sand" bearings. The "ordinary supporting strength" is defined as the supporting strength to carry loads due to or transmitted through ditch-filling which sewer pipe and drain tile will develop in actual ditches with the "ordinary" pipe-laying method.

The "ordinary supporting strength" of sewer pipe and drain tile is a very important factor, on which all calculations of supporting strength with different pipe-laying methods should be based, by the use of proper ratios, for the reason that in the great majority of cases of cracking of pipe in actual ditches the cracking occurs at loads just about equal to the "ordinary supporting strength" of the pipe which cracks. This has been demonstrated by very carefully and patiently collecting and studying the detailed data of all cases of cracking published or of which data could be collected during several years of correspondence and personal field investigation.

The "first class" pipe-laying method is that in which the underside of the pipe is very thoroughly bedded on soil for at least 90° of the circumference (suitably rounding the bottom of the ditch for this purpose and digging hub-holes for pipe with hubs) and the entire pipe is surrounded with thoroughly compacted soil, all under the direction of a competent inspector constantly on the work.

The "first class" pipe-laying method is extensively used in pipe sewer construction in large cities, and generally in all important pipe sewer construction carried out under an adequate, well-organized and thoroughly competent engineering force. There are many variations in the wording of the specifications by different engineers, but the corresponding variations in practice produce only minor effects on the actual supporting strength of the sewer pipe and drain tile in ditches.

The use of the "first class" pipe-laying method ought to be greatly extended beyond present practice.

The supporting strength to carry loads due to or transmitted through ditch filling which sewer pipe and drain tile will develop in actual ditches with the "first class" pipe-laying method may be set safely at at least 20 per cent. greater than the "ordinary supporting strength" of the same pipe.

The best engineers seem pretty well agreed that the use of concrete-cradles in pipe-laying ought to be greatly extended beyond present practice in the construction of all pipe sewers of 15 ins. and larger diameters.

There is at present no generally accepted practice as to the detailed dimensions and other characteristics of concrete-cradles for pipe sewers of different diameters, and only a very few tests have been made to ascertain definitely the actual effect of any particular design of concrete-cradle, in increasing the actual supporting strength of the sewer pipe or drain tile in ditches. The designs of concrete-cradles are made by rule of thumb, and vary with the whims of the designers, between wide extremes for the same service.

In the field tests at Ames, Ia., of the supporting strengths of sewer pipe and drain tile in actual ditches a number of concrete-cradles of different designs have been subjected to actual test, with general results as follow:

First—It is possible to design and build concrete-cradles of reasonable cost which will increase the cracking strengths of sewer pipe and drain tile under loads due to or transmitted through ditch filling 100 per cent. or more above their "ordinary supporting strengths."

Second—Variations of the dimensions and other characteristics of concrete-cradles (for the same diameter of pipe and other conditions) affect the increase of supporting strength greatly. The real effect of variations can be ascertained reliably only by actual tests to destruction.

Third—A large amount of experimental investigation of concrete-cradles of different designs tested to destruction are necessary to determine the best designs and the real values of concrete-cradles of particular designs.

It has been suggested that the supporting strengths which sewer pipe and drain tile develop in actual ditches could be materially increased by bedding them on and completely surrounding them with tamped gravel.

Accordingly, this type of bedding was tested in an actual ditch at Ames, Ia., in 1916. The test indicated that complete gravel bedding increases the supporting strength of sewer pipe to a value somewhat higher than that for "first class" pipe-laying or, say, to at least 25 per cent. above the "ordinary supporting strength" of the same pipe.

It is not sufficient that the average supporting strength developed by sewer pipe and drain tile in a particular ditch shall be barely equal to the loads on the pipe. Unless there is a proper excess of supporting strength over the load, those pipes which are weaker than the average will be cracked by the load and some unusual contingency may so increase the load as to crack even stronger pipe. A factor of safety is necessary for sewer pipe, just as for other engineering structures.

The proper way to determine just what factor of safety is necessary in order to prevent undue danger of cracking of sewer pipe and drain tile in ditches is to make a careful study of all known cases of actual cracking in ditches, and a similar study of the detailed data of as many cases of sound pipe in ditches as practicable. The authors of the bulletin have been making such a study for about eight years, and conclude that:

A study of all known cases of cracking of sewer pipe or drain tile in actual ditches, and of the detailed data of a large number of cases of sound pipe in ditches shows that a safety factor of 1½ is both necessary and sufficient to prevent cracking.

ROAD MAINTENANCE AND REPAIR*

By Alexander W. Graham
State Highway Engineer, Missouri.

To write something really "new" concerning the maintenance of roads is rather a difficult task, as the development of this phase of highway work has been steadily advancing and each succeeding step is so closely allied to the one preceding that it is practically known, even though not extensively used. However, the maintenance of roads in Missouri is decidedly *new* to a greater part of the State, and I will discuss some of the problems which are encountered.

As the foundation practically of all roads is primarily earth, and before any hard surface can be applied, a well-constructed earth road must be provided, I will begin at the bottom and point out some of the ordinary problems which are encountered in reconstructing, repairing and maintaining earth roads.

First of all, we encounter the one real problem of road work, namely, drainage. Personally, I would like to see the word "drainage" printed in every known language and pasted in the hat of every man who is connected with road work. In Missouri our old friend, the road overseer, with his cohorts who do not need plans or stakes to work from, has presented the state with some real works of art. The side ditches, or spaces where they should be, ramble over hill and dale and deliver their burden wherever convenient and in a large number of cases retain their burden until it can be distributed and thoroughly incorporated with the road itself. Sometimes the brilliant idea of carrying the water across the road is put into effect by building a dam and forcing the water to cross over the surface of the road. These dams (rightly named) are commonly known as "thank you mams," so-called, I suppose, from the fact that you receive the same number of jerks in passing over one of these obstructions as there are words in the phrase. I would add that I have heard these affairs named by the grouping of three words, but not the words referred to above.

But, seriously, the drainage of our roads is a very vital problem and involves in itself many different problems. Many of our culverts are too small, improperly built and have not been kept clear of obstructions. I am glad to say, however, that the old wooden culvert has about finished its work and is being supplanted by more permanent types of construction.

In the construction of permanent culverts we encounter the problems of size, grade and type. As determining the size of waterways is largely a matter of judgment, owing to the fact that, regardless of what formula you may use, your result will depend upon the assumptions made, I am reminded of a theory practiced by a friend of mine when estimating the cost of construction work which was to

*Paper read before the American Road Builders' Association.

estimate according to all known rules, double the result and add six hundred dollars.

Having decided upon the area of waterway required, the next problem is how to secure same without disturbing the grade of the road and at the same time keeping the flow line so that the culvert will not fill up with earth, etc. This result is not always possible, but by varying the shape or type of culvert, good results can generally be obtained. In a majority of cases, the defects mentioned above can be taken care of when laying the grade line, etc.

In the past, a great many of our roads were graded to the full width of the right-of-way, and, if in a cut, the outside ditch lines were left vertical. In some soils reasonably good results have been obtained, but in a majority of cases the banks will cave in, which not only fill up the ditches, but will damage the adjacent property. I think a reasonable slope both ways from the ditches is preferable, as it will permit the seeding of the slopes and when a good soil is obtained, frequent use of a mower will keep the slopes in a condition not only pleasing to the eye, but will prevent erosion and slides.

The old idea that grading a road meant shaping up the old travelled way regardless of grades, location, sharp turns, etc., has fortunately been supplanted by the growing demand for easy grades and turns and has given the highway engineer the opportunity to demonstrate the value of cuts and fills, better locations and alignment. The item of cost is rather troublesome as it is hard to convince local authorities that mere grading should be so expensive.

