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The Canadian Engineer

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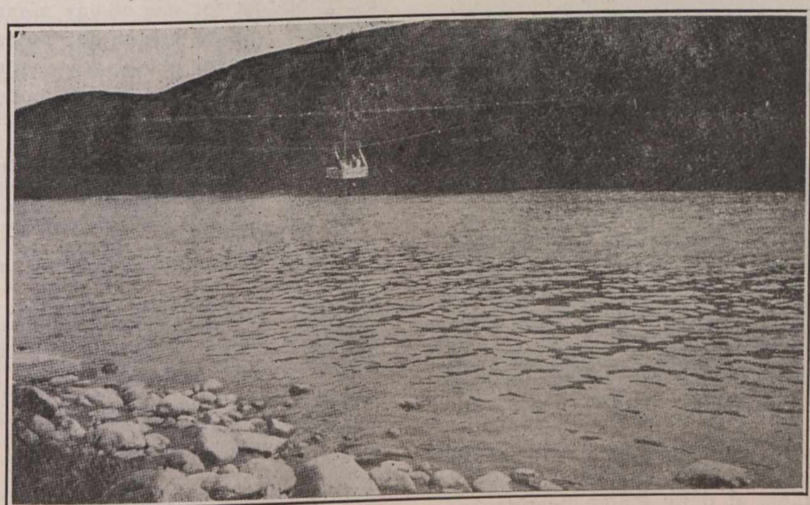
STREAM MEASUREMENTS.

In *The Canadian Engineer* dated November 3rd, 1910, was published an abstract of a report presented by Mr. P. M. Sauder to the Dominion Government on stream measurements in Alberta, Sask. Mr. Sauder, as chief hydrographer to the Government, presented his second Progress Report on Stream Measurements recently, and this report has just been issued. The methods used on the work are of interest, and we here present an abstract.

Moosejaw District.—For some time it has been realized that as the country becomes more thickly populated and the towns spring up, there are portions of the West which will not have a sufficient water supply for domestic and industrial purposes. The Council and Board of Trade of Moosejaw for 1909, were among the first to realize that while there is a sufficient water supply in the district, it is allowed to run off into the larger rivers, in the freshets, and the district is left with an inadequate supply during the remainder of the year. They petitioned the Government to investigate and report on the resources of the Moosejaw Creek and the best methods for the development of same.



Cable and Car on Elbow River, at Calgary, Alta.

Two gauging stations were established on the creek; one at a bridge on the N.W. ¼ Sec. 16, Tp. 16, Rge. 26 W. 2 M; and the other at a bridge on the road allowance between Secs. 14 and 15, Tp. 15, Rge. 25, W. 2nd Mer. Daily records were obtained at these stations, and the total annual run-off computed. A careful stadia survey was made of the valley from Moosejaw to a point a few miles above Rouleau, and a map showing the configuration of the surface of the ground by contours of 10-foot intervals, was prepared. While the topographic survey was in progress, a careful reconnaissance was made to discover the most inviting places for the location of dams and reservoirs. Cross-sections were taken at four dam sites offering the best opportunities for storage. The contour map shows the lands which would be flooded by the erection of a dam of any feasible height and tables showing the flooded areas and capacities of the reservoirs were also prepared. A report of this survey is given under the heading of Moosejaw Creek Drainage Basin.

The water supply in the vicinity of Regina, Moosejaw, and along the Soo Line of the Canadian Pacific Railway is limited and it is very important that we should continue a study of the regimen of flow of Moosejaw Creek for several years. This district will be extended during the coming year to include Souris, Qu'Appelle, and South Saskatchewan Rivers. Souris River, which heads in Canada, crosses the International boundary into the United States and then recrosses into Canada and finally empties into Assiniboine River east of Brandon. This river traverses a large territory in Canada and is the only stream in that district. It is proposed to divert it for irrigation purposes, in North Dakota, which may affect Canadian interests.

In all investigations of water resources the most important factor is the available supply. It is also the factor that requires the longest time to determine satisfactorily, owing to the great fluctuations in stream flow from year to year. The stream gaugings already undertaken should, therefore, be continued for a number of years in order that the records may be long enough to show extremes of flow as well as a reliable mean.

The low flow of 1910 has demonstrated the part that municipal water supply and sewage disposal have in the use of rivers and therefore data should be compiled to show the amount of such water supply and sewage and the source of the former (where in surface waters) and the disposal of the latter.

I do not think it necessary to elaborate on the importance of continuing observations during the winter on the more important streams. The minimum flow occurs during that season and should be determined for use in considering power schemes.

Next in importance to a knowledge of the available water supply is a knowledge of the fall of the streams, and the possibilities of storage. This is necessary to determine the value of the river for irrigation, water power, as an outlet for drainage ditches, and as an available channel for flood prevention work. River profile and reservoir site surveys should therefore be commenced as soon as possible on the more important streams of the West.

Definitions.—The volume of water flowing in a stream is known as run-off or discharge. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-feet," "acre-feet," "run-off per square mile" and "run-off in depth in inches" and may be defined as follows:

"Second-foot," is an abbreviation for cubic foot per second and is the body of water flowing in a stream one foot wide and one foot deep at the rate of one foot per second.

The "acre-foot" is the unit capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of one foot.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in Inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rain-fall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet and depth in inches" represent the actual quantities of water which are produced during the periods in question while "second-feet," on the contrary, is merely a rate of flow per second.

Explanation and Use of Tables.—The data obtained and the estimates made therefrom have been compiled in tabulated form and for each regular gauging station are given, as far as available, the following data:—

1. Description of station.
2. List of discharge measurements.
3. Daily gauge height and discharge table.
4. Table of monthly discharges and run-off.

The description of stations gives such general information about the locality and equipment as would enable the reader to find and use the station. It also gives, as far as possible, a complete history of all the changes that have occurred since the station was established and that might affect the records in any way.

The list of discharge measurements gives the results of all the discharge measurements that have been made at or in the vicinity of the gauging station or have been used in completing the records for the gauging station. It gives the date on which the measurement was made, the name of the hydrographer, the width and area of cross-section, the gauge height and the discharge in second feet.

The table of daily gauge heights and discharges given in this report is a combination of two tables kept in the office of the survey, namely, the table of daily gauge heights and the station rating table. The table of daily gauge heights gives the daily fluctuations of the surface of the water above the zero of the gauge, as reported by the observer. During high water, two observations of the gauge were made at some stations and the gauge height given in the table is the mean of the observations for the day. The discharge measurements and gauge heights are the base data from which the other tables are computed. The table of the daily discharges is the discharge in second-feet, corresponding to the stage of the stream, as given by the station rating table.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gauge height was highest. As the gauge height is the mean for the day, there might have been short periods when the water and the corresponding discharge were greater than given in this column. Likewise, in the column "Minimum" the quantity given is the mean flow for the day when the mean gauge height was lowest. The column headed "Mean" is the average flow for each second during the month. The computations for the quantities in the remaining columns have been based upon this mean. The drainage area for each gauging station was marked off on the sectional maps of the Department and the area taken off with a planimeter. In many districts, information regarding topographical features is very incomplete and the computed areas are only approximate. As the surveys of the Department are extended and completed these computations will be checked and, if necessary, corrected.

Convenient Equivalents.—The following is a list of convenient equivalents for use in hydraulic computations:—

1 second-foot equals 35.7 British Columbia miner's inches, or one British Columbia miner's inch equals 1.68 cubic feet per minute.
1 second-foot equals 6.23 British imperial gallons per second; equals 538,272 gallons for one day.
1 second foot equals 7.48 United States gallons per second; equals 646,272 gallons for one day.
1 second-foot for one year covers 1 square mile 1.131 feet, or 13,572 inches deep.
1 second-foot for one year equals 31,536 cubic feet; equals 724 acre-feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 British Imperial gallons per min. equals 0.268 second-foot.
100 United States gallons per min. equals 0.223 second-foot.
1,000,000 British Imperial gallons per day equals 1.86 second-feet.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 British Imperial gallons equals 3.68 acre-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 43,560 cubic feet.
1 acre-foot equals 271,472 British Imperial gallons.
1 acre-foot equals 325,850 United States gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 acre equals 43,560 square feet.
1 cubic foot equals 6.23 British Imperial gallons.
1 cubic foot equals 7.48 United States gallons.
1 cubic foot of water weighs 62.5 pounds.
1 foot per second equals 0.682 miles per hour.
1 horse-power equals 550 foot pounds per second.
1 horse-power equals 746 watts.
1 horse-power equals 1 second-foot falling 8.80 feet.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horse-power on water wheel, realizing 80 per cent. of theoretical power.

Methods of Measuring Stream Flow.—There are three distinct methods of determining the surface flow of streams: (1) By measurements of slope and cross-section and the use of Chezy's and Kutter's formulae; (2) by means of weirs, which include any device or structure that by measuring the depth on a crest or sill of known length and form, the flow of water may be determined; (3) by measuring the velocity of the current and the cross-section. This third method is the one most commonly used by this survey. The second is used when the flow is too small to be accurately determined by the third, while the first is only used in making estimates of the discharge of a stream when the only data available are the cross-section and slope.

Slope Method of Determining Discharge.—The slope of a stream, or rather of a section of a stream, is the difference in elevation between the upper and lower ends of the section, commonly called the fall, divided by the distance or the length of the section. Slope sections vary in length from two or three hundred feet to several hundred feet, depending largely upon the nature of the stream.

It is difficult to ascertain accurately the slope of the water surface in a stream, since in nearly all streams there are pulsations in the water, causing the surface to rise and fall locally. In most streams the slope of the bottom is far from uniform, and the flow of water in any given section is more or less influenced by the flow in the adjacent section, above or below. For this reason it is a good plan to consider a number of adjacent sections, comprising a considerable length of the stream in one computation, being careful to take into account the diversity of cross-section at various places in the length.

In determining the slope of the surface of a stream, levels are taken of the water surface at each end of the slope section, and referred to some datum or bench mark. A good plan is to set firmly a stout wooden stake below the water surface at each end of the slope section, and then to drive a nail into the top of each stake, so that the nail-head will exactly coincide with the water surface. The difference in elevation between the two nail-heads, divided by the distance between the stakes, will give the slope.

The wetted perimeter is that portion of a stream channel that is in contact with the water. The form or outline of the wetted perimeter of a stream has an important influence upon the velocity of the current. It is usually determined graphically from the plotted cross-section or may be measured by means of a flexible tape or chain after the flood has subsided.

The hydraulic radius, which is sometimes called the mean radius of the channel below the water surface is found by dividing the area of the cross-section (in sq. ft.) by the length of the wetted perimeter (in feet).

The Chezy formula, which is the fundamental formula for stream discharge, is:

$$Q = A\,V$$

in which Q = the discharge of the stream in sec. ft.
A = the area of the cross-section in sq. ft.
V = the mean velocity of flow, in ft. per sec.

In applying this formula to the determination of stream discharge, the mean velocity of a stream is considered a function of the slope and one of the wetted perimeter of the stream. This may be expressed by formula as follows:

$$V = C\sqrt{rs}$$

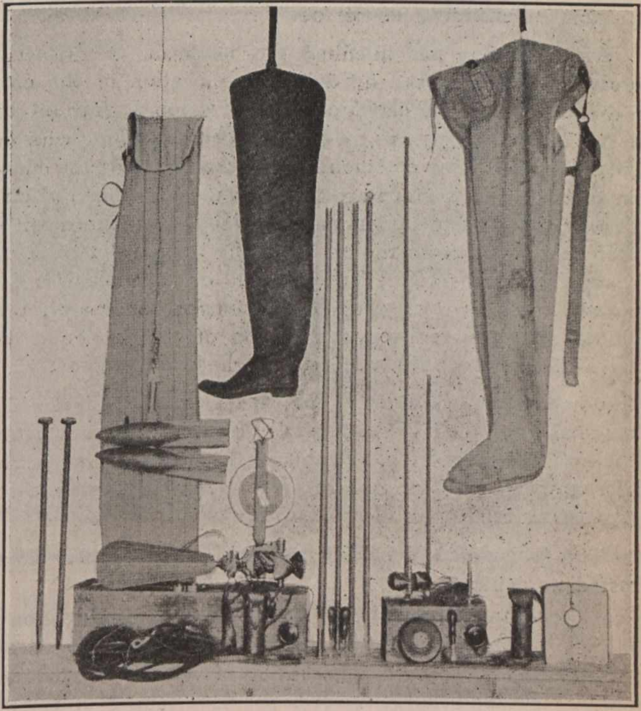
in which r = the hydraulic radius of the channel.
s = the surface slope.
and C is a variable coefficient, depending upon the nature of the channel.

In determining the value of C for any given case it is customary to make use of Kutter's formula, which is:—

$$C = \frac{41.6 + \frac{.00281}{s} + \frac{1.811}{n}}{1 + \left\{41.6 + \frac{.00281}{s}\right\}\frac{n}{\sqrt{r}}}$$

In this formula r and s have the same significance as in the Chezy formula and the new factor n is called the coefficient of roughness. It is a variable coefficient, and its value is dependent upon the size, shape, slope and degree of roughness of the channel. Tables of values of n are given in various text books, but it is difficult to choose the correct value. It is therefore advisable whenever possible to compute the value of n from a measured discharge. As the slope method of determining discharge is seldom employed except to estimate flood discharge, a current meter measurement is very often made at the slope section, during low water. Having determined the mean velocity, slope and hydraulic radius at the time of the metering, the value of C may be found from the formula $V = C\sqrt{rs}$ or $C = \frac{V}{\sqrt{rs}}$.

Trautwine's Pocket Book for Civil Engineers and other texts contain tables giving the value of n for different values of r, s, and c. From these tables we can interpolate the proper value of n for a particular section of the stream, at low water stage. In most cases this value of n is applicable to high water and flood conditions of the stream also and is used with values of r and s for the high water or flood cross-section to determine the value of C at the higher stage. Having determined the value of C the computation of the discharge is simple.



Meters and Equipment for Measuring the Discharge of a Stream by the Velocity of Method.

The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value of n to be used.

Weir Methods of Determining Discharge.—As yet no permanent weirs have been constructed by this survey, and the only regular weir measurements have been on small streams by means of a temporary weir. The weir used consists of a wooden base of 2-inch plank, to which is bolted a rectangular notch of three-eighths inch steel with bevelled edges.

In making a measurement by means of a temporary weir, the following directions should be followed as far as possible. The weir should be placed perpendicular and at right angles to the bed of the stream with the crest level. The discharge should be free in so much as the nappe should have sufficient fall to allow air to have free circulation underneath it, and the head or depth on the crest should not exceed one-third of the length. The channel of approach should be several times as wide as the opening and the depth of water in the bay or pond should be at least twice the head on the weir, so as to eliminate velocity of approach and cross-currents. In choosing a site for a weir, a point should be chosen that will fulfil the above conditions and give a good sized bay or pond.

To set up a temporary weir, a dam of sods and earth are thrown across the stream, the weir set in place and the sods tramped firmly around it to stop all leakage. On a stream with a sandy bed sods or clay must be placed on the bottom for a few feet upstream to form a mattress to prevent the undermining of the dam.

After the bay has filled up the head of the water is observed by taking the difference in elevation of the crest of the weir and the elevation of the water surface in the bay at a distance of 4 to 10 feet from the weir, with an engineer's level. Two common methods of getting the elevation of the water surface are (1) hold the levelling rod on a stone or other body under water and subtract the depth of water on the rod from the sight on the rod; (2) drive a pin divided into tenths of feet into the bed of the stream so that an even tenth is level with the surface of the water, then hold the levelling rod on the top of the pin and add the length of pin above the water to the sight on the rod.

When the head of water has been determined, the discharge is computed by using one of the standard formulae which will suit the case. Tables giving the discharges for different heads and lengths of crests are published in many engineering texts.

The formula used by this survey for rectangular sharp-crested weirs is:

$Q = 3.33\ (L - .2H)\ H^{3/2}$ being a modification of Francis' formula, to allow for end contractions and elimination of velocity of approach.

in which Q = discharge in sec. ft.; L = length of crest in feet; H = head in feet.

Measurements by means of temporary weirs should be made some distance above or below the gauge. If they are made close to a gauge, the gauge must be read before the weir is placed in the stream and the pond must be allowed to run off after the weir is removed before the gauge is re-read.

Velocity Method of Determining Discharge.—There are two methods of determining the velocity of flow of a stream, namely, direct and indirect. In the direct method by which the velocity is determined by means of floats, the liability of error is large, and the results far from satisfactory. This method is seldom used except for very rough estimates or when a current meter cannot be used. There are three common kinds of floats, viz.: surface, sub-surface and tube or rod floats. In each the procedure in the same. A straight piece of channel is selected for the run and two cross-sections taken at some convenient distance apart, usually from 100 to 200 feet. They are then divided into strips by means of a tagged wire. The velocity in each strip is then measured by noting the time taken by the float in traversing the run or distance between the two cross-sections. As the time and distance are both known the velocity can easily be computed. The velocity, whether measured by surface, sub-surface or tube floats, must be multiplied by a coefficient less than unity to reduce the mean velocity before being used to compute the discharge.

The indirect or current meter method is the most reliable and most widely used method of determining the velocity of the flow of a stream. The meter used by this survey is the Price Patent, manufactured by W. & L. E. Gurley. Troy, N.Y. It consists of six cups attached to a vertical shaft which revolves on a conical hardened steel point when immersed in moving water. The number of revolutions is indicated electrically. The rating or relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From this data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval.

The accuracy of a discharge measurement taken at a velocity-area station is dependent on two factors. the accuracy with which the area of the cross-section and the mean velocity of the flow normal to that section are measured. There is no special difficulty in measuring the first factor, but the second, the velocity, is very difficult to measure accurately, because it is constantly changing. It varies not only from the surface to the bottom but from one bank of the stream to the other, making it necessary to measure it at a number of points.

In making a measurement with a current meter, a number of points, called measuring points, are measured off above and in the plane of the measuring section, at which observations of depth and velocity are taken. These points are spaced equally for those parts of the section where the flow is uniform and smooth, but should be spaced unequally for other parts according to the discretion and judgment of the engineer. In general, the points should not be spaced farther apart than 5 per cent. of the distance between piers, nor farther apart than the approximate mean depth of the section at the time of measurement.

The measuring points divide the total cross-section into elementary strips at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the ends, the width of the strip, and the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.

Methods of Determining Mean Velocity.—There are a number of different methods of determining the mean velocity at the ends of these strips, or, as it is commonly called, the mean velocity in a vertical, namely, multiple-point, single-point, and integration. These three principal multiple-point methods in general use are the vertical velocity-curve, three point, and two point method.

Vertical Velocity Curve Method of Determining Mean Velocity.—In this method the centre of the meter is held as close to the surface of the water as is possible, being careful to keep it out of reach of all surface disturbances, and then at a number of different depths throughout the vertical. The velocity at each position of the meter is recorded. These observations are then plotted with velocities in feet per second as abscissae and their corresponding depths in feet as ordinates and a mean curve is drawn through the points. The mean velocity for the vertical is obtained by dividing the area bounded by the curve and its axis by the depth. In the absence of a planimeter for measuring the area, the depth is divided into 5 to 10 equal parts, and the velocities of the centre ordinates of these parts are noted. The mean of these velocities will very closely approximate the mean in the vertical.

It is often more convenient, when the depth is a number of feet and a fraction, as 7.4, to divide the depth into 7 parts of a foot width, and a part of 0.4 foot width. Then the velocity to enter for the narrow part is 0.4 of the velocity at the centre of it.

The vertical velocity curve is useful in studying the manner in which velocities occur in a vertical. From a study of a number of these curves the other shorter methods of determining mean velocity are deduced. This method is not used in general routine measurements, except during the winter, on account of the length of time taken to complete a measurement, for a change of stage is almost sure to occur during a measurement on a large stream which counterbalances the increased accuracy. For this reason its use is limited to the determination of the coefficient to be used in the reduction of values obtained by other methods of measuring velocity to the true value, to the measurement of velocities under new and unusual conditions of flow, and for measurements under ice.

Three-Point Method of Determining Mean Velocity.—This method gives the greatest accuracy outside of the vertical velocity curve and is the method most commonly used by this survey during the open season. The meter is held at 0.2, 0.6 and 0.8 depth. The mean velocity is then obtained by dividing by 4 the sum of the velocities at 0.2 and 0.8 depth plus twice the velocity at 0.6 depth. It is the best method to use during low water or in wide shallow streams having a rough bed where the thread of mean velocity varies considerably from the 0.6 depth.

Two-Point Method of Determining Mean Velocity.—In studying the vertical curves made at a number of different points and under varied conditions it has been found that the mean of the velocities occurring at 0.2 and 0.8 depths gives very nearly the mean velocity in the vertical. Use is made of this fact in the two-point method of determining mean velocity, the meter being held at 0.2 and 0.8 depth in the vertical. This method has been found more accurate than the single point method and the time required for a metering is not very much greater. This method has been found to give, also, a very close approximate to the mean velocity in measurements of ice-covered streams, although these flow under very different conditions from those of open water.

Single-Point Method of Determining Mean Velocity.—Experiments made under most favorable conditions and extending over a long period have established the point of mean velocity in a vertical at 0.6 of the depth. Therefore the error resulting from the use of the 0.6 depth as the depth of mean velocity is very small though in some few cases a study of the vertical velocity curve will show the need of a coefficient to reduce the observed velocities to the mean. The variation of the coefficient from unity in individual cases is, however, greater than the two or three point method and the general results are not as satisfactory. For that reason this method is not employed very extensively by the survey.

In the other principal single-point method the meter is held near the surface, at from 0.5 to 1 foot below the surface; care being taken to sink the instrument below the influence of wind or waves. The resulting velocities must be multiplied by a coefficient to reduce them to mean velocities. This coefficient as found by a large number of experiments, varies from 0.78 to 0.98, depending upon the depth and speed of the stream. The deeper the stream and the greater the velocity the larger the coefficient. In flood work coefficients varying from 0.90 to 0.95 should be used. This method is only used when the current is too strong to permit the sinking of the meter to any great depth below the surface of the water. It is often employed at times of flood, or when a stream is carrying a lot of drift wood or ice.

Integration Method of Determining Mean Velocity.—This method of determining the mean velocity in a vertical consists in moving the meter at a slow uniform speed from the bed of the stream to the surface and return in a vertical direction, the time and revolutions being observed. In travelling through all parts of the vertical the meter is acted upon by each and every thread of velocity from the bed to the surface of the stream, and the resulting observations determine the mean in that vertical.

This method is very useful in checking the results of other methods. It is, however, seldom used by this survey as the Price meter is not suited to observations by this method, since the vertical motion of the meter causes the wheel to revolve.

Gauging Stations.—The first step is to select a suitable locality for a gauging station. Although apparently simple, this is really a difficult task. Not only must the water be moving in nearly straight lines over a solid bed and between well defined banks, but the place must be accessible at moderate cost and there must be living near a competent person who can be engaged to serve as observer. Permanent gauging stations should only be selected after a very thorough reconnaissance. In the irrigation districts and in more thickly populated districts there is more or less diversion of water. This is apt to complicate matters for the hydrographer, or a gauging station above all works may not include all the tributaries of the stream and it is often necessary to establish gauging stations at several points along the streams, and on tributaries, canals and pipe lines, in order to obtain complete information regarding the water supply in a particular stream.

Measuring the Velocity with a Current Meter by Wading.

There are three classes of gauging stations, namely, wading, bridge and cable stations. The wading station can, of course, only be used in the case of small streams having a maximum depth at its highest stage of 3 feet or less. The equipment for a wading station is small, consisting usually of a plain staff gauge, graduated to feet and hundredths, and fixed vertically to one of the banks of the stream. For convenience a measuring line, usually a wire with tags, may be fixed permanently at this section. When taking the reading, the hydrographer should stand below and to one side of the meter so as to not cause eddies in the water.

