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The Canadian Engineer

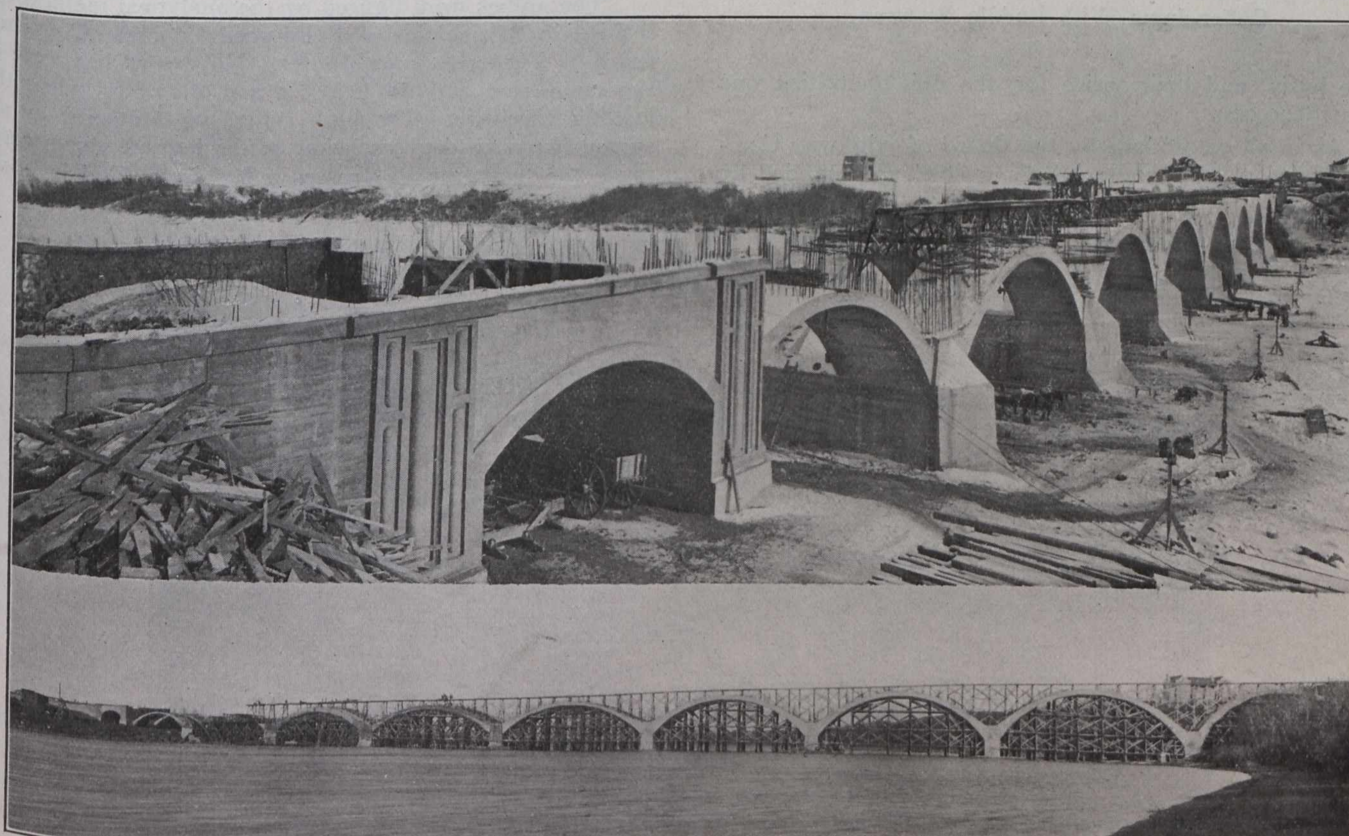
A weekly paper for engineers and engineering-contractors

NEW HIGHWAY BRIDGE AT SASKATOON, SASK.

A REINFORCED CONCRETE STRUCTURE OF TEN SPANS OF ARCH RIBS WITH SPANDREL WALLS AND COLUMNS—A 1,250-FOOT BRIDGE WITH FLOOR ON A GRADE OF 2.88 PER CENT.

THE City of Saskatoon, with a population of about 30,000, is situated on both banks of the south branch of the Saskatchewan River, and is served by a single highway bridge. This was built in 1907 and is a steel superstructure on concrete piers. In June, 1912, the Board of Highway Commissioners of Saskatchewan took up the matter of providing a second bridge. A conference was held with the city officials of Saskatchewan at which the needs of the city were presented and a site selected. The site chosen was between 25th St. on the city side and Saskatchewan Ave. on the east side. Saskatchewan Ave. is the south boundary of the grounds of the University of Saskatchewan. The river is some 900 feet wide at low water at this point and the elevation of the west bank is 50 feet lower than the east or University side.

Comparative designs in steel and reinforced concrete were made by the Board and finally a series of reinforced concrete arches was adopted as best suiting the requirements.

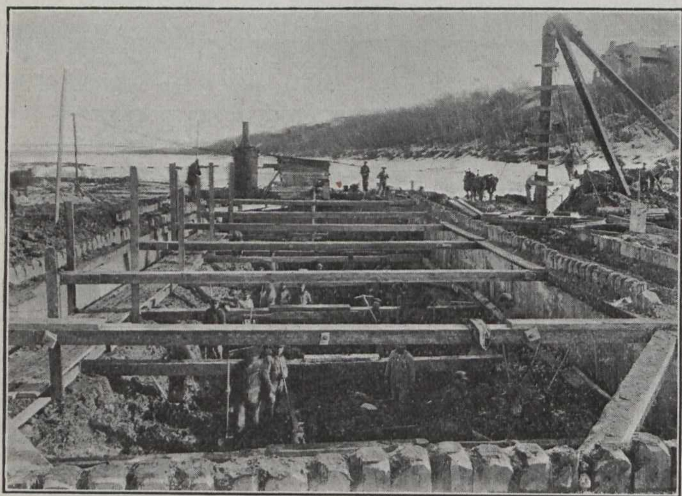


Views of Saskatoon Highway Bridge During Construction. Upper View Shows Its Present State.

The adopted design was that of a bridge consisting of a series of ten arches with the floor on a grade of 2.88%. Arch "A," a small one of 25-foot span, is earth filled. The other nine vary in spans from 66 to 150 feet and each consists essentially of two 16-foot arch rings 15 feet apart. The floor is supported from these arch rings by spandrel walls. The floor is made up of girders and beams. The total floor width is 65 feet, including two

8-foot cantilevered sidewalks. The total length of the structure, including retaining wall and approaches, is 1,490 feet. The bridge proper is about 1,250 feet long.

Tenders for the construction closed July 15, 1913. The R. J. Lecky Company, of Regina, were the lowest and successful tenderers. The work was let on the unit price basis and their price for the unit quantities was about $240,000.



Typical River-pier Excavation, Showing double Line of Coffer-dams With Puddle Between.

As in all work done by the Board of Highway Commissioners, cement and reinforcing steel are supplied by the Board. These added to the contract price bring the cost of the bridge, exclusive of paving, to about $400,000.

An agreement was entered into between the City of Saskatoon and the Board. The city agreed to pay one-third of the cost of the work. Construction was to be carried on under the Board, but the work was to be open to inspection by the city.

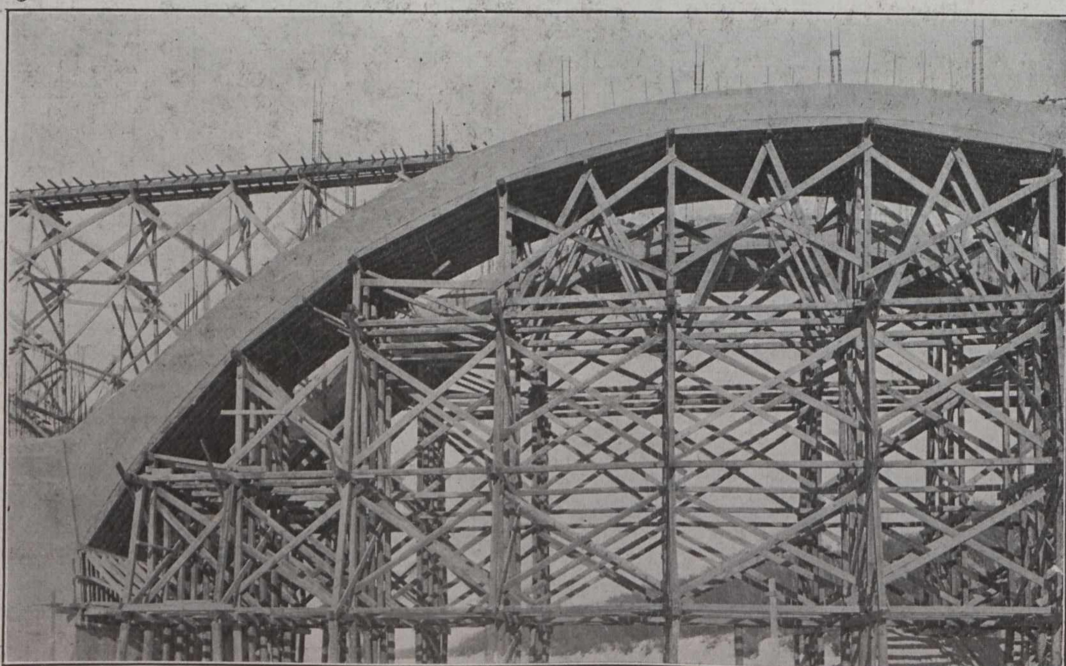
The loading adopted provided for 100-ton cars on each of two street car tracks, with loading from a 25-ton traction engine on the two 14-foot roadways on the remaining floor surface. Loading for sidewalks was taken as 150 pounds per square foot.

The allowable working stresses give 600 pounds per square inch as the maximum compression in the concrete, including temperature stresses. The range of temperature adopted was from 50 degrees to 90 degrees F.

The excavation for foundations revealed, after the first few feet, a hard blue clay. The original design required pre-moulded concrete piles under the shore abutments and piers. The sub-soil proved of such good quality that it was decided to use piling only under the retaining walls, in approaches, and under a small part of the east abutment. Wooden piling was used in these places.

Boring tests were made under all completed excavations and invariably revealed the same hard blue clay. A bearing platform was also used in foundation tests. Known weights were placed on a platform for 48 hours. This loading platform was supported by a bearing surface one foot square and periodic readings with a level were taken for any change in elevation. The tests were satisfactory and showed a safe margin for bearing power of the soil. Foundation pressures vary but are always less than four tons per square foot.

The arches were figured by the analytical method described in "Principles of Reinforced Concrete Construction" by Turneaure and Maurer. No two arches were of the same rise and the heavy grade of 2.88% made the loading eccentric. The high range of temperature assumed (from 50 degrees below to 90 degrees above zero) made the temperature stresses a big factor and in some arches temperature provided more stresses than all other stresses combined. This 140-degree range is thought to be the largest yet assumed in the design of any reinforced concrete arch.



Detail of Centering One of the 150-foot Arches.

The first sod was turned in August, 1913, and the river piers were begun in December. The work was continued throughout the winter.

The contractor, after some experimenting, used a double row of Wakefield sheet piling separated by a puddled clay core. Pier "GH," third from the east end, gave much trouble, and was one of the two piers unfinished when the ice went out in April, 1914.

The first arches, A and B, were poured in June, 1914, and the last arch in November of the same year.

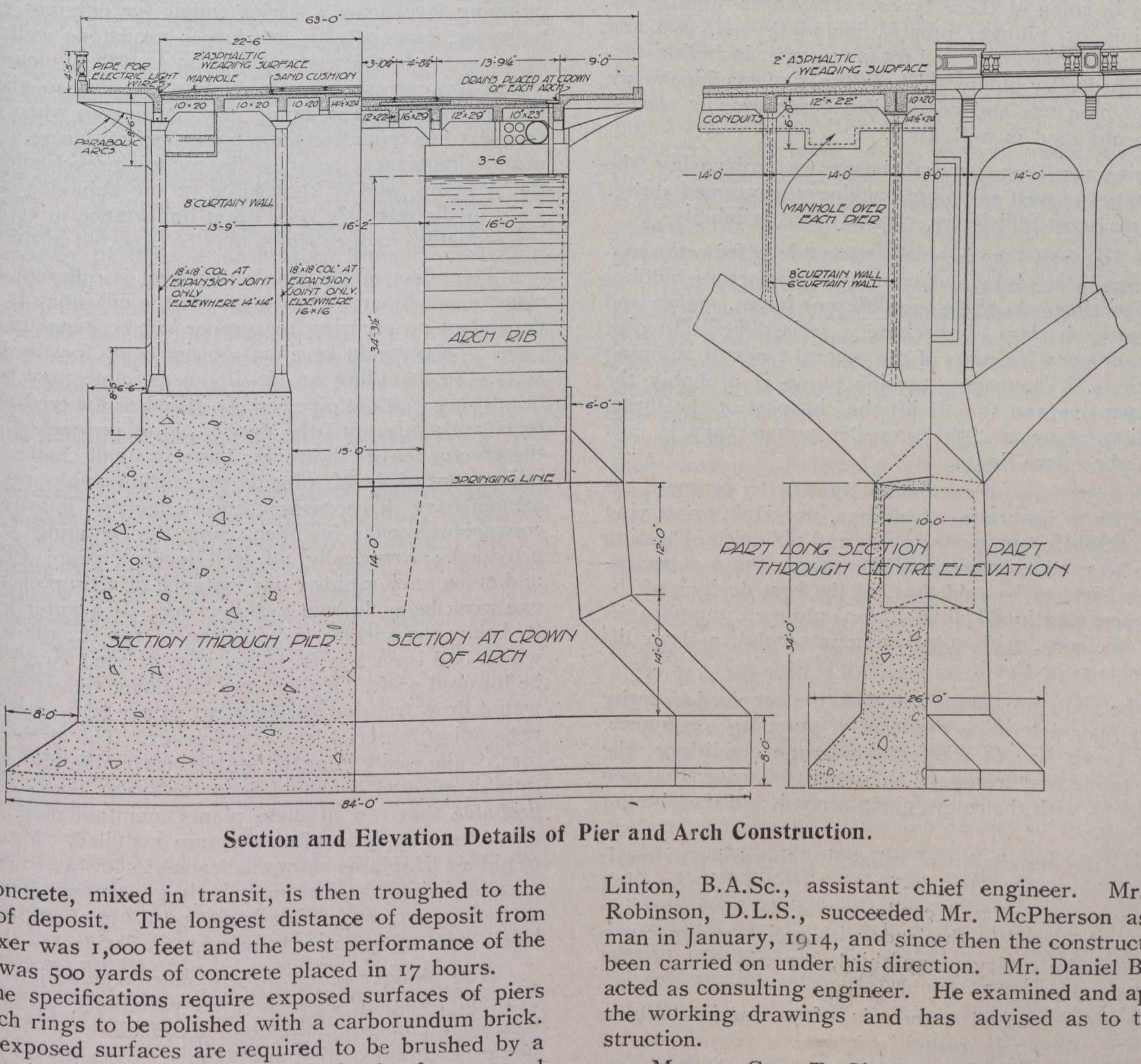
Since August all concrete has been deposited with a pneumatic concrete placing machine supplied by the Pneumatic Concrete Placing Co. of Canada, Limited, Montreal. This is the first work on which this machine has been used in Western Canada.* Measured quantities of aggregate cement and water are introduced into a closed chamber; air, compressed to 110 pounds per square inch at the receiver, is then introduced at various places into this chamber, and the mix is "shot" through pipes eight inches in diameter laid along a trestle built above the centering to a discharge box situated over the work.

Part of pier "JK," immediately below the springing line of arches, refused to take a proper set and it was decided to remove the faulty material. The centering was kept tight by means of wedges under these arches and the poor material was removed in parallel strips running longitudinally through the pier and a very workmanlike job was done.

Responsibility for the failure of this concrete has not yet been definitely fixed and at the present time the Board is having a most careful enquiry made.

Wedges have been struck for the centering of all arches and the centering has been removed. All of the arches are entirely satisfactory. The taking down of the centering completed the season's work. The superstructure and railing are still to do.

The bridge was designed under the direction of A. J. McPherson, B.A.Sc., chairman, Board of Highway Commissioners, by the bridge branch of the Board, A. P.