After the road has been reconstructed in accordance with standard rules governing grade, cross-section, drainage, etc., the problem of maintenance presents itself.

The maintenance of any road is the keeping of the surface dry and firm, free from ruts, holes, etc. This can be accomplished in various ways, but we Missourians pride ourselves on being the foremost exponents of the road-drag, and I do not believe there is any more practicable or economical way of maintaining an earth road than by the use of the drag. The type or kind of drag is a much-discussed detail, but I will not go into the subject here. The principle of the drag is to smooth the surface and prevent the road from flattening out and losing the crown, which, of course, is absolutely necessary if you expect the water which collects on the surface to reach the side ditches quickly.

In designing a road-drag it is well to keep the above-mentioned details in mind. The time to use the drag is when the surface of the road is moist, but not wet, as some soils stick to the drag if too wet. The effect of the drag is very similar to puddling clay in order to get a more dense mixture.

In the maintenance of all types of roads I am somewhat of a crank on one thing, *viz.*, the removal of snow from the roads as soon as possible after the storm is over. The first vehicle which travels over a road after a snow storm "breaks a track" and this is closely followed by each succeeding vehicle until a compact snow cushion is formed, upon which the entire traffic of the road is concentrated. It is obvious that this concentration of traffic upon such a small area of wearing surface will be excessive, and will cause two narrow depressions or tracks to form upon the road surface in which will collect the water from the melting snow and this will soften the road-bed and deep ruts will result.

The snow can be removed by reversing the action of the road-drag and dragging away from the centre, or by road-graders, snow-plows, etc., keeping in mind, however, that the snow should not be piled into the side ditches, as this will interfere with the drainage. After the snow has been pushed to either side it is well to go over the road with a shovel and break a channel through to the ditches at frequent intervals, as this will permit the melting snow near the travelled way to reach the ditches quickly and not be held near the road until the entire snow shoulder melts.

Sand-Clay and Gravel Roads

As the principles governing the construction of these two types of roads are very similar, I will discuss the maintenance of them as one subject.

The principal problem to solve when constructing either a sand-clay or gravel road is the bond, as neither sand nor creek gravel contain a bonding material which will tie the materials together firmly enough to withstand the traffic. It is impossible to write a specification which will be applicable in all cases, as the materials found in different localities are so different in character, and in a majority of cases, a careful study of the materials is necessary before any definite conclusion can be reached. It is well known that enough clay must be added to fill the voids and bind the gravel or sand together, but the determination of the proper amount is difficult, as too much clay is apt to cause the surface to "pick up" and not enough will cause the surface to ravel.

Assuming that the proper amount of clay is added, then the problem of compacting the mass presents itself. In handling this detail I am afraid that I differ from most engineers for the reason that I question the value of attempting to compact a gravel or sand-clay road with a roller. Of course, rolling is beneficial, but to my mind there is only one thing which will really compact a sand-clay or gravel road and that is the traffic. I do not think either type of road can be completed before it is opened to travel. This method is necessarily rather inconvenient to the public, but if the road is kept free from ruts and holes by frequent use of the road drag, it will not require many months of travel to compact it.

Many engineers advocate oiling a sand-clay or gravel road, but I am not very enthusiastic for this type of maintenance. My observation of oiled gravel roads is that the action of the oil, with the possible exception of laying the dust, is more harmful than beneficial. The physical characteristics of gravel make the oil act more as a lubricant than a binder and consequently the road will ravel. Again, we find oils which are not of uniform density and the bitumen will collect in spots and form a compact cake which causes the traffic to dig into the surface on either side of the hard spot. These spots make it very hard to drag the road properly, and are in themselves a detriment to easy riding. The worst enemy a sand-clay or gravel road has is extreme dry weather and the action of the oil tends to cause the metalling to dry out below the surface and a general loosening up takes place. A gravel or sand-clay road can be maintained to withstand reasonable traffic by frequent use of the drag and by adding additional material where needed to keep the cross-section true and free from depressions.

Waterbound Macadam

The principal thought which I have concerning waterbound macadam roads is not to build that type of road. However, waterbound macadam is far superior to mud, and if properly maintained will accommodate light traffic.

The maintenance of a waterbound macadam road must be constant and I think the patrol system is the best way of handling it. There is always a difference of opinion concerning the mileage of road that one man can keep in repair, and as this depends to a great extent upon the particular road to be patrolled, it cannot be answered very definitely. I think a good average is five miles, and if the travel is not excessive one man, if capable and energetic, when supplied with the necessary equipment and materials, should be able to keep this mileage in good condition.

The abrasion on a road of this kind produces, as is well known, a large quantity of dust which is not only very unpleasant for the traveller, but is a part of the road itself, and if blown away leaves a space to be refilled. Various remedies have been tried, and while all of them have some merit, I do not think anyone can say what is the best thing to do. The use of the lighter road oils has given good results in some instances and poor results in others.

I think, however, an application at least once a year of a light road oil is very good practice in the maintenance of waterbound macadam roads, the amount of oil depending upon the amount the road material will readily absorb. I will not discuss the surface treatments of heavy oils and rock screenings, as I think this is adding a wearing surface and should not be considered when writing specifications for waterbound macadam.

Bituminous Roads—Penetration Method

The methods employed in repairing and maintaining this type of road depend upon the causes of failure. It is safe to say that a large percentage of the failure of penetration work is due to faulty subgrade construction. On account of the large percentage of voids in the base course, the upward pressure locally applied by frost action is very injurious to the surface.

In discussing the subgrade we encounter the old problem of drainage, and it would be practically impossible to maintain a bituminous surface if the soil of the subgrade was not thoroughly drained. Tile underdrains are well understood and for most types of surface will drain a heavy water-bearing soil in a satisfactory manner.

Penetration work gives the best results when laid over a permeable subsoil. Gravel or a mixture of sand and gravel are ideal subsoils. A heavy soil of low permeability is not a good soil for penetration work, but if the road is not subjected to extreme low temperatures, good results can be obtained by careful drainage, and by increasing the depth of the base course. Where the road is subjected to extreme low temperatures and the subsoil is of low permeability, it is advisable to place an insulating layer of gravel, or a mixture of sand and gravel, beneath the base course. Some authorities recommend that the insulating layer be composed entirely of sand, but I question the wisdom of this idea, owing to the fact that when a compacted layer of sand becomes saturated with water, then freezes, you have a rigid layer of material which will not contain much resilience.

In repairing the surface of a bituminous macadam road which has been carefully constructed with due regard to drainage, subgrade, size of stone, quality of binder and other construction details, you, as a rule, will find that the problem is either one of patching and evening up the surface to a true cross-section or, if the surface is too badly worn, a complete scarifying and re-surfacing becomes necessary. The work or patching consists in repairing sections of the surface which contain (*a*) spots of excess bituminous material, (*b*) bare or lean areas, (c) areas where the stone has become loosened and a series of potholes have been formed, (*d*) areas where the surface presents a wavy appearance, etc.