Bridge stations, because of their permanency and the freedom of movement allowed the hydrographer, are much preferred. Very often, however, more particularly in swift currents, the piers materially affect the accuracy of the results. When the gauge cannot be attached to a pier, it is often attached horizontally to the guard-rail or floor of the bridge and the height of the stream is found by lowering a weight by a chain over a pulley. It is indicated by a marker on the chain. Distances of three, five or ten feet according to the size of the stream are marked on the lower chord of the down stream side of the bridge, to serve as a measuring line.

Frequently it is impossible to establish a permanent gauging station at a bridge. In that case the wire cable of a ferry can be utilized, or, if that is not available, a permanent wire cable is stretched across the river. For spans of average length a galvanized wire cable three-fourths of an inch in diameter is safe. It is supported at each bank by means of high struts or by passing it through the crotch of a tree. The cable is run into the ground and anchored securely to a "dead man" buried at least six feet below the surface, or, if convenient, it is anchored to the lower part of the trunk of a tree. A turnbuckle is inserted in the cable between the strut and anchorage to permit tightening the cable when it begins to sag. A permanent measuring line, usually a wire with tags 5 or 10 feet apart, is stretched across the stream just above the cable. A cage large enough to carry two men and instruments is constructed and suspended from the cable by means of cast iron pulleys. The cage is moved from point to point by hand. A stay line, usually quarter-inch guy wire, is stretched across the stream about thirty to forty feet upstream from the cable, and securely fastened. By passing a sash cord through a pulley hung on this stay line the current meter is prevented from being carried down stream.

Low Velocity Limitations.—Owing to the presence of a slight amount of friction in the current meter, a certain definite velocity is required to make the wheel revolve, i.e., to overcome the frictional resistance of the wheel. For this reason the meter is unsuitable for the measurement of low velocities, approaching this value. This velocity, which is required to overcome friction, and which is obtained from the meter rating curve, is called the velocity of no flow for the particular meter referred to. It varies in different types of meters, and also slightly in meters of the same type, according to the time the meter is in use, but very seldom exceeds 0.2 foot per second in any meter. From a number of observations the low velocity limit, below which values of velocity are unreliable, is found to be 0.5 foot per second. In many cases at low stages the gauging station on a stream becomes unsuitable for a discharge measurement owing to the mean velocity in the section falling below the safe limit. In such instances where it is possible to wade the stream a suitable gauging section may be located within a reasonable distance of the regular station and the discharge measurements made at this point. When a gauging is made at a cross-section other than the regular station, sufficient soundings should be made at the latter at the time of the gauging to develope the cross-section and compute the area. The measurement is thus referred to the regular gauging station and the mean velocity and area at the regular section is reported and used in the office computations.

Winter Measurements.—Previous to the season of 1910-11, no records were taken of the flow. During the past winter daily gauge height records were collected for a number of the more important streams in the Calgary and Macleod districts. Discharge measurements were made at these stations at intervals of from two to three weeks.

The laws governing the flow of stream in open channels have, through extensive investigations, become well defined, but the flow under an ice cover has been but little investigated. In winter as in summer the daily discharge of a stream is computed from frequent discharge measurements and daily gauge height observations. In most cases, however, the vertical, velocity curve method is used for the determination of the mean velocity in the vertical, as the mean velocity varies considerably. In fact, there are usually two points in the vertical at which the thread of mean velocity occurs under an ice cover. These points are near 0.2 and 0.8 depths and two-point method will give fairly accurate results, but in this report all discharges are based on computations from vertical velocity curves.

The discharge measurements are made through holes in the ice from 5 to 10 feet apart, and large enough to allow the meter to pass through freely. The measurement is then taken in the same manner as at open sections, except that the depth of the stream is taken as the distance from the bottom of the ice to the bed of the stream. The soundings, however, are always referred to the surface of the water in the holes, the distance from the surface of the water to the bottom of the ice being measured and subtracted from the sounding to obtain the depth. The meter should be kept in the water continuously to prevent the wheel from freezing and sticking.

The gauge is read once a day, the observer noting the elevation of the water as it rises in a hole cut through the ice, the height of the top of the ice, the thickness of the ice, presence of needle or slush ice, snow on top of ice, ice jams, and also any sudden changes in temperature. To do this observers are provided with an ice chisel for chopping holes, and a square to measure the thickness of the ice. Any form of gauge may be used but the chain gauge is the most satisfactory, as the staff gauge being frozen to the ice, heaves with it.

Some of the cross-sections used in the summer were found to be unsuitable for winter measurements. This was usually caused by the cross-section filling up with slush, needle or anchor ice. There is a flow through this ice and it is impossible to measure it. The most suitable stations for winter measurements are those where there is a long stretch of very smooth sluggish water above the station and a rapid fall below.

Re-Rating of Current Meters.—Each meter is rated before being used, in order to determine the relation between the revolutions of the wheel and the velocity of the water. The meter is driven at a uniform rate of speed through still water for a given distance, and the number of revolutions of the wheel and the time are recorded. From this data the number of revolutions per second and the corresponding velocity per second is computed. Tests are made for speeds varying from the slowest which will cause the wheel to revolve to several feet per second. The results of these runs, when plotted with revolutions per second as abscissae and velocity in feet per second as ordinates, locate points that define the meter rating-curve, which for all meters is practically a straight line. From this curve a meter rating table is prepared. Theoretically, the rating for all meters of the same make and type should be the same, but as a result of slight variations in construction, and in bearing of the wheel on the axis at different velocities, the ratings differ. After a meter has been in use for some time the cups may have received small injuries, or the bearing of the wheel on the axis may have changed owing to unavoidable rough usage. These changes will affect the running of the meter and change its rating. As a consequence each meter is re-rated at regular intervals and a new rating curve and table prepared. During 1910 several meters were re-rated by F. H. Peters by means of a gasoline launch on Chestermere Lake, and with only one excetion the meters varied but little from the original rating.

The boat method of rating meters is, however, very crude, and Mr. Peters has designed an up-to-date rating station consisting of a concrete lined tank, 250 feet long, 6 feet wide, and 5½ feet deep, and a car operated by a motor. This will be constructed at once and all the meters will be carefully re-rated at regular intervals.

Office Computations.—Rating Curves and Tables.—When a series of discharge measurements has been made at a gauging station a rating curve is constructed for that station, showing graphically the discharge corresponding to any stage of the stream within the limits covered by the gaugings. This curve, as it is usually drawn, has an abscissae, the discharges in second-feet and as ordinates, the corresponding gauge heights at which the discharges were made. A smooth curve is drawn through the resulting set of points and from this curve the discharges at any stage within the limits of the curve are taken. Some measurements may be more reliable than others owing to more or less favorable conditions at different times of gauging, or to other causes. In order to obtain the weight of the different measurements, curves with area and mean velocity, as abscissae, and gauge heights as ordinates, are also drawn. From a study of these curves any discrepancies in a measurement, either in its area or mean velocity, may be detected. Should it be necessary to extend the rating curve beyond the limits of actual discharge measurements the area and mean velocity curves may be constructed to the stages for which the discharge curve is desired and the latter found by taking the product of the two curves. The discharge curve under natural conditions of flow is always convex to the gauge height axis. The area curve is either a straight line or is convex to the gauge height axis, except in the case of overhanging banks when it becomes concave to the axis. This mean velocity curve is always concave to the gauge height axis, except in cases where standing water occurs below the stage of no-flow. In this case the curve will assume a reverse form, starting from the gauge height of zero flow with a curve convex to the gauge height axis and gradually reversing to a curve concave to this axis. In plotting all three curves the horizontal and vertical scales should be so chosen that the curves may be used within the limits of accuracy for the work, and in their critical position will make, as nearly as possible, angles of 45 degrees with each axis.

The rating curve being constructed, it becomes necessary to prepare a station rating table, giving the discharge at any stage of the stream within the limits of the daily gauge height observations on record. From this rating table the daily discharges corresponding to the daily gauge heights are read and tabulated. The rating table is constructed for tenths, half-tenths, or hundredths of feet, according to the readings of the gauge to which it is to be applied. The discharges for this table are read directly from the rating curve and are then adjusted so that the differences for successive stages shall be either constant or gradually increasing, but never decreasing, unless the station is affected by backwater.

Daily Discharge, Monthly Mean, and Run-Off.—The rating table being made to cover the range of daily gauge height observations, the next procedure in the computations is to make out a table of daily discharges from this rating table. The daily gauge heights are copied as they were sent in by the observer and opposite each the corresponding discharge is filled in from the rating table. The monthly discharge is found by totalling the daily discharges for the month in question and the monthly mean is obtained by dividing this total by the number of days in the month.

The run-off is computed with two different sets of units, depending upon the kind of work for which the data is intended, as follows: (1) Run-off in inches is the depth to which a plane surface equal in extent to the drainage area would be covered if all the water flowing from it in a given time were conserved and uniformly distributed thereon; it is used for comparing run-off with rain-fall, which is usually expressed in depth in inches. The mean run-off in second-feet per square mile for each month is used. The monthly mean run-off in second-feet is divided by the area of the drainage basin in square miles to find the monthly mean run-off per square mile. This result, reduced to run-off in depth in inches for the monthly period, is in the form required.

(2) The run-off in acre-feet is the form of most use in connection with storage. An acre-foot is equivalent to 43,560 cubic feet, and is the quantity of water required to cover an acre to the depth of one-foot. The monthly mean run-off in second-feet is used for the computation of run-off in acre-feet. The monthly mean is reduced to cubic feet per month and this quantity divided by 43,560 gives the run-off in acre-feet.

Thirty-Six-Inch Sharp Crested Rectangular Weir Used on Small Streams.

The run-off of the stream being computed both in depth, in inches and in acre-feet for each month, the run-off for the period, during which observations of run-off were made, is found by the summation of the amounts of run-off for the several months making up this period.

Changing Conditions of Channel.—On streams such as Milk River, whose bed is in a constant state of motion, measurements of discharge should be made every few days, otherwise considerable data relating to changes cannot be obtained. For discharges on days other than those on which measurements are taken, the interpolation method is used. The two methods of interpolation in general use are the Stout and Bolster Methods.

The Stout method deals with the correction of the gauge heights. A curve is drawn, using the difference between the actual gauge heights at the time of measurement and the gauge height corresponding to the measured discharge as ordinates and the corresponding days of the month as abscissae. From an irregular curve drawn through these points corrections for gauge heights can be made for days on which there was no discharge measurement. When the discharge is greater than that given by the curve the correction is positive and vice-versa. Each daily gauge height is corrected by the amount shown on the correction curve, and the corresponding discharge taken from an approximate rating curve for the station.

The Bolster method deals more particularly with the modification of the discharge. Results of discharge measurements covering a whole year or season are plotted, and though considerably scattered, will define one or more regular curves, called standard curves, the number and position of each indicating the radical changes. Where the river bed changes from day to day, the position of the standard curve also varies and must pass through the points indicating the different days. The points indicating two successive measurements are joined by a line, which for short distances on the cross-section paper is a straight line and otherwise a curve. This line is divided into a number of equal parts, each indicating an intervening day, the assumption being that as the change during this period is gradual the daily rating must pass through each point, or day, as represented by the divisions. A simple and convenient way of making these interpolations and moving the daily rating curve is to make a tracing of the standard curve with a vertical line of reference. By keeping the lines of reference coincident this curve can be shifted into any desired position and the discharge read for any gauge height.

PUMPING TERMS.

A number of different terms are used in connection with pumping, and very often it is hard to determine just what is meant by certain designations. The accompanying dia-

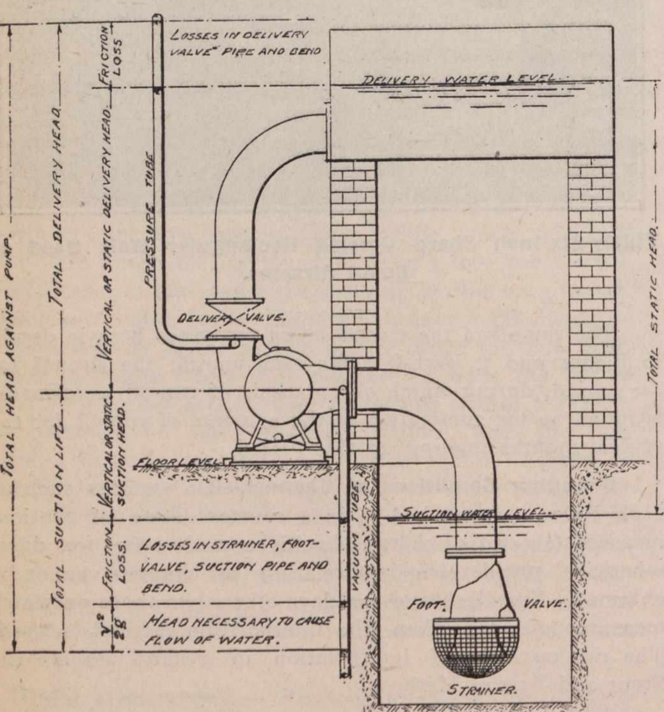


Diagram illustrating the Terms generally used in connection with Pumping.

gram, reproduced through the courtesy of Drysdale & Co., Limited, Yoker, Glasgow, W., from a pamphlet issued by them, shows graphically and clearly the meaning of the different terms.

AUXILIARY PLANT FOR POWER STATIONS.

By A. H. Finch, M.A.

(Continued from last issue.)

Auxiliaries as Labor-Saving Devices.—We now come to another class, or sub-division, of auxiliaries; those, that is, which are in reality, only substitutes for labor. It is here that a temptation towards multiplication is so often evident. Certain of them, however, are so obviously superior to the intermittent or collectively large amount or labor which they displace that there is usually no question as to the advisability of adopting them; such are water-service pumps and coal-handling machinery, cranes, and bilge pumps. In the case of cranes, it is the ability to concentrate the requisite power into a small space that is valuable; with coal-handling machinery it is advantageous in any event to use some form of mechanical lifting appliance, and the question of applicability of the power settles at once the method of driving.

Stokers.—No such argument applies to mechanical stokers. Here the question is between an expensive appliance, capable of giving smokeless combustion and better efficiency due to absence of frequently-opened doors and more even distribution of fuel, and a cheap arrangement involving a larger amount of labor and producing poor combustion at times. No comparison in an exact sense is possible, for the reason that the conditions prevailing in any given station—such as load factor or number of shifts worked—will radically influence the figures.

The following illustration is intended to apply to a boiler house running on a load factor of about 60 per cent. with three equal shifts, capacity 8,000 kw. The capital costs are taken to be:—

For mechanical stokers, shafting, motors, and wiring, and dumping gear	£3,460
For fire-bars and furnace fronts adapted to hand firing	320

Capital charges taken at 15 per cent. Maintenance charges on mechanical stoker gear, at 10 per cent., and on hand-firing apparatus, due to wastage of fire-bars, at 80 per cent.:—

Mechanical firing—	
Capital charges	$ 519
Maintenance	346
Power, say 16 kw. for 4,600 hours per annum at 0.25d.	77
Labor, 3 shifts at 125s. per week per shift	975
	£1,917
Hand firing—	
Capital charges	48
Maintenance	256
Labor, 3 shifts at 245s. per week per shift	1,910
	£2,214

In this instance there is apparently a balance of £300 in favor of mechanical stokers, making out a fairly obvious case. If, however, no night shift (in the ordinary sense) is worked, the necessary night attendance, if any, being in both cases the same, the mechanical arrangement is reduced to £1,592, and the hand firing to £1,577, and in such a case a more careful inquiry into the actual figures for maintenance, cost of power, etc., obtained in practice might point to adopting hand firing in spite of the better combustion obtained with the alternative method. Or, again, if we consider the case of an installation where native labor is available, the account for a 3-shift load might stand as under:—

Mechanical stoker—

Capital charges as before	£ 519
Maintenance as before	346
Power as before	77
Labor, 3 shifts at £104 per shift per annum, being composed of twice the number of men assumed in the previous example, but at something like one-sixth the rate	312
	£1,254

Hand firing—

Capital charges	£ 48
Maintenance	256
Labor, 3 shifts at £200 per shift per annum	600
	£904

showing a substantial advantage in hand firing.

Clearly, then, the labor conditions and the nature of the load are weighty factors in settling such a point. In fairness to the stoker method, it must be pointed out that better combustion generally results from its use, and inferior coals can be successfully burned. On the other hand, the method of hand firing offers greater flexibility and enables a wide variety of coals (as regards their components) to be used. Hence it is that no exact comparison is possible without details being in every case considered; while a further factor is the limitation imposed by the length of grates where very large hand fired boilers are involved. In such cases the necessary grate area can only be obtained by increasing the width of boiler, which may lead to structural difficulties and an abnormal amount of floor space.

Ash Handling.—Another item in which the labor question is a prominent feature is ash handling. Owing to the nature of the material, all mechanical apparatus, except of

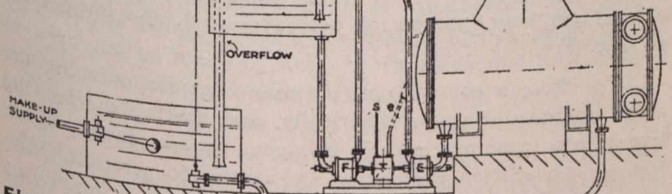


Fig. 1.—Diagrammatic Arrangement of Proposed Closed-Cycle System of Boiler Feeding.

E = Extract on Pump. F = Feed Pump. T = Auxiliary Turbine. S = Steam to Auxiliary Turbine. e = Exhaust from Auxiliary Turbine.

the simplest character, is a source of excessive maintenance costs. On the other hand, the conditions under which ashes have to be handled make it difficult to obtain labor at a reasonable rate. Where tunnels are used they are often unbearably hot, or, being situated below everything else, and liable to choked drains, they readily become flooded. Large quantities of dust are produced in the process of handling, and if quenching or spraying is resorted to, this results in the formation of active corrosive agents.

Systems have been developed in which air or water is the conveying agent, and these have the advantage over any mechanical system in that the handling involved is a minimum, and no moving machinery is required except a pump, which can be placed out of reach of damage from the dust, and a breaker or crusher. With this arrangement there is necessarily considerable wear on the tubes or channels which convey the ashes; but such parts are cheaply replaced. The drawback of the system, from the point of view we are now considering, is that it introduces two auxiliaries, viz., the crusher and pump; but the former can be a very robust piece of apparatus. The channels for conveyance of ashes can be brought close up to each boiler, and by using suitable means for introducing them into the crusher or channels, dust can be effectually confined.

Where the conditions of manual operation are so unfavorable, there is a strong case for mechanical handling, but the choice of apparatus should fall on that which can be made of the stoutest construction, a consideration which would operate against conveyors, elevators, or hoists of the usual description.

Switches.—The working of switches is a question wherein ease of manipulation from a distance is the paramount consideration. To bring the control of a large number of switches into any convenient compass can, it is true, be accomplished in the same way as with railway signals and points, by a system of levers and rods; but this system is being replaced on important signal installations by electricity, either alone or in combination with compressed air. In a power station where electrical manipulation is unaccompanied by exposure of apparatus to the rough conditions of a railway track, it is obviously indicated in preference to a purely manual process for control of a large number of switches, failure of the current being a remote contingency owing to the invariable practice of employing a battery.

There remains for consideration a class of casual services whereon motors are often employed, such as water softeners, weighbridges, air compressors, and boiler-cleaning pumps. The general principle applicable to such cases is that the extent of use should settle the method of driving. To take the cases cited; the softener may be used continuously, and so require regular attendance, or intermittently, being idle for weeks. In the former cases power operation is justified, in the latter, not; unless, owing to great size, manual labor cannot be advantageously employed. Weighbridges of a type in which a motor is necessary to move counterweights or raise the table only justify themselves by frequency of use. Air compressors, universally used for cleaning electrical apparatus, are a necessity in a large power station, but a luxury in a small sub-station where bellows will do the work; and boiler-cleaning pumps (for use with water-tube boilers) become necessary where the frequency of use is such that a boiler feed pump cannot be spared for the purpose, or where soft water is used for cleaning and the risk of getting it into the boilers cannot be run.

Certain auxiliaries are to be found associated with the purely electrical portion of a station, which do not fall exactly into either of the two arbitrary divisions that have been discussed. Such are fans for ventilating electrical apparatus whether rotating or stationary. The measure of the value of these is, in general, the degree to which they increase the capacity of a given weight of copper or iron in electrical apparatus. With rotating plant, the alternative is ventilation by what really amounts to a fan on the rotating portion of the generator itself; and as the rotating of this portion in most designs is necessarily accompanied by some fan action, it would appear a logical extension of the principal to make the rotor do the whole work of ventilation, the slight additional power requiring no increase in the shaft or bearings. Clearly, then, an auxiliary fan is not justified in this case, unless the conditions are such (for instance) that air has to be brought to the generator from a distance in an enclosed duct, the friction of which, unless it be unduly bulky, might result in an insufficient supply; or where air filters are necessary; or, in similar circumstances, when the resistance to be overcome is greater than can be dealt with by a rotor fan whose speed and diameter are fixed by those of the generator.

With non-rotary apparatus, such as transformers, the method of direct ventilation by air finds an alternative in cooling by oil, or water. Oil is of necessity the immediate cooling agent of the metal. It is practicable to cool the oil either by water-pipes within the transformer case, or by passing it through an external cooler, wherein water is circulated. Where a supply of water exists under sufficient head, a water pump is not necessary; but an oil pump is introduced with the method of external cooling. This is against the method; its advantage lies in more effective cooling and a reduction in the risk of leakage of water into the oil, which can be accomplished by giving the oil within the cooler a higher pressure than the water. Any system of water cooling has the advantage over the usual methods of fan cooling that the heat abstracted is not liberated within buildings; more important perhaps in tropical climates than in these latitudes.

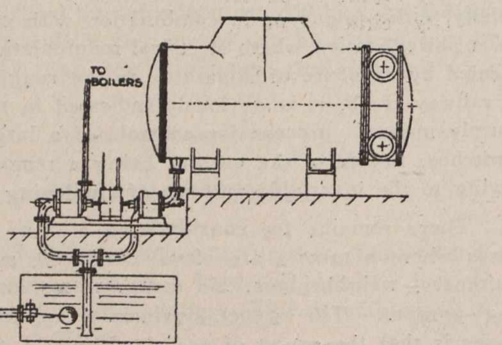


Fig. 2.—Diagrammatic Arrangement of an Alternative Closed-Cycle System of Boiler Feeding.

Exciters almost claim a place for themselves, particularly since so much attention has always been devoted to the subject. As between the independently-driven machine, and one directly coupled to the shaft of the alternator it is intended to excite, the arguments may be grouped thus:—

Against the direct coupled exciter—(1) Small size and inefficiency. (2) In turbine stations, addition to length of whole unit which may require a wider engine-house. (3) Cumulative effect on bus-bar pressure of a fall in speed. (4) Inability to be used for station lighting, etc.

Against the independent exciter—(1) Cost of separate engine or motor (usually the former) to drive it. (2) Cost of running the same, including maintenance and ultimate coal consumption. (3) Duplication.

Given sufficiently good voltage regulation, the method of direct-coupled exciter, even if accompanied by motor generators for battery charging or station lighting, produces a simpler total combination and one more easily kept in an efficient state of repair.

Methods of Driving Auxiliaries.—Three systems are in vogue, viz., electricity, steam (for certain limited services) compressed air. The last is the least efficient, but has the merit (where a reservoir is provided) of being to some extent independent of failure of the main supply.* For an infrequent service such as valve operation, economy ceases to be of importance, and the use of air may be justified by cheapness of the actual engine and piping employed in comparison with an electric motor and wiring. On the other hand, an independent source of power, viz., air compressor, is necessary, whereas auxiliary current at most requires only a transformer. On general grounds, since a power station must employ steam and generate electricity, it would seem preferable to use one of those agencies rather than air, which requires additional apparatus and only introduces an indirectness in the application of power.

Steam v. Electricity.—As between steam and electricity, the principle suggested is that steam should only be used where it introduces a simplification, not so much in respect of economy as by offering a simpler combination of apparatus. This is said with particular reference to the use of exhaust steam for feed heating. Where the exhaust cannot be so used, either wastefulness is introduced by exhausting to atmosphere, or complication ensues from the addition of an auxiliary condenser, and possibly an oil separator, to the total of auxiliary plant.