Section and Elevation Details of Pier and Arch Construction.

The concrete, mixed in transit, is then troughed to the point of deposit. The longest distance of deposit from the mixer was 1,000 feet and the best performance of the mixer was 500 yards of concrete placed in 17 hours.

The specifications require exposed surfaces of piers and arch rings to be polished with a carborundum brick. Other exposed surfaces are required to be brushed by a stiff wire brush and clean water immediately after removal of forms. No cement wash or plastering is permitted.

The specifications call for a mix of 1 of cement to 7 of sand and gravel combined in the piers. In the arch rings and superstructure a mix of 1 to 5 is specified. A pit run gravel was used in the piers and the same gravel graded by adding coarse gravel to it was used in the arch rings.

*See *The Canadian Engineer*, February 4th, 1915, p. 224.

Linton, B.A.Sc., assistant chief engineer. Mr. F. J. Robinson, D.L.S., succeeded Mr. McPherson as chairman in January, 1914, and since then the construction has been carried on under his direction. Mr. Daniel B. Luten acted as consulting engineer. He examined and approved the working drawings and has advised as to the construction.

Messrs. Geo. T. Clark and G. D. Archibald have been successively city engineers of Saskatoon during the construction. Mr. Fred Saynor is resident engineer for the Board.

The R. J. Lecky Co., of which Mr. R. J. Lecky is manager, are the contractors and Mr. L. O. Beam is their superintendent of construction.

We are indebted to Mr. Linton for this description of the structure.

MACHINERY FOR DEEP WELL PUMPING PLANTS.

THERE is a wide variation in the results obtained in deep well pumping, and a great deal of it may justly be attributed to lack of proper data upon which the design of the plant is made. The selection of machinery naturally depends upon its suitability to produce the required results under the conditions which exist. Obviously there is a great necessity for studying all the factors entering into the problem of construction and operation of plant. We reproduce the following useful data from a paper on the subject read by Mr. D. A. Graham, assistant engineer, Dabney H. Maury Company, Chicago, at a recent meeting of the Illinois Society of Engineers and Surveyors.

Mr. Graham divides deep well pumping machinery into three general types, although there are additional divisions in some of these types. They are: air lift, reciprocating or plunger pumps, including one, two and three plunger machines, and rotary pumps, including turbine and propeller pumps. These types of machinery are all in common use and no detailed description is needed by those engaged in well work.

There are four general bases for comparing the several types of well pumping machinery mentioned above. These are: cost, efficiency, capacity and reliability.

The first cost may be easily ascertained from the machinery manufacturers and from the contractors bidding for the erection. As there are different forms, makes and grades of each class of machinery, it is difficult to give general comparative costs of the several types of pumping installations. The rotary turbine pump is probably the most expensive and the air lift the cheapest of the three. The reciprocating and the propeller pumps vary in cost between these two limits.

Efficiency is a more difficult matter to estimate, as unreliability or ignorance of bidders, uncertain or varying well conditions, improper erection and difficulty of testing combine to produce results different from those expected. In general it may be said that, of the best designs of the three types mentioned above, the plunger pump ranks first in efficiency, with rotary pumps second, and air lift generally a poor third.

If the wells are already drilled, the required quantity of water may determine the type of pumping machinery. With a given size of well, and average conditions, the air lift stands first in regard to amount of water that can be delivered, with the rotary pump second, and the plunger pump third.

From the standpoint of reliability the order of merit is again changed. The air-lift, with all of its moving parts above ground and easily accessible for inspection and repairs, is well in the lead, with reciprocating pump second and the rotary pump third, especially at lifts of 100 ft. or more.

The four general standards of comparison above stated are commonly recognized, and a comparison of each case can readily be made by reducing all these factors to the basis of annual cost, including operating expenses, interest and depreciation. There are a number of other factors, however, which cannot be stated in general terms, and which affect, not only the importance of the general characteristics of each type, but may dictate one type to the exclusion of all others from consideration.

The more important of these factors are: size of well, straightness of well, character of water, both chemical and physical, pumping level of well and its probable fluctuations, number of units permitted, or the emergency reserve available, skill of the contractor who is to do the erecting, and the character of attendance and care the plant will receive after it is constructed.

For example, a turbine rotary pump cannot be successfully installed in a well smaller than 12 ins. in diameter, and the larger sizes produce the best results. A well so crooked as to cause a bend in rods or shaft of plunger or rotary pumps should never be used for these classes of machinery, except with a full knowledge of the breakdowns and repairs that are bound to result. Air lift is admirably adapted to crooked wells. Water high in sulphuric acid or carrying sand makes the use of either the plunger or turbine pump expensive, requiring heavy slow-corroding drop pipe.

The pumping level of a well at the capacity required is of prime importance in the selection of a pump. The pumping level usually varies widely for different rates of pumping, especially in the deeper sandstone wells. The statement of the water level in a well is meaningless unless the corresponding pumping rate is also given, although the rate of pumping is seldom given when data of this sort are requested from operating engineers. It is of utmost importance to know the pumping level before buying a pump, and a knowledge of the behavior of other wells in the territory is of great importance in estimating the probable changes which may be expected in the future.

The effect of varying water level is different in each class of machinery. In the air-lift the efficiency is largely dependent on securing the proper submergence of the air pipe. This should be about 60 per cent. for the best results. In installing an air-lift an estimate may be made in advance and the pipe readily raised or lowered after the tests are made until the desired point is reached. After the erector leaves, however, there is small chance for the adjustment of the air pipe by the station employees. They seldom have the necessary knowledge and it is rare that convenient means for measuring the pumping level are provided. Practically all well levels change with time and some vary rapidly, one instance of a drop of 70 ft. in one week being known to the writer. If a water level 100 ft. below the surface should drop to 120 ft., the air pipe, which had been 250 ft. below the surface, would have to be lowered 50 ft. If this were not done, the submergence would drop from 60 per cent. to 50 per cent., with a corresponding material loss of efficiency. The air lift, therefore, while easily adjusted within reasonable limits, is materially affected by changes in the water level, and it is probable that few of these plants maintain their best efficiencies very long after they are installed. Many tests of old air lift plants show efficiencies as low as 10 per cent. over all, while the manufacturer's guarantees now run to 30 and 40 per cent. This is due partly to changing water levels and partly to improvements in design.

The plunger pump also is affected materially by the original pumping level and its variations, although its reliability changes more than its efficiency. The rods, pump head and motive power must be designed for given loads. As long as the water level remains above the working barrel all goes well, as the entire machine is usually designed for a head equal to the depth the plungers are placed below the surface plus a constant surface pressure. If, however, the water level drops below or close to the barrel, trouble is sure to begin. The pump will take air, and breakage and loss of efficiency result. If the condition of the well permits, the barrel may be lowered, but the strain on all parts is thereby increased and trouble is likely to occur. Plunger pumps are not suitable for changing well conditions and should be specified only on thoroughly proven data.

The turbine pump has the same limitations as the plunger pump with an important addition. The efficiency and capacity of a turbine are only at a maximum for a very short range of head fluctuation and fall off very rapidly as the head increases. It is absolutely essential that a pump of this class be designed for a definite and known water level, and a change in this level frequently requires the reconstruction of the entire pump. There are some forms of rotary propeller pump which do not have this objection as they are built in sections and can be extended within the limits of strength and of motive power.

The number of units in the proposed plant and the emergency reserve, in the form of water storage or connection with neighboring supplies, may have an important bearing on the problem. With a number of units and sufficient reserve, the hazard due to breaking pump rods is materially reduced and such an accident can usually be repaired in a few hours. With the danger of interrupting the service, this contingency resolves itself into a matter of cost of maintenance. With only one unit, however, the importance of continuous service greatly enhances the value of the reliability of the air lift.

The skill, experience and responsibility of the erection contractor is of great importance, especially where anything but air lift is considered. If possible, a pump should be erected by its makers, or by their trained representatives, and the responsibility of the contractor and pump maker and their policy in dealing with customers' complaints should be carefully investigated. It is often better to have a fairly good well pump made by a concern which stands back of it, than a better pump which does not value the satisfaction of its customers enough to help them overcome the difficulties that are so often encountered in well work.

The erection of a well pump is of almost equal importance with its design, and must be carefully considered in selecting the type of machinery to be used. Many a good pump has been unsatisfactory because of improper installation or of unsuitable well conditions which should have been detected and reported by a competent erector.

The character of the attendance a plant will receive may vitally affect the selection of the type of pumping machinery. Few accidents can happen to an air lift which will not be immediately detected and remedied, although the efficiency may fall off very materially under unskilled or careless management. The other types of plants are more delicate and require constant and intelligent supervision.

The causes of trouble with well pumps are many and sometimes obscure. Probably the most common ones are crooked wells, sand in the water, too low a water level, or, as it is often stated, a lack of water, too high speed, and incorrect alignment.

The crooked well is the bane of the pump man's existence, and unfortunately is exceedingly common. It is difficult to drill a straight well where the rock strata are not homogeneous and horizontal, and the difficulty of measuring the well, coupled with the lack of competent construction supervision, has been largely responsible for the acceptance of so many crooked wells throughout the country.

A long line of rods or a shaft rotating at high speed cannot be expected to work around a corner without giving trouble, and, even where a pump is set on an incline to conform to a straight but inclined well, the unbalanced condition of the loaded parts is likely to give trouble. It is a perfectly safe rule never to install a plunger or rotary pump except where the rods or shaft can be made perfectly straight, and even inclined wells should be avoided as far as possible.

If the water level in a well drops to the barrel or pump, the machine will take air instead of water. This causes severe shock and is a frequent cause of pump trouble.

Plunger pumps should never be run at a greater speed than 90 or 100 ft. of plunger travel per minute, and the higher the lift and the larger the pump, the slower should be the speed. For ordinary crank motion pumps, operating with lifts of 50 and greater, 75 ft. per minute plunger speed is to be preferred.

Improper alignment of a well pump is a very common cause of trouble and no pains should be spared to avoid this condition. It takes an expert erector skilled in this class of work to produce the best results, and this is particularly true when a slight crook in the well or a general slope to the bore require that the pump be set on an incline in order to avoid undue stresses on the rods or shaft. Facing a pump in a different direction, and inclining it slightly from the horizontal, will sometimes make a pump work more easily and eliminate much of the trouble from breakdown. Proper alignment of motor or engine is essential, particularly in direct connected or geared units, as the vibration set up by a poorly aligned gear or shaft greatly increases the stresses in the machine.

It is useless to spend time and money in determining the well conditions and obtaining the right machine, and then to trust the installation work to any practical mechanic who may be the lowest bidder for the work. One would not think of trusting the adjustment of a six cylinder automobile motor to a foundryman, yet many well pumps are installed by men with as little special knowledge of their work as a founder might be expected to have of the gas engine. Unskilled erectors are responsible for many well pump troubles, and the greater the lift or the more unsatisfactory the well conditions, the greater becomes the importance of the skilled erector.

Unfortunately for the engineer, it is often a difficult matter to determine accurately the data necessary for the proper selection of well pumping machinery. Where the digging of the well is included in the work, or where there are sufficient reserve units to permit the dismantling of the well for testing and examination, the difficulties are not great, though the tests are rather expensive. But where the well is in constant use, it is generally very difficult to gain access to the water level and the condition of the well must be judged from the history of its construction and the operation of the existing pumping machinery. All wells are straight, according to the reports of the men who drilled them, but continual breakdowns, that cannot be explained by the lack of water or by too light rods or shafts, are generally indicative of a crooked well or improper erection, and should be viewed with concern.

Well pumping installations are found most frequently in the smaller towns and villages, where the engineer, if there was one, was generally limited to the absolute minimum of expenditure required to furnish a plant that would deliver water. This explains in part why it is so rare in such plants to find provision for measuring the water levels or the pump discharge. Apparatus which will show the water level in a well is simple and costs but a few dollars, and its presence adds materially to the safety of the plant and the ease with which its efficiency may be watched. Water levels, particularly in well populated regions, are gradually lowering, and sometimes very rapid drops in level are experienced. With provision for daily inspection the time when the water level will drop to the pump suction may be anticipated, while without it the operator never knows what the next day will bring. With apparatus for measuring water levels and discharge, installed as a permanent part of a plant, the efficiency of the machinery may be easily determined and maintained, and when the time comes for improvements, the data necessary for the proper selection of the new machinery may be readily and cheaply obtained.

It is impossible to lay down rules for the selection of well pumping machinery, as each case is a separate problem. The advantages and disadvantages of each class of equipment vary materially with changing conditions. Each installation must be considered by itself, and it is only by a knowledge of the machinery available, and the accurate determination of the pertinent data, that a well pumping plant can be installed with reasonable assurance of success.

UTILIZATION OF CLINKERS FROM GARBAGE DESTRUCTORS.

In his discussion of a paper on cinder concrete floor construction between steel beams, at a recent meeting of the American Society of Civil Engineers, Mr. T. Hugh Boorman, consulting engineer, New York, suggested that tests be made and a report brought in on the utilization of clinkers from garbage destructors. He stated that in 1902 his attention was first attracted to the use of clinkers in concrete, in the city of Bristol, England, where he found it was used by Colonel Yabbicum, in the construction of city cement sidewalks. He later reported in New York the advisability of the erection of the destructor to Mayor Low and after a lapse of time of some years, one was erected on Staten Island. In 1911 on an investigation of the municipal plants of a number of English cities the extent was realized to which these clinkers were utilized in concrete construction, and in addition it was found that in the Borough of Kensington, London, Eng., the clinkers were used by that municipality in the manufacture of asphalt blocks. On an inspection of the crematory at Atlanta, Georgia, last November, he found that through lack of appropriations the clinkers could not be utilized as suggested, as the old tin cans and other metal refuse were all baked together and the resultant product could only be utilized for ordinary filling-in purposes. The speaker had not investigated the several destructors that have been erected in western cities and so could not state as to whether their output could be utilized in the way in which he had found it was being done in English cities.

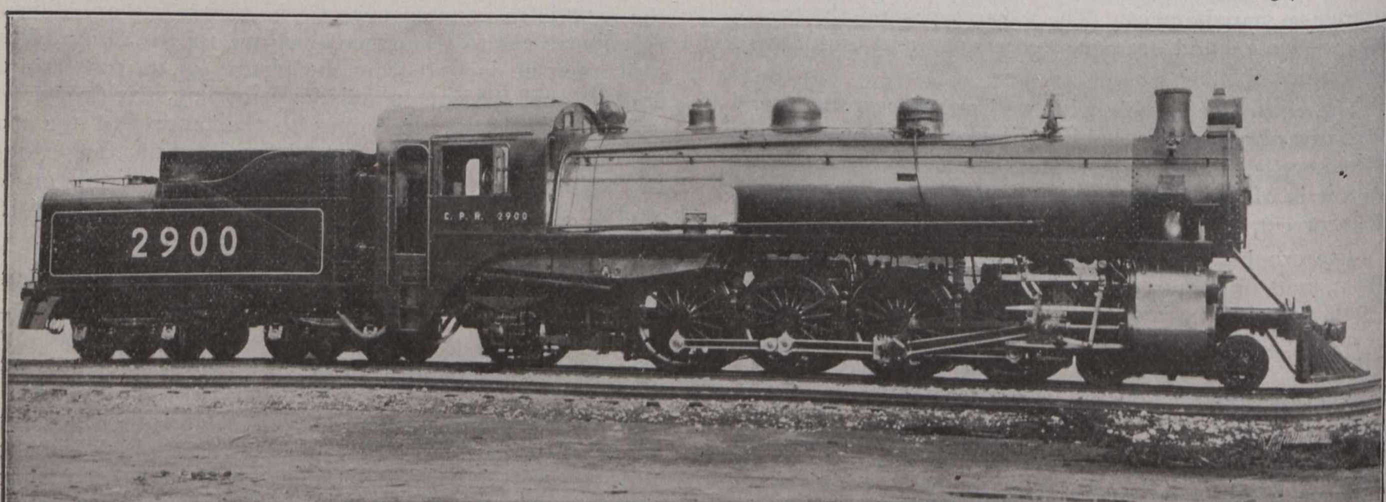
A bill is now before the Governor for signature, authorizing the Borough of Manhattan to make a contract for the erection of a destructor to be operated by contractors. Mr. Boorman expressed his view that any such project should be one carried on by the municipality itself, for while he was not prepared to endorse a statement made that the receipts from the handling of garbage and disposing of it by scientific method, would pay the expenses of the street cleaning department, he believed that a large revenue could be obtained towards paying such expenses. In view of this statement, he suggested that the committee be requested to make a report to the Society as to the comparative strength of concrete construction with clinkers, as in comparison with other aggregates.