As a rule, the spots of excess material can be trimmed down and, if necessary, sealed with a light heated application of bituminous cement. The bare or lean areas, if ravelling has not commenced, may be sealed in a similar manner, care being taken to clean the surface thoroughly of any dirt or deleterious matter before the bituminous cement is applied. Where the surface has ravelled and formed holes, a more careful treatment becomes necessary. I think the most successful way of treating this problem is as follows:—

All disintegrated material should be removed and sufficient new material added to give the required depth, and the area sealed as in the original construction. The question of how to compact the added material is a much-discussed problem, but I am inclined to think that if the areas are small, it would be best to hand-tamp the new material, as it would be difficult to get the required compression with the roller, without injuring the edges of the sound surface. Where the surface presents a wavy appearance, it is a question whether it would be best to scarify and re-shape the surface, or to cut off the high places and re-seal, or, by cutting out the depression and replacing with new material. This can only be decided by close study of the problem in hand.

B.C. GOVERNMENT WILL COMPLETE PACIFIC GREAT EASTERN RAILWAY

Press dispatches from Vancouver say that the negotiations between the government of British Columbia and the Pacific Great Eastern Railway have been concluded and that the government is to take over and complete that railway. The company is to pay the government $1,100,000, of which $750,000 will be in cash, and the balance after the war. The government will resume the operation of trains, which was recently suspended by the company, and will construct the line from Clinton to Williams Lake, a distance of 100 miles, during the present year.

The payment to the government releases the members of the company of their pledge to finish the line.

The decision was reached in a conference between Hon. John Oliver, provincial minister of railways, and R. C. Crombie, of the railway. No difficulty is expected in securing the necessary legislation.

The company hands over all its assets except the lands and holdings of the Pacific Great Eastern Development Company. The company is to pay the government $500,000 at once and $250,000 within four months. The remaining $350,000 may be paid at any time up to five years after the end of the war.

There are 37 mines under Provincial Government supervision, within a radius of 75 miles of Edmonton, Alberta. Of these 15 have trackage connection with the railways.

The University of Alberta gives the comparative value of Edmonton and Pennsylvania coal, expressed in B.T.U., as follows: Edmonton coals, 8,900 to 9,300; Pennsylvania, 12,800 to 14,800.

S. C. Charlesworth, Deputy Minister of Public Works, Alberta, stated before the recent convention of Local Improvement Districts and Municipal Districts that a system of 20,000 miles of good roads would mean a saving of $26,500,000, or about $1,000 a mile annually.

The Quebec Budget for 1917 shows payments to December 31st, under the Good Roads Act, 1912, of $15,571,548.18 from the authorized $20,000,000. Of this $5,656,388.20 went to government good roads. The estimate for Good Roads, 1918, is $400,000.

ROAD DEVELOPMENT IN ONTARIO*

By C. R. Wheelock
President, Ontario Good Roads Association.

THE roads of Old or South Ontario have developed from bush trails and portages to the present state. Traffic was originally confined to the waterways and gradually trails were opened up over portages between navigable streams and lakes. Food and material used by the natives and early settlers were carried over these trails. Year by year the main trails were extended and improved and eventually resulted in some of our main through highways, such as Dundas Street from Toronto to Dundas which was in early days the head of navigation for southwestern Ontario; that the Dundas road was laid out before any surveys were made is evident from the wandering route that it takes. Other examples may be found in the famous Talbot Road from Niagara Falls to Windsor, Hurontario Street and the Toronto and Sydenham Road from Port Credit to Owen Sound, and the Kingston Road running east from Toronto through Kingston, Cornwall and Prescott to the Quebec boundary.

As traffic increased, the trails were gradually widened and horses and carts introduced to provide transportation for heavier loads. It was then rendered necessary to make passable roads through the soft places in swamps and lowlying lands, and an attempt was made to pave such places with logs. The logs were of variable size laid on an uneven bottom, and the result was a most uneven surface. Many miles of this type of road were afterwards built, known as corduroy.

Many of the main through roads of the province were surveyed in the last decade of the eighteenth century. Dundas Street, to which I have previously referred, was surveyed about the year 1792, but was not bridged and fully completed for traffic until after the war of 1812, although the work of construction had been commenced some years previous to this time. This road adjoining Toronto may be taken as a concrete example of the development of our main roads. As stated before, it was originally a bush trail, afterwards surveyed and opened up as a main highway. The surface was built of broken stone and gravel. For years this had been added to as occasion demanded. Some years ago, to meet the increased traffic, a portion was resurfaced with waterbound macadam and a few years later the traffic became so intense it was necessary to apply a bituminous coating. A further increase in the volume of traffic has rendered that form of surface inadequate and last year a bituminous surface, known as asphaltic concrete, similar to that used on some of the well-known streets of Toronto, was constructed.

The first highway legislation of Upper Canada, enacted in 1793, authorized justices of the peace to be highway commissioners with overseers elected at parish meetings, who were under orders from the commissioners to repair roads, bridges and streets. It was also their duty to see that landowners fulfilled what had been known in England as "statute duty." This was the beginning of what is generally known as "statute labor," and under this system the most of the roads providing transportation for the early settlers were built and maintained. The statute labor law provided a means of opening up the original roads of this country when money was scarce and settlers few and far between, and although it was not without its limitations it solved most of the problems of land transportation for the greater part of last century. But the road laws that were suitable and worked out more or less satisfactorily in the province of Upper Canada in the nineteenth century are not suitable for the twentieth century conditions now surrounding transportation in the province of Ontario. The statute labor system has outgrown its usefulness. Township councils have been slow to acknowledge the disadvantages of this system for present-day road building and still cling to it at the sacrifice of good roads and economy, but many townships now appreciate the advantages of the later systems and as a consequence statute labor has been abolished in seventy-five of the most prosperous townships in the province. In thirty-five of these, road overseers have been appointed to take charge of the roads, as provided by the Ontario Highways Act, and 25 per cent. of the salaries of such overseers is paid by the government.

The old system in vogue had not been able to keep pace with the need for well-built post roads and about the year 1830, to meet this problem, toll companies were formed to finance this work. Thus the day of the toll-bridge and toll-road were ushered in. During the next twenty-five years many toll-bridges and toll-roads were built. The toll companies, whose duty it was to maintain the roads, were more inclined to pay dividends than to spend the money in making necessary repairs. Nothing was laid out on the roads that could be avoided; they were allowed to become in a deplorable state and were described as being an imposition upon the people and a great nuisance.

In 1874, county councils were authorized to take over township roads with exclusive jurisdiction over the same. Municipal councils could take toll to defray the expense of building or repairing plank, macadam or gravel roads. In 1889, an act was passed to facilitate the purchase of toll roads by municipalities. On roads so purchased all tolls were abolished and the roads maintained by the country. But until the Highway Improvement Act was passed in 1901 there had been no satisfactory solution of the toll-road question, a number of these roads were still in the hands of private companies, but have since been embodied in the county road systems assumed under the act.

The Highway Improvement Act was enacted after an agitation for improved roads carried on by the Good Roads Association.

The control of roads by the townships alone has not been satisfactory in building up an adequate system of public highways and there was for years a spirit of unrest in connection with the administration of the Statute Labor Law. A general agitation was commenced in favor of counties assuming the responsibility for the construction and maintenance of main market roads and for larger expenditures for highway improvement. This resulted in the organization of the Ontario Good Roads Association in 1894. A campaign of education was inaugurated. Farmers' Institute speakers were designated to introduce the question, and public meetings were held in different parts of the province. So numerous were the demands on the resources of the association that the government at its request in 1896, appointed a provincial instructor in road-making. This was the origin of the present Department of Public Highways in Ontario. As first created, it was a branch of the Department of Agriculture. In 1910 it had a staff of only three; since that year the growth has been more rapid, and in 1916 it was converted into a separate department under W. A. McLean, C.E., deputy minister, and has now a staff of about fifty employees.