Let us examine the case of a direct-acting feed pump working without lubrication. It consumes anything between 65 and 100 lbs. steam per water horsepower per hour, say 75 lbs.; whatever the pressure at release, in round numbers the exhaust carries away 1,200 B.T.U. (reckoned from 0 deg. F.) per lb. To fix the ideas, consider a 1,000-kw. turbine, using 18,000 lbs. steam per hour. With boiler pressure 175 lbs. per square inch, the water h.p. is 3.58, and the pump steam per hour $= 3.58 \times 75 = 268$ lbs. Therefore the heat available for feed heating is $268 \times 1,200$, or say 320,000 B.T.U. If the initial temperature of the feed be 90 deg. F. (28 in. vacuum corresponds to 101 deg. F.) each pound contains 90 B.T.U. reckoned from zero, and the whole feed contains $18,000 \times 90$, or 1,620,000 B.T.U. The final temperature therefore becomes—

$$\frac{1,620,000 + 320,000}{18,268} \text{ or } 100 \text{ deg. F.}$$

In this case, an expenditure of $\frac{268}{6.5}$, say 41 lbs. of coal of coal per hour, pumps the necessary feed, and heads it by 16 deg. F.

To effect a comparison, we may consider pumping the same quantity of water electrically, and heating the feed by live steam, assumed at 175 lbs. per square inch:—Water h.p. $= 3.58$; efficiency of pump and motor, 60 per cent. Then power required by motor, in kw. $= 3.58 \times \frac{5}{3} \times 0.746 = 4.5$ kw., which at 3 lbs. per kw.-hour, would result in a consumption of 13.5 lbs. of coal per hour. Quantity of steam to heat the feed 16 deg., = 256 lbs., requiring $\frac{256}{6.5}$ or 39.4 lbs. of coal. Total coal by this method, 44 lbs. which is therefore inferior as regards both steam economy and power to vary speed within wide limits.

Thus, apart from the question of capital cost, which is almost certainly in favor of the steam pump, a clear case can be shown for steam. But such superiority might vanish if, owing to the introduction of lubricant, an oil separator were rendered necessary, or the exhaust were wasted. Small reciprocating engines are inferior to electric motors in respect of upkeep, coal consumption, and stand-by losses when not in use, but kept ready for use; but small turbines are not necessarily so.

Reference was made at an earlier stage to a set consisting of a small turbine driving the condensing auxiliar-

*Employed for this reason in actuating the brakes on some form of electrical winding gear for collieries.

ies; and it was shown that certain advantages accrued to such a use of steam if the exhaust could be profitably employed. We thus arrive at an argument of the following order:—In modern high-vacuum plants, the air-pump discharge is so much reduced in temperature that if introduced into an economiser without further heating it would cause sweating of the pipes. Consequently feed heating is a necessity. Steam feed pumps and turbine-driven condensing auxiliaries can be shown to have a thermal superiority over similar electrically-driven services if the exhaust be used to heat the feed, and are compact and easily maintained. To the extent, then, that the exhaust can be usefully absorbed for this purpose steam driving is clearly indicated for such services. But if the use of steam involves either waste of the heat of exhaust or the introduction of additional appliances, it ceases to have any recommendation as against electricity, with a possible exception in cases where speed variation within wide limits is required. It has been argued that steam offers a protection against failure of the auxiliaries in company with the main generators when a complete electrical breakdown occurs. In the system just described, the auxiliaries most essential to the restarting of the plant, viz., those connected with the condensers, would be steam driven.

To the advantage of steam it is to be added that it detracts nothing from the capacity of electrical generating and transforming plant, and little more from that of boilers than does an electric service.

Electric power, on the other hand, while it detracts from capacity of alternators, etc., has the following broad advantages:—(1) Small attention required while running. (2) Relative ease of installation at any distance. (3) Ease of control from any desirable point. The latter quality is particularly useful in the case of motors which drive stoker gear or fans; or for an object like a coal conveyor which extends over a great length and may have to be stopped from anywhere in case of accident.

Means of Providing Power.—Where steam is employed it can usually be taken from the main range. Cases sometimes arise where the main supply is superheated, but saturated steam is required for, say a feed pump; in such cases, provision can be made by drawing the saturated steam supply from two or three boilers, which are not likely to be shut down all at the same time. As regards electricity, the distinctive advantages of the three-phase current (absence of brushes or commutator, and solid and cheap construction) and its disadvantages (invariable speed) are well known. A three-phase supply for auxiliary circuits may be provided by three different methods:—(1) By separate transformers connected with each generating unit; (2) by transformers from the bus-bars; and (3) by separate auxiliary generating sets.

(1) The first-named, generally known as the complete unit system, wherein all the auxiliaries connected with any main generator are driven from a transformer attached to that generator, possesses advantages in the matter of reliability, but it is obviously costly. In isolated stations and with electrically-driven condensing auxiliaries, it is justified if not pushed to excess, as is liable to become the case where the boiler-house is concerned. Without an altogether disproportionate amount of spare boiler plant, each boiler-house or group of boilers must be considered the common property of the engine-house. Consequently a unit system must be interconnected in some way, which leads to expense and begins to vitiate the principle of unity. But apart from this, the argument against the alternative of driving from bus-bars, which is valid in the case of the turbine auxiliaries, is not necessarily applicable to the boilers. For a bus-bar failure, or a failure of one of the station transformers, does not vitally affect the supply of steam, if feed-pumps are steam-driven, and natural draft can be substituted for artificial; the grates (if mechanical) can be operated by hand, for long enough to enable the bus-bars to be made alive again, or the reserve transformer switched in. Coal or ash-handling plant, or the crane, cannot be allocated to any one turbine. It thus becomes necessary to have in any case a connection from the station bus-bars to the unit transformers. Apparatus which is inalienable from its own generator is usually confined to air pumps; and in some cases, circulating pumps and ventilator fans. Where the circulating and air pumps are steam-turbine-driven, and the alternator supplies its own draft, the principal arguments for the unit system are absent.

(2) A supply from the main bus-bars through transformers has an advantage over either of the other methods in the matter of initial cost. The transformers detract, of course, as much capacity from the main alternators as the unit method, and have to be in duplicate. Otherwise this system is exceedingly simple and obvious.

(3) The recommendations of the independent method are protection from electrical breakdown of the main system, and increased saleable capacity in the main alternators. The cost is necessarily much greater than that of the bus-bar method, and space has to be found for at least two auxiliary steam-driven generators with their equipment.

A supply of continuous current from a three-phase station can be furnished (1) by motor-generators, with or without a battery; (2) by independent generators. The advantage of continuous current is its particular applicability to variable-speed services, cranes and locomotives. With the addition of a battery, auxiliaries are quite independent of the state of the main bus-bars. After these things are granted, its disadvantages soon become apparent in the upkeep of commutators and brushes, increased initial cost, and perpetual loss in conversion by motor-generator or storage in the battery. This, of course, would not apply in a D.C. station.

In some cases where alternating current is generated, the device has been adopted of having some auxiliaries driven by alternating, and others by direct, current furnished by a motor-generator in normal operation, and by a battery if the supply fails. Thus some at least of the auxiliaries, and the station lighting, can always be kept going. But the introduction of two electrical systems is objectionable.

Conclusion.—We may now summarize the conclusions indicated by the foregoing remarks. Starting from the assumption that a large station is to generate three-phase high-tension current, certain services must be arranged for, some driven by steam, others by electric power. Preference is to be given to three-phase current which can be provided for either by independent generators, by transformers from the bus-bars, or by transformers from each generating unit. Being necessarily in duplicate and steam-driven, independent generators are a costly means for obtaining the power. It has been shown that turbine-driven air and circulating pumps, with the possible addition of feed pumps on the same shaft, besides fulfilling a useful and economical function in heating the feed, render unnecessary a subdivision of auxiliary services into unit groups. Therefore, it is submitted that such pumps, with other electric auxiliaries supplied by transformers connected only to the station bus-bars, combine simplicity with a sufficient measure of reliability. The transformers must, of course, be in duplicate. But where for any reason, such as small size of units, with consequent wasteful consumption on auxiliary power, or excessive power rendered necessary by exigencies of the pumping system, steam cannot be economically adopted (having reference to the heating of the feed water), a grouping of motors into units, in which either one or two generators may participate, with electrically-driven condensing auxiliaries, is to be recommended on the score of immunity which it furnishes from simultaneous breakdown of all auxiliary services.

The following services may with advantage be electrically operated:—Mechanical stokers, if fitted; fans, if fitted (variable speed motors are desirable here, if efficient at low speeds; water service pumps of all sorts, except those very rarely used, where steam ejectors can be employed; economizer scrapers; coal and ash-handling plant; cranes.

The following should, where possible, be steam-driven: —Feed-pumps, and combined air and circulating pumps for the condensers.

Exciters should preferably be directly attached to the shafts of their generators.

Ventilation of alternators to be effected by fans on the rotors.

Switches to be electrically operated.

Large valves where speed of operation is essential may be operated either electrically, or, if the station is on a large enough scale to warrant a supply of compressed air always available for cleaning electrical apparatus and driving pneumatic tools, by air.

We may conclude by a brief reference to the tables which are appended to the Paper. Motor-generators and auxiliary D.C. sets are shown in separate column, as their inclusion among auxiliaries proper would be misleading. Steam feed pumps are estimated. A great divergence is exhibited in the degree to which auxiliary power is actually employed. Local peculiarities account for some of this divergence. For instance, in the case of Greenwich power is wasted due to the leakage of circulating water in connection with the straining appliances rendered necessary with Thames water, and electrically-driven feed pumps bulk largely in the total. At Carville, the station being set back some distance from the river in order to obtain suitable foundations, the power required for pumping water is considerable: on the other hand, practically none is needed for coal-handling owing to the advantageous use of the natural levels of the ground.

Of the two Glasgow stations, one (St. Andrew's Cross) employs fan-draft cooling towers, the other a canal. Hence the high figure in the case of the former.

At Stepney circulating pumps and fans account for much of the power. The latter also contribute a large proportion in the case of Brighton and Carville. In fact it is almost correct to say that they constitute the principal difference between the high figures and the low figures at Dunston where fan power is moderate and not duplicated.

Cambridge is of interest because it exhibits another factor of the auxiliary question. Being started as a single-phase station in days when single-phase motors were unsatisfactory, the bulk of the power is furnished by steam 12 h.p. only being electrical; the air and circulating pumps are for the same reason driven by gearing from the main turbines.

The installation of induced draft apparatus accounts for a large proportion of the power at the Newcastle and District Company's station. As a matter of everyday practice induced draft is not used there, but the fan motors are included because a classification has to be made on an uniform basis for comparison. The rated power of motors installed, which is the figure stated, is roughly a measure of the capital spent on auxiliaries. The daily energy used, which would be more indicative of the annual cost, might have been selected, but such a figure would be difficult (in some cases perhaps impossible) to arrive at: and the former figure brings out in a more striking fashion the importance of the whole question from the capital point of view.

Table I.—Aggregate of Auxiliary Power Installed at Various Stations.

STATION	Total main generating plant. kw.	Auxiliary power installed h.p.	Motor-generators or Auxiliary steam sets.	Auxiliary power h.p. per 1000 kw. of Main Plant.	Remarks
Lots Road, Chelsea	48,000 3-ph.	2,223	Four 135-kw. steam.	46.5	The 4 steam sets supply excitation and some D.C. motors.
Carville	35,000 3-ph.	3,411	Two 25-kw. One 100-kw. M.G.'s	97.5	
Greenwich (L.C.C.)	34,000 3-ph.	2,064	Two 150-kw. steam.	61	
Glasgow—Port Dundas	22,400 3-ph.	1,850	Two 40-kw. M.G.'s	80	
Dunston	19,000 3-ph.	1,184	One 9-kw. Two 50-kw. One 200-kw. M.G.'s	62	
Glasgow—St. Andrew's Cross	16,400 3-ph.	1,725	Two 40-kw. M.G.'s	105	Fan—draft cooling towers.
Brighton	10,200 3-ph.	912	Two 220-kw steam. Two 300-kw. M.G.'s	90	Motor-generators and steam sets used also for external load.
Hamburg Overhead	7,900 3-ph.	590	—	74.5	Condensing auxiliaries and feed pumps turbine-driven.
Markisches (Berlin)	7,200 3-ph.	508	—	70	
Stepney	6,000 D.C.	580	(D.C. Station)	96	
Newcastle and District Co.	5,450 D.C. & 1-ph.	473	(D.C. Station)	87	
Cambridge	1,880 1-ph.	117	One 45-kw. M.G.	62	Single-phase generators. Motor-generator for external load.
Alnwick	140 D.C.	15	—	107	Non-condensing.
Morpeth	60 D.C.	12.5	—	210	

* Figures for Greenwich are as regards 85% taken from a Paper read by Mr. Rider before the Inst. E. E. in 1909.

Table II.—Analysis of Power Used for Various Purposes. (All Figures h.p. per 1,000 kw. of Main Plant.)

STATION	Feed Pumps.	Stoker and Economizer.	Fans.	Condensing Auxiliaries.	Coal and Ash.	General Services.	Total.
Lots Road, Chelsea	5	5	—	19	7	11	47
Carville	12	4	33	41	3	5	98
Greenwich	12	3.5	—	34	7	4.5	61
Glasgow—Port Dundas	11	3	21	37	5	3	80
Dunston	10	2.5	14	26	3	7	62.5
Glasgow—St. Andrew's Cross	9	3	8	78	5	2	105
Brighton	12	3.5	45	24	2.75	2.75	90
Hamburg Overhead	32	3	—	25	9	5	74
Markisches (Berlin)	22	1.5	12.5	25	7	2	70
Stepney	11	3.5	12	49	6.5	14	96
Newcastle and District	8	3.5	22	48	1	4.5	87
Cambridge	21	1	1	33.5	—	5.5	62
Alnwick	107	—	—	—	—	—	107
Morpeth	110	—	—	100	—	—	210

A LARGE CONCRETE VIADUCT.

In municipal districts where railroad tracks traverse thickly populated sections the question of proper accommodation for safe and uninterrupted traffic across the railroad property has become a serious matter. At Weston, a small municipality just to the immediate west of Toronto, the problem has been solved by the erection of the concrete and girder steel viaduct forming the subject of the accompanying illustrations.

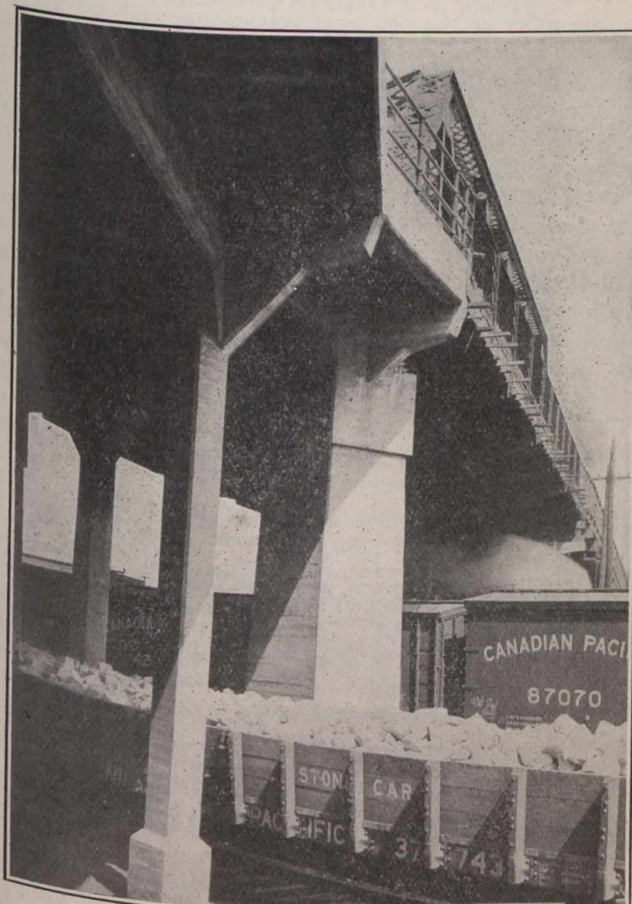


Fig. 1. View Showing Columns and Floor Beams.

A busy section of the main line of the Canadian Pacific Railway occupies the entire lower, open portions of the viaduct which, at this point is supported by a number of reinforced concrete piers. Leading to the spans an earthwork slope, held in place by a retaining wall of concrete, gives easy access to the higher parts of the structure. The entire length of the viaduct is almost 500 feet.

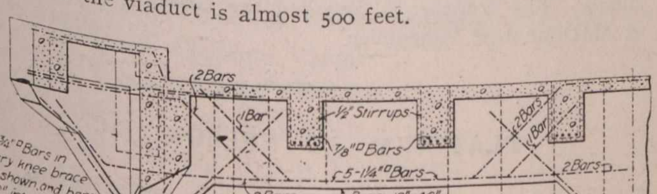


Fig. 2. Section through Bent Cap.

It is natural that the concrete columns supporting the central steel girder and bridge work should receive the major portion of the engineering attention. The footings for the columns were carried to a depth of 6 ft. below the ground level; the area of the base being 64 sq. ft., stepped up to a 2 ft. by 2 ft. 4 in. area at the base of the columns. The columns are 16 × 20 in. reinforced by four ¾-in. bars, extending from the bottom of the footings up through the columns; at the top of which they are bent at an angle of 45 deg. passing through the floor-feams up into the floor slab. These bars are hooped with No. 12 gauge wire at 6 in. intervals.

The floor beams have a varying thickness, according to their position in the scheme, from a section of 16″ × 36″ to a section of 36″ × 50″. These beams are reinforced by four bars each.

The overhanging sidewalk and sidewalk supports are carried on cantilever arms reinforced with ¾-in. iron bars bent to the shape of the cement work which forms a right angle with the viaduct at the end of every floor beam. The sidewalk stringer is 12 × 24 in. and is reinforced with three ⅞-in. bars, two of which are bent up an angle of 45 deg., at each sidewalk bracket. The sidewalk is 4 in. thick and is reinforced with No. 16 gauge expanded metal. It is finished with a 1-in. facing of 1 part Portland cement, 1 part sand and 1 part screened gravel not exceeding ⅝ in. in diameter, which was floated to a smooth surface. The surface was marked off in blocks about 6 ft. in length and afterwards rolled with a patent roller.

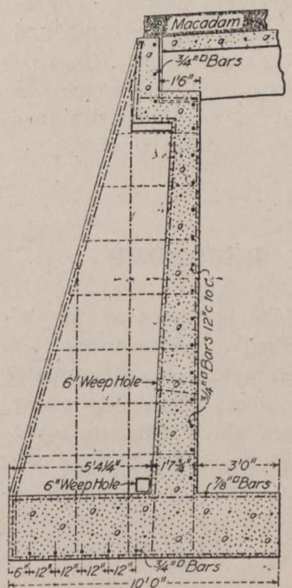


Fig. 3. Section Through Retaining Wall.

The bent supporting the steel span consists of two outer piers and a centre column. The outer piers are 6 × 6 ft. at the base, tapering to 5 × 5 ft. at the top and resting on footings each 10 × 10 ft. in area. These piers are reinforced with four ⅞-in. bars, one in each corner, and ½-in. stirrups spaced 12 in. on centres. The centre column is 20 × 20 in. with a base 2 ft. 4 in. × 2 ft. 4 in. × 2 ft. 8 in., resting on a footing with a base area of 8 × 8 ft. This column is reinforced with 4¾-in. bars hooped with No. 12 gauge wire.

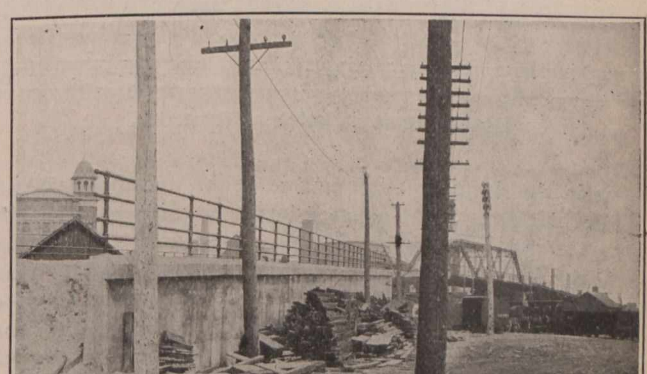
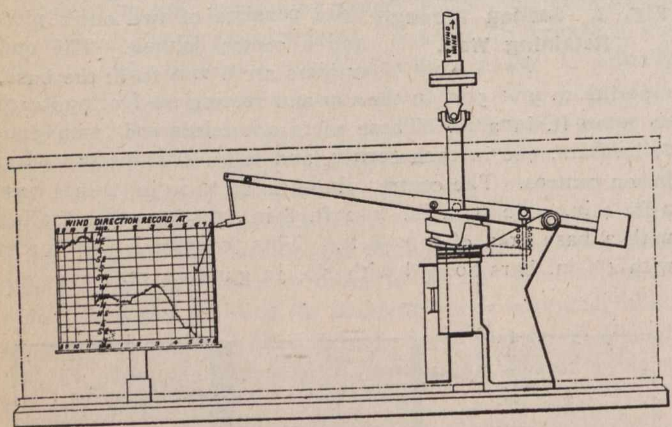


Fig. 4. View Showing Retaining Wall and Approach to Viaduct.

The sectional drawings, Figures 2 and 3, make clear the details of construction in the sloping approach. The footings of these walls from the lower end to the expansion joints which are located 104 ft. from the lower end are 1 ft. 6 in. in thickness, increasing in width from 5 ft. to 7 ft. 4 in. and are reinforced with eight ⅝-in. horizontal bars, spaced as shown in the accompanying drawing, and ¾-in. transverse bars, spaced 12 in. centre to centre. At the expansion joint the footings are increased to 2 ft. 4 in. in thickness and widen it to 10 ft. at the abutment, at a distance of 120 ft. This portion is reinforced with five ¾-in. longitudinal bars and ⅞-in. transverse bars placed 12 in. centre to centre. The lower section of the retaining wall, 104 ft. long, is designed as a simple reinforced concrete wall, while the upper section, 120 ft. long, is designed with counterforts. Both sections are reinforced with a double system of rods, When the structure has taken a more finished appearance the earthwork will receive a coating of macadam pavement and by this means there will be completed a substantial road bed over the entire traffic way. The cost of this viaduct is estimated at $25,218. The contractor was Mr. C. E. Lewis, of Toronto, and the work was designed in the bridge department of the city engineer's office.

A WIND-DIRECTION RECORDER.