C.P.R. LOCOMOTIVE 2900.

The accompanying illustration is of engine No. 2900, which was turned out of the Angus Shops, Montreal, last August. One of the main features in the design is the style of firebox adopted, which is 13' 5⅝" long and 7' 6⅞" wide inside, fitted with Gaines combustion chamber and arch, and having a grate area of 59.6 sq. ft. This engine was equipped with Vaughan-Horsey superheater, and vestibule cab, and latest design of screw reverse gear. C.P.R. standard practice of changeability of different parts with other types of engines was carried out wherever possible. Cylinders, pistons, piston rods, piston valves, cylinder heads, steam chest covers, boxes, axles, etc., are standard with other classes P-1 and N-3 engines. The main driving wheels are fitted with Cole driving box and axle, size 11" dia. x 21" long.

The following is list of general data:—

Type	4-8-2
Sub. Class	H-1a
Boiler pressure	200 lbs.
Firebox width inside	88⅞"
Firebox length inside	161⅝"
Number of tubes	210 and 30
Diameter of tubes	2¼" & 5¼"
Length over tube sheets	20' 8½"
Superheater	V. and H.
No. and dia. of superheater tubes	120 1¼" dia.
Average length or superheater tubes	19' 4½"
Superheating surface	760 sq. ft.
Firebox heating surface	299 sq. ft.
Tube heating surface	3,414 sq. ft.
Equivalent heating surface	4,853 sq. ft.
Grate area	59.6 sq. ft.
Cylinders	23½" x 32"



C.P.R. Production from Angus Shops, Montreal.

ONTARIO WATER SUPPLY AND SEWERAGE LEGISLATION

SOME FEATURES OF THE ONTARIO STATUTES AND THEIR ADMINISTRATION AFFECTING WATER-SUPPLIES AND SEWERAGE SYSTEMS. FROM PAPER DELIVERED BEFORE THE ILLINOIS SECTION OF THE A.W.W.A., MARCH 10th, 1915.

By F. A. DALLYN, C.E., B.A.Sc.,
Provincial Sanitary Engineer of Ontario.

PRACTICALLY all legislation which places municipal enterprises under control of government commissions is of recent enactment. This is also true of legislation relegating the control of waterworks and sewerage installations to federal, state or provincial health bodies.

In 1873 there existed no central organization for the administration of Public Health Regulations in Ontario. The authority at that time was vested almost entirely in the members of the municipal councils, who by virtue of their office became health officers. The Act relegating authority to the municipal councils would not in this day be considered at all complete. One of the typical sections of the Act reads:—

> Any two of these officers shall have the right to enter into and upon the premises in the day time for the purpose of examination to see whether they were in an unclean or filthy state.

They had power to order the proprietor or occupant of the premises to remedy the condition; they could also order persons suffering from contagious diseases to be removed to some hospital when the medical practitioner reported that this could be effected without danger to the health of the patient. There was apparently no regulation whatever respecting water-supply or sewerage, although there existed at that time in the Municipal Act a clause giving power to a council to pass by-laws for preventing the wasting and fouling of public water, and for regulating the construction and drainage of cellars, sinks, water closets, privies and privy vaults.

The Provincial Board of Health of Ontario was not created until 1882, and from that date until 1911 the control of the local board of health was vested in this central body. This body had a secretary with offices in the Parliament Buildings. He had a good deal of executive power, but all plans, etc., relating to water and sewage were left to the board and decided at the quarterly meetings.

The Municipal Waterworks Act of 1882 gave to municipalities rather wide powers. (1) Providing for the control of the streams acting as sources of municipal water supplies within a distance of one mile in the cases of villages or towns and three miles in the case of a city. (2) Prohibiting the draining of sewers or extraneous matter that would in any way taint or foul the source of a water-supply. There is no mention of water purification works in this Act, efforts being directed mainly toward exclusion of pollution. Strangely enough no mention of this matter appears in the Public Health Act of that date. The passing of this Act in 1882 coincides very well with the period when so much was talked of about the self-purification of streams. Bacteriology at this date was a very young science.

In 1884 the Public Health Act was further amended, and provided that—

> Whenever the establishment of a public water-supply or a system of sewerage should be contemplated by the council of a municipality it shall be the duty of the said municipality to place itself in communication with the Provincial Board of Health and to submit all plans in connection with said system to the Board.

The Board was authorized to enquire into and report upon the plans, copies of their report being forwarded to the Municipal Council, and also filed with the Government. This Act also contained a general clause which required that—

> No sewer or by-laws for extending the same shall be constructed in violation of any of the principles laid down by the Provincial Board of Health and subject to the appeal of the Lieutenant-Governor-in-Council.

It seems rather strange to think that as recently as 1886 such an indifferent character of legislation could exist, although research assures one that the information existing at this date upon the subject of epidemiology and the control of the pollution of streams was largely a blank as far as useful knowledge was concerned.

The executive health officers of the various municipalities met and formed an association. The activities of this body, which was largely controlled through the Provincial Board of Health, materially influenced the advance of sanitary science. Perhaps the greatest advantage at this time was the manner in which their deliberations included citations of European efforts, especially those of the Rivers Pollution Commission and the Local Government Board, who were doing a splendid work in advancing legislation and publishing information along these lines. In considering the amendments of this period one must remember that very little exact information was forthcoming until the reports from the Lawrence Experimental Station were issued in 1891, 1892 and 1893, and these for several years remained largely in the hands of the laboratory workers.

In 1895 the Act was further amended, and required municipalities to furnish, together with the plans of the proposed works, an analysis of the water from the proposed source. The analysis was a chemical one, and the water was reported upon largely according to old albuminoid standards. The Act recited that "where the Provincial Board reported against the supply it should not be lawful to establish such works." The jurisdiction of the Board was increased; it was now permitted to suggest changes in connection with the plans submitted, and their decision became binding, subject to appeal to the Lieutenant-Governor-in-Council.

It was not until 1906 that the Act was amended and a clause inserted making it unlawful to discharge sewage, drainage, domestic or factory waste, excrement or other polluting matter of any kind whatsoever, which either by itself or in connection with other matter corrupts or impairs the quality of any water supply. A penalty under the Act was set at $100 for each conviction, and each week's continuance after notice was set out as constituting a separate offence.

The most forward step of the legislature was taken in 1911, when it was enacted that the chief health officer, who was also the secretary, should be the executive officer of the board, and at intervals between meetings of the board should perform such duties and acts and have such powers as are by the Act vested in the Provincial Board of Health. To those who are interested in the administration of legislation such an amendment can be seen to be of the utmost advantage. Applications from municipalities can now be considered as soon as received instead of being held some times for several months for a quarterly meeting of the board. The Act was further reinforced and a section added, reciting:—

> That no by-law shall be passed for the raising of money for water and sewerage purposes until the proposed water supply or sewerage system, as the case may be, has been approved by the Provincial Board of Health, and such approval has been certified to and signed by the Chairman and Secretary of the Board.
>
> It provided that the preamble of the by-law should recite such approval.

During 1911 and 1912 the Public Health Act was carefully redrawn by John W. S. McCullough, M.D., D.P.H., the present Chief Officer of Health, and was passed by the Legislature of 1912. One important amendment stands out and provides that (Clause 96, Section1):—

> Where the Provincial Board reports in writing that it is of opinion that it is necessary in the interest of the public health that a waterworks system or an adequate water purification plant, or a sewer or a sewerage system, or an adequate sewage treatment plant, should be established or continued, or that any existing waterworks system, water purification plant, sewer or sewerage system, or sewage treatment plant, should be improved, extended, enlarged, altered, renewed or replaced, it shall not be necessary to obtain the assent of the electors to any by-law for incurring a debt for any of such purposes.

A further clause was added to the Act requiring municipalities to make reports to the Board of such information as may be required of it on forms to be furnished by the Board. This clause was especially arranged to apply to both waterworks and sewerage. The wording of the clause respecting submission of plans was slightly altered and made to apply to extensions of existing systems as well as to new systems.

In 1914 the Act was further modified to permit, with the approval of the Provincial Board of Health, the sewage disposal system of a municipality to be continued into or through, or to be situate in any adjoining township municipality. The Act provides that before approving of such work the Provincial Board of Health shall give notice to the Clerk of the township that such application has been made, and shall hear all objections before granting approval. After the approval has been granted the municipality receiving such approval is permitted to expropriate and arbitrate the value of the lands the same as if the work had been situate within the limit of the municipality.

(Mr. Dallyn then quoted from the Public Health Act as amended in 1914, Sections 89 to 98 inclusive, relating to the installation of public water supplies and sewerage systems and to by-laws for borrowing funds for these purposes.)

The Ontario Railway and Municipal Board is a body which is empowered by the Legislature to validate certain classes of debenture issues. Owing to carelessness in municipal government many illegal debentures have been sold at one time or another in perfectly good faith. Purchasers of such debentures on being made aware of the irregular character of their holding naturally desire to validate them; to make this possible, certain powers of the Legislature were delegated to the Ontario Railway and Municipal Board. The Municipal Act was amended in 1914 to provide for irregularities in water and sewage debenture issues. This amendment reads:—

> In the case of a by-law for raising money for any of the works or apparatus mentioned in Sections 89-94 of the Public Health Act the Board may upon presentation of a certificate by the Provincial Board of Health approving the by-law, notwithstanding that the certificate of the Provincial Board of Health was not obtained prior to the passing of the by-law, or that the by-law does not contain the recital of such approval.

This sub-section was made retroactive since 24th March, 1911.

It is also of interest to note another amendment of the Municipal Act of last year, which recites:—

> That where under this or any other Act power is conferred on a municipal corporation to borrow money for any purposes without the assent of the electors, it shall include not only the power to borrow money to issue all debentures, but also the power to agree with any bank or person for temporary advances to meet the expenditures incurred from time to time for such purposes.

The recital of legislation is usually a rather dry affair to those of us who are interested in getting things done. The lack of legislation is a terrific handicap, and it was largely with the idea of presenting a complete record of the legislation in Ontario that this paper was prepared. As will be seen, legislation began in 1873 with the power distributed and vested entirely in the municipal bodies. This has gradually been withdrawn, step by step, and conferred upon a central body and reinforced in such a fashion as to make it effective. Naturally one asks, Is there any real advantage in such centralization of power? Personally, when it comes to a matter of handling town planning and civic developments it seems to me to be perfectly apparent that centralization is almost imperative. The difficulties that disappear with centralization of power are improper administration, limited information and biased opinion.

It was discovered shortly after the passing of the Ontario Public Health Act that its administration required not only a first-hand knowledge of municipal conditions and finances, but also an intimate knowledge of the problems associated with sewage and water purification. To make possible this latter, an experimental station for the examination of water and sewage and purification processes was erected in 1909 and has been operated since that date. At this Experimental Station graduate students in the engineering courses and in medicine are given the opportunity of doing post-graduate work, for which they receive a nominal salary. Their energies are controlled by the Provincial Board of Health, and their work is mainly directed to research in the operation of purification units and apparatus. The Legislature grants an appropriation each year for this work.

Some few months ago, in order that further advantage might be taken of the control exercised by the Provincial Board of Health and to assist in reporting upon extensions requiring the approval of the Board, standard regulation and application forms were designed in the office of the Board—one for water and one for sewage. These forms were referred to some seven of our representative city engineers for comments before being approved as a Regulation under the Act. In arranging these forms the endeavor has been to ask of the designing engineer such information as should rightly be in his possession when designing work of this character. To careless engineers the information required seems to be rather burdensome, but to those who have introduced an orderly habit into their work it causes no inconvenience whatsoever. It is the intention of the Board to circulate the information received through municipalities, so that in a general way they may be informed of what their neighbors are doing, as well as the current prices obtained for different classes of material. It appears to the writer that the general result of this supervision will be towards the standardization of all work of this class in the province. Such a consummation is one which we all know to be to the utmost advantage of all concerned. Efforts of this kind must needs be slow in their onward march. Advances which threaten to centralize power are not as a rule well received by the uninformed.

PROGRESS IN STEAM TURBINE PRACTICE.

"Engineering" recently printed a letter giving figures of the steam consumption per kilowatt-hour of three turbines installed at different dates in the St. Pancras Borough electric station. The principal figures are as follow:—

	Date installed.	Kilowatts.	Full load.	¾ load.	½ load.	¼ load.
Reciprocating engines	1903	450	19.5	21.0	22.6	27.65
Turbo-direct current	1906	1,000	17.0	18.0	19.5	24.5
Turbo, alternating current	1909	2,200	16.15	17.1	18.85	22.8
Ljungstrom turbo-alternating	1914	1,000	12.75	13.57	14.67	17.76
Ljungstrom, guaranteed	....	5,000	11.8	12.38	13.4	15.9

A PORTABLE WINCH.

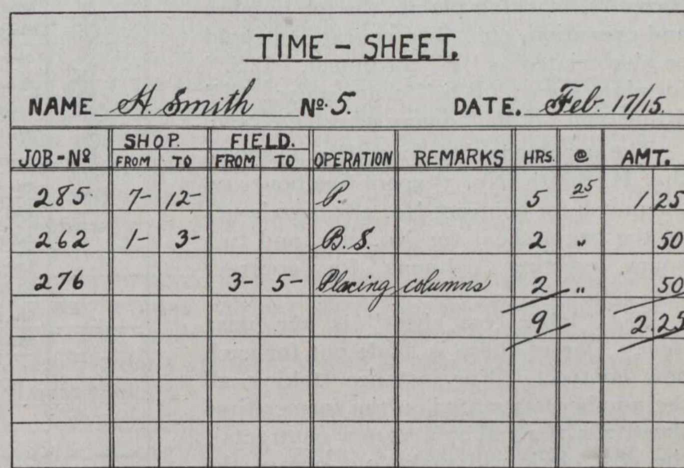
The construction of the New York subway necessitated the building of the portable motor-driven winch, which has since demonstrated its usefulness in many other fields. When used for lifting material out of the subway, a trestle or light frame work carrying a sheave is placed directly over the opening. The hoisting rope is passed over the sheave, given two or three turns around the friction drum, the motor started and the slack paid off as the material is hoisted. When used to assist teams in hauling loads up heavy grades, one end of the rope is fastened to the wagon tongue and the other end given several turns around the friction drum. Current is obtained from the 550-volt trolley circuit. The winch is manufactured in two sizes by the Dobbie Foundry and Machine Company, Niagara Falls, N.Y. The small outfit operates at a rope speed of 152, and the large one at 178 feet per minute. Westinghouse Electric compound-wound motors at 5 and 7½ h.p. respectively are used to drive these outfits, which are said to be very light and compact and easily portable.

STRUCTURAL STEEL COST SYSTEM.

By H. Barrett Power.

THERE is probably no word which means more to the modern business man than the word "system." One of his principal problems to-day is to have a proper "cost" system in connection with his business, to enable him to see clearly his profits or losses on various jobs or contracts from time to time.

The following article refers particularly to "Structural Steel Costing," at which the writer has spent several

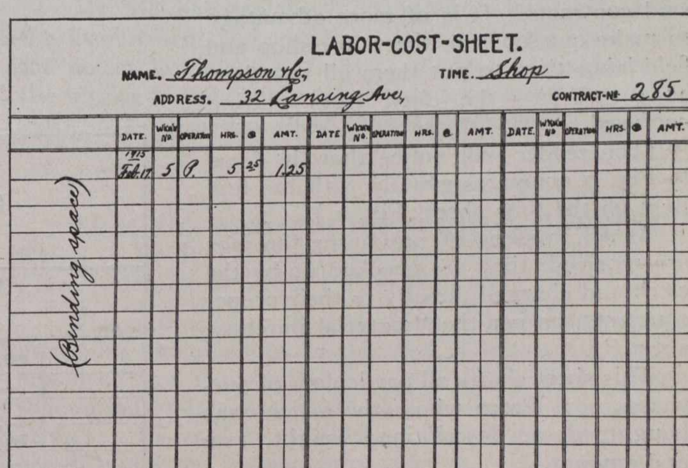


TIME - SHEET.