The administration of the department covers provincial highways, county road subsidies, township road superin-

*Paper read before the annual meeting of the Association of Ontario Land Surveyors.

tendents, county and township bridge specifications, testing of road materials, and motor vehicles.

To meet the changing conditions and demands of the people, in 1901 the Highway Improvement Act, previously referred to, was passed, which, after being amended from time to time, was supplemented by the Ontario Highways Act in 1915-16 and the Provincial Highway Act in 1917.

The classification and description of roads under the above acts, taken from the department's last report, are as follow:—

County Roads. These roads are essentially the market roads—the farmers' roads. They radiate from market towns and shipping points, and meet the needs of accumulated farm traffic. The aiding of these market roads by the province is an effective means of assisting townships in their road improvement, in that township councils are thereby relieved from the burden of their most expensive roads, and can devote their energies to the improvement of less-travelled roads, comparatively inexpensive to maintain.

County roads are aided to the extent of 40 per cent. for construction and 20 per cent. for maintenance. All county councils are authorized under the Highway Improvement Act to assume and control a system of leading roads within the county.

Provincial County Roads. Co-operative with provincial roads, but under county control, certain roads may be designated by the Highways Department as "Provincial County Roads." To such roads the province will contribute 60 per cent. of the cost of construction and maintenance. These roads are intended to enable the more equitable maintenance of certain county roads, carrying a considerable portion of through traffic, but which the county may efficiently maintain, and which are not of sufficient importance to be classed as provincial, or which it is not desirable, or expedient, for the province to assume as provincial highways. They continue to be county roads, but because of heavy through traffic will receive an increased subsidy. In general, they will form branches of the provincial highway system, joining up cities and other important terminal points of traffic. They constitute an intermediate link between the provincial and county road systems, and may be subject to special regulation.

Suburban Roads. Provision is made under the Ontario Highways Act that a city may co-operate with the county council in improving the leading county roads adjacent to the city, and thereby obtain a more substantial type of construction for such suburban roads.

A commission is appointed to determine the roads and the length of each adjacent to the city to which the city would contribute.

For construction, the province contributes 40 per cent. and the county and city each 30 per cent.; for maintenance and repair, the province 20 per cent. and the county and city divide the remainder equally between them.

The section of county road designated as "suburban" remains a county road for which the county is responsible; the work of construction and maintenance to be carried on under the county road superintendent, but subject to the instructions of the special commission.

Provincial Highways. Described in the preamble to the act as: "A highway or system of highways from the south-western boundary of Ontario to the boundary line between Ontario and Quebec, together with highways connecting centres of population or other important terminal points."

The Lieutenant-Governor-in-Council, upon recommendation of the Minister, may designate any highway or a system of public highways through Ontario to be acquired, constructed, assumed, repaired, relocated, deviated, widened and maintained by the Minister of Ontario as a provincial highway.

Every provincial highway and all property acquired by Ontario under this act shall be vested in His Majesty and shall be under the control of the department.

The corporation of every municipality in which work of construction or repair and maintenance is from time to time carried out, shall repay to Ontario 30 per cent. of the expenditure made by the department within such municipality.

No part of the cost of surveys, of machinery, plant and equipment and the repair and maintenance thereof, all general overhead and staff expenses and salaries, and the cost of additional land or property for deviating, widening, or any other purposes of the department, shall be charged to the municipality, but shall be borne and carried by Ontario.

Up to the year 1916, only 20 counties had assumed systems of county roads as authorized under the Highway Improvement Act; now 34 counties out of the 37 in Old Ontario have adopted such systems and are proceeding with the work in a systematic manner under the regulations of the department. The total mileage covered by these roads is 8,427, and the total mileage constructed to date 2,275, the total approximate cost being $8,600,000, an average of $3,780 a mile. As the total mileage of rural roads in Old Ontario is 55,000, the mileage covered by county roads at the present time is 15 per cent. of the total. It is estimated by the Highway Department that 20 per cent. of the township roads, those usually included in a county system, carry 80 per cent. of the total farm traffic.

The county roads, when completed, will form an excellent system of market roads located in every part of the province. The provincial county roads will join up these county systems for through traffic and will merge the whole into a province-wide system reaching every county and town in the province, and to complete this system, trunk roads will be added, known as provincial highways, for trans-provincial traffic. This will create a system of provincial highways which will not have an equal in any province or state on this continent.

Road construction has been greatly retarded owing to war conditions, but, as stated above, over 2,000 miles of this system has already been built, the organization is complete, and the work will go ahead with leaps and bounds when the war is over.

In conclusion, a few words respecting road construction. The day for haphazard work by untrained men is past. The road problems of to-day require to be carefully worked out by the expert and the correct principles applied. A bridge is never designed without knowing the particulars as to loading, etc., and in the days of heavily loaded motor trucks it is also necessary, if we are to intelligently design our roads and get the best results, to take into consideration such particulars as the maximum load, width of vehicles, width of tires, nature of traffic, nature of sub-soil, etc.

The maximum load is the chief factor in determining the depth of foundation and a road built for light traffic may at certain times in the year have its surface broken up like pie crust by a heavily loaded truck.

The Ontario land surveyor has the technical qualifications, the training, and the experience to successfully carry on this work, and it would be in the interests of the public and himself to give this important branch of the profession more attention.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto

The Calorific Power of Fuels. By Herman Poole, F.C.S. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Limited, Montreal. Third edition, re-written by Robert Thurston Kent, M.E. 267 pages, illustrated, 6 x 9 ins., cloth. Price, $3. (Reviewed by R. O. Wynne-Roberts, consulting engineer, Toronto.)

Fuel is undoubtedly the great and absorbing subject of the time, and the prospects of improvement in quantity and quality are somewhat remote, for even after peace is declared it will take months, at least, to enable the conditions to be readjusted.

Since 1898, when the first edition of this book was issued, many improvements in the use of coal, in the testing of its value, and in the efficiency of its consumption, together with the development of science in the production of new fuels, have taken place. And, moreover, tne information collected by careful studies, under practical conditions, afford an abundant scope for discussion. The fuel tests made by the United States Geological Survey and the United States Bureau of Mines, and the comprehensive and valuable reports issued, form the basis of the third edition of this book.

This volume is divided into eleven chapters and appendix. Chapters 2, 3, 4 and 5 deal with calorimeters and calorimetry. As the book was originally commenced as a translation of M. Scheurer-Kestner's "Pouvoir Calorifique des Combustibles," several of the calorimeters described are mainly European. Some well-known calorimeters are not mentioned, such as Parr's, Boys', and others.

Chapter 6 contains many tables giving data as to the analyses and value of coals found in the United States, Europe and elsewhere. Lignites are to be found in most countries. The writer had occasion in 1912 to investigate the lignite deposits in Saskatchewan and presented a report thereon to the provincial government. Consequently, any new information on this fuel was welcome, but my wish was not gratified to any appreciable extent, when perusing this book.

Peat is at present occupying considerable attention in parts of Canada. The author states that peat is partly decomposed and disintegrated vegetable matter that has accumulated in any place where the ordinary decay or decomposition of any material has been more or less suspended, although the form and a considerable part of the plant structure are more or less destroyed. It is formed by the agglomeration of vegetable debris and retains a large amount of water, which will not separate without heat. Its composition varies but little from that of wood, the principal difference being less oxygen and more carbon. The heat of combustion is lower than that of coal or lignite. The relative heating values of peat and other fuels are given as follows: Pennsylvania anthracite, 12,366 B.t.u.; Pittsburg bituminous coal, 13,365 B.t.u.; Texas lignite, 7,870 B.t.u.; Wisconsin brown peat, 7,468 B.t.u.