The wind-direction recorder which is shown in the accompanying figure, and was described in a recent issue of London Engineering, forms an example of a singularly simple solution of an awkward problem. The instrument, as will be gathered, consists of a pen which moves in a vertical plane, and traces a recording curve on the surface of a revolving drum. The pen is driven from a cam which is connected up to and actuated by a wind-vane, while the drum is driven by self-contained clockwork. The wind-vane is not



Diagrammatic Sketch of Recorder.

shown in the figure. It is mounted at the top of the vertical spindle, which is made of such length as may be necessary to enable the vane to be situated in an exposed position above the building in which the instrument is placed. Wind-direction recorders of other types than the present have, of course, been constructed. In one of these the chart is connected to the drum, and the pen is driven by clockwork, while others use two pens in various ways. The advantage of the present type lies in its extreme simplicity and in the fact that the movements of the pen are vertical and the charts rectilinear. It is obvious that an instrument having a simple and continuous groove in the cam could not be constructed on the lines of the figure, since with backing and veering winds the vane, after making a complete revolution, would cause the pen to so alter its zero in reference to the chart that the readings would become meaningless. In other words, if the vane is to be free to make complete revolutions in any direction—and this is, of course, essential—then there must be, at some point, a means of re-setting the pen on the chart. The simple method which has been devised for this purpose forms the main point of interest of the recorder under notice. As will be seen from the figure, the cam groove is in the form of a spiral, so that as the vane moves round, one way or the other, with a wind of varying direction, the pen either rises or falls on the chart. The zero adjustment is arranged for by the vertical slots at the ends of the cam groove, one of which can be seen in the figure. If, owing to continuous progression in one direction, the roller on the pen lever reaches one end of the spiral groove, it immediately moves through the vertical slot in to the upper, or lower, part of the groove, as the case may be. The effect of this is naturally to trace a vertical line on the revolving chart, and at the same time to alter the zero of the pen. The chart, as will be seen, has a portion of its direction scale duplicated, so that after this vertical movement, the pen still indicates correctly the direction in which the wind is blowing. The instrument produces a broken curve of the type shown in the figure, but it is clear that such a curve presents no difficulties in reading. The details of the instrument are well shown in the figure. The pen lever is counterweighed and is also controlled by a spring. Its downward movement, when its roller travels in the vertical slot in the side of the cam remote from that shown in the figure, is brought about by its own weight; while its upward movement, when its roller is in the slot shown, is brought about by the spiral spring, which is compressed at the right moment by means of a lower lever, which has a roller working on the underside of the cam. This underside of the cam is formed to engage the roller of the second lever only when required. The pen lever is fitted up with a vertical dashpot to prevent shock when it makes its quick movements. The instrument is manufactured by Messrs. Negretti and Zambra, of 38 Holborn Viaduct, London, E.C.

MILLION-DOLLAR DAM.

According to a statement of Mr. A. S. Dawson, chief engineer of the department of natural resources of the Canadian Pacific Railway, Calgary, contracts have been let for a million-dollar work on the irrigation block. This includes a concrete aqueduct to cost half a million, other concrete structures to cost $300,000, and thirty steel bridges to cost one hundred thousand. The aqueduct is the first of its design to be constructed. It will be ten thousand five hundred feet long, with a maximum height of fifty-five feet, and will irrigate one hundred thousand acres of the Canadian Pacific block. The contract is awarded the Grant-Smith Company & McDonnel of Vancouver.

PLATINUM AT NELSON, B.C.

The investigation of the Geological Survey as to the platinum discoveries reported in Nelson last summer shows there is no foundation whatever for the statements then made that metals of the platinum group occur in the dykes in which they were reported. Two of the most reliable assayers who handled samples of the supposed platinum bearing dykes stated that they were unable to get even a trace, and their reports are now confirmed by the Geological Survey, as in all the samples taken by Mr. Leroy no platinum whatever was found with the exception of a doubtful trace in one sample.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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CONTENTS OF THIS ISSUE.

TORONTO BUILDING BY-LAW.

The revision of the Toronto building by-law is nearly completed. It will be remembered that in May, 1911, a Citizens' Committee, composed of representatives of the technical and business organizations of the city, presented a memorial to the Mayor and the City Council, asking for a general revision of the by-law, and suggesting along what lines the revision should be done. The draft by-law for regulating reinforced concrete construction is now complete, and has been submitted to the Citizens' Committee for their opinion. A copy of the by-law will be found in this issue of *The Canadian Engineer.* The Citizens' Committee states that, in the main, the by-law as revised is acceptable. The committee offers a number of comments covering certain minor points on which the by-law is excessively severe. It must be said that the Citizens' Committee has secured a vast improvement in the conditions of the old by-law. The useless and prohibitive restrictions on reinforced concrete construction in the original regulations are, many of them, struck out, or so modified that the by-law as it now stands is a workable instrument; while severe, it is not excessively or unfairly so. It is unlikely that any further change will be made in the draft as published. With restrictive legislation against reinforced concrete construction reduced to a fair competitive basis, there is no question that there will be a great impetus in the number of buildings of this type which will be erected in Toronto in the future. The revision comes too late to have much effect on the building industry this year, but next season will undoubtedly show a great increase in the number of reinforced concrete buildings erected.

THE REPORT OF THE TORONTO WATER COMMISSION.

The report of the Commission appointed to investigate the question of Toronto water supply has at last been published. An abstract of the report will be found in this issue of *The Canadian Engineer.* On the whole, the recommendations made are what were expected. The Commission has taken a definite stand against Lake Simcoe water and in favor of Lake Ontario as a source of supply. Taking this view, naturally their decision is in favor of Scarboro' as a point of local supply on account of prevailing currents, etc. They mention, however, the possibility of an auxiliary lake supply later from the west of the city. One feature of the report which merits commendation is the emphasis placed on the prevention of waste by means of meters. We have in these columns emphasized the necessity of taking measures to prevent the criminal waste of water going on in Toronto, and it is high time steps were taken, either by the installation of meters or the organization of an efficient inspection department to cut down this waste. The present plant on the Island is to be retained, and it is recommended that the intake pipe and the filtration plant there be duplicated. The Commission reasons that on account of the already large outlay on the Island plant that it would be uneconomical and unnecessary to abandon it. We must confess that we find it hard to understand why the Commission recommends slow sand filtration at the Island and mechanical filtration at Scarboro'. If one method is good in one place, why is it not good in the other? The water at both locations is Lake Ontario water, with little difference in quality and conditions of turbidity. If the slow sand filtration plant at the Island is not as good as the mechanical filtration plant at Scarboro' will be, why duplicate the present installation? The Commission may have good reasons for their recommendations, but these reasons have not been given in the report.

The report recommends an emergency chlorination plant in connection with the plant at Scarboro', at which it will be possible to chlorinate either before or after filtration. To avoid interruption of service, they recommend another independent source of electric power other than Niagara. It is an open question whether an auxiliary power plant, either steam, oil or gas, should not be provided rather than another electrical supply. The difficulties of electrical supply are mainly in the transmission systems, and a storm which would cause interruption of service on the Niagara line would probably have a similar effect on any other line.

RAILWAYS AND THE PEACE RIVER REGION.

The progressive railway policy in Alberta, planned by Premier Sifton, has again drawn attention to the possibilities of the Peace River country. The trend of settlement in Canada, and also in the United States, has been westward, following the construction of railways. As the land in the railway belts (the more southern part of Western Canada) is being rapidly filled, as the older railway lines throw out their feeders northward, and, as the location and construction of the new National Transcontinental Railway proceeds, attention is being attracted to the great northern reserves.

The two sections next likely to receive the greatest attention from capital and immigration are Northern Ontario and the Peace River district. We have previously discussed in these columns the possibilities of the former. Even the little known about the fertile Peace River country creates substantial hopes of future development.

At a point some 400 miles due north of Edmonton, for instance, splendid crops of wheat, barley, oats, peas, etc., have been regularly raised for over twenty years, the product for the season of 1906 being 25,000 bushels. That the production of grain in these northern, sparsely-settled regions has already resulted in the establishment of local grist mills of considerable capacity, which manufacture flour by modern processes. Potatoes and other vegetables have been for many years satisfactorily cultivated at Fort Good Hope, on the Mackenzie River, fourteen miles from the Arctic circle.

Vegetation matures quickly in northern latitudes, owing to the long days during the season of growth. According to a statement made to the Senate Committee, which took evidence regarding the unexplored regions of the Dominion in 1907, there is in the Peace River section as much good agricultural land fit for settlement, and yet unsettled, as there is settled in Manitoba, Saskatchewan and Alberta to-day.

Mr. J. K. Cornwall, an enthusiast regarding the Peace River region, considers the waterways of the Mackenzie watershed as the finest in North America. The most southern point reached by navigation on the Mackenzie watershed is at Fort McMurray, at the junction of the Clearwater and Athabaska Rivers, a point about 275 miles north, and a little east of Edmonton. The distance from McMurray to the Arctic ocean is approximately 1,600 miles. In all this distance, the connected waterways are navigable for steamers that are now plying upon them, and have been for twenty years. There are in this long system of waterways two distinct divisions.

The Peace River practically passes through the centre of the vast Peace River district, and in the development of this district will always play an important part, as navigation is practically without a dangerous rapid or obstacle of any kind throughout its whole course, with the exception of one at the Vermilion Chutes.

As to the number of months in the year that this stretch of waterway in the Mackenzie basin is open for navigation, Mr. Cornwall says that all the rivers running to the north, and each with their source in the Rocky Mountains, namely, the Athabaska, the Peace and the Liard, "go out" between April 20th and May 1st, on the average. They are all navigable a week after they go out, but where these rivers enter the lakes the navigation opens later, it being not much before the first week in June, when the lake ice breaks up and disappears. Navigation is opened on an average about the middle of June.

This waterway runs through a country of great natural resources. Timber, asphaltum, copper, salt and fish are some of its natural resources. The agricultural possibilities of the Peace River district are unsurpassed in the North-West. Flour is ground at Fort Vermilion, which is 670 miles north of the United States boundary, and is in latitude 58.30. The Hudson Bay Company has a large and excellently equipped flour mill there which cost $45,000.

As progress is made in the Alberta government's railroad programme, we shall hear much more regarding the Peace River region, rich in possibilties and natural resources.

EDITORIAL COMMENT.

If it is true, as reported, that Mr. K. L. Aitken, the managing engineer of the Toronto Hydro-Electric Commission, will not return to take up his duties after his six months' leave of absence, it looks to us as if the Commission were making Mr. Aitken the scapegoat for the troubles they see looming up, and which they are primarily responsible for. We have had occasion to criticize the Toronto Hydro-Electric Commission before, and we feel that it is not too late even yet to replace the present Commission with one more thoroughly in touch and in sympathy with the Ontario Hydro-Electric Commission.

* * * *

In the inquest being held over the collapse of the Neilson building in Toronto the testimony of the witnesses has been of considerable interest. We do not care to comment on the accident until the inquest is closed. The evidence of the Assistant City Architect as given on Monday last, however, shows a most remarkable lack of appreciation of the eccentric loading of walls, and his evidence throughout has been conspicuous in his misunderstanding of the terms, "factor of safety" and "safe load."

REPORT ON TORONTO WATER.

During the latter part of 1910 and early in 1911, serious conditions developed in connection with the water supply of the city of Toronto. These conditions were, apparently, due to the failure of the seventy-two inch steel intake pipe, which partly filled with sand, thus cutting off the lake supply from the city. During the month of February, 1911, the city was compelled to fall back upon the Blockhouse Bay as its source of water supply. At this time the citizens were advised to boil all water used for domestic purposes.

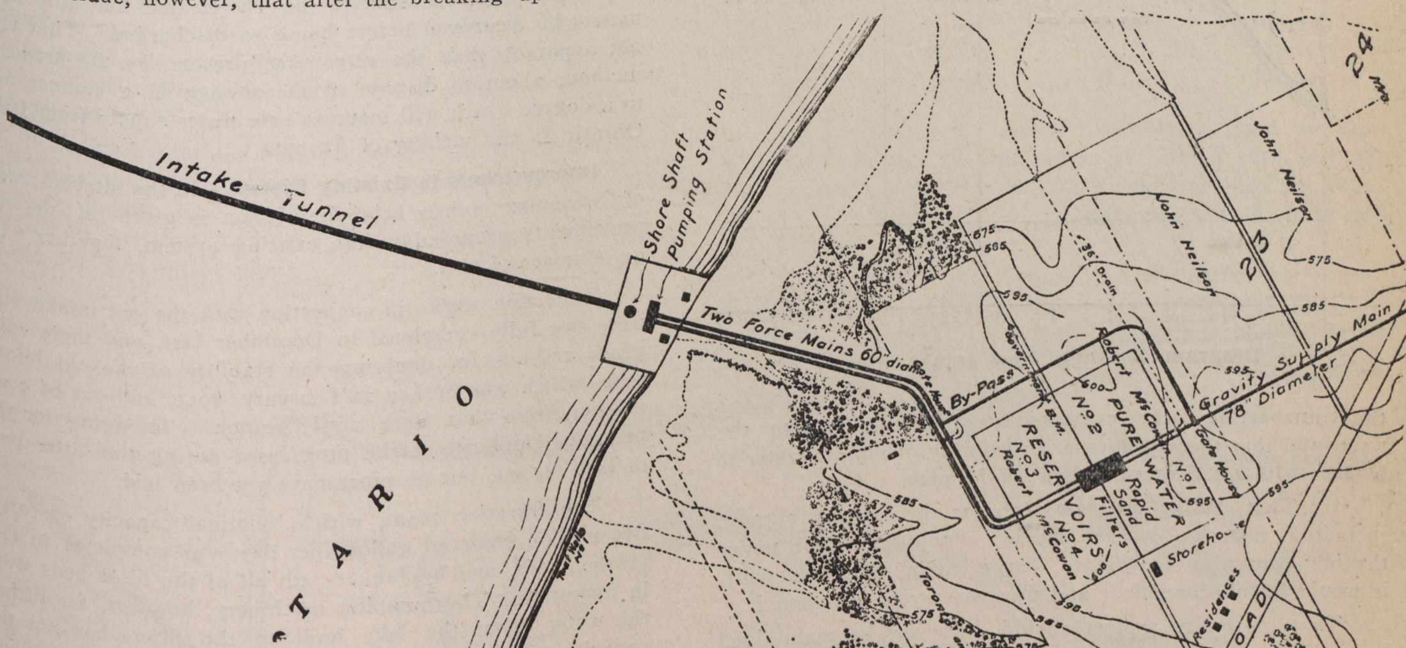
The chlorination plant, which had been in continuous operation since March, 1910, so purified the water, however, that there was no apparent increase in disease that could be attributed to the use of the Bay water. It was reasonable to conclude, however, that after the breaking up of the ice, the polluted harbor water might readily find its way to this temporary supply, and the advent of warm weather would increase the danger.

The waterworks department was then strenuously engaged in removing sand from the intake pipe in order to secure lake water at the earliest possible moment.

At this same time a sand filtration plant was under construction for treatment of the water supply.

The above circumstances, together with an acknowledged general feeling that the whole question of the present system of water and future requirements demanded immediate consideration, led the city council to ask for an independent examination and report. A board of consulting engineers was appointed, composed of Messrs. Isham Randolph, J. G. Sing, T. Aird Murray and W. Chipman, to consider the question, and they have now formulated and presented their report. An abstract of their report appears herewith.

A first interim report was presented to the Board of Control on March 24th. This report dealt exclusively with improving the supply, which was then being drawn from Blockhouse Bay, as it did not appear that Lake Ontario water could be obtained through the intake pipe for some considerable time. It was recommended that "Long Pond" be converted into a settling basin by constructing three dams on the harbor or city side leading from the harbor, and that a cutting be made to Lake Ontario at Clandeboye Avenue, across the Island, in order to introduce lake water into the pond. This report was adopted and the work immediately proceeded with, but it was not until May 10th that it was completed, from which time to June 29th, the city supply was drawn from the lake by way of Long Pond.



Plan of Proposed New Plant at Scarboro'.

For the first three months the greater part of this board's time was occupied with problems connected with protecting the temporary city supply from contamination while repairs were being made to the intake pipe, and in designing a new duplicate intake pipe to ensure a constant supply to the system.

Surveys, soundings, collection of and analyses of samples of water, and compilation and study of data, have been in almost continuous progress since the appointment of this board. Two test wells were also sunk on the beach at Scarboro' to determine the character of the underlying strata, about which there existed conflicting opinions.

The recommendations and estimates of cost with reference to a supply of water from Scarboro' are here given.

Recommendations and Conclusions.—(a) That the present and future source of water supply for the city of Toronto must depend solely upon Lake Ontario.

(b) That bacteriological, chemical and visual examinations of Lake Ontario water from Mimico to Scarboro' Heights have demonstrated that there is no locality within ten miles from the north shore of the lake from which water can be drawn which will at all times present a safe supply, unless such water be subject to some form of purification Although it is also apparent, from the evidence gathered, that water in the immediate vicinity of the city is subject to a greater degree of impurity for longer periods than water at a distance. It is also concluded, from the evidence, that

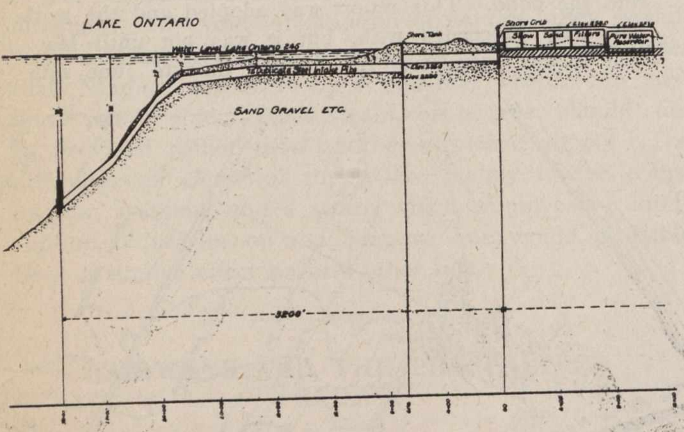


Diagram Showing New Intake Pipe.

the transporting lake currents are from the east to the west, and that there is a lesser probability of impure water to be met with off Scarboro' than off Mimico.

(c) That, taking into consideration the existing system, including filtration works, intake, conduits, tunnel under the bay, pumping machinery, large mains, and reservoir, it would be uneconomical and unnecessary to abandon it.

That the entire system should, however, be maintained in a proper condition of efficiency and each part or section brought up to a safe minimum capacity of at least sixty million gallons per day.

(d) That, by laying the duplicate intake pipe, now under contract, the duplication of the filtration plant, the connecting up of the sixty-inch steel conduit across the Island, and the installation of additional pumping machinery at John Street station, the existing system may be relied upon to supply sixty million gallons per day, and for a short period may meet a demand of ninety million gallons.

And that these proposed improvements be immediately undertaken, otherwise the city will undoubtedly be confronted with a water famine in the immediate future.

It is concluded that until the second intake be completed, Long Pond be retained in such condition that it may be converted into a settling basin for the city water supply upon twenty-four hours' notice.

(e) That all available evidence points to the necessity of increasing the water supply to meet the demands of one million population, and that it is not advisable to rely upon the present location for such increased supply. Taking into consideration the probable future rapid growth of the city, it is reasonable that the present location of supply be considered only as a central unit, and that extra units be installed either east or west of the central unit. That, owing to the demonstrated fact that purer water is obtainable for longer intervals of time east of the harbor than to the west, and owing to the high elevations of the plateau at Scarboro', a second unit be first installed at this location.

That all preliminary surveys, plans, etc., for the Scarboro' system be proceeded with immediately and works placed under contract.

It is concluded that, until Toronto can be assured of a second independent and reliable supply of water from the lake, what have been considered as exceptionable and unpreventible circumstances may again arise to the discomfort of the citizens and consequent lack of confidence in the organization of the waterworks department of the city.

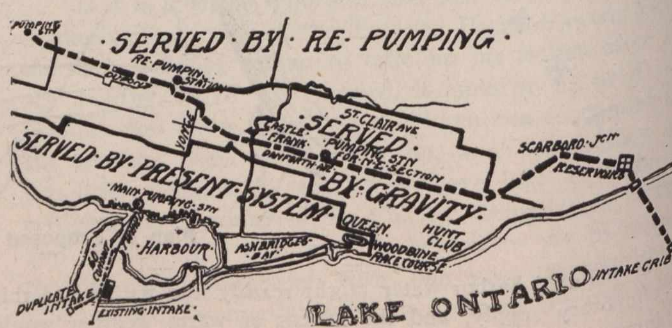
The possibility that a third unit of supply may in the future be required to the west of the harbor, is admitted but not as yet anticipated.

(f) That, owing to the fact that the city is about to discharge its sewage into Lake Ontario at a point about two and one-half miles east of the harbor, it is of the utmost importance that the sewage be so treated that infectious matter be destroyed before being so discharged. That it is not apparent that the city is at present, by the proposed method, about to dispose of the sewage in a manner and to a degree which will insure a safe water supply from Lake Ontario in the vicinity of Toronto.

Improvements to Existing System.—In the interim report of November 30th a brief description is given of the improvements proposed to the existing system, together with an estimate of cost.

Protection works in connection with the old intake pipe were not fully completed in December last, and there exist grave reasons for doubting the stability of the old intake pipe, which was broken in February, 1911, and out of commission from that date until August. Dredging for the proposed duplicate intake progressed during the latter part of last season, but no pipes have yet been laid.

The filtration plant, with a nominal capacity of forty-five million Imperial gallons per day, was completed in December 1911, and by January 4th all of the filter beds were in operation. The pumping machinery, however, for lifting the water from the lake level to the filters has not the capacity specified, but this matter will probably be remedied by the contractors. The filtration pumping station is much too small for the machinery installed therein, and this board includes in the proposed improvements an extension of the filtration pumping station to the southward. Some of the machinery in the existing building may be moved into the



Sketch Showing General Proposed Extension.

extension proposed, and there should also be installed therein a second steam pumping unit and duplicates of the electrically operated machinery. It may not be necessary, at first, to double the capacity of the filters, but another pure water reservoir should be immediately constructed and a sufficient area of filters to meet the maximum demand for water that may be anticipated during the time that the Scarboro' project may be under construction.

The construction of the second reservoir will permit the existing one being emptied for cleaning, inspection and repairs. By the by-pass pipes shown, the contents of either of the pure water reservoirs may be discharged into either of the conduit pipes. In case of accident to either intake, the arrangement shown will permit water being drawn from Long Pond to the filtration plant pumps and from thence passed through the filters and the second conduit to the tunnel.

A connecting pipe about 600 feet in length is to be laid from the sixty-inch conduit to the south shaft of tunnel, provided with valves at each end. This pipe is to be laid below the bed of the bay.

At the John Street pumping station the board recommends that a steam operated pumping engine of twenty-five million gallons capacity be added, or it may be advisable to substitute two fifteen million-gallon units in lieu of one twenty-five million gallon unit. To accommodate this machinery it is proposed to extend the 1904 pump house westerly.

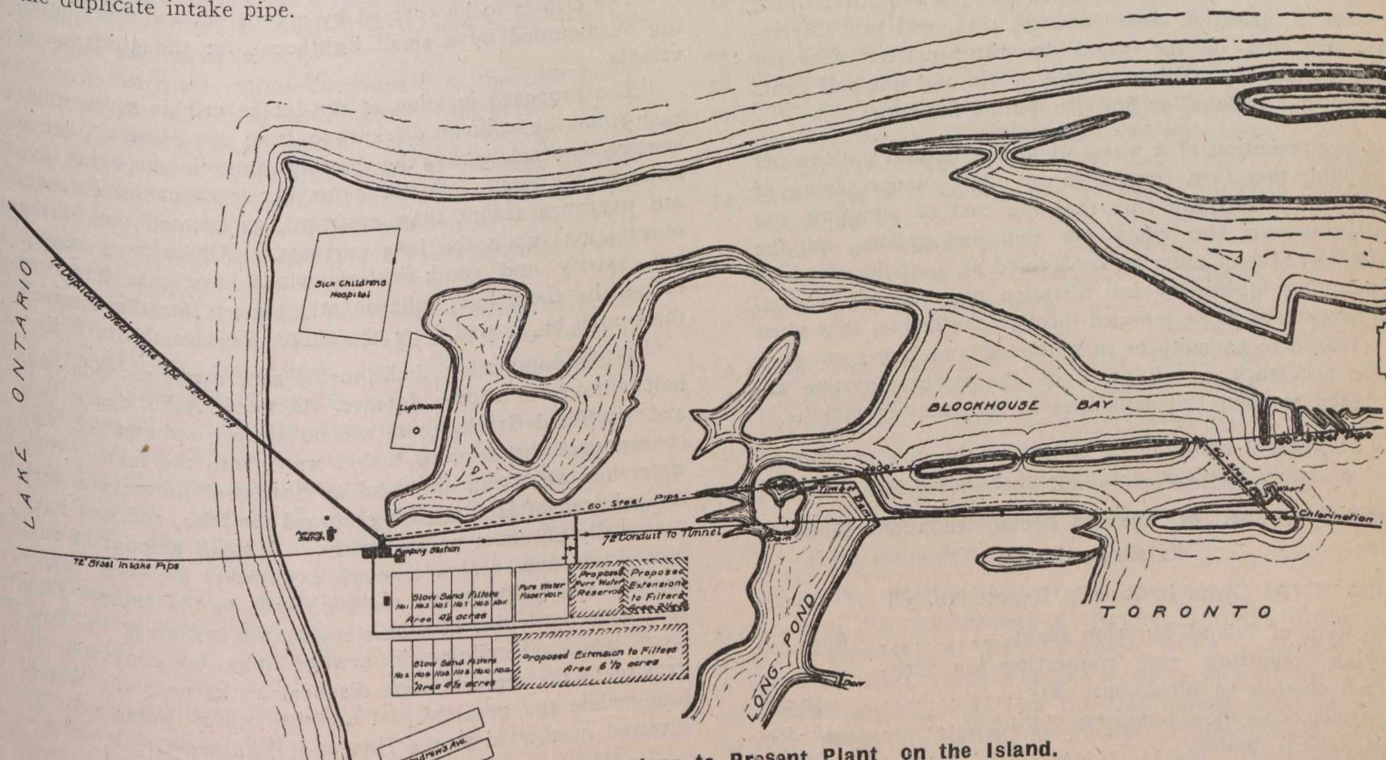
It would also now appear advisable to add two additional electro-turbine units each of not less than thirteen and one-half million gallons capacity.