NAME H. Smith Nº 5. DATE. Feb. 17/15.

JOB-Nº	SHOP FROM	SHOP TO	FIELD FROM	FIELD TO	OPERATION	REMARKS	HRS.	@	AMT.
285	7-	12-			P.		5	25	1 25
262	1-	3-			B.S.		2	"	50
276			3-	5-	Placing columns		2	"	50
							9		2 25

Fig. 1.



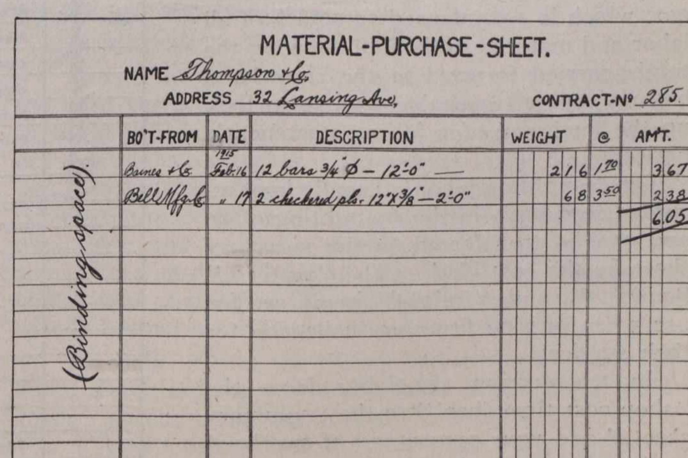
LABOR-COST-SHEET.

NAME. Thompson & Co., TIME. Shop

ADDRESS. 32 Lansing Ave., CONTRACT-Nº 285

(Binding space)	DATE.	WK'M'N NO.	OPERATION	HRS.	@	AMT.	DATE	WK'M'N NO.	OPERATION	HRS.	@	AMT.	DATE.	WK'M'N NO.	OPERATION	HRS.	@	AMT.
	1915 Feb. 17	5	P.	5	25	1.25												

Fig. 2.



MATERIAL-PURCHASE-SHEET.

NAME Thompson & Co.

ADDRESS 32 Lansing Ave., CONTRACT-Nº 285.

(Binding space)	BO'T-FROM	DATE	DESCRIPTION	WEIGHT	@	AM'T.
	Barnes & Co.	1915 Feb. 16	12 bars ¾" ϕ – 12'-0" —	216	1.70	3 67
	Bell Mfg. Co.	" 17	2 checkered pls. 12"×⅜" – 2'-0"	68	3.50	2 38
						6 05

Fig. 3.

years. The method involved may, however, be altered slightly to suit other lines of business.

Our first factor is the "time sheet." In almost every manufacturing plant or workshop in which the time sheet is left for the employee to fill in, there are errors or omissions which, if not rectified next day by the time-keeper or cost clerk, always cause the cost to be inaccurate, and therefore make the system practically useless. The employees should be instructed to make their time sheets out correctly, marking plainly the job number and operation, etc. The operations could be abbreviated as "P" for punch, "P.S." for plate shear, "B.S." beam shear, "F" fitting and "E.W." emery wheel, etc., etc.

The accompanying form (Fig. 1) shows that H. Smith (No. 5) spent five hours on the punch for contract No. 285, two hours on the beam shear for No. 262, and two hours erecting columns for contract No. 276.

The "labor cost sheet" is our next item. One of these is made out for each new contract. For instance (taking all the numbers as stated on the former time sheet, 285,262 and 276, as new contracts), the cost clerk will make out one of the following forms for each number and enter thereon all time chargeable to the said contracts. It is of more advantage to make out separate sheets for shop and field labor than to put them all together, as it prevents the clerk from getting confused.

(The reader will notice that the form in Fig. 2 compares exactly with the first item on the time sheet, Fig. 1.)

As all invoices of purchases for jobs are received, they are checked up by the clerk and charged directly to their proper contracts, as per the "material purchase sheet."

This sheet shows all particulars of purchases as: From whom the article was bought, date, description, weight, rate and amount.

When a contract is completed, we have the "summary cost sheet" to be made out, which is a condensed summary of all labor and material in the job, showing the totals carried forward to the right-hand bottom corner, to enable anyone to look up the final cost of a job at a moment's notice.

The draughting labor is usually kept recorded separately in the draughting office and can be transferred to the summary sheet by the cost clerk. The "pattern," "cartage" and "freight" items are for use when outside firms are called on for their services.

In transferring the labor from the "shop cost time sheet" to the "summary sheet," add your percentage of overhead to the amount, as in Fig. 4. The overhead expense in the majority of large

SHOP - COST - ANALYSIS - SHEET.

NAME *Bell Bros. & Co.*

ADDRESS *14 Torrance Sq.* CONTRACT Nº *310*

ARTICLE *Box Girders "Mark G.3."*

Description. *(material)*

(Binding space)

CLASS-OF-WORK.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	TOTALS. HRS.	TOTALS. AMT.
Draughting.	2	30	.60	8	40	3.20													10	3.80
Yard-Work.	22	20	4.40	3	30	.90													25	5.30
Templates.	2	27	.54																2	.54
Pattern-Work.																				
Laying-Out.	8	25	2.00	15	30	4.50													23	6.50
Beam-Shear.																				
Plate-Shear.	2	22	.44	2	17	.34													4	.78
Saw.																				
Punch.																				
Fitting.	4	30	1.20	1	20	.20	2	22	.44										7	1.84
Drill.	12	25	3.00	6	27	1.62													18	4.62
Rivetting.	8	20	1.60	8	30	2.40	2	22	.44										18	4.44
Planer.																				
Bull-Dozer.																				
Power-Hammer.																				
Emery-Wheel.																				
Blacksmith (fire).																				
Bolt-Cutter.																				
Painting	5	20	1.00	3	25	.75													8	1.75
TOTALS.	65	-	14.78	46	-	13.91	4	-	.88										115	29.57

Fig. 5.

ERECTION - COST - ANALYSIS SHEET.

NAME *Bell Bros. & Co.*

ADDRESS *14 Torrance Sq.* CONTRACT Nº *310*

Description. *2 Box Girders "Mark G 3."*

(Binding space).

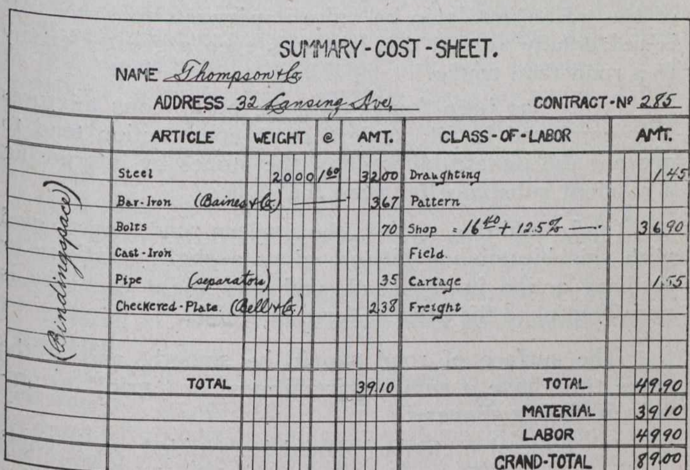
ERECTING.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT.	HRS	@	AMT	TOTALS. HRS.	TOTALS. AMT.
Columns (steel).																				
" (c.i.).																				
Beams.																				
Trusses.																				
Stairs.																				
Fire-Escapes.																				
Ornamental &.																				
Bl'ksm'h-Work.																				
Cast-Iron.																				
Girders.	12	25	3.00	4	35	1.40	8	30	2.40										24	6.80
Miscellaneous.	3	25	.75	1	35	.35	1	30	.30										5	1.40
Painting.	4	25	1.00																4	1.00
TOTALS.	19	-	4.75	5	-	1.75	9	-	2.70										33	9.20

Fig. 6.

steel plants runs from about 90 to 130% of the shop labor. In one plant at which the writer has had experience, the percentage was placed at 125%, which is shown on the example.

The "shop cost analysis sheet" (Fig. 5) is for a certain part of a job when the manager wishes to know exactly what it costs him for laying out, shearing, punching, or fitting, etc., on a plate girder or built-up column section, etc.

If the time sheets are made out correctly, the cost clerk will experience no difficulty in finding out the required information a month or so after the work has been



SUMMARY-COST-SHEET.

NAME Thompson & Co.

ADDRESS 32 Lansing Ave. CONTRACT-No 285

ARTICLE	WEIGHT	@	AMT.	CLASS-OF-LABOR	AMT.
Steel	2000	1.60	32.00	Draughting	1.45
Bar-Iron (Baines & Co.)			3.67	Pattern	
Bolts			.70	Shop = 16^{40} + 12.5%	36.90
Cast-Iron				Field	
Pipe (separators)			.35	Cartage	1.55
Checkered-Plate (Bell & Co.)			2.38	Freight	
TOTAL			39.10	TOTAL	49.90
				MATERIAL	39.10
				LABOR	49.90
				GRAND-TOTAL	89.00

(Binding space)

Fig. 4.

turned out of the shop. The sheet shows practically all the necessary operations in a structural steel shop, from draughting to painting, and may also be used for the analysis of complete jobs.

The last illustration is that of the "erection cost analysis sheet," which is generally used for complete jobs. The manager can see from this sheet what it costs for the erection of the columns, beams, trusses, etc., of a job, and can then figure his rates for estimating purposes. There are columns allowed for the various rates of labor, which may be employed on the job. Both these "analysis" sheets have a space at the top for the description of the article or contract.

SAINT JOHN, N.B., RAILWAY COMPANY.

According to the report for 1914 of the St. John Railway Company, the following works were carried through during the year:—

Extension of railway from Kane's Corner to Crouchville, and from the One Mile House past Rural Cemetery to Coldbrook and Glen Falls, in all 3¾ miles. They also built another fireproof car barn on Wentworth Street, size 58′ x 213′; laid 2,500′ of gas mains and installed 236 gas ranges and appliances; and purchased 12 new semi-convertible cars with equipment.

Blister copper to the extent of 22,000,000 pounds was produced last year by one smelting company operating in British Columbia.

Permits have recently been issued in Winnipeg for forty-two apartment blocks, the aggregate estimated cost of which is $2,488,500.

Railway mileage in Alberta is apportioned to the different companies as follows:—C.P.R., 1,887; C.N.R., 1,188; G.T.P., 707; E.D. and B.C., 240; A. and G.W., 75. In 1905 the only mileage was held by the C.P.R., and amounted to 1,060.

STUDIES IN ROAD CONSTRUCTION.

(Continued from last Issue.)

REGULATIONS OF THE DEPARTMENT RESPECTING COUNTY ROADS. By W. A. McLean, Chief Engineer of Highways, Ontario.

Mr. McLean dwelt in an explanatory way upon a number of the regulations of the public works department with respect to road systems, upon compliance with which the counties of Ontario become entitled to the provincial grant of one-third of the cost of construction. He showed clearly that the details of construction for all roads could not conform to a schedule form or fixed plan, but that they must be in accord with principles. The value of keeping accurate accounts and returning proper statements to the departments were strongly emphasized. Stress was laid upon the establishment of permanent grade and the earthwork involved therein and upon the importance of surface drainage. Relative to the purchase of suitable machinery, it was stated that the stone crushers which counties had purchased were, in some instances, too small. It was observed that there was considerable economy in having a stone crushing plant capable of supplying about 100 cubic yards per day. As a guide to the counties, the Department's approval should be obtained in the purchase of machinery.

Concerning the construction of bridges, the necessity of sound engineering advice was emphasized. The services of a bridge engineer were very necessary if the road superintendent was not an engineer.

Mr. McLean explained the system of inspection which the Department had adopted. It was clearly shown that the object in view was to place its staff of engineers at the service of the county superintendents to be of as much assistance to them in their work as possible.

TRAFFIC AND MODERN ROAD CONSTRUCTION. By R. C. Muir, A.M.Inst.C.E., assistant engineer, Ontario Office of Public Highways.

The author showed that traffic is a primary factor governing the selection of the type of construction to be employed on a road and affecting its width, grade, crown, foundation and type of surface. He divided it into three classes: Horse-drawn vehicles, fast motor traffic and heavy motor or horse-drawn vehicles. He pointed out that roads must be built according to the traffic that will be developed by improvement and the potential traffic of expanding local conditions. A knowledge of this traffic is indispensable to the road engineer.

It was shown what effect the width of tires had upon the road surface. The author expressed his opinion that for light vehicles the width should not exceed 2½ inches or be less than 2 inches. Wheels of large diameter did less damage than those of small diameter, and a 2-wheeled vehicle did more damage than one with four wheels owing to sudden and irregular twisting motion. It was also shown that springs materially decreased the resistance to traffic, and diminished the wear of the road, especially at speeds beyond a walking pace.

He claimed that the theory had never been substantiated respecting the destructive force of motor car wheels at high speeds being due to suction underneath the tires. The accepted theory was that the destructive agent is a shearing force developed between the wheel and the road, causing the wheel to act as a grind stone on the surface.

The slip to driving wheels was also taken into account, as well as the slew to hind wheels on curves.

The serious problem presented by the motor truck upon roads which have not been constructed to carry them, was also considered, and it was emphasized that more attention be paid to the construction of the foundation. The effect of traction engines on faulty roads was also brought out.

The author, in dealing with the effect of horses on the road surface, referred to the types of shoes used and showed that the damage to the surface under ordinary conditions was considerable. The grooving of the road, due to the tendency of all traffic to keep in one line, was likewise given consideration.

The author stated that such problems as these formed the most pressing phase of road investigation of to-day, and that attention should be concentrated upon the needs of mechanical traffic, but horse traffic was still such an important factor that its requirements should not be lost sight of. He then referred as follows to the construction of traffic roads:—

Roads adjacent to the larger cities require a heavier type of construction with a more durable surface, to carry the larger number of vehicles, more heavily loaded, and moving rapidly. The more frequent and faster traffic demands the resistent surface; and added to this the heavily loaded vehicles require a stronger form of foundation.

With a waterbound macadam road it has been found that the traffic now using some of our roads not only wears the surface of the road, but produces a movement among the stones themselves at some depth below the surface, causing a rocking action of the stones and producing a rubbing which gradually wears off the angles of the stones until they are of a rounded shape and have no interlocking to resist movement among themselves. This is the main cause of the excessive mud on macadam roads, and it is also the main cause of the destruction of roads. It was to meet this interstitial wear, and to confine it, so far as possible, to the surface, that the bituminous-bound road has been introduced.

One of the earliest endeavors to meet this interstitial wear, and to confine it to the surface, was the treating of existing road surface, with a painting of tar.

Then came tar-macadam, which consisted of crushed stone of various sizes, thoroughly heated, then coated with tar, mixed by machinery or by hand, and then laid on the road and rolled.

Another method which is used extensively in Britain is tarred furnace slag; the tar being applied when slag is hot, thus ensuring penetration.

While the perfect road to suit all conditions and circumstances has not yet been devised, bituminous roadways approach nearest to the theoretical and practical type of road.

The points to be aimed at in modern road construction may be summarized as follows:—

(1) The travelled portion of road should be built on a foundation of sufficient strength to carry the weight of the traffic and to distribute the pressure of the wheels over the subsoil as to avoid any depressions.

(2) Upon this foundation there should be a wearing surface so constructed as to minimize the abrasive action of the traffic, and also be quite impervious to water. It is universally agreed that water is even a greater enemy to a road than traffic.

(3) It has been found that the bituminous mixtures now employed in all modern road construction tend to prevent the interstitial wear of the stones by interposing a resilient substance between the stones.

(4) In addition to this, the modern road, constructed with this bituminous binder, gives a slight elasticity or resilient action in the road, and this slight elasticity is very helpful to the present form of traffic.

The surface of road should be smooth, and at the same time have a sufficient roughness or "grip" to prevent its being slippery.

(5) Excessive camber should be avoided, as it tends to divert the traffic on to the crown of road.

The requirements of a modern road may be summed up as follows:—

(1) It should be sufficiently wide to meet the traffic requirements, but must not be extravagantly costly in its first construction.

(2) The foundation must be sufficiently strong to bear the weight of traffic, and the surface must be durable and require the least possible amount of repairs at low cost.