Brix obtained with peat an evaporative power of 5.11 lbs. of water.

Peat that is reduced to a powdered form has a larger percentage of volatile matter than coal, burns with a hot flame, and is well adapted for use in powder burners.

Seven pages are devoted to peat and four pages to wood fuel. Denatured alcohol may some day be a very important liquid fuel, especially as it can be produced with facility in Canada.

The appendix contains the code issued by the American Society of Mechanical Engineers relating to boiler tests, and eighteen tables.

The book will be found useful. It is well printed and written in plain terms.

PUBLICATIONS RECEIVED

Smithsonian Institution.—Annual report, 1916. Chas. D. Walcott, secretary, Washington, D.C.

Concrete Pressure Pipe.—Pamphlet published by Portland Cement Association, Chicago.

Existing Lake Levels.—Report of George M. Wisner, chief engineer, Sanitary District of Chicago.

Smith Gas Producers.—Illustrated catalogue published by the Smith Engineering Company, Lexington, Ohio.

The Ontario Bureau of Mines.—Report for 1917. Department of Lands, Forests and Mines, Toronto, Ont.

A Trip Through the Plant.—An illustrated pamphlet published by the Seybold Machine Co., Dayton, Ohio.

Ontario Provincial Board of Health.—Report for 1916. Published by Provincial Board of Health, Toronto, Ont.

Mines Branch of the Department of Mines.—Summary report for 1915. Published by Department of Mines, Ottawa, Ont.

Production of Cement, Lime, Clay Products, Etc., in Canada for 1916.—Mines Branch, Department of Mines, Ottawa, Ont.

Report of Minister of Public Works.—Report for the fiscal year ending March 31st, 1917. Department of Public Works, Ottawa, Ont.

American Society of Municipal Improvements.—Transactions for 1917-18. Published by Charles Carroll Brown, Secretary, Indianapolis, Indiana.

Dam and Water Power Development at Austin, Texas. Report by Daniel W. Meade. Published by the author and Charles V. Seastone, consulting engineers, Madison, Wisconsin.

Proceedings of American Institute of Electrical Engineers.—Published under the auspices of the Meetings and Papers Committee. Single copies, $1.

The Collapse of Short, Thin Tubes.—By A. P. Carman, Engineering Experiment Station, University of Illinois. Illustrated. Bulletin 99. Published by the University of Illinois, Urbana, Ill. Price, 20c.

Espanola District, Ontario.—By Terence T. Quirke. Memoir 102, Geological Survey, Canada, No. 85, Geological Series. Illustrations and geological maps. Published by Department of Mines, Canada.

Tide Levels and Datum Planes in Eastern Canada.—By W. Bell Dawson, M.A., D.Sc., M.Inst.C.E., F.R.S.C., superintendent of Tidal Surveys, Canada. Published by the Department of the Naval Service, Ottawa, Canada.

Tides at the Head of the Bay of Fundy.—Study of tide levels, compiled by W. Bell Dawson, M.A., D.Sc., F.R.S.C., M.Inst.C.E., superintendent of tidal surveys. Published by the Department of the Naval Service, Ottawa, Canada.

Conservation of Trade.—By Hon. Frederic Nicholls, chairman, special committee of the Senate of Canada on conservation of Canadian trade. Reprints and extracts from the debates of the Senate. Deals with trade conditions after the war.

Tests of Oxyacetylene Welded Joints in Steel Plates.—By Herbert F. Moore. Results of experiments testing strength of welds under (a) static load in tension, (b) repeated load (bending), and (c) impact in tension. Published by Engineering Experiment Station, University of Illinois, Urbana, Ill.

Road Material Surveys in 1915.—Memoir 99, Geological Survey of Canada, No. 82, Geological Series. By L. Reinecke. Deals with deposits of stone and gravel along a proposed Ottawa-Prescott highway in Ontario and road material available for a Hull-Grenville highway in Quebec. Illustrations and geological maps. Published by Department of Mines.

Power-driven Air Compressors.—The Canadian Ingersoll-Rand Co., Limited, Montreal, has recently issued Bulletin K-301-A, describing two-stage, power-driven air compressors of the duplex type. This is a 16-page pamphlet, outlining notable features of construction such as the "Circo" leaf valves, Haight 100 per cent. belt wheel joint, bath lubrication system, dust-proof frames and casing, compactness of design, accessibility of parts, etc.

COST OF WATER WASTAGE

In a report which he has just completed, City Engineer Mercier, of Montreal, shows in a striking and emphatic manner how costly are the unnecessary water-tap leaks. Universal metering of the service would tend to remedy all such leaks, as it would then prove more costly to the householders to neglect them than to repair them.

"A tap from which water is leaking drop by drop," says Mr. Mercier in his timely report, "loses 12 gallons of water in a day, which amounts to 84 gallons in a week and 4,368 gallons in a year. It costs 29 cents to pump the yearly wastage on one tap. For 1,000 taps so leaking, eleven tons of coal would be required and $290 in salaries.

"But the loss assumes graver proportions when the tap is one-thirty-second open. It spills 211 gallons a day, 1,178 a week, 76,876 a year. A thousand such taps require in a year 177 tons of coal to pump the water and $5,380 in salaries. Putting this loss in concrete terms, it may be thus estimated:

"Five cars of coal; or the salary of five constables; or the salary of five firemen; or the cost of paving 2,000 square yards of street, which represents the piece of St. James Street between St. Lawrence Boulevard and Place d'Armes. Further, it represents the cost of planting trees 25 feet apart on both sides of 1.2 miles of street, say, on Cote des Neiges Road from Sherbrooke Street to the entrance to the cemetery. It is as much as the city pays in a year to nine hospitals.

"It would buy 2,600 books for the civic library, and is equal in value to 10,760 gallons of milk, sufficient to feed 120 children.

The Serious Waste

"If the running tap is one-sixteenth open, the figures mount tremendously. Such a tap wastes 668 gallons a day, 4,676 gallons a week, or 243,152 gallons a year. A thousand such taps require for pumping 559 tons of coal and $17,020 in salaries. The waste equals 14 cars of coal, the wages of 17 policemen or firemen, and would pave St. Catherine Street from Metcalf Street to Phillips Square. It would plant trees in the manner above mentioned for four miles. It is as much as the civic grant in a year to 17 hospitals. It would buy 8,500 books for the library. It is as much in value as 34,050 gallons of milk, food for 372 babies.

Then, If Open More—Read!

"If the tap is turned on one-eighth, the wastage of water becomes still more alarming. It reaches 2,330 gallons per day, 13,612 gallons per week, or 811,865 gallons per year. To pump this amount for 1,000 taps demands 1,868 tons of coal, and costs $56,811 in salaries. The loss represents 47 tons of coal, the wages of 56 police or firemen, the paving of 18,000 square yards of street. It would plant with trees twelve miles of street. It would represent city grants to 17 hospitals, six dispensaries, nine homes for the aged or children, six refuges, and 34 miscellaneous institutions. It would buy 28,400 books for the library, or buy 113,622 gallons of milk, enough to feed 1,244 children for a year.

"Turned on one-quarter, that wasteful tap would lose 7,632 gallons per hour, 53,222 per week, 2,767,564 per year, a pumpage that would require 6,336 tons of coal, and cost $193,729 in wages.