If the electro-turbine units are added, and the two steam units substituted for the larger unit recommended, then the estimate of cost given in the interim report should be increased by $157,000, making a total of $1,287,000 exclusive of the duplicate intake pipe.

At Cleveland, Ohio, with Lake Erie as a source of supply, the general metering of the services was decided upon in 1901, at which time about six per cent. of the services were metered, the per capita consumption per day being one hundred and sixty-nine U.S. gallons, or one hundred and forty-one Imperial gallons. The reduction effected in the consumption was as follows:

Year.	Number of Services	Percentage Metered.	Gallons per Capita.
1901	55,130	6.42	169.40
1902	56,816	19.88	167.80
1903	58,852	42.81	141.60
1904	60,627	50.09	138.50
1905	64,137	69.70	130.80
1906	69,128	82.19	123.00
1907	72,225	88.60	117.50
1908	74,490	93.61	100.30
1909	76,777	97.48	93.64
1910	80,686	97.67	101.80

With fifty per cent. of the services metered the consumption was only reduced seven per cent.; with seventy-five per cent. metered the reduction was twenty-five per cent., and with practically all of the services metered, forty per cent. reduction.



Plan Showing Proposed Extensions to Present Plant on the Island.

The foregoing estimate will include a new forty-eight-inch force main from the pump house to Front Street, with connections to existing mains.

Waste Prevention.—The problem of waste prevention by the installation of meters, and efficient inspection, has not been considered in detail by this board, so far as Toronto is concerned, as it is understood that the city is taking up the question by means of a special committee. It is concluded, however, from the experience of this board, that the general metering of the domestic supply, with a minimum charge for each service, would reduce the per capita consumption by approximately one-third, and that the cost of installing the meters would be more than compensated for by the reduction in the cost of delivery. Furthermore, the existing plant could be made to supply a third more population than at present.

The main argument that is now urged against the adoption of meters is the cost of installation, and the maintenance charges. The argument that meters restrict the use of water has proven fallacious from experience, and may be dismissed.

As to the cost, the results at Cleveland are of value. At the end of 1910, 78,809 meters were installed, the cost of the meters and setting being $1,340,000, but this included several thousand meters in stock. The average cost of each meter set was about $17.50. The setting in the basement cost less than $4 each, and during recent years a larger percentage are being set in the basements. Of the eighty thousand meters over seventy thousand are on services five-eighths inches in diameter. The largest size of meters may be installed in brick chambers, but it will be found more economical and convenient to instal them in basements.

In Toronto, the cost of the meters would be higher than in Cleveland, also the cost of the setting, but as the great majority of the buildings in this city are of brick with proper basements and cellars, it would not be necessary to construct many brick vaults or chambers. To meter the entire city would cost approximately as follows:

60,000 meters set in basement, at $14	$840,000
10,000 meters set in vaults or chambers, at $30	300,000
Total	$1,140,000

The interest and sinking fund on the above amount may be estimated at $60,000 per year. At Cleveland the annual maintenance charges are less than thirty cents per meter. It may be assumed, therefore, that the maintenance charges in Toronto would be $20,000 per year. The depreciation may be taken at six per cent., or $66,000. This gives a total annual expenditure of $146,000 for metering.

By the report of the city engineer for 1910, Schedule 21, the cost of supplying water in Toronto is given for that year as five and three-quarter cents per thousand gallons, delivered to the consumer. This cost is the highest since 1894, the average for the twenty-six years being about five cents per thousand gallons.

The filtration plant constructed in 1910 and 1911, which has been in operation since January, 1912, will probably increase the cost of the water by three-quarter cents per thousand gallons, making a total of six and one-half cents per thousand gallons, or $65 per million for 1912.

The prevention of a waste of fifteen million gallons per day would, therefore, result in a total annual saving of $355,875. It is quite true that the cost of pumping and filtration is only two cents per thousand gallons, but the waterworks system must be considered as a whole, of which the pumping machinery and filtration plant is only a part. If more water is to be pumped through the mains, they must be increased in capacity or in numbers, and larger conduits will be necessary, as all parts of the existing system are now taxed to their full capacities in the summer months.

The general adoption of meters in the city of Toronto would probably result in a saving of $200,000 per annum.

Estimates of Cost of Specific Recommendations Made in Existing System.

(As Given in Interim Report No. 3.)

Duplication of Island filtration plant	$750,000
Lowering, repairing and connecting the sixty-inch conduit in Blockhouse Bay	50,000
One 25,000,000-gallon pumping engine	155,000
Three 200-h.p. boilers	20,000
Engine house and boiler house, complete	50,000
Engineering and superintendence, 10 per cent.	105,000
Total	$1,130,000

(Extra Expenditure not Given in Interim Report No. 3.)

Duplication of intake pipe	$333,000
Substitution two 15-million gallon pumping units for one 25-million gallon engine	40,000
Two electro-turbine units, each 13½-million gals. capacity	60,000
Additional boiler	7,000
Additional buildings	25,000
Force main, 48-in., across Esplanade to Front St.	10,000
Engineering and superintendence, 10 per cent.	15,000
Total additional	$490,000

Cost of meters:

60,000 meters set at $14	$840,000
10,000 meters set at $30	300,000
Total cost of metering	$1,140,000

Description of Proposed New Works.—The supply of water for the proposed new system is to be drawn from the lake at a distance of about two miles from shore, and opposite lot 16 in the township of Scarboro'. At this point the depth of water is about one hundred feet.

The proposed intake crib will be of reinforced concrete and steel, with a diameter of one hundred and ten feet at the base, and a height of about one hundred and fifteen feet. This crib will be sunk into the shale and clay of the lake bed, and the compartments filled with concrete. The inlet shaft will be sunk vertically from the centre of the crib to the elevation of the tunnel, from which point work on the tunnel will be prosecuted towards shore.

The interior of the crib will be an open cylinder about seventy feet in diameter, into which the water from the lake will flow through a number of ports at different elevations, controlled by valves, by means of which the supply may be drawn from any desired depth.

The crib is to be covered by a concrete and steel building surmounted by a small lighthouse for the guidance of vessels.

The proposed location of the intake crib is seven miles east from the effluent discharged from the Morley Avenue sewage disposal works, the existing water intake being five miles to the west. Furthermore, the transporting currents are westward rather than eastward, as pointed out in the observations upon the lake currents. All currents caused by easterly and south-westerly winds have a tendency to follow the shore line, consequently the greater the distance the intake be located from the shore, the less the turbidity.

At the point selected the turbid zone rarely extends one-half mile from shore; further, between Ashbridge's Bay and Highland Creek, there are no surface streams of any consequence discharging turbid water into the lake. The watershed adjoining the lake at Scarboro' presents a very limited area of land draining toward the lake, and can have practically no effect on its purity. A small amount of surface water now drains through a number of small water courses and gullies from the highlands to the shore. This area will, no doubt, become a residential section of the city, from which the domestic sewage may be conveyed by gravity to the main sewage disposal works near the Woodbine, while the greater part of the storm water may be diverted northward to the Don and Highland Creek.

From data obtained from the office of the Geological Survey, Ottawa, and other sources, the surface of the Hudson River geological formation was assumed to be at a depth of less than one hundred feet at the shore line at Scarboro'. Two test wells were sunk by this board on the beach, in each of which the surface of the rock was struck about fifty feet beneath the lake level. The depth at which the rock of the Hudson River formation is struck on the south side of Lake Ontario has been determined by borings, and the vertical distance to the top and to the bottom of the formation has also been determined at a few points along the north shore between Highland Creek and Mimico, from which it may be safely concluded that the Hudson River shales form the bed of the lake for some miles southward from the north shore, although the rock surface may be overlaid with a few feet of clay, sand and silt.

The intake crib is to be connected with the pumping station at the shore by a tunnel two miles in length and ten feet interior diameter, to be constructed in the shale of the Hudson River formation at a depth of about one hundred and sixty feet below the lake surface, to avoid as far as possible the infiltration of water. At the shore end, a vertical shaft will be constructed one hundred and sixty feet in depth, through which the water will rise to supply the pumping machinery.

Before preparing detailed plans of the intake crib and tunnel, a sufficient number of borings should be made along the line of the proposed tunnel to determine accurately the surface of the Hudson River shales and the character of these shales for some feet in depth. This work can only be performed advantageously in the summer months, and should be proceeded with during the coming season.

At the shore end of the tunnel about five acres should be enclosed by a concrete breakwater, the interior space to be filled by materials excavated from the tunnel, and the surplus from the grading on shore.

Upon the site thus formed a pumping station is to be erected, also shop and residences for engineers, office, etc. The building may be of brick or reinforced concrete, fireproof throughout.

The pumping machinery will comprise four electrically operated high pressure turbine pumps, each of fifteen million Imperial gallons capacity per twenty-four hours. Three of these units should be installed at first, and space left for two or more additional units.

Electric current is to be transmitted to the new pump house from the municipal hydro-electric sub-station to be erected at the south-east corner of Gerrard Street and Carlaw Avenue, a distance of about eight miles. To avoid all possibility of interruption to the service, another independent source of electric power should be connected with the pumping station, preferably from the Trent Valley or some source other than Niagara.

From the pumping station two parallel rising mains of steel, each sixty inches in diameter, will convey the water to filtration works on the plateau above, the total lift being about three hundred and seventy feet. These two mains are to be laid on a grade not exceeding forty-five degrees at any point on the line, the total distance from the pump house to the filtration works being two thousand feet.

As the water supply off Scarboro' will be free from turbidity, excepting after heavy gales, and as the possibility of sewage pollution from the city will be less than at the existing intake, and as this pollution can only occur with strong westerly winds, the necessity of filtration may not at first be apparent; but, it should be borne in mind that bodies of infected water are floating in the lake, and to guard against the possibility of danger from this source, it is advisable that the water should at all times be filtered.

The board has concluded that a mechanical filtration plant will meet the requirements at Scarboro', and will cost less than a slow sand filtration plant similar to that on the Island.

The filter tanks or beds are to be constructed over the reservoirs.

A chlorination plant for emergency service is also to be provided in connection with the filtration plant, so located that the chlorine may be applied to the raw water or to the filtered water.

The capacity of the reservoir estimated upon will be one hundred and thirty million gallons, equivalent to twenty acres in area and twenty-five feet in depth. By subdividing the reservoir into four units, opportunity will be given for repairing and cleaning. The reservoirs will be constructed of reinforced concrete, and covered by a groined roof.

The outlet from the reservoir will be through two or more pipes leading to one supply main By means of by-pass pipes the supply may be pumped directly from the pumping station into the main leading to the city.

About forty acres of land will be required for the reservoir and filtration works, but this board recommends that one hundred and twenty acres be purchased, or all of lot 22 between Kingston Road and the lake. The pumping station and the rising mains will be located on lot 21, which adjoins lot 22 to the eastward.

Estimated Cost of Scarboro' Project.

1. Intake tunnel, 10,560 lineal feet, 10 feet diameter		$633,600
2. Shore shaft, 160 feet at $150, and lake shaft, 60 feet at $150		33,000
3. Intake crib		500,000
4. Pump house site, retaining wall		80,000
5. Pump house		30,000
6. Pumping machinery, 60 millions capacity (4 units, 15 each)		150,000
7. Transmission line, 8 miles		48,000
8. Rising mains, two 60-inch pipes, each 2,000 feet long		80,000
9. Grading for and laying rising mains		20,000
10. Land for filtration works, reservoir, etc., 120 acres, at $600		72,000
11. Filtration works, mechanical filter, capacity 60 millions per day, machinery and laboratory		653,400
12. Covered reservoir, 130 millions capacity		1,071,000
13. Gravity supply main from reservoir to high level pumping station, 55,000 feet steel pipe (delivered)		880,000
14. Excavating for, laying, and covering at $5	$275,000	
Tunnel at Castle Frank, 1,200 ft., at $25 extra	30,000	
Crossing River Don, extra	15,000	
		320,000
15. Main from high level pumping station to West Toronto, 17,500 feet. 48-in., 42-in., and 36-in. (laid)		262,500
		$4,833,500
16. Ten per cent. for contingencies, engineering, etc.		486,500
Total estimated cost		$5,320,000

From the Scarboro' reservoir the water supply will gravitate to the city through a steel conduit, the diameter from the reservoir to East Toronto being seventy-eight inches, from East Toronto to the westerly side of the Don seventy-two inches, and from the last named point to the existing pumping station at Poplar Plains Road, the diameter may be reduced to sixty-six inches. This gravity main is to be laid along the concession road allowance westerly from the reservoir to the north side of the G. T. Ry., thence following the north-westerly side of the G. T. Ry. to Danforth Road, thence westerly along Danforth Road and Danforth Road produced, to the westerly side of the River Don, thence by a tunnel under the Castle Frank Hill to the Rosedale Ravine, thence along Rosedale Valley Road and McPherson Park to Yonge Street, thence via Ramsden Park, Peers Avenue, Avenue Road and McPherson Avenue, to the high level pumping station.

The pressure from this gravity supply main will be sufficient for all that portion of the city located south of the escarpment known as Wells Hill in the central part of the city, and all south of the easterly branch of the Don in the easterly part of the city. East Toronto area, now supplied by the intermediate service, and West Toronto, will thus be supplied from the Scarboro' reservoir by gravity. For the higher districts, lying north of Davenport Road and the easterly branch of the Don, it will be necessary to repump the water required, and as this district is rapidly increasing in population, additions to the pumping machinery will be frequently demanded.

By the adoption of the Scarboro' scheme, all of the existing pumping machinery at Poplar Plains station may be used for the highest district, the intermediate district being served by gravity.

In the West Toronto district and the East Toronto district, it may be eventually found desirable to instal booster pumping stations for general service, but in the low level district and the intermediate district, it would be a mistake to increase the ordinary pressure materially for fire service, although in the out-lying districts it may be permissible to do so.

A large supply main is also to be laid from the intersection of Avenue Road and McPherson Avenue westerly along McPherson, Bridgeman, Main, Brandon, Kingsley, Pelham and Lyndon to West Toronto, this main to be forty-eight inches in diameter at McPherson, reducing to thirty-six inches at Lyndon.

It is estimated that the construction of the proposed Scarboro' works will take from three to five years to complete.

POWER SITES IN THE WEST.

Notwithstanding the various rapids, the North Saskatchewan River may be considered a navigable stream throughout its length from the head of the Grand rapids, near Lake Winnipeg, to Edmonton and beyond. For many years, it has been navigated by the Hudson's Bay Company's steamboats, which make one or two trips a year to carry supplies for the posts.

The Bow River rises in the watershed of the Rocky Mountains, and flows in a southeasterly direction until it reaches the foothill country at the "Gap." It then turns to the east as far as Calgary, and, thence, runs south and east to its confluence wih the Belly River. Between its source and the "Gap," a number of streams flow into it from the various mountain valleys that it intersects. Almost immediately after leaving the mountains it is joined from the south by the Kananaskis River, a stream of good size and fairly uniform flow, which has its source in the eastern ranges of the Rocky Mountains in muskegs and lakes lying at a considerable elevation. From this point to its confluence with the Belly River, the Bow furnishes the run-off channel for the eastern slope of the Rocky Mountains and is fed by numerous streams. It is broken in several places by falls and rapids. At Calgary, a hydro-electric plant, operating under a low head of 14 feet, derives its power from one of these. A large development at Horseshoe and Kananaskis Falls, where a head of 70 feet is obtained, is now completed.

Rising in the watershed range of the Rocky Mountains and receiving many glacial tributaries, the Athabasca River contains many valuable power sites between its source, at an altitude of about 5,000 feet, and its debouchement into Lake Athabasca at an altitude of 690 feet. Of these, the most noted are at the succession of falls and rapids known collectively as the Grand Rapids. As they can only be rendered navigable by canals, the question of interference with navigation does not require consideration.

The remarks respecting the Athabasca also apply in large measure to the Peace River. In addition to the power sites in the ranges west of the Rockies, there are two important sites on this stream. The upper is at Rocky Mountain portage. At this point the river is a raging torrent flowing 25 miles through a canon, and has a total fall of 270 feet. The lower is situated at Vermilion fall, the only interruption to navigation between its confluence with Slave River and above Dunvegan, a distance of upwards of 530 miles.

NEW BUILDING BY-LAW FOR TORONTO.

The text of the new by-law for Toronto regulating reinforced concrete construction is given below. Some slight changes may be made before the by-law is ratified by the City Council.

1. The term "reinforced concrete" as used in this by-law is to be understood to mean an approved concrete mixture reinforced by steel of any shape so combined that the steel will take up the tensional stresses and assist in the resistance to shear, and the construction must be of such a nature that the stresses can be calculated by the accepted formulas of modern engineering practice.

2. (1) Before permission to erect any reinforced concrete structure or any structure containing reinforced concrete is issued, complete drawings and specifications, signed by the architect or engineer who designed the structure and clearly showing all details of the proposed construction, and the size, shape and position of all reinforcing rods, stirrups or other forms or metal, also a certified copy of the computations of the architect or engineer showing how the strength of the different portions of the structure was arrived at, shall be submitted to the department of the city architect and superintendent of building for examination and approval, and when satisfactory, the approved signed drawings, specifications and static computations shall be filed in the said department until the completion of the work, provided, however, that permission to erect any reinforced concrete structure does not in any manner imply the acceptance of the work or relieve the architect or engineer who designed the structure from full responsibility for the actual construction.

(2) All reinforced concrete construction shall be performed under the personal and constant supervision of either a fully qualified engineer or competent superintendent.

(3) It shall be the duty of the engineer or superintendent in charge of the work to keep an exact record of the progress of each operation, which record shall clearly show the position of and give the date of placing of all concrete and the date of removal of forms, a certified copy of which is to be furnished the inspector of buildings weekly, and upon the completion of the work the correctness of the records, which have been furnished weekly, to be certified to and sworn to, if considered desirable, by the person under whose constant supervision the work was carried out.

(4) Inspection by the engineer or superintendent in charge shall cover the following:

(a) The materials;

(b) The correct construction and erection of the forms and supports;

(c) The sizes, shapes, arrangement and fastening in position of all reinforcements;

(d) The proportioning, mixing and placing of the concrete;

(e) The strength of the concrete by tests of standard test pieces made during the progress of the work;

(f) Whether the concrete is sufficiently hardened before the forms and supports are removed;

(g) Prevention of injury to any part of the structure by and after the removal of the forms;

(h) Comparison of dimensions of all parts of the finished structure with the plans.

(5) The execution of reinforced concrete work shall be confided to workmen accustomed to this class of construction who shall be under the control of a competent foreman, and it is to be distinctly understood that under no conditions will the engineer or superintendent in charge of the work be permitted to act in the dual capacity of both inspector and foreman.

Forms.—3.—(1) All forms shall be built rigid, plumb and true, thoroughly braced and with tight joints so that no appreciable part of the concrete mixture can escape, and their interior dimensions must conform to the dimensions of the concrete sections shown upon the approved plans. All forms shall be supported so as to carry the dead load of the construction as a liquid without spring or deflection, and any form that becomes twisted or warped shall be correctly adjusted before concrete is placed therein. Building paper will not be allowed in forms for any purpose whatsoever.

(2) If forms are to be hung from steel beams the hangers and the method of hanging shall be subject to the approval of the inspector of buildings, and no hangers that are difficult to remove shall be used.

(3) The forms for beams, girders and lintels shall be so designed that at least one side of each beam or girder may be removed without disturbing the bottom portion of the form or its supports.

(4) All posts supporting forms for slabs, beams or girders must rest upon wedges which can be loosened and removed without producing undue strains in the floor or roof system.

(5) Posts which are to be supported from the ground must be provided with footings of sufficient area to do away with any liability of appreciable settlement owing to insufficient foundation.

(6) All column forms shall have an opening left at the bottom to enable cleaning out and adjustment of the steel to be attended to, which opening is not to be closed until the column is to be poured.

(7) All shavings, chips, sawdust, ice or other foreign matter must be removed from within all forms before concrete is placed therein.

Cement.—4.—(1) Only Portland cement will be accepted in reinforced concrete construction and this cement must comply in all respects with the requirements of the standard specifications of the city engineer's office of the city of Toronto, which are as follows:

(a) The specific gravity of the cement shall not be less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

(b) It shall leave by weight a residue of not more than 8 per cent. on the No. 100 and not more than 25 per cent. on the No. 200 sieve.

(c) It shall not develop initial set in less than thirty minutes and must develop hard set in not less than one hour, nor more than ten hours.

(d) The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Age.	Neat Cement.	Strength.
24 hours in moist air		175 pounds
7 days (1 day in moist air, 6 days in water)		500 "
28 days (1 day in moist air, 27 days in water)		600 "
	One part cement, three parts Standard Ottawa sand.	
7 days (1 day in moist air, 6 days in water)		200 "
28 days (1 day in moist air, 27 days in water)		275 "

(e) Pats of neat cement about 3 inches in diameter one-half inch thick at the centre and tapering to a thin edge shall be kept in moist air for a period of 24 hours.

(f) A pat shall then be kept in air at normal temperature and observed at intervals for a least 28 days.

(g) Another pat shall be kept in water maintained at as near 70 degrees F. as practicable and observed at intervals for at least 28 days.

(h) A third pat shall be exposed in any convenient way in an atmosphere of steam above boiling water in a loosely closed vessel for 5 hours.

These pats to satisfactorily pass the requirements shall remain firm and hard and show no signs of distortion, discoloration, checking, cracking or disintegrating.

(i) The cement shall not contain more than 1.75 per cent. of anhydrous acid (SO_3) nor more than 4 per cent. of magnesia (MgO).

(2) No cement shall be used in any reinforced concrete work unless it has been tested either at the manufactory or at some acceptable laboratory and a certified report of the test filed with the inspector of buildings.

(3) All such tests shall be made in not more than carload lots or in smaller quantities if so directed by the inspector of buildings, and when laboratory tests are to be made the cement shall be delivered at the job at least two weeks before it is required for use so as to allow ample time for testing.

(4) Proper care is to be taken to separate lots delivered so that they can be easily identified if found unsatisfactory, and a suitable place must be provided for the storage of all all cement. No cement shall be used that has absorbed sufficient moisture to cause it to granulate or become lumpy when thoroughly dried.

(5) Any cement without the makers' name and brand on the barrel or package will be rejected without test, as will also any cement in barrels or packages bearing other than the makers' name and brand.

(6) The inspector of buildings may require a certificate from the manufacturer to the effect that the cement has been seasoned or subjected to aeration for at least thirty days before leaving the works.

(7) All tests shall be made at the expense of the contractor, and all cement or other rejected material must be immediately removed from the job and the vicinity.

Aggregates.—5.—(1) Extreme care shall be exercised in selecting the aggregate for mortar and concrete and careful tests must be made where any doubt exists of the materials for the purpose of determining their qualities and the grading necessary to secure maximum density or a minimum percentage of voids.