(3) The road should be safe, firm, hard and at the same time resilient, with an even surface, and yet give sufficient foothold for horses.

(4) It should be as noiseless as possible, and should be incapable of gathering any dust or mud. The surface should be so constructed that water cannot penetrate; and that camber be as flat as possible, compatible with the speedy draining off of the water falling on surface.

(5) There should be no possibility of interstitial movement among the stones of which the road is constructed.

The following is a statement showing the amount of traffic, in the author's opinion, certain roads should carry:

	Average daily traffic—12-hour day.				
Class of road.	Light vehicles.	Heavy 1-horse vehicles.	Heavy 2-horse vehicles.	Motor cars.	Total.
A good gravel road will wear reasonably well and will be economical with	80	45	25	150	300
Requires to be oiled with				over 150	
Gravel road coated with either hot or heavy cold oil, ½ gal. per sq. yd. (cold oil must be used yearly)	100	70	40	500	710
Waterbound macadam will stand with	150	200	70	not over 100 at high speed	520
Macadam, with a dust layer will stand				350	
Macadam with tar carpet coat will be economical with .. (Will stand at least 30 motor trucks, perhaps more.)	300	100	50	1,200	1,650
Waterbound macadam with a good surface coating of tar will stand with	100	60	40	1,800	2,000

Constant repairs at a cost of 3 cents a square yard a year will often save an expenditure of 40 cents to 75 cents a square yard for re-surfacing.

ESTIMATING COST. By Hugh A. Lumsden, B.Sc., Assistant Engineer, Ontario Office of Public Roads.

The author referred to the difficulty encountered by engineers in estimating costs of highway work, owing to the great lack of data from practical experience previous to eight or ten years ago. This data was important, despite the entry of the motor truck and its revolutionizing effect on road building.

He observed that the variety of methods and terms employed in defining unit cost produced further difficulties in that no definitely recognized unit was adopted. For instance, "a cubic yard" may be taken to mean: (1) A cubic yard of consolidated surface in finished road; (2) a cubic yard of loose stone in wagons; (3) a cubic yard on the road, not including screenings; (4) a cubic yard rolled, or (5) a cubic yard unrolled. Besides other units, *e.g.*, a ton, a toise, a cord, a square yard, etc., are also used. He corroborated Mr. H. P. Gillette's opinion in favor of the cost per cubic yard, meaning the cost per cubic yard of material of consolidated road after its construction is completed.

Familiarity with local conditions is essential before commencing an estimate; with the traffic the road may be expected to carry; with the character of the soil; with the present condition of the road; with the extent to which hill cutting and grading will be required; what diversions may be advisable; what local material may be obtained, or freight rates to nearest siding; the quality of local material; what road machinery is available; cost of local labor, men and teams, and many other items which occur, peculiar to each individual road.

On commencing to get out an estimate on a road of any kind, states Mr. Lumsden, we would urge the necessity and the aid provided in having before one a map showing the location of road to be built, and a cross-section showing the type of road it is proposed to construct. The presence of such drawings may often remind one of special features in connection with the work which might easily otherwise have been overlooked.

Where different local conditions will be met with, it is wise to divide the whole road into a number of sections, over each of which conditions will be approximately the same, and for each work out an estimate. Thus we may have a section to stone along which it is more economical to ship in stone and haul to the road, while on an adjoining road or section it may be cheaper to use local stone from nearby quarries.

Mr. Lumsden then follows, in the manner given below, the construction of a waterbound macadam road, selecting that type for its great mileage and the many features common to all roads that it comprises.

After determining the diversions required, the cost of right-of-way per acre is figured next. On these diversions some clearing of right-of-way and grubbing may be necessary and the cost of clearing and grubbing per acre is thus required. Permanent structures must be provided for. For bridges, by which we mean structures of 10-foot span or greater, it will usually be found not only safer but more economical in the end to employ a bridge engineer. For culverts, the cost of similar structures built in the neighborhood will serve as a fair criterion by which to check up our estimate. The cost of culverts (shown as so many cubic yards concrete and so much per yard) the number of pipe required, their proposed location, length and diameter, must then be summarized, as thus 400 feet C.I.P. @ 75c. per foot. We must first know our purchase price of pipe f.o.b. at nearest siding and also what it will cost to haul that pipe onto the work, and estimate so much per foot for the laying cost.

Having then completed the estimate of expenditure for bridges, culverts and pipe, we should consider that of grading. This item will necessarily vary greatly, depending on the particular sort of country through which the road runs. Rather than take the cost on similar roads and for estimating, and state a certain lump sum per mile, it is very much preferable in every case to run levels over the road, plot a profile, lay down a grade line and work out the approximate yardage to be moved, where possible, making cuts and fills balance. The slight expense necessary to lay out the work in this way is saved many times over in future years by reason of the increased efficiency of the road.

Having found the quantities to be moved, we must decide on the most economical means of moving. A small No. 2 drag scraper or slip weighs about 100 pounds and holds approximately 1/8 yd. Where the grade is being built from side borrow, circular runways leading up onto the grade are used, around which three or four teams are continually working, one extra man to load the scrapers being required. The average man and team will probably put in from 60 to 80 yards of average material. Where a haul of over two hundred feet is required it is more economical to use wheelers, the smaller sized wheelers being used for heavy, tough soils and those of larger size in light soils. No. 1 wheeler will hold 1/5 yd. and No. 2, 1/4 yd., No. 2½, 1/3 yd., and No. 3, 4/10 yd. In hauling by wagons 4 men should load a yard wagon in 4 or 5 minutes. A good average team can be expected to haul a load from 10 to 15 miles and return empty in one day. In estimating what we may expect a wagon to haul to the load, much will depend on the state of the road. Gillette estimates that on very poor roads of heavy sand or gumbo less than a yard of material could be safely loaded; for ordinary poor earth roads one yard, and for good earth roads a yard and a half can safely be hauled, while over good macadam roads 2½ yards is not too big a load. To loosen up material a team on a plough may be expected to loosen from 300 to 500 yards per day.

The cost of the stone, concrete, or whatever material is to be used in the subgrade is, as a rule, by far the greatest item in cost of construction. Under this head we often estimate the cost under the four headings: (a) Materials, (b) Labor, (c) General expenses, (d) Supplies.

In following out a waterbound macadam road we may thus enumerate the principal items which must enter into any estimate of cost:

1. Cost of Materials.—Where broken stone (to arrive at the actual cost of crushed stone of required size at the quarry in cubic yards) is obtainable locally the portable crushing and screening plant required may be expected to cost in the neighborhood of $3,000. This will include crusher, screen and bin, 15 h.p. engine and boiler. To operate such a plant requires an engine man, foreman and two men to feed the crusher. One hundred yards per day would be a fair output for such a plant, and the average actual cost of crushing and screening may be expected to run from 25c. to 35c. per yard.

The only factor in regard to screenings is that, although screenings will be required over and above what will be got from the crusher, when crushing the required amount of rock, there is usually such an abundance about the quarries that a somewhat lower charge will often be made for screenings. From 40 to 70 cents per yard is very often the purchase price of crushed rock.

The charge for freight on stone and screenings varies somewhat, due to switching charges where the road is located on a line other than that on which the quarry is situated; where shipment can be made direct over one line the freight rate, within a radius of 65 miles, is 60c. per ton-mile. When switching is required another 60c. is usually charged. Competition on the part of the railways may often change these rates which, therefore, depend largely on the location of the quarry.

It is unusual that any charge will be made for the use of water. Where this is done it varies greatly. The possible cost of pipes to furnish water of pumps, etc., should always be taken into account. The amount of water we should expect to use will depend largely on the quality of the stone and on the weather. From 2 to 3 gallons per square yard is a fair approximation.

2. Labor.—For loading stone and screenings a fair average would be 2½c. per cubic yard, when loading from screening bins. From cars, 1 man can load from 15 to 20 yards per day.

In hauling stone and screenings a very common size of wagon box is 9 ft. long by 3 ft. wide by 1½ ft. high, containing 1½ yards. Since loose broken stone consolidates about 10% when hauled even a short distance, it is important to state whether the measurements to be made after loading the wagon or when the stone is delivered at the work. From 22c. to 25c. per cubic yard per mile is a fair average for hauling with wagons.

This cost of hauling is one of the greatest items, as well an one of the most interesting. In this connection the writer was fortunate enough to hear a most interesting paper by Professor Agg, of Iowa State College, read at the American Road Builders' Congress at Chicago two months ago. He enumerated the chief factors entering into the cost as: (1) Length of haul; (2) rate of travel; (3) time lost while loading at cars and unloading at work; (4) time lost in travel on account of bad roads; (5) capacity of outfit per trip; (6) cost of operation. In estimating, he assumes speeds of 2½ miles per hour for teams, 3 miles per hour for traction outfits and 10 miles per hour for motor trucks. Average hauling capacity he assumes as: Teams, 2 tons; motor trucks, 5 tons; traction outfits ,15 tons, and he valued teams at 50c. per hour, motor trucks $2, and traction outfits $3.

In spreading stone binder one man should spread 30 to 40 yards in a day; nevertheless, a mechanical spreader would probably reduce the cost.

In rolling about 65 yards of loose stone will compact to 50 yards compacted material. A cost of 25c. per cubic yard of compacted material is reasonable. A roller should roll from 60 to 100 cubic yards per day.

For a foreman a wage of about $4 per day is a fair average. This amounts to 5 cents per cubic yard of material.

3. General Expenses.—Under this head we would include the salary of superintendent, watchman and waterboy, timekeeper, insurance on working, etc. All of these would amount to about 20c. per cubic yard of material.

Supplies.—This includes cost of coal, of oil and of waste, all for the roller; also interest, depreciation and repairs on roller, wagons and other road machinery.

The question of depreciation in the value of road machinery may be of interest.

Records show that there is no reason whatever why rollers (the original cost of which runs from $2,500 to $3,000) should not last from 20 to 25 years. Several rollers on which careful records have been kept have been known to last this length of time in England, although wheels and other parts may have been replaced.

Engineering.—The great importance of this item in connection with roadwork, as in all other kinds of work, cannot be too greatly emphasized. Even if engineering costs may run as high as 5% to 10% of the total cost of the work, be assured that this cost is made up many times over in the money that will be saved in each and every feature in the work, through employing capable engineers to draw up plans and to superintend any construction work in progress.

Contingencies.—Notwithstanding the greatest possible care and forethought, this item should always be provided for. Fifteen to twenty per cent is, we believe, a reasonable allowance.

Having totalled our cost of construction and shown what it will cost per cubic yard of material in place we should then refer to previous data showing cost of construction of similarly built roads, and if greatly different we should then go into details to discover the cause of the difference. In this way are published data and records of the very greatest assistance.

One is frequently asked the cost of putting on a surface coat of tar or heavy oil; for instance, Tarvia. A fair average for estimating purposes would be 10c. to 12c. per square yard for first application, including stone chips, the amount of Tarvia applied being from ⅓ to ½ gallon per square yard, costing from 10c. to 15c. per gallon.

An enquiry made some years ago by the Washington Office of Public Roads showed that the average cost of gravel road in 31 States of the Union was $2,047 per mile.

For macadam roads in 34 states the average cost was $4,989 per mile.

COST KEEPING AND ACCOUNTING. By W. Huber, A.M.Can.Soc.C.E., Assistant Engineer, Ontario Office of Public Roads.

In emphasizing the value to road engineers and superintendents of the keeping of records, the practice of contractors in this respect is referred to as being one of the greatest assets to his success in estimating on new work and in keeping each phase within or close to the estimate during progress of construction. The latter's cost records of grading, excavating, haulage, materials, etc., enable him to figure closely, reducing the amount to be added under the head of contingencies. It is observed that by giving such work the same attention as the contractor would give it, and by insisting on the same degree of efficiency from employees, the road superintendent or engineer should be in a position to do his work as cheaply and as efficiently as the former.

The success and economy of road construction is pointed out to be a matter of efficiency—in handling machinery, directing labor and selecting materials. An efficient system of cost keeping has for its objects:—

(1) To enable the superintendent to prepare at any time, either on completion or during progress, a detailed statement of the cost of each section of road built, showing the expenditure on each part of the work as, grading, culverts, cost of stone, labor, etc.

(2) To show, while work is in progress, the unit costs of various operations, as cost of quarrying or crushing per cubic yard, cost of excavation per cubic yard, cost of draining per rod, cost of hauling stone per yard-mile, cost of finished road per square yard or per mile, etc.

(3) To facilitate comparison of the performances of various foremen and gangs; to show where work is being done economically and where inefficiently, and to enable the superintendent to recognize efficiency in some gangs and to take the necessary steps to produce it in others.

(4) To form a basis for estimating the cost of future work.

(5) To supply data for the preparation of the road superintendent's annual returns to this office, and to insure such data as will satisfy the requirements both of this office and of the provincial auditor.

One of the chief requirements of such a system is simplicity. As the superintendent will have difficulty in himself furnishing all information required for the keeping of satisfactory records, he will be dependent for a considerable amount of it on his subordinates. For this reason, the system should be free from all complications, at the same time furnishing all necessary information. The information obtained should also be arranged in convenient form for future use, the ultimate object being the putting into suitable form all information collected, and making it immediately available.

The persons concerned in the proposed system are the foreman, road superintendent and treasurer, and it cannot be too strongly emphasized that success depends on each one and on all three. The foreman's work should comprise the keeping of a time book for each section of road under construction, the making out of a suitable pay-list at regular intervals, and the preparation of a brief report to be submitted periodically to the superintendent. The superintendent's work will consist of classifying the accounts and pay-lists as they are submitted to him, endorsing each account with the number of the road to which it is to be charged, and the nature of the work on which it is to be applied. He will then make a list of these accounts on a distribution sheet and forward it, with the accounts, for approval and passing, to the county road committee. These distribution lists, if properly made out, will give all the data necessary to a complete analysis of the year's expenditure. In addition to classifying accounts, the superintendent will also file the weekly reports received from his foremen and will arrange the data contained therein in such manner as to be available for convenient reference. The county treasurer's work will be the posting of the expenditures as shown on the distribution sheets which will have been forwarded to him from the road committee after approval. He will open a separate account for each road built during the season and will keep the accounts in such a way that he will be able to tell at a glance the amount spent during the season on the entire system, on any one road, or on any one part of the work of each road, as grading, culverts, cost of stone, labor, etc.

In order that the work involved may be reduced to a minimum, and that the systems of the different counties may be as nearly uniform as circumstances will permit, the use of printed forms should be made to as great an extent as possible. A little study in the preparation of these forms and in adapting them to their particular requirements will be well repaid in the ease with which they can be filled out and interpreted. The forms which it is suggested to use and which should, where possible, be standardized, are: Time book; pay-list; foreman's report; distribution sheet, and special loose-leaf ledger page.

In the introduction of new methods of time-keeping, the superintendent's first and hardest task will be the thorough instruction of all the foremen in the few principles concerned. By stimulating his interest, better results can be obtained than by the more unpleasant method of compulsion.

The time book as ordinarily used, shows only one thing—the actual time spent on the work by each man. It makes no attempt to show in what capacity he is employed or how his time is spent. In an improved system of cost keeping this latter is essential. A book has just been designed in the Office of Public Highways specially adapted to county road work, which embodies a number of new features, chief of which are:—

(1) Special provision has been made for distributing the time; *i.e.*, showing exactly how much of each man's time is chargeable to each part of the work, such as grading, tile-draining, road construction, culverts, etc.

(2) The space for each day's entries has been considerably enlarged without increasing the size of the book. This will be appreciated by the majority of foremen whose stiff fingers and dull, soft lead pencils are not adapted to fine clerical work.

(3) Double spaces for each day are provided so that if a man changes from one part of the work to another, the fact may be recorded and the proper proportion of his time charged to each part.

(4) The dimensions of the book have been kept down in order that it may be easily carried in the foreman's hip-pocket.

(5) Explicit instructions for using the book are printed inside the cover.

The principal innovation in this new time book consists in indicating beside the daily entry of a man's time, by means of a symbolic letter, the part of the work on which the man has been engaged during the day. The main divisions of the work are enumerated in the instructions, others may be added or substituted as occasion demands. By this means, a man's time, no matter how often he changes his work, is accurately recorded, and this record forms the basis of a system of distributing the cost of labor, which may be put to a variety of purposes.