"If turned on full, the amount of water wasted would be 20,160 gallons per hour, 131,120 per week, and 7,338,240 gallons a year. This, estimated on the 1,000-tap basis, would consume 16,877 tons of coal in pumping, and cost $573,677 in salaries."

TYPHOID IN TORONTO

Chlorination of the water supply and inspection of milk supplies are reducing the typhoid death rate more and more every year in the city of Toronto. "In 1917 there were only 95 cases in the city, with the extremely low death rate of 3.8 per 100,000 of population," says a recent bulletin issued by the Toronto Department of Public Health. "There are so few cases of this disease in the city hospitals that it is difficult for students in the medical faculty to obtain a sufficient number of cases for examination and study purposes.

"There is not one case of typhoid per annum for each four physicians in Toronto, so that many physicians never see a single example from one year's end to the other.

"When it is considered that we had 739 cases of typhoid fever reported in the year that the present health department organization began its labors, one can realize how much the general health of the city has improved, for the number of cases of typhoid fever is considered to be the best single criterion of the healthfulness of a city."

Letters to the Editor

Provincial Consulting Engineering

Sir,—I have read the interesting article by Mr. R. O. Wynne-Roberts in your issue of February 14th and I would like to say at once that in referring to his objection to the proposal I put forward at the Hamilton conference, that we should have more skilled engineering advice in provincial authorities, I had no idea of suggesting that his objection was not well founded. Indeed, since I have conferred with several engineers on this matter I find there is good ground for the objections which they put forward to engineering advice being provided through the agency of government departments. Their objection, however, is not to the principle of such advice being given but to the possible evils which may arise in connection with giving it. For instance, it is contended that when engineers are attached to government departments they sometimes exercise the dual function of supervising the work of local authorities and of designing and carrying out the work themselves. It never occurred to me that this kind of thing was done to any very large extent and I admit that if it were to be a regular practice in connection with government engineering, I should entirely oppose any suggestion to create more official engineers or improve their status. In my judgment, an engineer who is employed by any government authority as a salaried official should not only be prevented from undertaking constructive private work himself, but should be made to feel that it is most improper to do so. Of course, it is essential that official engineers should be paid a sufficient salary to make them independent of private work. The point, however, is that any advocacy I have made to increase the number of provincial and municipal engineers is based on the assumption that they would not be permitted to do private work and that their functions would be largely of a judicial character.

In regard to the second objection which Mr. Wynne-Roberts raises in his letter, I admit the soundness of his contention that men who are paid by the government should not be permitted to take the bread out of the mouths of those who are engaged in private practice as a general rule. There are exceptions, however, and I think Mr. Wynne-Roberts himself agrees that no hard and fast rule can be laid down in this respect.

It will be noticed that I deliberately used the term "small municipalities" when I suggested that advice and assistance should be given. These small municipalities cannot employ skilled consultants and until they can, there is no objection to giving them advice through the provincial government. On the other hand, when larger municipalities are able to employ skilled engineers the presence, in the provincial government, of a department of municipal affairs would be a great stimulus to local authorities to employ proper engineering assistance.

I do not think that any engineering advice and assistance given by the government should be other than gratuitous but it should only be given where a local authority has inadequate means to employ an engineer. In other cases the function of the department would be to encourage the use of engineers in private practice. I am aware that there is the difficulty of not being able to draw the line, but we had to meet exactly the same kind of circumstances in connection with town planning in England and we succeeded because we always erred on the safe side by not giving advice or assistance except in very necessary cases. As Mr. Wynne-Roberts says, the function of the government engineer in England is primarily judicial, and it will only be necessary for it to be advisory in Canada while we are waiting for improved status for the engineer and while we are trying to get rid of our present low standards of sanitation in some municipal areas.

I am grateful to Mr. Wynne-Roberts for the generous way in which he deals with my suggestions. With him I would like to see the engineers themselves more persistent in demanding a better recognition of their skill and executive ability.

I have the utmost respect for members of the legal profession, but when one hears it so frequently reiterated that engineers have no judicial or executive ability and, therefore, that lawyers only are fitted to become members of judicial or executive bodies, it makes one feel that engineers must be without an agency to adequately represent them collectively in securing proper recognition of the profession.

Only recently we have seen engineers made heads of great trunk railways, of the food department of the United States and of some of the chief administrative departments of Great Britain. We are told that among the most successful executive heads of the intelligence branch of the British army is a man who was a consulting engineer in Toronto up to the outbreak of the war. When we look round and see the position which the engineer takes as an executive and in a judicial capacity when the opportunity is provided for him, one can only lament the fact that that opportunity is so wanting in Canada and feel that the engineers themselves must be partly to blame. At any rate it is certain that improvement will only come if the engineers take the initiative and if they be loyal to one another in insisting upon every member of the organized profession practising up to an ethical standard equal to that of any of the great professional institutes in other countries.

THOMAS ADAMS,
Town Planning Adviser,
Commission of Conservation.

Ottawa, Ont., February 22nd, 1918.

Quebec Bridge Main Shoes

Sir,—Referring to the article on expansion joints and traction trusses, Quebec Bridge, appearing in your issue of February 7th, 1918, the contents of the concluding paragraph of this article might leave the impression on the reader's mind that the main shoes were not placed on the centre line of the main piers.

As a matter of fact, inasmuch as the final alignment of the whole structure from shore to shore depended on the placing of the main shoes, these shoes were set with exceptional accuracy and on the centre line of the main piers.

The deviation of 3 inches from the theoretical span of 1,800 feet is in the final distance centre to centre of main piers. As stated in the article, a total allowance of 4 inches was made in the expansion joints between the cantilever arm and suspended span to take care of a possible error of this kind.

A. J. MEYERS,
Chief Draftsman,
Board of Engineers, Quebec Bridge.

Montreal, P.Q., February 12th, 1918.

EXPANSION OF MINERAL INDUSTRY ESSENTIAL

Canada pays more money for imported mineral products than she receives from her mines, the commission of conservation reminds us. The value of the mineral production for the calendar years 1913, 1914 and 1915 was $145,600,000, $128,865,000 and $137,100,000 respectively. The imports of products of the mine and manufactures of mine products for the same years were valued at $259,300,000, $181,676,000 and $146,324,000. As the imports also include manufactured, or partly manufactured products, they are much more valuable than the minerals we produce. If, however, Canadian minerals were turned into manufactured products in Canada, the present trade balance in minerals would be reversed.

It is only fair, though, to point out that Canada is under serious disadvantages in the matter of manufacturing. The relatively small and scattered population makes distribution from points of production to points of consumption both difficult and costly. Similarly, where, for example, coal is essential for reducing ore and for manufacturing, the cost of transportation necessary to bring the two raw products together, bears heavily on manufacture. Copper, zinc and lead are produced principally in Western Canada, while the manufacturers and chief markets are in eastern Canada. In spite of these handicaps, a comparison of the figures for imports and those for production shows the opportunity that exists for developing a home market that will increase as the war goes on. Premier Lloyd George in his recent address stated that "Economic conditions at the end of the war will be in the highest degree difficult. . . . There must follow a world shortage of raw materials, which will increase the longer the war lasts, and it is inevitable that those countries which have control of raw materials will desire to help themselves and their friends first."

The mineral resources of Canada, if developed, could supply not only our own needs but also permit the exportation of a surplus to other parts of the British Empire. There is, in Canada, an urgent need for production to pay for our war debt and borrowings before the war, and if we are to get the greatest value out of our mineral industry it is necessary that our metals and minerals be refined and made into manufactured or partly manufactured products in Canada. The production of certain mineral products in Canada has been stimulated by the war and new industries created. In the period of reconstruction, after the war, it will be necessary to safeguard and provide for the further extension of these industries.—From "Conservation."