(2) Fine aggregates shall be uniformly graded from coarse to fine and consist of sand, crushed stone or gravel screenings, passing when dry, a screen having one-quarter inch diameter holes, and not more than six per cent. passing a sieve having 100 meshes per lineal inch. It shall be of clean silicious material free from vegetable loam and other deleterious matter.

(3) Mortars composed of one part Portland cement and three parts fine aggregate, by weight, when made into briquettes, shall show a tensile strength of at least 70 per cent. of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

(4) Coarse aggregate shall consist of inert material such as crushed stone or screened gravel which is retained on a screen having one-quarter inch diameter holes. The particles shall be clean, hard, durable and free from dust or other deleterious material, and the maximum size shall pass in any direction through a one inch diameter ring. A graduation of the size of the particles from fine to coarse will be considered advantageous.

(5) Samples of all aggregates must be submitted to the inspector of buildings and his approval of them obtained before being used in any work.

Reinforcement.—6.—(1) All steel used for reinforcement shall be medium steel made by the open hearth process, and be rolled from new billets. No re-rolled steel will be allowed. The steel shall have an ultimate tensile strength of not less than 60,000 pounds per square inch of net cross section, and an elastic limit of at least one-half of this ultimate strength, and for sizes up to ¾ inch in diameter shall bend cold 180 degrees around a diameter equal to the thickness of the piece tested without sign of fracture on the outside of bent portion.

(2) For sizes greater than ¾ of an inch in diameter it shall bend cold 180 degrees around twice its own diameter without sign of fracture on the outside, except in cases where all bends necessary in the construction are to be made hot, in which case the steel shall bend cold 90 degrees around its own diameter without sign of fracture.

(3) All material tested to destruction shall show a uniform silky fracture and all reinforcing steel shall be free from checks, cracks, flaws or other imperfections, also free from paint, oil, dirt, grease or heavy rust or scale.

(4) If deformed bars are used only the net section—the section exclusive of all projections—of the area of such bars shall be considered effective.

(5) Tests of the steel proposed to be or being used in any reinforced concrete structure shall be made at the expense of the contractor upon the request of the inspector of buildings, and such tests shall be made at a place satisfactory to him and under the supervision and direction of the architect, engineer or superintendent in charge of the work.

(6) A certified copy of the report of all such tests to be filed with the inspector of buildings immediately after being made.

Mixing.—7.—(1) The ingredients of concrete shall be thoroughly mixed dry after which the proper amount of water shall be added and the mixing continued until the cement is properly distributed and the mass uniform in color and homogeneous.

(2) Methods of measurement of the proportions of the various ingredients, including water, in each batch shall be used which will secure separate uniform measurements at all times. The use of boxes especially constructed for the purpose will be preferred, but the use of iron wheelbarrows may, with the consent of the inspector of buildings, be used for measuring stone and sand.

(3) All concrete materials shall be measured loose.

(4) All concrete must be machine mixed using a batch mixer of an approved design if the amount of concrete in the work exceeds fifty (50) cubic yards. Continuous mixing machines will not be allowed.

(5) A competent foreman must be in constant attendance at the mixer to give his approval of every batch which leaves the machine.

(6) When the amount of concrete does not exceed fifty (50) cubic yards, the mixing may be done by hand on a smooth watertight platform not less than fourteen feet by twelve feet square, and having a raised rim around the edge at least three inches in height. The fine aggregate shall be first evenly spread on this platform and the proper proportion of cement shall then be spread over the aggregate when the ingredients shall be thoroughly mixed with hoes or shovels, then spread out evenly over the platform while in a dry state. Clean water shall then be applied and the cement and fine aggregate thoroughly mixed until a mortar of the proper consistency is formed which shall be evenly spread over the platform. The stone or gravel after being wetted shall then be evenly spread over the mortar and the whole mass thoroughly mixed with shovels and hoes by being turned over and worked at least three times, not counting the shovelling off the platform. No more than three-quarters of a cubic yard shall be mixed in any one batch.

(7) The materials must be mixed wet enough to produce a concrete of such consistency as will flow into the forms and about the metal reinforcement and which at the same time can be conveyed from the mixer or platforms to the forms without separation of the coarse aggregate from the mortar.

(8) Retempering mortar or concrete, i.e., remixing with water after it has partially set, will not be permitted.

Placing Concrete.—8.—(1) Concrete shall be deposited in the forms as rapidly as possible after leaving the mixer, and under no circumstances shall concrete be used that has attained initial set before final placing, nor shall such concrete be returned to the mixer.

(2) When placing concrete is once started it shall, if possible, be carried on as a continuous operation until pouring of the section or panel is completed.

(3) When being deposited or poured the concrete shall be agitated continuously with suitable tools such as a straight shovel or slicing tool kept moving up and down until all the ingredients have settled to their proper place by gravity, and the surplus water has been forced to the surface. Filling the forms completely and puddling afterwards will not be permitted. In placing the concrete the work shall be so laid out that the partly set concrete shall not be subjected to shocks from men hauling or wheeling material over it.

(4) Before placing concrete care should be taken to see that the forms are constructed as hereinbefore specified for and thoroughly wetted, and the space to be occupied by the concrete free from debris.

(5) When the placing of concrete is suspended all necessary grooves for joining future work shall be made before the concrete has had time to set. When work is resumed concrete previously placed shall be roughened, thoroughly cleansed of foreign material and laitance, drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts of fine aggregate.

(6) Care must be taken to stop work at such a point that the joint formed when the work is resumed will have the least possible effect on the strength of the structure. Footings shall be cast to their full depth at one operation.

(7) Construction joints in beams and girders shall be vertical and at a point midway between supports, unless a beam is located at this point, in which case the joint shall be offset at a distance equal to twice the width of the beam.

(8) Construction joints in slabs shall be near the centre of the span. No joint will be allowed between slab and beam or girder.

(9) Any concrete which may run past the bulkheads must be cleaned up and removed before the concreting of the next section is started.

(10) Where brackets are used the brackets will be considered a part of the beam or girder.

(11) All columns are to be poured a sufficient length of time ahead of the floor construction to allow the concrete in the column to properly set up. The pouring of a column must be in one continuous operation to the bottom of the beam or girder is supports and during the pouring the concrete shall be well stirred or puddled with a long rod or tamp to expel all bubbles of air and prevent voids and honeycombing. Joints in columns shall be perpendicular to the axis of the column.

(12) In slab construction the finish must be laid integrally with the rest of the slab or it will not be considered as part of the slab in calculating the strength of same.

(13) Whenever possible the edges of girders, beams and columns shall be chamfered and the sides of beams and

girders splayed in order that the forms may be more easily removed.

(14) All reinforcing steel shall be accurately located in the forms and secured against displacement and the lateral spacing of the steel in lintels, beams or girders shall not be less than two and one-half diameters centre to centre.

(15) No concrete shall be poured until the engineer or superintendent in charge has examined the particular section in which it is desired to proceed with this portion of the work and has expressed himself satisfied with the structural condition and cleanliness of the forms and the placing, splicing and fastening in its proper position of the steel reinforcement.

(16) When concreting is carried on in freezing weather, the material must be heated and such provisions made that the concrete can be put in place without freezing. The use of frozen, lumpy sand or stone depending on hot water used in mixing to thaw it out will not be permitted.

(17) All concrete shall be kept at a temperature above freezing until it has thoroughly hardened, and all concrete which is frozen shall be removed.

(18) Concrete placed in warm weather, or which from any other cause is exposed to premature drying, shall be kept thoroughly wet during the first week after being put in place.

(19) Concrete shall not be placed in water unless unavoidable, but when this cannot be avoided, unusual care must be exercised to prevent the cement from being floated away, also the formation of laitance. The concrete shall also be deposited through a metallic tube or from a bucket having a bottom dump, and care shall be taken to keep the surface of the concrete as nearly horizontal as possible. The proportion of cement in concrete deposited under water shall be 25 per cent. in excess of that required for similar work deposited in the ordinary way.

Removal of Forms.—9.—(1) Forms shall not be removed until the concrete is thoroughly set and is of sufficient strength to carry its own weight together with whatever live load is liable to come on the construction.

(2) No form shall be removed without the approval of the architect or engineer or the superintendent in charge of the structure.

(3) The original supports for beams and girders must remain in place for at least twenty-one days after the concrete has been poured and before these supports are interfered with, the entire forms must be removed from supporting columns and the sides of beams and girders stripped so as to enable a thorough examination of the concrete to be made.

(4) The form shall not be removed from columns in less than six days, and forms supporting floor slabs shall not be removed in less than ten days after the concrete has been poured. The sides of forms for beams and girders may be removed at the same time as the forms supporting the floor slabs.

General Assumptions.—10.—(1) As a basis for calculations for the strength of reinforced concrete construction the following assumptions shall be made:

(a) A plane section before bending remains plane after bending.

(b) The modulus of elasticity of concrete in compression within the usual limit of working stresses is constant.

(c) In making calculations the tensile stress of concrete shall not be considered.

(d) The steel shall take all the tensile stresses.

(e) Perfect adhesion is assumed between concrete and reinforcement. Under compressive stresses the two materials are, therefore, stressed in proportion to their moduli of elasticity and their distance from the neutral axis.

(f) The ratio of the modulus of elasticity of steel to the modulus of elasticity of concrete shall be assumed to be fifteen for concrete with a crushing strength of 2,000 pounds per square inch after hardening for 28 days.

(g) Initial stress in the reinforcement due to contraction or expansion in the concrete may be neglected.

(2) The span length of beams and slabs shall be taken as the distance from centre to centre of supports, but shall not be taken to exceed the clear span plus the depth of the beam or slab. Brackets shall not be considered as reducing the span.

(3) The dead load shall include the weight of the structure and all fixed loads and forces.

(4) The live load shall include all loads and forces which are variable.

(5) The weight of reinforced concrete shall be taken as 150 pounds per cubic foot.

Bending Moments.—11.—(1) The bending moment for slabs and beams, when not continuous over supports, shall be taken at not less than $\frac{WL}{8}$.

(2) When slabs and beams are built continous over two or more supports, the bending moment shall be taken at not less than $\frac{WL}{10}$.

(3) When slabs and beams are continuous over one support only, the bending moment shall be taken at not less than $\frac{WL}{9}$.

(4) In the case of square panels reinforced in both directions and continuous over all supports, the bending moment of the slab shall be taken at not less than $\frac{WL}{20}$ provided, however, that when square floor slabs reinforced in both directions are continuous to walls, the bending moment of the slab shall be taken at not less than $\frac{WL}{18}$.

W = Total uniformly distributed load.

L = Span of beam or slab.

(5) The length of a slab in which reinforcement in both directions will be allowed for is limited to one and a half times the width. The proportion of load on a slab up to this limit which will be considered as being transferred to the side and end supports will be that obtained by using the following formulas:

(a) Load on longer supports $= \frac{L^4}{L^4 + B^4}$

(b) Load on shorter supports $= \frac{B^4}{L^4 + B^4}$

L = Length of span of slab.

B = Breadth of span of slab.

(6) The amount of reinforcing steel may be gradually reduced to seventy-five per cent. of that calculated per foot in width, commencing at the quarter point and continuing to the support. The reinforcement spanning the shortest direction shall be placed below the reinforcement spanning the longer direction.

(To be continued).

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

Reinforced Concrete Buildings. By Ernest L. Ransome and Alexis Saurbrey. Published by the McGraw Hill Book Company, New York. Cloth, 6¼ × 9½ inches, 235 pages, 176 text figures. Price $2.50 net.

The authors of this volume are the president and chief engineer of the Ransome Engineering Company of New York. So many books on reinforced concrete of the stereotyped form have come to hand recently that it is a pleasure to note one on the subject of a different kind. The book covers the salient features of the design and construction of reinforced concrete buildings. The authors do not attempt to cover extraneous matter, but confirm themselves strictly to the subject in hand. The question of elementary structural theory and design is not taken up, but the authors treat the subject from the point of view of the experienced engineer. This is an advantage, for it allows of an expansion on features which make it most useful to the designer; on the other hand many books already exist which if necessary will furnish information with regard to earth pressures and the hundred and one other items included in the completed design. The book is divided into three parts, dealing respectively with the history of reinforced concrete, construction, the rational design of building and their practical construction. The history of reinforced concrete construction as narrated by Mr. Ransome is most interesting, and he is well qualified from his long connection with the methods used to deal with it. The part on design is a well arranged rational treatment of the subject. One serious criticism is to be noted, however, and that is that the authors have not seen fit to use the nomenclature now commonly used in connection with the theory of reinforced concrete.

The portion of the book devoted to practical construction is very good, taking up, as it does, materials of construction, floor systems, foundations, finishing operations, fireproofing, repairs, accidents, superintendents' specifications and the theory of beams as illustrated by texts. It must be said, however, that the personal part of both Mr. Ransome and Mr. Saurbrey obtrudes itself into the book far too much. Far too many references are made to Mr. Ransome's patents, work, etc., and Mr. Saurbrey's name might be left off many of the illustrations of finished work. The book forms a most valuable addition to the subject and should be in the library of every engineer interested in the design of reinforced cocrete buildings.

Sewage Disposal. By George W. Fuller. Published by the McGraw-Hill Book Company, New York. Cloth, size 6 × 9 in., pp. 744, 80 illustrations. Price $6.00 net.

The announcement that a treatise on sewage disposal was being prepared by Mr. Fuller was made some time ago, and it was with more than ordinary interest that its appearance was awaited. Mr. Fuller's reputation in this field is too well known for any comment to be necessary as to his fitness for writing such a book. Now that the volume has been published we must say that the result is even beyond expectation. The book is an example of what a technical treatise should be. Among the numberless volumes now being presented to the engineering public it is refreshing to occasionally meet with one for which praise can be the only comment. The author with his intimate association of twenty-five years in the development of this branch of engineering science and his long experience in presenting clearly to his clients the purposes of the works he has designed, has eminently qualified him to write a book which is of equal service to the student of the subject and to the engineer of standing. Certainly, no one interested in the subject of sewage disposal should be without a copy. The author in the preface states the divisions into which the volume falls and while it is impossible in a short review to touch on all the features outlined, these divisions give a fair idea of the way in which the subject is taken up. The book is divided into four parts of approximately equal size. The first part is devoted to a very complete description of the composition of sewage, and the behavior of bacterial and biochemical processes in the decomposition of sewage. The importance of oxygen and deoxygenation not only as a means of measuring the strength of sewage but in the relation to proper conditions of the flow of sewage through collecting systems and various disposal devices, is discussed fully. The second part of the book is devoted to a recital of American experience in the disposal of sewage by dilution in inland streams, lakes, tidal estuaries and oceans. The limiting factors and conditions in present practice are described at length, with suitable summaries. The third part deals with the preparatory arrangements for the treatment of sewages. Descriptions are given of screening, settling tanks, septic tanks, chemical precipitation tanks, electrolytic treatment and strainers, with the present day practice with regard to each. The fourth part of the book deals with filtration matters with regard to present practice. The closing pages of the book are devoted to æration, sterilization and ozonization processes as they are now understood, with a few explanations as to institutional and residential plants, and a final comparative summary of general costs and effiencies. The volume shows the results of an extraordinary amount of research not only in the technical press, but also in the gathering of data from existing plants. The treatise forms the most concise yet comprehensive text on the subject of sewage disposal which is in existence at the present time.

Suspension Bridges and Cantilevers.—Their Economic Proportions and Limiting Spans. By D. B. Steinman, C.E., Ph.D., Assistant Professor of Civil Engineering, University of Idaho. New York: D. Van Nostrand Co., Science Series. Boards, 4 × 6 inches. pp. 185, 1 plate. 50 cents.

Forty years ago Sir Benjamin Baker wrote an important monograph on "Long-Span Railway Bridges," in which he discussed and compared from the economic standpoint the types of bridges suitable for this class of construction. What was thus done for long-span bridge building in the materials then available has with equal effectiveness been done for present day conditions and materials by Professor Steinman in his readable little book just issued as one of the Van Nostrand Science Series.

The purpose of the writing is declared by the author to be the furnishing of adequate data from which the limiting and ecomonic spans for suspension bridges and cantilevers might be deduced in any consideration of the relative adaptability of the two types to long-span bridge construction. To this end designs and estimates of weight and cost were prepared for suspension bridges of 1,500, 2,250 and 3,000 feet span, and for cantilever bridges of 1,000, 1,500 and 2,000 feet span. The author then proceeds to establish the maximum practicable span for each type, the maximum economic span and the span of equal cost for the two types. It is of interest, but of doubtful practical value, to learn that the theoretical maximum span for suspension bridges and cantilevers, or the spans at which they cease to be self-supporting, is 14,700 feet for the former and 5,600 feet for the latter. The maximum practicable span for suspension bridges is established as varying from 3,500 to 4,900 feet, depending upon the live load, while for the cantilever the maximum practicable span is shown to be from 2,000 to 3,000 feet. These maximum practicable spans, it is explained are the limiting spans to which it would be possible to build the bridges in question, altogether apart from the character of the undertaking as an investment. Where bridges are required to pay their own way and not become a charge on those who erect them, the limiting span for the suspension bridge is set at 3,170 feet and for the cantilever 2,700 feet. The range of economic usefulness for the cantilever is defined as from 1,670 feet to 2,700 feet, and for the suspension bridge from 1,670 feet to 3,170 feet, the span of equal cost being 1,670 feet.

Several subsidiary investigations of value are included in the book such as the determination of the economic rise-ratio for suspension bridges, the minimum depth of stiffening trusses for adequate rigidity, the economic depth of stiffening truss, etc. Tables giving data concerning a large number of notable suspension and cantilever bridges and bibliographies relating to the subject add to the usefulness of the book.

While the conclusions relating to the maximum practicable spans are necessarily based upon debatable hypotheses, the author has made a contribution of distinct value to the engineering profession.—C.R.Y.

Centrifugal Pumping Machinery. By C. G. de Laval. Published by McGraw Hill Book Company, New York. Cloth, size 6¼ × 9½ inches, 181 pages, 19 tables, 159 illustrations. Price $3.

The book deals with the theory and practice of centrifugal and turbine pumps. There are few treatises in the English language which go into the principles which govern the actual design. The theories of centrifugal pumps are analyses based on certain assumptions, and but few of these analyses are at present published in English. The writer in this book gives three different theories which give approximately the same result. The basis of the principle of one of these is that the motion of the particles of water throughout the space between the blades strictly follows those particles contiguous to the blades. Another assumes that the water enters the inner periphery of the wheel in a radial direction across the entire width of the wheel. Neither of these assumptions is true, but they afford the means of attacking the problems which would otherwise be impossible. Many descriptions of existing installations are given. The book might be improved by the omission of some of the photographs, as they only occupy valuable room. The book will be a valuable one to both the designer of centrifugal pumps and the engineer who wishes some accurate knowledge on efficiencies, etc.

Dredges and Dredging. By Charles Prelini. Published by the D. Van Nostrand Co., New York. Cloth, size 6 × 9 inches, 280 pages, 82 illustrations. Price $3.

Dredging is a subject of considerable importance in our commercial life. Many millions of dollars are invested in plants and outfits, and as a result of dredging work vessels of great tonnage can now use the harbors of the world in safety. This treatise is a valuable addition to literature on the subject. The volume is a history of dredging showing the various stages up to the present time. The book is divided into twenty-nine chapters, devoted to different aspects of the subject and the various problems incidental to the work. Chapters are devoted to soils and their characteristics, excavation of sub-aqueous rock, hints on selecting dredges for various work, the different types of dredges in use, the cost of operating dredges, and much other valuable data. Complete descriptions of the methods used on recent large works are given. The book will be found to be a most complete and valuable exposition of the subject. The only criticism we would offer is the fact that wood cuts have been used in place of half-tones and zincs.

Tunnel Shields and the Use of Compressed Air in Sub-Aqueous Work. By William Charles Copperthwaite. Published by Constable and Co., Ltd., London. Second edition, revised. Cloth, size 8 × 11½ inches, with 260 illustrations and diagrams. Price $8.25.

There are very few accounts in English of shield work in tunneling operations. The employment of a shield, with of without the aid of compressed air, is of English origin, and the length of a tunnel so constructed in Great Britain is many times greater than the total amount of similar work elsewhere, yet the subject is no where dealt with with any degree of fulness in English text books. In this volume a history of recent developments in shield work is given and a collection of a mass of information scattered through many publications and consequently difficult and troublesome of access, is here made available. The work is a most authoritative one, and should form part of the library of every engineer interested in the use of compressed air in sub-aqueous work. The whole field of tunnel work with the use of compressed air is covered most thoroughly, and the volume includes descriptions of tunneling methods used to date on all the great works in Europe and America.

Valuation of Public Utility Properties. By Henry Floy. Published by McGraw-Hill Book Co., New York. Cloth, size 6¼ × 9½ inches, 386 pages. Price $5.

The valuation of utility property is of such recent date that at the present time there exists no general practice or formulated theory of the subject. No comprehensive text book exists, although much important information relating to valuation work has been published in various papers. This is the first attempt to digest and compile this material. The author states that he has endeavored to digest the opinions, papers, discussions, reports of commissions, and court decisions relating to the subject, in so far as possible, and to present the summary of the best practice with typical examples thereof. His aim has been to indicate, if possible, the line along which theory and practice seemed likely to be standardized. It must be said that he has succeeded very well in his object and has presented a well-balanced, logical discussion of the subject. Approved methods of ascertaining values are given, and the examples of appraisals used are more or less historic, and have already helped to establish precedence of current practice.

A Manual of Civil Engineering Practice. By F. Knowles Taylor. Published by Charles Griffin and Co., London. Cloth, size 6¼ × 9 inches, 809 pages, including index, with 1,179 illustrations, including 35 folding plates. Price, $7 net.

The author states that the work has been specially arranged for the use of municipal and county engineers. The discussion includes among many other subjects the mechanics of engineering, design of structures in brick, stone, reinforced concrete, roads, electric tramways, bridges, river works and land drainage, hydraulics and pumping machinery, waterworks and sources of supply, sewage disposal, sanitation, refuse disposal, and a chapter on specifications. With the limitations of space imposed on the author, he does not attempt to deal fully with many of the above subjects. A great deal of valuable information, however, is contained in the volume, and the book will appeal to the whole civil engineering profession as well as to the municipal engineer. One criticism must be registered against the work and this is, no doubt, due to the lack of space, that is, the brief mathematical treatment in connection with the development of some of the formulæ, which tend rather towards empiricism. The book should form a most valuable reference volume when the engineer lacks the time to look up the more highly specialized text book.

Reinforced Concrete Design Simplified. By John C. Gammon. Published by Crosby, Lockwood and Sons. Cloth, 9½ × 11 inches, 116 pages. Price $3.

The engineer has more and more to deal with the design of reinforced concrete in connection with building and engineering work Its many advantages as a system of construction have made its introduction one of the most important advances in engineering lines in the past century. It seems most probable that its use will increase with time. In the design of reinforced concrete, however, much valuable time must be used in making computations, which often have to be repeated many times with an accompanying waste of energy. The author has compiled a number of tables and diagrams which give at a glance the values of the different variables. These diagrams cover all phases of reinforced concrete design. For instance, having the bending moment for a beam, by reference to one of the diagrams, the economical size, the limiting conditions, the area of steel, the size of member required, can all be determined at a glance. Diagrams are also included for determining the sheer reinforcement, the design of columns, and of T beams. The book is extremely well indexed with side tabs for quickly turning to any required place, and the use of the diagrams is extremely simple. This book should be well received by the reinforced concrete designer. In fact, we would say that is is almost indispensable.

The Principles of Specification and Agreement Writing. By C. R. Young. Published by The Canadian Engineer, Toronto. Paper, 6 × 9 in., 47 pp. Price 25 cents net.

This book is made up of a series of six articles published in The Canadian Engineer on "Specification and Agreement Writing." The subject matter, the preliminaries to the contract, the composition of an engineering contract, the legal essentials and the desirable characteristics of an engineering contract, subject matter of the specification, specific and general clauses, the agreement and practical suggestions. The treatment is logical and clearly reasoned. The book is a most concise exposition of this most important subject and should be in the hands of every engineer engaged in preparing specifications.