In this system there must be a separate time book for each section of road built. In cases where the pay-list is prepared by the road superintendent two time books will be employed on each section and used alternately, one being in use while the other is in possession of the superintendent for the purpose of making out the pay-list. A number of these time books have been printed to serve as models.

In order that the information contained in the time book may be permanently recorded, a new form of pay-list has been devised. In this pay-list the main feature is provision for recording the distribution of the time, as shown by the time book. If the time has been properly distributed and the totals made up in the time book, the preparation of the pay-list will be simply a matter of copying from the time book. The column showing the time worked on each day of the month has been retained in compliance with the requirements of some auditors who demand that this be shown. In any case, the distribution of each man's time must be given. The distribution on the pay-list is given under the same headings as in the time book. Provision is also made for showing the total cost of labor on each part of the work at the foot of the distribution column. This will be computed on the basis of each man's time and rate, and the total of these column footings should check with the total of the pay-list.

By means of the system thus outlined, all labor on county roads may be charged to that part of the work to which it belongs. The same should be done with all accounts for materials and other services not shown on the pay-lists. As in the case of labor, a little time spent in systematizing the passing, paying, and recording of accounts will be profitably spent.

All accounts should be submitted to the road superintendent, long enough before the regular meeting of the road committee to allow him to classify and distribute them. A distribution sheet will be found of service, on which will be recorded the following information:—

Person or firm submitting the account.

The class of work to which the account or part of account is to be charged (culverts, tile draining, road surface, etc.).

The road section on which the expenditure is to be made.

The part of each account (where the account is chargeable to more than one class of work or more than one road section) chargeable to each class, or road section.

The total of the account.

The account may usually be charged to one of the following classes of work, and should be so designated in the proper column in the distribution sheet: Grading, draining—Material, labor. Culverts—Material, labor. Road surface—Material, labor, fuel, oil, etc., contract. Bridges—Material, labor, contract. Maintenance—Material, labor; and miscellaneous.

Pay-lists will be recorded on this distribution sheet in the same manner as accounts. If a pay-list or account contains items chargeable to more than one section of road, or to more than one class of work, the account is to be divided so as to show the amount chargeable to each section or to each class of work. By supplying these details respecting each account, the road superintendent is virtually instructing the treasurer as to the posting of that account in his ledger. This distribution sheet, which should accompany each and every batch of accounts, will give the treasurer all information necessary to a proper keeping of the county road accounts, and will enable the treasurer and superintendent to prepare, independently of each other if necessary, at the end of the year's work, reports on the year's expenditure which will be identical.

Thus far the information and data recorded in time book, pay-list and distribution sheet, has been for the period covered by a single pay-list. The next step in recording costs is to re-arrange this information in such a way as to show the expenditure on each piece of work, and the total of such expenditure up to any given time. For this purpose it will be necessary to open an account in the ledger or account book for each separate work, and to have this account divided into heads corresponding with the details supplied on the distribution sheet. The various headings suitable for this form have already been outlined, and if care has been taken in the preparation of the distribution sheet, the work of the treasurer is reduced to that of copying from the distribution sheet into the column designated.

To make the system of cost and record-keeping complete, two other forms are suggested: a daily memorandum book for the foreman, in which he may keep a record of his work, and a report form to be filled out at regular intervals, preferably to cover the same period as the pay-list, and submitted along with the pay-list to the superintendent. Since the information asked for in the report is a summary of that collected in the memorandum book, the preparation of this report will be accomplished largely by copying.

The object of the diary, in addition to forming the basis of the periodical report, is to enable the foreman to keep an accurate record of his work and have it constantly with him for reference. The facility with which he will be able to compare one day's work with another's should be an important factor in producing increased efficiency. This book, if desired, could be incorporated as a separate section of the time-book, the one book then showing for each day how the time of the gang was spent and the amount of work done. The necessity for regular daily entries should be impressed on the foreman. If the report is submitted with, and made to cover the same period as the pay-list, the superintendent will have all the material necessary for conveniently calculating any unit costs which he may require.

The utility of the system as here outlined may now be more fully comprehended. At the end of the year, by a process no more difficult than the adding of a number of short columns, the treasurer or superintendent may produce a detailed statement of the cost of each part of the work. It is not necessary even to wait till the end of the season; the same information being just as easily obtained at any time during the year. All information ordinarily required, *e.g.*, the cost of grading, culverts, road material, labor, fuel consumed, etc., may be obtained in this way. Unit costs and other detailed information may be obtained from pay-lists and report sheets, and may be recorded according to the superintendent's own ideas. Finally, the labor of preparing the annual statement, which has heretofore been the horror of more than one superintendent, will be eliminated.

(To be continued.)

LOADING OF VEHICLES ON HIGHWAYS.

The Ontario Legislature has before it a bill introduced by Mr. George S. Henry to regulate the loading of vehicles operated on highways. If enacted in its present form, the requirement will not permit an excess of 4 tons per wheel, or of 12½ tons per vehicle. It will also prohibit the use of flanges, clamps or ribs on wheels, that will cause injury to the highway. It restricts, outside of cities, the weight per inch of width of tire to 600 pounds, unless the road be a brick, block, concrete or bituminous pavement with concrete base.

A clause prohibits a speed over 15 miles per hour for vehicles carrying over 4 tons, and 6 miles per hour for vehicles with iron or steel tires carrying over 6 tons. In the case of the latter having hard rubber or similar tires, the allowable speed is 12 miles per hour. Speed on bridges may be limited to 6 miles per hour at the discretion of the municipal corporation.

The municipality may grant a general or special permit for moving vehicles producing loads in excess of the limits mentioned above, but in such cases the owner of the vehicle is made responsible for any damage. Disregard of the above requirements involves a penalty of $100, which shall be spent in the maintenance and repair of the highway.

About 22 per cent. of the total railway construction in Canada during 1914 took place in the province of Alberta.

Ontario has built well over 3,000 miles of waterbound macadam roads since the introduction of the county road system in 1901.

Alberta has 1 mile of railroad for every 125 persons in the province. The mileage has doubled in three years, there being now a total of 4,097 miles.

Editorial

RUN-OFF FROM DRAINAGE AREAS.

In investigating the yield of drainage areas for water supply projects the general practice has been to measure the quantity of water drawn for consumption and to add to it the quantity wasted over the dam of the storage reservoir, or otherwise, and then to make an addition or subtraction, as the case may be, for the amount of water added to, or drawn from, storage. This gives approximately the natural flow of the stream as it would be if no storage reservoir existed. This approximation is generally found sufficiently accurate for practical purposes. There are times, however, when greater accuracy is necessary for best results, and in this connection there are other features which must be taken into account. A consideration of the whole is likewise necessary to make the records of yield obtained from certain drainage areas applicable to others.

The New England Waterworks Association has had a committee of nine investigating the problem since March, 1911. This committee, in a report which it submitted recently, emphasizes the importance of taking account of the extent of water surface upon the drainage area. When a considerable portion of an area consists of water surfaces, it is obvious that the evaporation causes the yield of the drainage area to be materially less than if the water surfaces did not exist. This is particularly so during summer months. The committee, therefore, advise that where accuracy is required the drainage area should be divided into land surfaces and water surfaces and the yield of each given separate consideration.

Swamps have water standing in them part of the year, and present damp surfaces much of the time, and may, therefore, be considered as intermediate between the upland from which the evaporation is least and the water surfaces from which the evaporation is greatest.

There are other corrections which it would be desirable to make, but which cannot be made because the necessary data are lacking. For instance, in the case of large rivers, it is not feasible to make corrections for the water drawn from or added to storage in the various reservoirs and millponds upon their drainage areas. Hence, the measured flow of such streams is not exactly the natural flow. The difference, however, is small except in the drier portions of the year, when the measured flow may be considerably more than the natural flow, and such streams cannot be used for deducing accurately the yield in dry times of drainage areas without storage.

It is pointed out that, under ordinary conditions, when the correction is made for water added to or drawn from a storage reservoir, the correction covers only the visible storage and not the storage in the interstices of the ground around the reservoir. It is generally impracticable to include this feature in the computations. As a rule, the amount of such invisible storage is small in comparison with the visible storage, but it may be large enough to materially affect the deduced natural yield of a drainage area in dry months.

On a drainage area where proper correction is made for storage in the reservoirs under the control of the water authorities, there are in some places other small reservoirs not under such control which are not included when making the corrections for storage.

In some instances, water is diverted from or into a drainage area in connection with systems of water supply and sewerage, and such diverted water is generally taken into account in preparing the records, but there is frequently some percolation or leakage past a dam, or through the natural barriers which retain a lake or reservoir, of which no account is taken.

STEEL RAIL PRICES.

For the first time since 1901, steel rails are now being quoted openly at less than $28 per ton. This basic price was fixed for Bessemer rails at the time of the formation of the United States Steel Corporation and has been maintained by that corporation and the independent mills alike since that date. Very recently the Algoma Steel Company, a Canadian corporation, has entered the United States market, quoting open hearth rails at $25 per ton on board cars at the mills, or $27.60 f.o.b. at Chicago, as compared with $30 at the mills quoted by the manufacturers in the United States. At least three railroads, the Pere Marquette, the Big Four, and the Toledo and Ohio Central, have contracted for rails at these prices.

Several reasons can be assigned for this cut by the Algoma Steel Company. The acute state of business in Canada, created by the European war and the recent removal of the tariff on steel products entering the United States from Canada coincident with the fact that there is no tariff on iron ore moving in the opposite direction, are however the principal factors.

From its geographical situation at Sault St. Marie this steel company is able to deliver rails by water at any of the lake ports and may therefore become a serious competitor of the mills in the United States. It will be interesting to note whether the Canadian roads do not demand a similar reduction.

OIL IN WESTERN CANADA.

Discussing the oil field of Western Canada at the Institution of Petroleum Technologists, Great Britain, Mr. Cunningham Craig said recently: "All drilling for oil is to some extent speculative, and no one who has studied these western prospective fields with any care has failed to point out over and over again that, though the rewards of success would be great, the possibility of complete failure in any one district is considerable. Yet it seems almost impossible that there cannot be a paying oilfield waiting for development somewhere between the far north and the international boundary. There will doubtless be many disappointments, for much of the development work now in progress was foredoomed to failure, but I believe, and I think that everyone who has travelled sufficiently in Western Canada will concur, that there is petroleum in these great territories and that it will be discovered and produced profitably at no very distant date."

CIVIC WORK IN VICTORIA, B.C., DURING 1914.

In the annual report of the city engineer's department of Victoria the expenditure on civic works, exclusive of the Sooke Lake water supply system, approximated $1,493,300. This included $260,000 for sewers, $139,400 for waterworks, $95,325 for streets, bridges and sidewalks and $720,000 for local improvements. The expenditure on the Sooke water supply system was about $663,000. The city's population is about 50,000; its area is 4,640 acres.

A total of 112,301 square yards of paving was done during the year. This was all sheet asphalt, with the exception of one heavy grade which was paved with asphaltic concrete. About 5.90 miles, or 24,536 square yards of sidewalks were laid, and 9,851 square yards of boulevards were constructed during the year. About 3.54 miles of surface drain and 1.39 miles of surface drain laterals were constructed under local improvement on streets that were paved, also 1.44 miles of sewer laterals.

In 1914 all construction work on surface drains, boulevards, sidewalks, curbs and gutters, grading and concrete base for paved streets was done by day labor, and the asphalt surface laid by the Canadian Mineral Rubber Company, Limited, under contract. The municipal paving plant, the contract for which was awarded to the Warren Bros., for the sum of $13,505 f.o.b., Victoria, is being installed at the present time, and will be ready for operation in the spring, when the asphalt surface will also be laid by city workmen under the day labor system.

The average cost, including labor and material, of the different classes of work under local improvement for the year 1914 was as follows:—

Grading per cubic yard, 55c. to $1.25.
Curb and gutter, per lin. ft., 41 cents.
Concrete base, per sq. yd., 92c. for 6-in. thickness.
Concrete base, per sq. yd., .755 for 5-in. thickness.

Labor—

Concrete foreman, $5.50 per day of 8 hours.
Grade foreman, $4.00 per day of 8 hours.
Mixermen, engineers, $3.50 to $4 per day of 8 hours.
Laborers, $3.00 per day of 8 hours.

Sewers.—Sanitary sewers were laid on 36 streets, and work progressed steadily on the North West Trunk Sewer. The low level main was laid from Douglas Street to the gathering basin on Cecelia Road, which has also been constructed and is at present being used as a septic tank. The sewer is also completed from low water level at Macauley Point to a point on Dunsmuir Road, about 300 feet east of Head Street. Tunnels are being driven at four different places between Head Street and Selkirk Water, and this section should be completed about October, 1915.

The sewer and surface drain mains were laid from Carroll Street east to their respective mains between Cecelia and Burnside Road in Gorge Ravine, and the location of the main surface drain was altered at Cecelia Road, where it interfered with the Canadian Northern Railway Company's right-of-way, and was also extended to high water.

The section of the Kings Road storm sewer west of Cedar Hill Road was completed, and the drain extended north and east to the corner of Belmont and Haultain Street.

6.1 miles of sewer mains were constructed during the year, bringing the total mileage in the city up to 115.

The following are the average labor costs, not including blacksmithing, of the different classes of work in sewers for trenches up to 8-ft., in depth:

Rock excavation, per cubic yard	$4.46
Hardpan excavation, per cubic yard	1.91
Earth excavation, per cubic yard	.67
Pipe-laying, 8-in. pipe, per lin. ft.	.068
Backfilling, per cubic yard	.24
Tunneling in rock, per lin. ft. of tunnel (6 ft. x 7 ft.)	8.06
Tunneling in earth (including timb.) (7 ft. x 7 ft.)	4.27
Pipe-laying reinforced concrete 36-in. pipe in tunnel, per lin. ft.	.75
Pipe-laying, 36-in. pipe in open trench ...	.46
Labor—	
Foremen in tunnel work, per 8-hour day ..	$4.50
Foremen in open trench, per 8-hour day..	4.00
Hoistmen, machine drillmen, carpenters and mechanics, per 8-hour day	$3.50 to 4.00
Laborers, per 8-hour day	3.00
Laborers, below depth of 6 feet, per 8-hour day	3.25

Street Oiling.—An approved method was used for oiling the streets, a tank from an old sprinkler was fitted on to the body of a Peerless truck, and by its use oil was applied to from four to five times the yardage done last year by a team in the same length of time. About 733,000 square yards of streets were oiled at a cost of 1.23 cents per sq. yard. This included cost of oil and sand, and all labor for removing dust, sprinkling oil, spreading sand, teams and rental of plant, but did not include overhead expenses.

In 1914 a sand sprinkler was made and attached to a motor truck with the result that the downtown streets could be sanded in frosty weather at the rate of 15,000 square yards per hour, and at a cost of 34½ cents per thousand square yards for labor, sand and rental of truck. They hope to use this sand sprinkler for following up the oiling, as it will be much cheaper than sprinkling by hand from carts, and the sand will be more evenly distributed. By using a heavy gravity oil and following up with a coating of sand they not only eliminated the dust nuisance but a good wearing surface was formed which improved and preserved the road surface.

Street Cleaning.—It was found, in 1913, that cleaning with hand brooms was cheaper than with horse brooms, and the latter were not used in 1914. The cost of cleaning with horse brooms and disposing of street sweepings was 33.9c. per 1,000 square yards in 1913, with hand brooms 26.9c. per 1,000 square yards, and with brooms and pick-up cans 21.5c. per 1,000 square yards, the latter being used in the business districts only. In 1914 the cost with hand brooms and pick-up carts and cans was 16½c. per 1,000 square yards. The wages of the men in the business district were not reduced.

Waterworks.—The following construction work was carried out during the year:

Mains laid	2.27	miles
Meter services, 413, making	2.4	"
Services and renewals to lots and boulevards on paved streets....	3.47	"
Hydrants installed		102
Meters installed		936
Meters tested, removed and repaired		760
Valves on mains		51
Valves to hydrants		102

The total mileage of water mains in the city, exclusive of Victoria West, which is served by the Esquimalt Water Works Co., is 130¼. From tests made by the city analyst the water in Elk Lake was found unsuitable for domestic purposes, and they purchased the entire supply from the Esquimalt Water Works Company. The consumption varied from 3½ million Imperial gallons per twenty-four hours in the winter, to 5½ millions in the summer.