THE EXPERIMENTAL PLANT AND SANITARY ENGINEERING SERVICE

"At the Experimental Plant of the Provincial Board of Health problems arising in connection with sewage disposal and purification of public water supplies are studied. Units of appliances, such as mechanical slow sand filters, sewage tanks, sludge plants, etc., are established and their capacities and values tried out. In this way the Board through the Engineer is able to offer expert advice to municipalities proposing to erect a water purification plant or a sewage disposal works. For all of these works plans, specifications and an engineer's report are required by law to be presented for approval of the Board. If the plans are faulty, too expensive, inadequate or unsuitable for the work in hand they are checked up by the Board's Engineer and the municipality is often saved considerable unnecessary expense and trouble.

"The volume of work of this character is bound to become very extensive in Ontario. In a recent year upwards of four million dollars' worth of work of this character passed through the hands of the Board."—Public Service Bulletin, Province of Ontario.

A vertical water turbine which tested at 94.5% efficiency, has been installed at Copper Cliff, Ont., for the International Nickel Co., by Henry Holgate, consulting engineer, Montreal. The unit delivers about 9,000 h.p., operating under 85-ft. head.

The quantity of cement imported into Canada from the United States is being reduced yearly. In 1913, there were imported 986,464 barrels; 1914, 88,591 barrels; 1915, 51,240 barrels; 1916, 19,692 barrels. The value of the 1913 importations was $1,580,506, and of the 1916 importations, $31,067, showing a reduction of over one and a half million dollars.

RECEIVER FOR CENTRAL RAILWAY

Judgment has been rendered by Sir Walter Cassels, sitting in the exchequer court, Montreal, rejecting the petition of the directors of the Central Railway Company of Canada for confirmation of a scheme of arrangement between that company and its creditors. Immediately following the rejection of the scheme of arrangement an application was made by John W. Cook, K.C., counsel for the City Safe Deposit and Agency Company, Limited, of London, England, who are trustees for the bondholders, asking for the appointment of F. Stuart Williamson, of Montreal, as receiver. This application was made in a suit taken by the trustees, which has been pending for some time. The application was granted and Mr. Williamson was sworn in as receiver.

These judgments are the culmination of various legal proceedings in the exchequer court concerning the affairs of the Central Railway Company, of which C. N. Armstrong is president, having succeeded to this office upon the death of the late Senator Owens.

The other directors of the railway are W. D. Hogg, K.C., E. A. D. Morgan, J. T. Bethune, J. O. Dupuis and J. D. Wells, the latter having also acted as secretary of the company. Apart from certain subsidiary roads, it was intended that the main line of the Central Railway should run from Montreal to Midland, but only twenty miles have been partially constructed. Bonds to the value of more than £427,000 have been issued, these being largely held in England and France. These bonds do not seem to have been highly regarded by the Canadian investing public.

A SOURCE OF TOLUOL

There is an almost untapped supply of toluol, the basis for T.N.T., in the form of a waste product of a sulphite pulp mill. This waste material is the spruce turpentine which can be collected during the cooking in a simple apparatus whose cost is estimated at less than $100. The collection of the spruce turpentine is simple and the material can be shipped for refining to a central point by means of drums, tank cars or barrels. If any acid reaction is found after collection this may be neutralized with lime, but care in collection will eliminate this difficulty. It is probable that the crude turpentine can easily stand a shipment of requiring 14 days in transit. A refining plant handling 500 gallons per day of the crude material is about the smallest commercial unit. At present prices for toluol, $5 per barrel for the crude material might be obtained. Experiments and estimates as well as actual practice have shown that one gallon of crude turpentine per cord of wood is not an impossible yield. The yield, however, varies with a number of factors, such as, the kind of wood, its age and condition, method of cooking and the process of collection. A plant in New Jersey is making 1,000 gallons of toluol a week now and could make much more if the spruce turpentine were available.—Exchange.

NEW SHIPBUILDING ENTERPRISES

A number of representative citizens of Sault Ste. Marie called upon Sir William Hearst, premier of Ontario, recently to discuss with him plans for establishing a shipbuilding industry at Sault Ste. Marie. Before the war steps were taken to establish a shipbuilding plant and drydock, but work has been delayed. Now it is proposed to begin the construction of wooden ships in connection with the steel plant, with a view to steel-ship construction later.

The British Columbia shipbuilding programme is to be augmented by the construction of forty wooden ships, aggregating a total of 140,000 tons. Twenty of these ships will be built in Victoria by a syndicate of capitalists, headed by J. G. Price, president of the Cameron-Genoa Mills Shipbuilding, Limited, the new shipbuilding concern to be known as the Victoria Shipbuilding, Limited, while the remainder will be built by the British-American Shipbuilding and Engineering Company, Limited, which had secured the lease of a shipbuilding site on the old Kitsilano Indian reserve at Vancouver. The larger company is headed by J. A. Sears, of Vancouver.

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Principal Contents of this Issue

EARLY STREET CLEANING

Muddy streets, although a nuisance to pedestrians, are in one way beneficial to public health. The amount of street dust which must be breathed by the populace is greatly reduced when the streets are wet and muddy late in the winter. When the streets dry after the first spring thaws, and too early for the summer sprinkling carts and flushers to get into action, there is always a great increase in the amount of general sickness prevailing in cities.

Many physicians formerly attributed this prevalence of ill-health during early spring to the fact that one's constitution was likely to have been weakened by the strain of having withstood a whole winter of severe cold weather. This theory has been gradually abandoned and most physicians now attribute a large portion of the spring ailments to street dusts.

The dread power of street dusts is well known. Scores of the most virulent germs find their habitat in such dust. Out of forty-six inoculations into animals by Dr. Cornotti, with bacteria from city dust, thirty-two caused infectious diseases (*vide* "Bacteria in Daily Life," G. C. T. Frankland, London, 1903, p. 216).

B. tuberculosis, B. coli. comm., the bacterium pneumococcus, staphylococcus and streptococcus, pyogeneus, diphtheria, anthrax and tetanus, have been recognized as permanent inhabitants of dust (*vide* "Quantitative Study of the Bacteria in City Dust," Winslow and Kligler, American Journal of Public Health, Vol. 2, New York, 1902, pp. 663-701; and "Street Dust as a Factor in Spreading Disease," Anders, Medical Record, Vol. 78, New York, 1910, pp. 563-6).

Tonsilitis, quinsy, laryngitis, pneumonia, influenza, tuberculosis, asthma, rheumatism, diarrhoea, skin disease, conjunctivitis, trauma of the cornea, nasal catarrh, frontal sinus affection and middle ear disease from irritation of eustachian tubes,—all these lurk in the dust of the streets; chronic catarrhal colds and augmentation of the adenoid growths frequently are due to irritation and infection by street dust (*vide* "Dust Menace and Municipal Disease," Anders, Journal of the American Medical Association, Vol. 57, Chicago, 1911, pp. 1524-6).

Moreover, dust may, by predisposing an irritated condition of the respiratory organs, so lower the vitality of the mucosa that the development of any germ deposited thereon will be favored (*vide* "Dust and Its Danger to Children," La Fetra, Archives of Pediatrics, Vol. 23, New York, 1906, pp. 869-72).

A very alarming relation between dust and disease is revealed in the fact that experiments show dust-carried infection of infantile paralysis (*vide* "Experimental Poliomyelitis," Neustaedter and Thro, New York Medical Journal, Vol. 94, New York, 1911, pp. 613-5 and 813-20).