Elements of Engineering Estimating. By A. Suggate. Published by The Technical Publishing Company, London. Cloth, size 5 × 7 inches, 135 pages. Price 90 cents.

This little volume, a practical handbook for students, draughtsmen and engineers, so the author states, gives in a suggestive manner the methods of estimating on engineering work. The prices given throughout the book are, of course, of use to Canadians on account of the difference in labor costs. The remarks and suggestions on the general basis of making estimates are very good however, and will repay attention by engineers on this side of the water.

Drill Work, Methods and Cost. Issued by the Cyclone Drill Company, Orrville, Ohio. Cloth, size 7 × 10, 350 pages.

A great many of the troubles encountered by drill-men are due to lack of experience or ignorance of the subject. While in no sense a catalogue, it contains valuable data pertaining to the drilling of wells and kindred subjects compiled by R. R. Sanderson, sales manager of the Cyclone Drill Company. Instructions are given as completely as possible, covering drilling operations, beginning with the setting up of the drill step by step through all the operations necessary to complete wells and blast holes in various kinds of material. The book is being distributed among the customers of the company and those interested in the subject.

A Short Course in Graphic Statics. By W. L. Cathcart and J. I. Chaffee. Published by the D. Van Nostrand Company, New York. Cloth, size 5 × 7½ inches, 180 pages, 58 illustrations. Price $1.50.

The aim of the book is to provide students of mechanical engineering with a brief course in graphic statics. The treatment has been restricted to the properties and general uses of the force and equilibrium polygons, as the author assumes that this is sufficient for the solution of most of the problems met in practice by a mechanical engineer. Some little attention has been given to the stresses in girders, etc.

Practical Gyrostatic Balancing. By Herbert Chatley. Published by The Technical Publishing Co., Ltd., London. Cloth, size 5 × 7½ inches, 72 pages. Price 65c.

This book forms a small and inexpensive treatise on the subject of gyrostatic control. This piece of apparatus is becoming daily of more and more importance in connection with the question of the automatic balancing of all kinds of locomotives, vessels and air-craft. The book should prove useful to inventors and engineers who desire a working knowledge of its mechanism.

Treatise on Hydraulics. By Mansfield Merriman. Ninth edition. Published by John Wiley and Sons, New York. Canadian agents, Renouf and Co., Montreal. Cloth, 6¼ × 9½ in., pp. 565, 224 figures. $4 net.

Merriman's hydraulics, which in this volume has reached the ninth edition and thirty-seventh thousand, needs little comment other than to note the changes rendered necessary by the advances in the subject. The book is known by all engineers and has become a standard textbook on the subject. The book in this edition has been revised and reset in order to cover the advances of the last nine years since the eighth edition was issued. The new matter includes descriptions of hydraulic instruments, methods of measuring water, oblique weirs, submerged tubes, regulating devices for pipes, conduits, dams, backwater, rainfall, evaporation and runoff. The tables of coefficients for orifices, weirs, pipes, conduits, and channels have been revised and extended so as to include the results of recent experiments. A change in the old arrangement of the tables is noted; instead of being collected at the end of the book they are now placed in the text in connection with the matter explaining them.

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Department of Public Works. The annual report of the Department of Public Works of the Province of Saskatchewan for the year 1911.

Progress of Steam Measurements. Report for the calendar year 1910, by P. M. Souder, C.E., Department of the Interior, Dominion of Canada.

Ottawa River Storage and Geodetic Levelling. Reports on the above, being Vol. 2 of the report of the Minister of Public Works, Dominion of Canada.

U. S. Government Specifications for Portland Cement. Circular of the Bureau of Standards No. 33. S. W. Stratton, director. Issued May 1st, 1912, by the Dept. of Commerce and Labor, U.S.

Report of Board of Commissioners, Toronto Waterworks, 1912.. Report upon the existing waterworks system and upon an additional water supply for the city of Toronto, by the Consulting Board recently appointed.

Report of the Department of Mines, 1911. For the Province of Nova Scotia. Copies may be obtained from the Commissioner of Public Works and Mines, Halifax.

Sanitary District of Chicago. Being the papers relating to the application of the Sanitary District of Chicago for permission to divert 10,000 cubic feet of water per second from Lake Michigan. Issued by the Department of Marine and Fisheries, Canada.

An Investigation of the Coals of Canada with Reference to their Economic Qualities. In six volumes, by J. B. Porter and R. J. Durley, assisted by P. C. Dennis, E. Stansfield and a staff of special assistants. Vol. 1 issued by the Mines Branch, Department of Mines, Canada. Price $1.

Report on the Geology of the Area Along the T. and N. O. Railway (Ontario Government Railway). Trial line between Gowganda and Porcupine, by J. G. McMillan.

The Strength of Reinforced Concrete Beams. Being the results of tests of 333 beams. By Richard L. Humphrey and Louis H. Losse. No. 2 Technological Papers of the Bureau of Standards, Dept. of Commerce and Labor, U.S.

The Los Augeles Aqueduct. Sixth annual report of the Bureau of the Los Angeles Aqueduct. Wm. Mullholland, chief engineer, Los Angeles, 1911.

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U.S. Reclammation Service. The tenth annual report, 1910-1911. F. H. Newell, director, Department of the Interior, U.S.

Water Power Development in the United States. Report of the Commissioner of Corporations. Issued March 14th, 1912. Dept. of Commerce and Labor, Washington.

Year Book, 1911, Swedish Chamber of Commerce in London. Containing the fifth annual general report of the Council, London, E.C.

Waterworks Efficiency. Bulletin of the Milwaukee Bureau of Economy and Efficiency. On the present capacity and future requirements. By F. E. Turneaure, Milwaukee, Wis.

Massachusetts Institute of Technology. Contributions from the Sanitary Research Laboratory and the Sewage Experiment Station. Vol. 8, issued by the Dept. of Biology and Public Health, Massachusetts Institute of Technology, Boston. Price $1.

The Present State of Development of Large Steam Turbines. By A. G. Christie. Being a re-print from the journal of the American Society of Mechanical Engineers.

Practical Road Engineering. For the New Traffic Requirements. Compiled from the special "Roads" issues of the "Surveyor" and "Municipal and County Engineer," by H. Percy Boulnois. The St. Bride's Press, Ltd., London.

Mechanical Engineer's Price Book, 1912. Edited by Geoffrey Brooks. Issued by E. and F. N. Spon, Ltd., London.

A Model Erection Shop is the title of a very artistic 16-page booklet just issued by Lockwood, Greene and Co., architects and engineers for industrial plants, 93 Federal St., Boston. It describes with illustrations the construction of a one-storey, reinforced concrete, sawtooth roofed machine shop which is unusually well lighted, and at the same time has its floor area covered by an abundance of cranes running on concrete girders. The booklet will be sent on request to Lockwood, Greene and Co., 93 Federal St., Boston.

CATALOGUES RECEIVED.

The Morrison Water Tube Boiler. Circular No. 1, describing boiler recently patented in the United States and Canada. Copies of pamphlets may be obtained from Egbert R. Morrison, general sales agent, Sharon, Pa.

Concrete Mixers. Circular issued by The Cement Tile Machinery Co., Waterloo, Iowa, describing their small batch concrete mixers.

Machinery and Supplies. Catalogue No. 42, illustrating machinery and supplies for the mining man. Mussens, Limited, Montreal.

Road Machinery. Pamphlet issued by The Barron and Cole Company, Barron Bldg., New York City, illustrating different types of road machinery manufactured by them.

Electrical Wires and Cables. Catalogue and hand-book bound in red morocco, illustrating electrical wires and cables manufactured by The Canada Wire and Cable Company, Limited, Toronto, Canada.

Sewage Appliances. Book issued by Tuke and Bell, Limited, sewage specialists, London, E.C., illustrating different types of sewage sprinklers, distributors, sewage installation, air compressors, flushing syphons, etc.

Rock Drills. Pamphlet issued by McKierman-Terry Drill Co., 115 Broadway, New York, illustrating their "Wizard" rock drills.

Manganese Steel. The Taylor Iron and Steel Co., Highbridge, N.J., forward pamphlet describing their "Tisco" manganese steel crusher, hammers, screen plates, etc.

Steam Pumps. Catalogue No. 8 of the Smart-Turner Machine Co., Ltd., Hamilton, illustrating different types of pumps manufactured by them.

Continuous Reinforced Concrete Pipe. The Lock-Joint Pipe Co., 165 Broadway, New York, forward their latest catalogue on concrete pipe constructed under the Meriweather system. A very artistic catalogue showing a number of recent installations of the pipe.

Waterworks Specialty. The Waterworks Equipment Co., 50 Church St., New York, present catalogue illustrating special types of hydraulic apparatus. Copies may be obtained by addressing the company.

Alternating Current Generators. Pamphlet No. 13b, issued by Pruce Peebles and Co., Ltd., of Edinburgh, illustrating Peebles medium and slow speed alternators.

Machine Tools for Heavy Work. The Wiener Machinery Company, 50 Church St., New York, representatives for the United States and Canada of Ernst Schiess, of Dusseldorf, Germany, forward catalogue illustrating different types of heavy machine tools, turning lays, boring mills, planing and milling machines, etc.

Steel Forms and Centering. The Standardized Steel Form Company, Niagara Falls, Ont., forward pamphlet illustrating the Blayney Collapsible and telescoping system of steel forms and centering for plain or reinforced, seamless, concrete pipe. Copies may be obtained by addressing the Standardized Steel Form Company, Niagara Falls, Ont.

Hydraulic Benders is the title of a new and interesting 64 page 6 in. by 9 in. catalogue devoted exclusively to hydraulic machines just published by The Watson-Stillman Co., 50 Church St., New York. Free copy will be mailed to interested parties requesting Catalogue No. 83.

CLAYS AND CLAY INDUSTRIES OF EDMONTON DISTRICT.

The Edmonton Board of Trade some months ago requested Professor Orton, an authority on clay and clay industries, to make a report on the possibilities in that direction in the Edmonton district. Professor Orton was asked to report upon the following points:—

1. Are the clay industries now established at or near Edmonton producing from their available material as good products as is practicable from the material they are using?

2. Are there other clay materials in the neighborhood available for the production of different and more valuable products than are now being made, and if so, what are the possibilities?

In answering the first question, Professor Orton states that two distinct classes of material are now being used here, consisting of (a) the glacial clays of the upper levels, and (b) the deposits on the river flats, composed of the silt deposited by the river in eddies and quiet spots and left by receding floods.

In regard to the material under class (a), the report seems to indicate that these materials present certain difficulties not commonly met with in other districts where the industries have attained considerable development. The report states that "the strata being worked showed the typical faults of glacial clay beds, viz., lack of continuity in character. They were shifting and changing in proportions of sand from day to day, and the problem of the pit foreman, to keep a reasonably fixed proportion of both clay and sand going up in each car load, is not an easy one, and will require constant vigilance. The quality of the body produced by this mixture of tough and sandy material, as evidenced by the kilns of brick standing burnt and ready for shipment, as well as by the waste piles and bats lying about, is fairly good for common building brick. It is not in any sense a fine material, but it makes a fairly good, strong and serviceable common brick. There seems no likelihood of making any materially different or materially improved product from this clay."

The report indicates that the material in class (b), that is to say, the river silt deposited on the river flats, presents even greater difficulties. The report states that these clays are alike in one respect, namely, they are all very treacherous and difficult to dry without cracking. The upper brown layer, worked alone, would make a fairly tough, plastic paste, and would work well in the machinery, but it would give prohibitive trouble in drying. The use of the sandy and silty layers is absolutely imperative to weaken it, to get sound or unchecked bricks. On the other hand, the sand and silt is of itself too weak and friable to make a brick, and is equally fatal to the quality of the burnt product, if allowed to get too high in amount. The manufacturers are, therefore, between two horns of a dilemma—cracking on the one hand, and weak, crumbly, worthless product on the other.

To quote the report: "If by constant vigilance the proportions can be kept inside the proper limits, the product will be a somewhat pale red brick of rather low, but sufficient strength, which, when in position in a building, will doubtless give good service.

"The possibility of improving the brick as to its hardness, strength and color by use of other processes than those employed has been considered. I cannot hold out any hopes of any important improvement in these respects."

In regard to the second point on which Professor Orton was asked to report, the results of his investigations indicate that there are possibilities of very important development. These occur in connection with the stratified shale and clay of an earlier formation than the glacial deposits or river silt now being used.

An exhaustive series of tests was made on samples of shales and fire clays taken from the various mines in the vicinity and from points along the river bank where the original stratified shales were exposed. While these materials present difficulties which do not occur in the clay deposits of Ohio, Pennsylvania, and other portions of the continent where clay industries have reached large proportions, it appears to be the opinion of Professor Orton that these difficulties are not insuperable, and that the profitable production of other and more valuable products, such as certain forms of tile and terra cotta and vitrified products, is commercially possible.

The project is rendered difficult by the somewhat abnormal character of these clays and shales. They show peculiarly sticky and soapy characteristics, which render them hard to work in the moulds; and they also show an abnormal percentage of shrinkage in drying, resulting in an amount of cracking, rendering the products useless. By an exhaustive series of experiments Professor Orton has demonstrated that treatment can be devised which will overcome these difficulties. While such treatment will materially increase the expense of manufacture, the cost is not considered by any means prohibitive, in view of the cost now entailed in bringing such products from present sources of supply. It is not practicable to enter into details of the elaborate experiments conducted by Professor Orton along these lines, and parties interested are advised to study the full report in the secretary's hands.

Professor Orton concludes his report as follows: "To utilize the Edmonton shales and fire clays is a proposition that should not be undertaken by any person or corporation who have not considerable financial resources, and who have the courage to use them. It is highly likely that a considerable period of expensive and costly experimenting would have to be made before a plant could be adjusted to do on a large scale what has been demonstrated on a small scale in the foregoing tests. On the other hand, a firm that has the money and intelligence to take up and solve this problem along the lines here laid down will, in my opinion, be able to produce vitrified clay products of at least fair quality at a cost far below that at which the goods can be brought in either from Vancouver or Ontario, or the nearest American clay-working centres."

ENGINEERING NOTES.

Galt, Ont.—Mr. W. H. Breithaupt, C.E., of Berlin, Ont., explained his proposed system of storage dams, to prevent disaster from excessive water in the Grand River, before a largely attended meeting of the board of trade. In a clear manner the speaker explained the reasons for flood conditions and the feasibility of a scheme for holding back a large portion of the water, thus reducing the danger of damage to property and providing a reservoir from which the water could be supplied in the summer months to maint in a reasonably good flow and provide continuous water power.

Montreal, P.Q.—Civic Controller Ainey has proposed a new scheme for the elimination of the level crossings of the Grand Trunk Railway within the limits of this city.

Mr. Ainey proposes to build tunnels under thirteen of the streets where these crossings are situated, devoting the two million dollars, which the city is being asked to contribute toward the cost of elevating the tracks, for this purpose.

He claims his scheme will save $1,000,000 in the expenditure for this work.

PERSONALS.

MR. CHAS. MOOGK has received the appointment of city engineer for the municipality of Waterloo, Ont.

MR. JOHN O'NEILL has been appointed to the position of municipal engineer for the city of Fredericton, New Brunswick.

MR. ANDREW BASHFORTH has been appointed general manager of the Provincial Steel Company, Limited, Cobourg, Ont.

MR. R. H. LEE, engineer for the municipality of Kamloops, British Columbia, has tendered his resignation to the civic authorities.

MR. GREGORY FEENEY has been appointed to a position on the engineering staff of the St. John & Quebec Railway Company.

MR. JAMES RUDDICK has been appointed to the position of general construction engineer for the Dominion Coal Company at Glace Bay, Nova Scotia.

CHIEF ENGINEER BRUCE, of the Dominion Government service on the final location of the second section of the Hudson Bay Railway, has resigned his position.

MR. JOHN L. FEENEY has retired from the office of engineer for the municipality of Fredericton, N.B., and will take a position in the Dominion Engineering Department in the city of St. John, N.B.

MR. FRANK E. STERNS will be on the engineering staff of the new Welland Canal, and will devote his energies to the matter of lock design. He is a Canadian and a graduate of McGill University.

MR. MORRIS F. G. WILSON, an English authority on drydock construction, arrived in Ottawa May 24th, and will act for the government in the selection of a suitable site for the proposed Quebec drydock.

MR. GROVER KEITH, formerly of Sussex, who has been on the staff at the St. John & Quebec Railway Company's offices, has been appointed to a residency on the line between Fredericton and Gagetown, N.B.

MR. R. C. HARRIS has been appointed to the position of works commissioner for the city of oronto. In addition to the duties accompanying this office he will be supervisor of the cleaning of streets and the disposal of garbage.

MR. E. W. RICHARDS, head of the stores and purchasing department of the Toronto hydro-electric department, has been appointed to the position of appraiser in the customs department of the Dominion Government.

MR. WALTER H. FLYNN has been appointed to the position of superintendent of motive power on the lines of the Michigan Central Railway. Mr. Flynn, previous to this appointment, was master mechanic of the same company.

MR. R. G. SNEATH, C.E., a graduate of Toronto University, has been appointed to the position of resident engineer on the installation of the sewage disposal plant for the municipality of Melfort, Saskatchewan, for Messrs. McArthur and Murphy.

JACOBS & DAVIES, Inc., have opened their Montreal office in the Eastern Townships Bank Building, 263 St. James Street, for the practice of general consulting and construction engineering, which business will be under the management of Mr. Paul Seurot, their representative in Canada.

MR. W. S. HARVEY, A.M., Inst. C.E., chief assistant engineer for the city of Lethbridge, Alta., has just been elected an associate member of the Canadian Society of Civil Engineers. Prior to coming to Canada in 1910 Mr. Harvey was in charge of the sewerage and general engineering work for the city of Plymouth, England.

MR. J. J. TAYLOR, who has lately been engaged on the Gibson and Minto line, has been appointed inspecting engineer for the Federal Government on the St. John Valley Railway, and will enter upon his new duties at an early date. Mr. Taylor was in charge of part of the preliminary survey work on the Valley Railway for the Provincial Government some time ago.

Mr. J. B. CHALIES, B.A.Sc., graduate of the University of Toronto, has been appointed superintendent of the new water-power branch of the Department of the Interior, which was originally under the Railway and Swamp Lands branch of the Department. The new water-power branch will make surveys of all the water-powers of Canada and gather data on stream fall.

CAPTAIN L. A. DEMERS has been appointed to the position of harbor master of the port of Montreal. Captain Demers is a native of Montreal, having been born in that city August 18th, 1862. He was educated in St. Mary's Academy and holds a commercial certificate from that institution. In 1878 he became an apprentice on a sailing vessel, and in 1886 was made mate; his final examination as master was passed in 1889. For some time he has been Dominion wreck commissioner.

MEETINGS.

Montreal, P.Q.—The Montreal Electrical Society, which has arranged a somewhat ambitious programme for the coming summer season, held a most important meeting Tuesday evening last at the Fraser Institute Hall. The primary object of this new society appeals to the younger members of the electrical industry, as it fills a want long felt, with the opportunity for local electrical men, young and old, to meet, exchange views, and take advantage of professional papers to be read by some of Canada's leading electrical engineers. With a membership approaching the two hundred mark, this new society appears to have made a good start. As the society will pay several visits to neighboring power plants, accompanied by classified engineers, the benefit to the younger members is easily seen.

MEETING OF AMERICAN SOCIETY OF ENGINEER DRAFTSMEN.

The regular monthly meeting of the American Society of Engineer Draftsmen, held on May 16th, in the Engineering Societies' Building, was marked by the admission to junior membership of Miss Marie Oberlander, a student of architectural drawing at Teachers College, Columbia University. Miss Oberlander is the first woman to be elected as a member of this organization.

The guest of the evening was Mr. F. F. Nickel. M.E., consulting engineer to the Worthington Pump Co., who delivered a very interesting and instructive lecture on "Practical Application of the Slide Rule."

A paper by Mr. R. E. Boehck, a member of the society. of Evansville, Ind., on "The Development of Logging Machinery," was read and discussed.

COMING MEETINGS.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd 8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
5-29	Water works, sewerage and electric light systems, Melfort, Sask. (P. & S.)	5-2
6-10	Electrical equipment, Vernon, B.C. (S.)	5-16
6-17	Electric Generating Station Equipment, Bassano, Alta. (S.)	5-30
6-10	Cement sidewalks, Maple Creek, Sask. (P & S.)	5-30

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal)

(Maple Creek plans and specifications on file at The Canadian Engineer Office, Winnipeg, Man.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Australia, steel rails and fish plates	May 29.	May 2.	60
Bassano, Alta., electric generating machinery	June 3.	May 16.	66
Berlin, Ont., waterworks improvements		May 23.	72
Edmonton, Alta., pile wharf	June 17.	May 23.	60
Fredericton, N.B., wharf	June 6.	May 16.	60
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Hamilton, Ont., motors, turbine pumps, etc.	June 3.	May 16.	74
Kenora, Ont., fire hall	May 31.	May 23.	59
Lebret, Sask., school house	May 31.	Apr. 25.	61
Lunenburg, N.S., sewerage system	June 1.	May 9.	60
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
Melfort, Sask., school building	May 29.	May 16.	60
Moose Jaw, Sask., water works fittings	May 30.	May 16.	74
Moose Jaw, Sask., retaining wall and sidewalks, Collegiate Institute	June 5.	May 16.	60
Moose Jaw, Sask., valves and hydrants	June 1.	May 23.	72
Moose Jaw, Sask., sewer pipe and specials	June 1.	May 23.	72
Moose Jaw, Sask., cast-iron pipe and specials	June 1.	May 23.	74
Montreal, Que., bridge Bevan's Creek	June 1.	May 23.	59
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa, Ont., station and other buildings	May 31.	May 9.	74
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Owen Sound, Ont., wharf	June 4.	May 16.	60
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of waterpowers	June 26.	May 2.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Sault Ste. Marie, Ont., approach to wharf	June 4.	May 16.	60
Toronto, Ont., cast-iron penstocks	June 4.	May 9.	74
Toronto, Ont., storm overflow sewer	June 4.	May 16.	72
Toronto, Ont., dredging	June 4.	May 23.	72
Toronto, Ont., bridge construction	June 6.	May 23.	72
Toronto, Ont., concrete abutments	June 5.	May 23.	72
Toronto, Ont., concrete breakwater	June 6.	May 23.	72
Vancouver, B.C., bridging, grading, etc.	May 31.	May 9.	62
Vernon, B.C., electrical equipment	June 10.	May 16.	72
Vernon, B.C., cast-iron pipe	June 10.	May 23.	60
Vernon, B.C., valves and hydrants	June 10.	May 23.	60
Winnipeg, Man., Court House	June 1.	May 23.	60

TENDERS.

Amherst, N.S.—Tenders will be received up to Monday, June 3rd, 1912, for the following work:—Digging trench, depth ordered by Engineer, laying and caulking cast-iron water pipe, and backfilling trench, on six streets in the town of Amherst, N.S. Specifications and all other information may be obtained at the office of W. F. Donkin, Town Clerk, Amherst, N.S.

Bassano, Alta.—The time for receiving tenders for electric generating station equipment has been extended until June 17th. Specifications at the offices of The Canadian Engineer, Toronto and Montreal. (See advt. in The Canadian Engineer).

Calgary, Alta.—Tenders will be received until June 3rd, 1912, for the erection and completion of combined police and fire stations for the city of Calgary. Plans, specifications and full particulars at the office of the architects, Messrs. Lang and Major, Suite 11, Board of Trade Building. J. M. Miller, city clerk, Calgary.

Edmonton, Alta.—Tenders will be received up to noon of June 10th, 1912, for the ornamental iron and stair work required in connection with the new court house at Calgary. Specifications, plans, etc., may be had at the Structural Engineer's office, new Parliament Buildings, Edmonton, or at the branch office of the Department of Public Works, Calgary. John Stocks, Deputy-Minister of Public Works, Edmonton, Alta.