During the year very satisfactory progress was made on the Sooke water supply. Up to the end of the year 15.7 miles of concrete flowline pipe were laid, leaving not quite twelve miles to complete the work. On the pressure pipe line 9¾ miles were completed, leaving less than a mile to complete. The Humpback reservoir has been filled with water from the drainage area around it, and also by tapping two mountain streams connecting them up to the flowline pipe at the manholes, and early this year they propose to obtain about two million gallons daily from this source. Upon the completion of the flowline, which should be some time in June, they will be able to put the whole system in use.

EARTH ROAD CONSTRUCTION AND MAINTENANCE.*

By John H. Mullen,
Deputy State Engineer of Minnesota, Minn.

A STUDY of actual road conditions in any of the western provinces or states will disclose the fact that over 90% of the public highways are, and must remain, earth roads, and for that reason the construction and maintenance of this class of roads is the most important work of the road engineer or other officer charged with administration of road affairs. With the possible exception of brick or concrete, almost any kind of road surfacing is of a temporary nature and must be replaced, but a properly located and constructed earth road grade is a permanent improvement.

The first point to take into consideration in planning a road system is location. Too many of our important roads are poorly located; in many cases on account of the tendency to follow the first trails, but usually the poor location is due to holding strictly to subdivision lines. In gently rolling and well drained country it is probably better to follow the section lines, but where heavy grades are encountered or other bad topographical conditions exist, a complete survey of the road situation should be made and a location determined upon without regard to property lines which will provide the most economical and satisfactory road for all times. The relatively unimportant road of to-day may be one of heavy travel in twenty or fifty years, and our responsibility is great in this respect; that we are probably determining the limits of travel for many years in advance.

In location, the factors to take into consideration are: Volume and direction of traffic, limiting grades, possibilities for adequate drainage and safety of the travelling public. The character of traffic is rapidly changing and the gradient becomes more of a limiting feature as the use of motor vehicles increases. If possible, roads should be so located that the maximum grade does not exceed 5%. The elimination of railroad grade crossings comes under the head of location and is very important as affecting the safety of the public. In a great many cases the necessity of making grade crossings can be avoided or the danger reduced by minor changes of location. With the advent of rapid motor travel there is also danger in abrupt change of road line and to avoid this the alignment of roads should be so planned that a clear sight distance of 250 feet is provided at any point. These things should all be taken into consideration when laying out a road system and in general a good rule for road officials to adopt is to only apply construction funds on permanent locations.

Adequate drainage is the all-important feature of road work. A successful road plan must provide for the removal of water from the road surface and side ditches before it may saturate the subgrade, and to accomplish this it is necessary to have a sufficient crown on roadway with proper depth and fall in ditches. In the average soil a crown of ten inches on a 20-foot roadway is necessary and the depth of ditch below crown should be at least 2 feet at time of construction, but this may vary in accordance with the character of the soil. Surveys should always be made to determine upon lines and disposal of drainage, as the eye cannot be trusted in judging these points. Off-take ditches should be located where necessary and in any event the water must be removed from road ditches as quickly as possible. Frequently it is found necessary to construct roads through wet locations where drainage cannot be secured, and in such places the top of grade must be kept at least 3 feet above the water level. The most common neglect of drainage is found where grades are built up by borrowing the material from road ditches with blade graders. The wrong and usual method in such cases is to have the profile of road ditches conform to the surface of the ground, with the result that water stands in the depressions and saturates the grade. On this class of construction extra ditching should always be arranged for in order that continuous lines of drainage may be provided. In clay cuts it is not unusual to find great difficulty in draining the roadway shortly after the frost leaves the ground and after heavy rains. This condition can be remedied by the laying of farm drain tile or by rock-filled drains or other methods of subdrainage. The proper drainage of a road is of such great importance that it will be found economical in all cases to have surveys made and ditch grades established by an engineer, for the expense of this work is negligible as compared with the value of the information obtained.

The proper cross-section for earth roads depends upon the character of the soil and topography of the country, but as a general standard for average soil a crown of one inch per foot and a twenty-foot roadway is satisfactory. For main trunk roads 24-foot roadways should be provided, and on lateral roads where travel is very light 16 feet is an economical width. To establish a standard height of crown or depth of ditch for all roads is, however, an error, for local conditions require in many cases that two or three different sections be used within the same mile. A knowledge of the soil where improvement is to be made is necessary, as one will sometimes find that opposite conditions obtain on portions of the same job. For instance, in Hubbard County, Minnesota, one piece of road is through light soil which cannot be excavated to a greater depth than one foot without reaching a fine drifting sand, while on another portion of the road the soil appears to be heavy loam, but by excavating a foot and a half in depth we reach a first-class road gravel. Both of these sections were built by drawing the material up from the sides, but on the former a very low crown was held and wide, shallow ditches were dug, while on the latter a high grade was built up in order to dispose of the stripping and deep ditches were dug to obtain the surfacing material. On the sandy portion of this road we found that the top soil to a depth of eight inches to a foot would give almost as good a surface as gravel, but it required a great deal of dragging to bring it to proper

*Delivered last week at the Manitoba Agricultural College.

condition. Dragging this top soil was only effective during a rain or while the road was saturated. Where different kinds of material are found on the same line of road, the grading should be so planned that the difference of material will be of advantage to the road. By hauling clay on the sandy portions and sanding the heavy sections, more satisfactory results will be secured, and in many cases at practically no greater expense. Probably the worst condition we have to contend with is the heavy gumbo soil of the Red River Valley, of which Manitoba has considerable. We have experimented a great deal with that soil and have found that best results can be obtained by the construction of deep ditches and high, wide grades. We require a minimum depth of 2½ feet in ditches with a distance of 50 feet outside to outside, and build up the grades by the use of tractors and graders. By running the tractor on the roadway all the time and bringing up the material in thin layers, the roadbed becomes very well compacted and therefore more impervious to water and capable of sustaining greater loads without rutting. Measurement of grades built in this manner show in some cases a compression or shrinkage of 50% from excavation. It is in such locations as this that drainage is especially important. A gumbo road is perhaps one of the best roads to drive over when it has dried smooth, but even with proper construction and an efficient dragging system it becomes almost impassable under heavy traffic during wet weather. To meet this condition and also on very heavy clay soil we have found that three or four inches of sand or fine gravel spread to a width of about 16 feet makes an impervious crust after travel has mixed it somewhat with the heavy soil, and provides an excellent road.

There are many different kinds of machinery used on highway construction but the most common implement is the ordinary blade grader, and it is the promiscuous use of this machine without regard to drainage or final grade lines that results in so much poor road work. Blade graders are essential to both construction and maintenance work and have the advantage of low cost and will move material from ditches to roadway cheaper than any other method, but there is nearly always a tendency when using these machines to make the work too light and the requirements for drainage are overlooked in the desire to cover a large mileage at a low cost. In many cases, blade graders are used where earth should be hauled along the line of the road rather than borrowed from the sides, and in such locations drainage is not secured, knolls are increased in height and mudholes result in the depressions. It is necessary in all cases where blade graders are used, to have, in addition to the grader crew, a grading or ditching outfit to cut down the knolls and open lines of drainage.

An important point in road specifications, particularly in cut and fill work, is to require what we call "construction dragging," which means that a road drag shall be used constantly during the building of grades and that the roadbed is kept smooth at all times during construction. In that manner the formation of chunk holes and ruts is prevented.

A question confronting those in charge is whether road work shall be done by contract or day labor. Our experience has shown that light grading and blade grader work can be more economically done under force account or day labor, but in heavy work requiring considerable equipment and on which measurements can be more accurately made it is better to handle the work by contract.

Any road construction is without permanent value unless an adequate system of maintenance is established, and on earth roads it is absolutely necessary that a continuous system of dragging and general maintenance be provided immediately after construction. The most effective and cheapest method of maintenance is by the use of the ordinary road drag. The surface of a road which has been travelled for some time becomes consolidated by what may be called a puddling action and if the road is kept crowned and smooth this surface will permit the water to run off before damaging the roadbed. The constant use of a road drag will, by spreading at frequent intervals a thin layer of puddled earth over the road surface, tend to build up an impervious crust which will resist the action of moisture and abrasion of vehicles. The work of dragging must be organized if the best results are to be secured. The maintenance in each road district should be placed in charge of one man for the season, who should be held personally responsible for the condition of his roads. This element of personal responsibility is valuable in any branch of road work. Forces should be organized before the spring break-up, for the most effective work can be done while the frost is leaving the ground. Those living along the road must of necessity be employed to do the dragging, but the limits of each man's work must be fixed in order that responsibility may be placed for the good and the indifferent work. To secure good-natured rivalry and encourage better work, contests may be organized and prizes given for the best dragged sections of road. This has been very effective and a good roads sentiment may be created by arranging these contests with good road picnics, at which the prizes are awarded. Commercial clubs of the cities and villages can aid by putting up drag prizes and taking an interest in the work.

There are many patented drags and various dragging devices on the market, but the home-made wooden drag, whether built on the plan of the split log drag or similar to the Minnesota planer, are the best for maintenance of earth roads, but the planer gives a smoother roadway than the drag, for it levels out the longitudinal inequalities which the log drag seems to accentuate. The wooden drag renders the road surface more impervious by a smearing action which the iron or steel drag does not give, and is therefore recommended and most generally used. The best time to drag is as soon after a rain as the material will move without gumming, but no attempt should be made to drag when the road is dry and hard.

I have endeavored in this paper to bring out the essential points on earth road construction and maintenance which have been encountered in the supervision of over four million dollars' worth of that class of work, and in conclusion I wish to emphasize the fact that surfaced roads must at best be limited to a very small percentage of the road mileage, especially in the newer sections of the country, while the proper construction and maintenance of the earth roads will provide good roads for the whole community.

ENGINEERING IN ENGLAND.

The British House of Commons has given the Imperial Government authority to take over the control of the entire engineering trade of the country and to place it under a combined management for the purpose of increasing the output of munitions of war. Mr. Lloyd George declared that the government proposed to organize the entire engineering community through a committee headed by business men, with the idea of assisting in the increase of output.

WATER WASTE PREVENTION BY INDIVIDUAL METERS versus DISTRICT METERS.*

By R. O. Wynne-Roberts, Regina.

THERE are many cases where it would be difficult to make an equitable charge for water consumed unless the quantity was measured. These are industries, institutions, premises requiring water in very small quantities for sanitary purposes, and large consumers. But the large majority of consumers do not actually need much water, although it is well known that an inordinate quantity is used or misused. This has arisen in some instances from the fact that it was considered more economical to supply than to check; in other cases it is due to indifferent management and neglect until the waste has created serious disabilities on the part of some of the water authorities.

There is now a general movement for the conservation of water and the principal means taken is to install individual meters on all water connections. The object of this short paper will be to discuss the question as to whether the general installation of individual meters or the provision of district meters is to be advocated.

Waste of water must be eliminated as far as practicable and economical, for the keynote of successful management of all businesses is to stop leaks of all kinds.

A waterworks system loaded with a high rate of supply is not unlike a ship which has a constantly leaky water ballast, for neither the waterworks nor the ship can be operated to its full legitimate capacity, nor made to be revenue producing to the extent it should. The proprietors of the waterworks who propose to install a general meter system so as to reduce some of the leaks may be compared with the shipowners who have some of the leaks in the ship's hull repaired and pumps provided to reduce the water ballast. Carrying the analogy still further, the waterworks proprietors who install bulk and district meters, a few individual meters and by means of efficient inspection reduces all leaks to a minimum are similar in purpose to the shipowners who have the ship's hull thoroughly overhauled and ample pumps provided to keep the water ballast empty. In both these cases the property is maintained in an efficient condition and made to produce the maximum revenue at the minimum cost.

Most of the cities are relatively small, and if it be assumed that the average size is about 20,000 population, it will doubtless represent a large number of towns. The unrestricted total consumption is, say, 150 gallons per head daily. In such a city there would be about 3,500 water connections, and if all are metered there would be that number to fix and maintain. The water authority, to secure full control over the meters, would buy the meters and rent them out

Adopting the careful analysis of costs made by the Wisconsin Railroad Commission and mentioned in their report of 1911, the average annual cost is as follows:—

Labor, moving and resetting meters	$0.18
Labor, meter and fittings department	0.34
Supplies, meter and fittings department	0.12
Maintenance of meter	0.35
Reading meters and delivering bills	1.35
	$2.54

*Paper submitted last week to the Illinois Section of the American Waterworks Association.

To these must be added:

Depreciation, say	$0.50	
Interest	0.36	
		$0.86
Total per meter per year		$3.40

The cost of metering will fall on the consumers and in this case it would amount to $11,900 per annum.

The cost of filtered water at the works will be about $3.50 per million gallons.

Individual meters measure the water entering the premises and consequently constitute good waste detectors. The saving in the quantity of water used before and after installing meters varies greatly, but in all cities metering has effected a tangible reduction in the quantity of water pumped. Published figures are often misleading because the diminution in the quantity consumed by the people is often small compared with the losses on the mains. When the total quantity of water registered by individual meters is ascertained, the unaccounted-for losses amount to from 20 to 66 per cent. of the total quantity pumped. It will be fair to expect 33 per cent. reduction in the pumpage by universal metering. Supposing the head of the pumps is 100 feet and the price of coal is $4 per ton, then the saving in fuel due to diminished pumpage will be about $1,200 per annum. The cost of labor will remain practically the same.

District meters could be installed in this city for about $3,000; a small number of individual meters would be required, as explained in the commencement, and inspectors would be employed to make a systematic and frequent survey of the whole waterworks. The annual expenditure in this case would be as follows:—

Interest on $3,000	$ 150	
Depreciation	150	
		$ 300
Two inspectors	$2,500	
Clerks, etc.	1,500	
		4,000
250 meters @ $3.40		850
Miscellaneous		250
Total		$5,400

By careful and diligent inspection the pumpage should be gradually reduced to one-half and the saving in fuel on the same basis as before would be $1,800.

The above estimate is liberal. The writer had control of waterworks and by means of this method was able to supply the public on less than 30 gallons per head daily for all purposes; the railroad companies were large consumers. The London Water Board use from 1,300 to 1,400 Deacon meters to detect waste and by discovering and localizing leaks the average supply is under 45 gallons per head daily. By means of pitometer survey at Ottawa, Canada, leaks amounting to 5,300,000 gallons per day were remedied in a short time. Washington has in seven years detected leaks aggregating 40 million gallons daily. Three permanent self-recording district meters have been installed in Regina, but systematic inspections have not yet been started. The record obtained from the district meters enable the officials to detect leaks and to localize them, and by this means keep the consumption at a reasonable figure. Such meters and records are a check on the pumps and on the daily occurrences in the district controlled.

The reduction of waste is equivalent to increasing the capacity of the waterworks to meet growing demands and at a reduced cost or with increased revenue.

Even in cities where the rate is fixed by the public utility commissions and individual meters are compulsory, district meters are essential to provide an efficient and economical system. With both individual meters and self-recording district meters the quantity of water necessary to satisfy all requirements should not exceed 50 gallons per head per day, except in special cases where the industrial consumption is abnormally high.

The financial situation as estimated in the foregoing illustrations will be as follows:—

Individual Meters.

Cost of operation...$11,900	Saving in fuel	$1,200
	Value of water saved	1,277
		$2,477

District Meters.

Cost of operation...$ 5,400	Saving in fuel	$1,800
	Value of water saved	1,914
		$3,714

The difference between the estimated cost of operating the two methods and the savings effected by them are $9,423 and $1,786 respectively, or the extra cost per water-paying consumer per annum is $2.70 and 52 cents.

Coast to Coast

St. John, N.B.—More than 450 applications have been received from railway men for the new C.P.R. corps of engineers to be mobilized for war service.

Purple Springs, Alta.—At a mass meeting of farmers, Mr. J. J. McLellan presented a resolution to petition the minister of interior for government irrigation, or the extension of the C.P.R. system of irrigation, which was accepted.

Victoria, B.C.—Sir Richard McBride, says a dispatch, will ask the people of British Columbia to support his railway policy, which may include further assistance to Mackenzie and Mann to complete the Alberta-Victoria line on Vancouver Island.