To sum up, suspicion points to street dust as one of the worst etiological mischief makers. City and town engineers who value the health of their public will begin the thorough sprinkling and flushing of streets at the earliest date permitted by the weather. There should not be the unnecessary delay that has occurred in past years in many Canadian municipalities.

ELECTRIFICATION OF RAILWAYS

Replying to a delegation which called upon the government at Ottawa last week urging the electrification of the Ontario lines of the Grand Trunk Railway, Premier Borden said in part: "I suppose it is a more or less technical question. I can see that we are in a different position to many countries and that we can succeed more quickly along such lines than in the United States, but you will agree that there is no use of our embarking on such proposals without seeing whether we are on the right track."

There can be no question but that Canada does occupy an enviable position so far as the electrification of her railroads is concerned, blessed as she is with a most valuable heritage of developed and undeveloped water powers. We should be in a position to tackle this problem with considerable confidence and excellent prospects of success. The day ought not to be far distant when Ontario's stores of electrical energy might be applied in channels where they are most needed.

Electrification of railways in Ontario would mean the releasing of vast quantities of coal which could be used more advantageously for heating purposes.

Speaking before the annual meeting of the American Institute of Electric Engineers a few days ago, E. W. Rice, Jr., president of that body, declared that ten per cent. of the ton mileage of the railways in the United States is taken up in moving coal, and as most of the coal is used by railways, they are stumbling over themselves by clinging to steam power. He furthermore stated that electrification of railways of the United States would save about a hundred million tons of coal annually.

If more of our railroads which are now operated by steam engines using coal as fuel, were driven by electrical power, hydraulically generated, it would mean that many of our water powers hitherto undeveloped would be harnessed for useful work. As every undeveloped water power is to all intents a burning coal mine (for coal of equivalent power would be saved if the water power were utilized), to that extent the exhaustion of the coal supply would be postponed.

PERSONALS

Capt. LEROY Z. WILSON, of Brampton, Ont., B.A.Sc. '09 University of Toronto, has been awarded the Military Cross.

EUGENE McG. QUIRK, A.Can.Soc.C.E., of Montreal, has been appointed to the Canada Registration Board of the War Committee.

JAMES HUNTER, formerly of the Hunter Structural Steel Co., Toronto, has received an appointment as structural engineer with the Marine Boat Corporation, New York.

J. G. SEYFRIED, formerly structural engineer with the bridge department of Canadian Allis-Chalmers, Limited, Toronto, has joined the Lackawanna Steel Company, Buffalo, as structural engineer.

ROSS H. McMASTER, the assistant general manager of the Steel Company of Canada, has been appointed to the staff of the Canadian War Mission to Washington. He will be purchasing agent for the iron and steel industries.

J. J. SCOLLOM, formerly general superintendent of the Davenport Works of Canadian Allis-Chalmers, Limited, Toronto, and latterly manager of that firm's shipyard at Bridgeburg, Ont., has been appointed manager of hull construction for the Marine Boat Corporation, of New York.

FREDERICK H. PETERS, commissioner of irrigation and chief engineer of the Department of the Interior, Calgary, Ont., addressed the Ottawa Branch of the Canadian Society of Civil Engineers on Thursday last upon "Ways and Means for Improving and Defining the Status of the Engineer."

THOMAS LEES, A.M.Can.Soc.C.E., formerly resident engineer for the Canadian Pacific Railway at Calgary, Alta., has been appointed engineer of water services at headquarters at Winnipeg. R. C. HARRIS, formerly of Edmonton, will succeed him and will be replaced by H. H. TRIPP, of Kenora, Ont.

J. F. RHODES, A.M.Can.Soc.C.E., publicity manager of the Canada Cement Co., Limited, has resigned to accept a position with the Trussed Concrete Steel Co., at Youngstown, Ohio. Mr. Rhodes came to Canada about four years ago after having been in the employ of the Grasselli Chemical Co. as designing engineer. He is a graduate of the University of Pennsylvania.

A. P. S. GLASSCO, B.Sc., A.M.Can.Soc.C.E., has been appointed secretary and bursar of McGill University, in succession to W. Vaughan, retired. Mr. Glassco graduated in engineering at McGill in 1901, and later was appointed assistant bridge engineer of the G.T.P. From 1905 to 1908 Mr. Glassco was assistant engineer of the Quebec Bridge Commission and afterwards assistant manager of the Cleveland Bridge Company. Subsequently he was a member of the engineering firm of Atkinson, Glassco & Lawrence, Montreal.

OBITUARIES

JOHN J. MOLLOY died at Winnipeg on February 19th. He was born at Guelph, Ont., in 1837, going west in 1872 as resident engineer of the C.P.R., construction of which was then just starting. He left the C.P.R. in 1897 to take charge of Dominion government surveys. He retired from public life in 1917. Mr. Molloy represented Provencher in the Manitoba House for several years.

CAN. SOC. C.E., OTTAWA BRANCH

John Blizard, A.M.Can.Soc.C.E., will present a paper before the Ottawa Branch, Canadian Society of Civil Engineers, this evening on "Availability of Energy as a Source of Power and Heat." Mr. Blizard will deal with his subject from the standpoint of the power and fuel requirements of the Dominion.

CAN. SOC. C.E., MONTREAL BRANCH

Philips B. Motley, engineer of bridges, Canadian Pacific Railway, will read a paper to the members of Montreal Branch, Canadian Society of Civil Engineers, this evening on "Tests of Chain Guards on the Panama Canal." Henry Goldmark, M.Can.Soc.C.E., who wrote the paper, will not be able to be present, so Mr. Motley has consented to read it for him. The paper will be illustrated by lantern slides.

CAN. SOC. C.E., TORONTO BRANCH

A meeting of the branch is to be held in the Chemistry and Mining Building at the head of McCaul Street on Tuesday, March 5th.

President H. H. Vaughan and Secretary F. S. Keith of the Canadian Society of Civil Engineers will be present to place before the branch the possible activities of the society under the new by-laws passed at the recent annual meeting.

A.I.E.E., TORONTO BRANCH

The following program has been arranged by the Toronto Branch of the American Institute of Electrical Engineers for the month of March:—

Friday, March 1st, at Engineers' Club, 96 King Street West, at 8 p.m., N. P. Jackson, of the Research Division, Westinghouse Electric and Manufacturing Co., Pittsburgh, will read a paper on "Commercial and Industrial Research."

Friday, March 8th, is the date of the Institute meeting at Cleveland, Ohio, in which the Toronto section is participating as a host.

Friday, March 15th, at Engineers' Club, 8 p.m., J. J. Frank, of the General Electric Co., Pittsfield, Mass., will read a paper on "Recent Developments in Transformer Practice."

The mine operators at Kirkland Lake, Northern Ontario, propose to have a comprehensive survey made of the geological structure of that district.

B. F. Haanel, B.Sc., Chief of Fuels and Fuel Testing Division, Department of Mines, Ottawa, addressed the members of the Toronto Board of Trade to-day on "Peat."

Through contracts placed by the British Government direct, British Columbia's shipbuilding programme is to be augmented by the construction of forty wooden ships, aggregating a total tonnage of 140,000.

W. G. Clarke, Thos. Cantley, Percy Black, Jas. Kelleher and Walter Crowe have been appointed members of the newly-formed Nova Scotia Provincial Highways Board. W. G. Clarke, of Bear River, N.S., is chairman.