Toronto, Ont.—A measure has been introduced by Mr. G. H. Gooderham, M.P.P., in the Ontario Legislature which will make owners of heavy motor trucks and wagons liable for rutted roads, and will give municipal corporations power to recover the amount of the damage from them by appeal to a county judge.

Vancouver, B.C.—In the suit of J. McIlwee & Sons, of Denver, against Foley, Welch and Stewart for $500,000 damages, judgment was given for plaintiffs for $31,000 and costs. The judge held that the plaintiffs should have gone back to work when they were offered a chance after the first dispute between contractors and sub-contractors occurred.

The Pas, Man.—Three thousand men will be wanted next month for construction work on the Hudson Bay Railway, says a dispatch. The right-of-way has been cleared of trees to within 40 miles of Port Nelson, and the grading work will be carried to this point by October. Supply caches are established from Split Lake to the bay with food for 5,000 men. The government's end of the work requires an additional force of 1,000 men, made up of engineers, rodmen, surveyors, bridge erectors, skilled labor and teamsters.

PERSONAL.

F. McARTHUR has resigned his position as city engineer of Regina, Sask. L. A. Thornton is now both city commissioner and city engineer.

T. A. RUSSELL has been appointed head of a school of military transport for the training of mechanical transport men at Exhibition Camp, Toronto.

M. WEIR, of Montreal, has been elected president of the Canada Foundries and Forgings Company, Limited, Brockville, Ont., in succession to John McGill.

ALLAN PURVES, superintendent at Chilliwack of the British Columbia Electric Railway, succeeds Robert King as superintendent of the London division.

THOMAS VILLENEUVE has been appointed sanitary inspector for Cobalt, in succession to Mr. Robert Sharpe, who has left for the front. There were 45 candidates for the position.

C. R. BURT, who has been factory manager of the Russell Motor Car Company, Limited, Toronto, for some time, has been appointed assistant general manager and elected to the directorate.

WILLIAM MAUND, travelling auditor of the Temiskaming and Northern Ontario Railway, has been appointed secretary-treasurer of the road in succession to Mr. A. J. McGee, deceased.

PROF. H. T. KALMUS, Queen's University, has resigned and is leaving to take up his residence in Boston. He lectured in metallurgy and also conducted experiments in Cobalt for the Government.

W. F. BRENDON RUBIDGE, '10, O.L.S., A.M. Can.Soc.C.E., is resident engineer on the construction of the Rosedale section of the Bloor St. viaduct for the Dominion Bridge Co., who are the general contractors.

W. H. PUGSLEY, reeve of Richmond Hill, has been elected chairman of the York County Highways Commission. The other members of the commission are Controller Foster, vice-chairman; Alderman David Spence and Warden Johnathan Nigh.

KENNETH J. DUNSTAN, manager of the Toronto Exchange of the Bell Telephone Co., has been appointed division manager, in charge of the Ontario division, with headquarters at Toronto. Frank Kennedy is appointed assistant manager of the Toronto exchange.

W. A. McLEAN, of the Ontario Highways Commission, speaking on international highways and good roads before the Canadian Club of London, proposed a national highway to commemorate the memory of Canadians who fall in the European war.

W. H. DAY, B.A., professor of physics, Ontario Agricultural College, reminds *The Canadian Engineer* that for a number of years the College has been making drainage surveys for farmers free of charge, except for travelling expenses. This offer is again renewed. Farmers having drainage difficulties may secure assistance by writing the department of physics, Ontario Agricultural College, Guelph, for information and regular application forms.

J. R. GRANT, M.Can.Soc.C.E., and secretary-treasurer of the Vancouver branch of the Society, was dined by representative engineers prior to his departure for the front where he will serve with the Royal Engineers. Mr. F. C. Gamble, chief engineer of the department of railways, Ottawa, the president of the Canadian Society, was in the chair, and the vice-chairman was Mr. G. R. G. Conway, chief engineer of the British Columbia Electric

Railway Company, the chairman of the Vancouver branch of the society.

LIEUT.-COL. LACEY JOHNSON, superintendent of the Angus shops of the Canadian Pacific Railway Co., has been appointed general welfare agent of the company. He will look after the general uplift of ideals and service among the railroad employees. He was born in 1855, at Abingdon, Berkshire, England. He entered railway service in 1870, and served his time as a premium apprentice to the Great Western Railway of England at Swindon works for five years. He has had long experience with the Grand Trunk and Canadian Pacific Railways.

OBITUARY.

MR. J. C. ROTHREY, a prominent railway and electrical engineer in the employ of the Canadian Northern Railway, died last week. He was born in Glasgow 67 years ago and was regarded as one of the most able railway engineers in Canada. His first practical experience here was the construction of the Gorge Railway between Niagara Falls and Lewiston.

PROGRAMME OF ROAD CONGRESS NEXT WEEK.

An advance proof of the official programme of the second Canadian International Good Roads Convention and Exhibition, to be held at Convocation Hall, Toronto, March 22nd to 26th, has just come to hand. According to it the first day's session will include addresses by W. A. McLean, the president; Hon. J. S. Hendrie, Lieutenant-Governor of Ontario; Hon. Finlay G. MacDiarmid, minister of public works, Ontario; Mayor T. L. Church, president, Union of Canadian Municipalities; J. A. Sanderson, president, Ontario Good Roads Association; U. H. Dandurand, honorary president, Dominion Good Roads Association, and Hon. J. A. Tessier, minister of roads, Quebec.

On Tuesday morning the second session will be opened by a paper on "Road Construction in New York State," by George C. Diehl, engineer of Erie County, New York. A paper on wearing surfaces will be read by George W. Tillson, president, American Road Builders' Association, and a discussion of it will be opened by J. S. Dobie, O.L.S.

Another paper on Tuesday morning will deal with questions of financing, one of the chief problems of the good roads movement.

In the afternoon B. Michaud, minister of roads, Quebec City, will read a paper on road laws, a discussion of which will be opened by J. F. Beam, Black Creek, Ont., and A. McGillivray, provincial highway engineer, Manitoba. Another paper entitled "Road Construction in Wisconsin" will be read by A. R. Hirst, state highway engineer, Madison, Wis. The third session will close uith a paper on bridges and culverts, a discussion of which will be introduced by Norman M. McLeod, Lucius E. Allen and Frank Barber.

On Wednesday R. A. Meeker, state highway engineer, New Jersey, will give an address on road construction in that state. A paper on foundations will be read by J. Duchastel, city engineer, Outremont, discussion to be opened by A. M. Jackson, Brantford. Another paper on machinery will be presented by F. E. Ellis, manager, Essex Trap Rock and Construction Co., Peabody, Mass. Wednesday afternoon Major W. W. Crosby, Baltimore, will read a paper on dust prevention, discussion to be opened by Prof. A. T. Laing, University of Toronto. A paper on maintenance will be read by Gabriel Henri, chief provincial engineer, Quebec. Another on road organization will be presented by George H. Henry, Todmorden, Ontario.

Thursday's session will include the following papers: "Road Location," C. R. Wheelock, county engineer of Peel, Ont.; "Gravel and Stone Roads," John H. Jackson, park superintendent, Niagara Falls; "Good Roads and the Contractor," H. T. Routly, O.L.S., Huntingdon, Que.; "Town Planning," Thomas Adams, Commission of Conservation, Ottawa; "Traffic," Col. W. H. Schier, Massachusetts Highway Commission; "Brick Roads and Streets," E. A. James, engineer, York Highway Commission.

The closing day of the congress will be largely devoted to business, but the following papers are scheduled: "Bituminous Construction," J. Pearson, Constructing and Paving Co., Toronto; "Concrete Roads and Streets," H. S. VanScoyoc, chief engineer, Toronto-Hamilton Highway; "Creosoted Wood Block," A. F. Macallum, city engineer, Hamilton.

The presentation of each paper will be followed by a period of discussion, and the names of our most prominent city and town engineers and road superintendents appear in the list of those who have been arranged to open the discussions.

UNIVERSITY OF TORONTO ENGINEERING SOCIETY.

Mr. C. E. Hastings has been elected vice-president of the Engineering Society in connection with the School of Practical Science, University of Toronto. The contest was keen and the following were the other officers elected: Vice-president, Mr. W. D. Honeywell; corresponding secretary, Mr. R. S. C. Bothwell; recording secretary, Mr. J. McEachern; treasurer, Mr. G. H. Sohn; chairmen of clubs—Civil, Mr. H. A. Babcock; electrical and mechanical, Mr. G. A. Daniels; chemical, Mr. B. Boyd; architecture, Mr. J. L. Skinner; mining, Mr. B. A. McCordan; 4th year representative, Mr. J. R. Kirby; 3rd year representative, Mr. H. R. Nicholson; 2nd year representative, Mr. J. H. McVean; Curator, Mr. J. Gardener.

COMING MEETINGS.

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

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—Second Annual Convention, Toronto, March 22 to 26, 1915. Secretary, Geo. A. McNamee, Dominion Good Roads Association, Montreal.

TORONTO ELECTRICAL SHOW.—The second annual exhibition, to be held in the Arena, Toronto, April 12th to 17th. Secretary, Mr. E. M. Wilcox, 62 Temperance Street, Toronto.

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

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

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

23288—February 15—Amending Order No. 13993, dated June 12th, 1911, by striking out sub-clause (d) in paragraph 1 of operative part of Order. 2. Granting leave to Lachine, Jacques-Cartier and Maisonneuve Ry. Co. to cross Montreal Tramways Co. at such an elevation over said track as will ensure clearance of 15 feet, so that use of track to Montreal Tramways Co. will not be interfered with.

23289—February 12—Authorizing C.P.R. to construct road diversion in Sec. 17-8-17, W. 2 M., and construct, at grade, its Weyburn-Stirling Branch Line across said diversion at mileage 19.61 on said Branch.

23290—February 15—Authorizing C.P.R. to construct certain extensions to siding of Provincial Reformatory in Lot 3, Con. 1, and Lots 3 and 4, Con. 2, Division G, Tp. Guelph, mileage 29.02, Hamilton-Goderich Sub. Division.

23291—February 13—Authorizing C.P.R. to operate bridges Nos. 24.2, 7.17, and 10.8, Port Burwell Subdivision; No. 103.25, Hamilton and Goderich Subdivision; and No. 33.6, Bobcaygeon Subdivision, all on Ontario Division.

23292—February 15—Relieving C.N.R., from providing further protection at crossing of highway a mile and three quarters (1¾) west of Elgin, Man.

23293—February 13—Authorizing G.T.R. to operate bridges Nos. 278, mileage 73.75, over Nottawasaga River; 274, M. 59.40, over Public Road, near Palgrave Station; 265, M. 46.80, Public Road, near Inglewood Station; 263A., M. 41.21, over Toronto Suburban Ry., near Georgetown Station; 262, M. 34.00, and Stewarton Viaduct, all in Province of Ontario.

23294—February 13—Prohibiting Windsor, Essex and Lake Shore Rapid Ry. Co., until further Order of Board, from operating electric cars over crossing of Gravel Road, near Windsor, Ont., when gates are down on crossing of M.C.RR.

23295—February 15—Approving proposed location Can. Nor. Alta. Ry. Co.'s combined Station and Section-house at Bilby, Alta.: Provided that when traffic on highway is blocked for more than five minutes at any one time by reason of location hereby approved, Board be at liberty to relocate station.

23296—February 15—Approving plans showing Edmonton, Dunvegan and B.C. Ry. Co.'s station "B," filed under file No. 18903.91.

23297—February 15—Approving location G.T.P. Branch Lines Co.'s station at Gerrond, Lots 4 and 7, Tp. 45, Rge. 26, W. 2 M., Sask., on Prince Albert Branch, station to be in accordance with Ry. Co.'s Standard Structural Plan No. 1.

23298—February 12—Authorizing C.N.O.R. to construct across Petit Bois Franc Road, which road shall be diverted in accordance with plan prepared by F. C. Laberge, C.E., and dated December 30th, 1914; C.N.O.R. pay to town of Cartierville sum of $12,000 as soon as Road is legally closed; and upon such payment all its responsibility shall cease; remainder of cost of diversion of road be paid ½ by town of Cartierville, and ½ by town of St. Laurent.

23299—February 15—Amending Order No. 12321, dated November 18th, 1910, by adding following: "It is further ordered that, during the season of navigation, the said crossing be protected by a watchman between the hours of 7 a.m. and 7 p.m. daily."

23300—February 15—Extending, until May 15th, 1915, time within which G.T.R. install bell at crossing of highway immediately west of Oakville Station, Ont.; required to be installed by Order No. 23249, dated February 2nd, 1915.

23301—February 18—Authorizing C.P.R. to construct trestle over Don Branch of its railway, Toronto, Ont., at mileage 2.00 from Leaside Junction: Provided vertical clearance be 22 feet six inches.

23302—February 18—Relieving, so long as character of movements over crossing shown to exist continues, C.N.R. and G.T.P. Ry. Cos., from maintaining night signalman to operate interlocking plant at crossing at Camrose, Alta.; home signals and derails be set clear for G.T.P. Ry. and all signals and derails on line of C.N.R. set at stop during night hours; key of tower be left in custody of G.T.P. Ry. Rescinding Order No. 23228, dated February 1st, 1915.

23303—February 8—Relieving G.T.P. Branch Lines Co. from erecting and maintaining fences, gates and cattle guards on Melville-Canora Branch, mileage 0 to mileage 54.72, Sask.

23304—February 8—Relieving G.T.P. Branch Lines Co. from erecting and maintaining fences, gates, and cattle guards on Moose Jaw Northwest Branch, mileage 0 to 66.6, Sask.

23305—February 8—Relieving G.T.P. Branch Lines Co. from erecting and maintaining fences, gates, and cattle guards on Regina-Moose Jaw Branch, mileage 0 to 43.3, Sask.

23306—February 18—Refusing application Corporation City of London, Ont., for Order directing G.T.R. to provide and maintain electric bell at crossing of Dundas St., by London and Stratford Branch of said Railway. Speed of trains operated over said crossing be limited to rate not exceeding ten (10) miles an hour.

23307—February 19—Approving of an Order by Exchequer Court of Canada appointing Thos. J. Kennedy and Vivian Harcourt, Receivers of the Algoma Central and Hudson Bay Railway Company.

23308—February 19—Approving revised location C.P.R. Swift Current Northwesterly Branch Line, from point in Sec. 17-23-20, W. 3 M., mileage 111.95, in a Northwesterly direction to point in Sec. 24-23-1, W. 4 M., mileage 112.56.

23309—February 19—Amending Order No. 23274, dated February 11th, 1915, by striking out word "Ontario" where it occurs in seventh line of recital to Order and substituting word "Quebec."

23310—February 18—Relieving C.N.O.R. and Canada Cement Company, Limited, from maintaining night signalman to operate interlocking plant at Belleville, Ont.; home signals and derails be set clear for C.N.P.R.; key of tower be left in custody of C.N.O.R.

23311—February 19—Relieving C.N.R. from providing further protection at crossing of highway between Lots 10 and 11, Con. 8, immediately south Mount Albert Station, on Parry Sound Subdivision, in township East Gwillimsbury.

23312—February 22—Authorizing C.P.R. to use bridge No. 814 on Winnipeg Beach Subdivision, Man. Div., Man.

23313—February 19—Authorizing Erie and Ont. Ry. and M.C.RR. to operate their trains over crossing in Tp. Moulton, Co. Haldimand, Ont., near Attercliffe, without first being brought to a stop.

23314—February 19—Relieving C.N.R. from erecting and maintaining fences, gates, and cattle guards along certain portions of its Ry., between North Bay and Port Arthur, Ont.

23315—February 19—Relieving C.P.R. and C.N.R. from maintaining night signalman to operate interlocking plant in Lot 101, parish of St. Pauls, Man.; home signals and derails be set clear for C.P.R.; and key of tower be left in custody of C.P.R.

23316—February 20—Authorizing C.P.R. to use bridge No. 42.2 on Drummondville Subdivision, Eastern Division, Quebec.

23317—February 22—Authorizing C.P.R. to use bridges at Main St., Parkside St., Scotia St., and East Kildonan Road, in municipality of Kildonan, Man.

23318—February 20—Authorizing Esquimalt and Nanaimo Ry. to construct spur for Weeks Dunnel Cedar Co., Limited, from point on easterly limit of its railway, mileage 29.7 Comox Extension, at Fanny Bay, Newcastle District, Vancouver Island, B.C.