Lethbridge, Alta.—Tenders for paving a number of lanes in concrete will be received up to noon of Friday, June 14th. 1912, by G. W. Robinson, secretary-treasurer. Plans and specifications may be obtained at the office of A. C. D. Blanchard, City Engineer, Lethbridge.

Maple Creek, Sask.—Tenders will be received up to June 10th, 1912, for the supplying of material and construction of approximately 7,000 yards of cement sidewalks in the town of Maple Creek. Plans and specifications can be seen at The Canadian Engineer office, 820 Union Bank Building, Winnipeg, and at the office of the secretary-treasurer, D. Paterson. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders for the supply and delivery of 50 ornamental light standards suitable for Tungsten lighting, will be received up to noon of June 14th, 1912, by the City Commissioners. Plans, etc., may be obtained from J. D. Peters, electrical superintendent, Moose Jaw.

Newmarket, Ont.—Tenders will be received by O. E. Tench, architect, up to the evening of June 15th, 1912, for the erection of a six-roomed Public school building in the town of Newmarket. Building to be of stone and brick, with artificial stone trimmings; flat roof; plumbing; warm air heating. Plans and specifications may be seen at the office of architect. Dr. C. H. R. Clark, Chairman of Board, Newmarket.

Oshawa, Ont.—Tenders will be received by the Town Engineer up to noon of June 8th, 1912, for the construction of 25,000 sq. ft., more or less, of cement concrete sidewalks. (See advt. in The Canadian Engineer). Frank Chappell, C.E., Town Engineer.

Ottawa, Ont.—The time for receiving the tenders for the construction of station and other buildings on the Transcontinental Railway is extended to noon of June 14, 1912. P. E. Ryan, secretary, the Commissioners of the Transcontinental; Railway, Ottawa. (See advt. in Canadian Engineer.)

Ottawa, Ont.—Tenders will be received by the Public Works Department, Ottawa, until June 4th, 1912, for dredging at Miramichi Bay, N.B. Combined specifications and form of tender can be obtained on application to the Secretary of the Department.

Ottawa, Ont.—The Department of Public Works will receive tenders until June 4th, 1912, for electric light wiring, fittings, etc., for the Post Office building, Port Hope, Ont. Plans and specifications to be seen on application to the caretaker of the building, Mr. Jas. Curtis, or to Mr. Thos. Hastings, Clerk of Works, Postal Station "F," Yonge Street, Toronto, and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the construction of a rifle range at Chatham, Ont., will be received by the Director of Contracts, Militia Headquarters, Ottawa, until noon of May 30th, 1912. Plans, etc., can be seen at the offices of the officer commanding the first division, London, Ont.; at the office of Lt.-Colonel J. S. Black, brigade major, 1st Infantry Brigade, Chatham, Ont.; and at the office of the director of engineer services, headquarters, Ottawa. Eugene Fiset, colonel, deputy minister, Dept. of Militia and Defence, Ottawa.

Ottawa, Ont.—Tenders will be received until July 2nd, 1912, for the erection of a number of buildings for Indians on Reserves No. 2, 3 and 4, Fort George, B.C. J. D. McLean, Asst. Deputy and Secretary, Department of Indian Affairs, Ottawa.

Saskatoon, Sask.—Tenders will be received up to noon of June 5th, 1912, for all trades required in the erection and completion of an hotel on Twentieth Street, Saskatoon, for R. J. Barry, Esq. Plans and specifications can be seen at the Builders' Exchange, Saskatoon; and at the offices of the architects, Thompson, Daniel & Colthurst, Central Chambers, Saskatoon.

St. Catharines, Ont.—Bulk or separate tenders will be received for the erection and completion of a Sunday School building for St. George's Church, St. Catharines, Ont., until June 10th, 1912. A. E. Nicholson, O.A.A., architect, 46 Queen Street, St. Catharines, Ont.

Tisdale, Sask.—Tenders for the various works and materials in connection with installing a system of storm water sewers in the village of Tisdale, will be received up to June 15th, 1912. Plans and specifications may be seen at the office of the Commissioner of Public Health, Regina; or at the office of the Secretary-Treasurer, W. E. Moore, Tisdale.

Toronto, Ont.—Tenders for the supply and delivery of coal and wood required for Government House, Parliament Buildings, Osgoode Hall, Normal and Model Schools, Toronto, and for the Normal Schools at Ottawa, London, Peterboro, Hamilton, Stratford, North Bay, the Institutions for the Deaf and Dumb, Belleville, and the Institution for the Blind, Brantford, for 12 months ending 30th June, 1913, will be received up to noon of June 4th, 1912. Forms of tender, etc., at the office of H. F. McNaughten, Secretary Department of Public Works, Toronto, Ontario.

Toronto, Ont.—Tenders for dredging Murray Canal will be received at the office of L. K. Jones, Secretary Department of Railways and Canals, Ottawa, until June 5th, 1912. Specifications, etc., can be seen at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the resident engineer of the Ontario-St. Lawrence Canals, Cornwall.

Toronto, Ont.—Tenders for regulators will be received by the Secretary, Toronto Electric Commissioners, City Hall, Toronto, until noon of Wednesday, May 29th, 1912. Specifications may be seen and forms of tender obtained from the Toronto Hydro-Electric System, 31 William Street, Toronto. P. W. Ellis, chairman.

Toronto, Ont.—Tenders, whole or separate, will be received by the Secretary-Treasurer of the Board, until Friday noon, May 31st, 1912, for the several trades required in the erection of a new school building on Manning Avenue, enlargement of Pape Avenue School, and for heating and ventilation, plumbing and electrical work in the new Duke of Connaught School on Morley Avenue, also for sale of old buildings. Full particulars may be obtained at the offices of the Superintendent of Buildings, City Hall. W. W. Hodgson, chairman of committee; W. C. Wilkinson, secretary-treasurer.

Toronto, Ont.—Tenders for the construction of a concrete arch bridge over Copeland's Creek, between Concessions 13 and 14, Township of Tiny, County of Simcoe, and known as McConnell's Bridge; and also for a combined concrete slab bridge, dam and abutments at Lot 12, Concession 4, known as Gregg's Bridge, will be received until Saturday, June 8th, 1912. Plans and specifications at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide Street East, Toronto. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders will be received by the Chairman of the Board of Control, City Hall, Toronto, up to noon on June 5th, 1912, for the construction of cribs for Princess Street Yard, also additions to retaining walls of the Weston Road viaduct. Specifications, etc., at the Department of Railways and Bridges, City Engineer's office, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders will be received by the Chairman, Board of Control, City Hall, Toronto, up to noon of June 4th, for the construction of asphalt, bitulithic and concrete pavements, grading, concrete curbs, concrete walks, sewers, and steel pipe for a number of streets in the city of Toronto. Specifications and full particulars may be obtained at the office of the City Engineer, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control.

Toronto, Ont.—Tenders will be received at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide Street East, Toronto, up to noon of June 8th, 1912, for the construction of a concrete abutment for a bridge, known as the Clubine Bridge on Yonge Street, in the County of York, about 1½ miles north of the town of Aurora. Plans, etc., at the office of the engineer. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders for all trades in connection with midsummer repairs to the Separate schools for the S[illegible] School Board for the city of Toronto, will be received till 5 p.m., June 3rd, at the office of the Board, 24 Duke Street. Specifications, etc., at the office of the architect, Chas. J. Read, 404 Confederation Life Building, Toronto.

Vancouver, B.C.—Tenders will be received by Messrs. Mackenzie, Mann and Company, Ltd., Metropolitan Building, Vancouver, B.C., up till noon of July 8th, 1912, for the superstructures and substructures of ten bridges over the Fraser, Thompson, and North Thompson Rivers on that section of the Canadian Northern Pacific Railway between Port Mann and the Yellowhead Pass, Province of British Columbia. Detailed drawings, specifications, etc., may be obtained on or after June 5th, 1912, at the office of the Consulting Engineers, Waddell & Harrington, Winch Bldg., Vancouver, B.C. (See advt. in The Canadian Engineer).

CONTRACTS AWARDED.

Cobourg, Ont.—Messrs. McLaren and Co., 65 Cumberland Street, Toronto, have been awarded the contract to erect a sewage disposal works for the House of Refuge in this municipality.

Lethbridge, Alta.—Messrs. Smith Bros. and Wilson were the successful bidders on the tender to erect a manual training school. The building is to cost $35,150, not including the plumbing work. Other bidders were W. H. Holt at $35,750, and Hotson and Leader at $59,200.

London, Ont.—At a meeting of the Commissioners the Gartshore-Thomson Company, of Hamilton, was awarded the contract for supplying all the pipe at $35 a ton for special orders, and $31 a ton for pipe from 4 inches to 18 inches in diameter. Jenkins Bros., of Montreal, were given the contract for valves from 4 to 12 inches, the prices varying from $5.42 for the smallest to $35.63 for the largest. The tender of the London Foundry Company for the 18-inch valves at $150 was accepted.

Moose Jaw, Sask.—Messrs. Fielding and Shepley, St. Paul, Minn., U.S.A., have been awarded the contract for approximately 34,000 square yards of paving, their prices being:—

Fielding and Shepley, St. Paul.—3", 16 lb. treatment creosoted wood paving blocks, paving per square yard, $2.84; between tracks extra per square, 30c.; excavation per cubic yard, 65c. (Accepted.)

Alternative tender.—3½ blocks, paving, $3.10; between tracks, 30c.; excavation per cubic yard, 65c.

Other tenders received were as follows:—

Bitulithic and Contracting, Limited, Winnipeg.—Bitulithic paving 5" in thickness, paving (lanes excluded) per square yard, $2.90; between tracks per square yard, extra, 30c.; excavation per cubic yard, 70c.

R. Bangham, Windsor, Ont.—2½ asphalt block, paving per square yard, $3.44; between tracks per square yard, extra, 6c.; excavation per cubic yard, 50c.

Moose Jaw Paving Co., Moose Jaw.—16 lb. treatment creosoted blocks, paving per square yard, $2.94; between tracks per square yard extra, 65c.; excavation per cubic yard, 69c.

National Paving and Contracting Co., Winnipeg.—Sheet asphalt, paving per square yard, $2.60; asphaltic concrete, paving per square yard, $2.55; paving between tracks per square yard. 70c.; excavation per cubic yard, 75c. E. B. Bonnell, city clerk.

North Battleford, Sask. — The Canadian Westinghouse Company have received the contract calling for the supply and erection of a 500 kw. generator and equipment, the price being $5,580.

North Battleford, Sask.—Messrs. Laurie and Lamb have received the contract to erect and furnish a 750 hp. steam engine, the price being $20,250.

North Battleford, Sask.—The contract calling for the erection and supply of a boiler has been awarded to Messrs. Babcock and Wilcox, Ltd., the price being $8,700.

Point Grey, B.C.—A $1,500 contract for the supplying of galvanized piping for use in extending the water supply system of the municipality has been awarded to Messrs. Robertson and Godson of Vancouver.

Quebec, Que.—Messrs. M. P. and J. T. Davis, contractors, have the contract for the structural work in connection with the Quebec Bridge, and are present making preparation for the sinking of the caisson required for the building of the main pier.

The Dominion Steel Company have the contract for the superstructure of the bridge, and are extending and fitting up their shops at Lachine for the manufacture of the larger metal parts.

Saskatoon, Sask.—Messrs. R. J. Lecky Company, Limited, Regina, have been awarded the contract for the erection of the new Knox Church. The cost of the building is estimated at $129,000.

Saskatoon, Sask.—The contract for furnishing material for and construction of Superstructure 23rd Street Subway has been awarded to The Dominion Bridge Co., Ltd., their price being $12,188. Other bidders and their prices are: The Canadian Bridge Company, $15,200; The Canada Foundry Company, $11,520 (this tender did not include ties, waterproofing, brick or concrete covering); W. M. Scott, of Winnipeg, $13,400.

Saskatoon, Sask.—The contract for plumbing and heating in connection with the seven-story Ross Block to be erected on Third Avenue has been awarded to Thomson and Homer.

Saskatoon, Sask.—Messrs. Shannon Bros. & Cassidy secured the contract to build the new King George Hotel at a sum of $127,000.

The same firm also received the contract to build the new Westmount School. Both schools will contain fourteen rooms and will be of brick construction. Tenders other than the winning one on the King George School are: Smith Bros. and Wilson, $127,000; D. A. Black, $133,920; and Bigelow Bros., $137,700.

The tenders on the Westmount School including the winning tender of Shannon Bros. and Cassidy, are A. W. Bell, $114,000; Dinnie Construction Company. $119,000; Shannon Bros. and Cassidy, $128,395; Lyall Mitchell Company, $128,500; Smith Bros. and Wilson, $128,500; D. A. Black, $142,900; and Bigelow Bros., $149,800.

Thorold, Ont.—The contract for the erection of the Ontario Pulp and Paper Mills, Thorold's new million-dollar industry, was let to the Lackawanna Bridge Co., of Buffalo, and work will be started on the industry in the course of a couple of weeks. The mills, when completed, will manufacture news print paper exclusively. They will turn out from 120 to 130 tons every twenty-four hours.

The machines are to be the largest ever built, and are now well under construction by the Husey and Jones Company, of Wilmington, Del.

The mill will be operated entirely by electricity, requiring about ten thousand horse-power, which will be secured from the Ontario Power Company at Niagara Falls.

Winnipeg, Man.—St. John's College has let to Worsick Bros. the contract for the erection of a new college building at a cost of approximately $40,000.

RAILWAYS—STEAM AND ELECTRIC.

Province of Alberta.—At a meeting of the directors of the Alberta Central Railway held in Ottawa, the name was changed to the Dominion Central Railway owing to the fact that the road has now a Dominion charter.

Future plans of the road were discussed and it is the intention of the promoters to build a line north and south through Alberta connecting across the boundary with the Great Northern and Northern Pacific. The road will run along the slope of the mountains with feeders east and west.

Central Ontario.—The Lake Erie and Northern Railway project, with a line to Port Dover from Brantford, via Simcoe, and from Brantford to Galt via Paris, is now assured, providing by-laws carry in the various municipalities for debenture stock.

Hamilton, Ont.—A report has been presented to the municipal council dealing with the entrance of the Canadian Northern Railway to this city. The City Corporation did not look with favor on the proposed entrance and passed a resolution to that effect, but mentioned that an alternate route as proposed by City Engineer Macallum, might be adopted without resistance from the Corporation. This route leaves the line proposed by the company southerly of its intersection with the main line (London branch) of the Grand Trunk Railway and proceeds then across Cook's Paradise to the westerly side thereof, connecting with the Toronto, Hamilton and Buffalo Railway, near Main Street, crossing underneath the streets of the city as far easterly as Wentworth Street.

Toronto, Ont.—The municipal council have decided to spend the sum of $35,000 in obtaining a report on the best solution of the transportation problems of this city; also to appoint a railway expert for the legal department of the city. This latter appointment and the traffic experts are to be Canadians if suitable men apply for the positions.

Western Ontario.—A report states that the proposed electric line the Messrs. Mackenzie and Mann are contemplating building will come to Exeter via Stratford and St. Mary's, and from there go to Lake Huron. It is proposed to have the terminal on this lake located at Brand Bend.

LIGHT, HEAT AND POWER

Montreal, P.Q.—It is announced by the Montreal Light, Heat and Power Company, that beginning July 1st a further reduction in gas and electric rates will be effective. Gas will be sold at 95 cents per 1,000 cubic feet. The present price is $1. Electric lighting is to be seven cents per kilowatt hour as compared with 7½ cents at present.

Moose Jaw, Sask.—A report coming from Sask toon states that the power-house in Moose Jaw has been destroyed by fire, that the city is without electrical conveniences, and that there is a danger of the water supply failing.

District of Rainy River.—The Department of Public Works has ordered an investigation by departmental engineers of the water power situation along the Rainy River.

GARBAGE, SEWAGE AND WATER.

Bassano, Alberta.—At a meeting of the town council, May 6th, the John Galt Engineering Company of Winnipeg and Calgary were appointed engineers for the installation of a waterworks and sewerage system which will cost approximately $150,000. The by-law covering same will be voted on in the near future. A short description of this system will be found in our issue of March 21st, page 439.

Kincardine, Ont.—The Water and Light Commissioners of this municipality have decided to dispose of one steam pumping engine or exchange the same for a new pump.

Toronto, Ont.—The Toronto Board of Trade is not favorable to the city's acceptance, without further question, of the plan of the board of expert engineers calling for an eight million dollar expenditure on waterworks. They will recommend that the question of securing a perpetual supply from Georgian Bay be considered; also that the expert who installed a water system in California, bringing water for hundreds of miles, be engaged to make a report.

BUILDINGS AND INDUSTRIAL WORKS.

Crabtree Mills, P.Q.—Plans and specifications are being prepared for alterations and extensions and new dam for Messrs. E. Crabtree & Son, Limited, paper manufacturers, Crabtree Mills, P.Q.

Fort William, Ont.—The management of the Page-Hersey Company, who have taken over the agreement made between the Corporation and F. V. Samwell regarding a tube works, intend commencing construction operations on a plant in the course of a few weeks. The address of the Page-Hersey Company is Galt, Ont.

Magog, P.Q.—Plans and specifications are being prepared for a new weave shed, for the Dominion Textile Company, Limited, by T. Pringle & Son, Limited, Industrial engineers.

Medicine Hat, Alta.—Operations are to begin immediately on the erection of the new building for the Medicine Hat Milling Company.

Montreal, P.Q.—The firms and prices tendering on the erection of the new City Hall Annex, are as follows:—$649,000, made by the Peter Lyall & Sons Company, Limited; the next lowest being that of C. E. Deakin, $678,000, and the highest that of Mr. Joseph Bourque, $725,000.

Montreal, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Engineers, for extensions to reclaim plant for the Canadian Rubber Company, of Montreal, Limited.

Montreal, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Industrial Engineers, for a new slasher house for the Dominion Textile Company, Limited, Hochelaga Branch, Montreal.

Montreal, P.Q.—T. Pringle & Son, Limited, Industrial Engineers, are preparing plans and specifications for a manufacturing plant for "The N. K. Fairbank Company," Cote St. Paul, Montreal.

Moose Jaw, Sask.—Plans have been completed by Messrs. Reid & McAlpine, for the erection of a new building for the Young Women's Christian Association. The building will be three stories and basement, and of considerable size.

Nelson, B.C.—The management of the Dominion Saw Mill Company will erect a new mill on the site of the Yale-Columbia plant which was destroyed by fire last March.

Newcastle, N.B.—The municipal council are preparing to erect a new court house at an approximate cost of $31,000. Mr. Fairns is architect to this committee.

Ottawa, Ont.—The management of the Ottawa Gas Company are planning to increase the output of their plant by the erection of large subsidiary works. These works are to be placed on eight and one-half acres recently purchased by the company in the eastern part of the city.

Saskatoon, Sask.—The Winnipeg Paint & Glass Company are making preparations for the erection of a warehouse in this city. The new building will be metal clad 50-ft. x 100-ft. Mr. J. S. McDiarmid, Winnipeg, is interested in this matter.

Three Rivers, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Industrial Engineers, for a new cotton mill plant at the St. Maurice Valley Cotton Mills, Limited, at this point.

Toronto, Ont.—The Canadian Fairbanks-Morse Company, Limited, Toronto, are planning the erection of a large tractor shop on their property at Bloor Street West, Toronto. The plans and specifications for this building are being prepared by T. Pringle & Son, Limited, Industrial Engineers.

Welland, Ont.—The Cataract Rubber Company, Limited, has been incorporated with a capital stock of $250,000, and will locate its factory in Welland. The provisional directors are E. J. M. Block, of Buffalo; Jacob Dilcher, of Buffalo; and Myrtle A. Overholt, Col. L. C. Raymond and L. B. Spencer, of Welland. The company will manufacture rubber tires of all kinds and other rubber goods.

BRIDGES, ROADS AND PAVEMENTS.

Helena, Ont.—A steel bridge in course of erection on the line of the Grand Trunk Railway, collapsed. A break in a steel brace allowed a section of the structure to fall.

Ottawa, Ont.—There is a probability that Spark Street will be paved with asphalt during the coming season.

Orillia, Ont.—A petition calling for the paving of four blocks on the Main Street is receiving attention from the council. The cost of this work is estimated at $58,000.

York County, Ont.—A deputation from Pembroke, Ont., made an inspection of the work of the York County Commission for the purpose of securing first hand information on county road improvements to be placed before the ratepayers of Renfrew County in an attempt to encourage similar work in that division.

FIRES.

River St. Lawrence, P.Q.—The steamer "Iona," from Kingston to Montreal, was burnt and sunk in this river on May 18th last. The ship was loaded with soft coal and was owned by the F. E. Hall Company, of Montreal. The loss is estimated at $20,000.

St. John, N.B.—Messrs. Hutchings & Company, and Messrs. Patterson & Company had their plants destroyed by fire recently. The first-named company are bed and mattress manufacturers, the other engaged in the printing business.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending May 13th, 1912:—

A London firm manufacturing chairs and tables make inquiry for the names of Canadian manufacturers of turned goods, suitable for common wood chairs, such as turned spindles, stretchers, chair seats, etc.; the firm are also in the market for supplies of Canadian beech.

A London firm manufacturing printing inks, litho colors, litho varnishes, relief stamping colors, relief stamping varnishes, etc., wish to appoint Canadian representatives.

A Scottish firm manufacturing breast drills, diaphragm pumps, semi-rotary pumps, and chucks for vertical machines and lathes, desire to get into touch with Canadian buyers.

A Yorkshire firm manufacturing hot water boilers and radiators are open to correspond with Canadian buyers.

A Danish correspondent asks to be placed in touch with Canadian manufacturers of building materials open to do business with Denmark.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A London firm who are buyers of old scrap copper, brass, gun metal, etc., would be glad to receive offers from Canadian exporters.

CURRENT NEWS.

Nelson, B.C.—A new powder magazine has recently been completed for the Giant Powder Company. It is constructed of fire and weather proof brick and concrete, and fitted with a complete system of lightning conductors and bullet proof steel doors, powder and cap magazines. An 800-ft. approach from the water and the railway to the buildings has also been constructed.

The powder magazine is 22 by 32 feet and the cap house is 8 by 10 feet in size. Each building has a double room, the inside filled with earth and the covering being of asbestos. Lightning conductors have been installed at all the corners of the buildings and doors, which are of 8-plate steel, and all other metallic work are electrically connected with these conductors. The magazine will accommodate between two and three carloads of powder. The cost of buildings and approach is in the neighborhood of $4,000.

Province of Quebec.—A great deal of field work will be done this coming season in geological and mining investigations in the Province of Quebec, by both the Dominion Department of Mines and the Provincial Mines Branch.

The following programme has been settled upon:—

The Dominion Geological Survey will send two exploring parties in North-western Quebec. One of these will investigate the mining possibilities of the country to the east of the Bell River, between Grand Lake Victoria and Lake Mattagami. The other party will operate along the Nottaway River, from Lake Mattagami northwards. This is along one of the most likely routes for the projected Montreal-James Bay railway.

Another Geological Survey party will continue the work begun two years ago in Brome and Missisquoi counties, mapping out in detail the geology of the region.

Mr. J. Keele, of the Federal Geological Survey, who has made a specialty of the investigation of the clay deposits and industry, will begin a scientific inventory of the clay and shale resources of the province. The importance of this work may be gathered from the fact that last year the value of the products of the clay industry of the province of Quebec exceeded $1,500,000. A large quantity of clay is imported from New Jersey for the manufacture of pottery, drain-pipe, glazed tiles, etc., and it is quite possible that this investigation may result in the discovery of clays suitable for these purposes in this province.

The Dominion Mines Branch will begin a study of the peat deposits, and will report on their suitability for fuel purposes. The province of Quebec, unfortunately, does not possess coal deposits and is dependent upon Nova Scotia and Pennsylvania for its supply of fuel.

The Quebec Mines Branch will send out two parties. One of these will investigate the mineral resources of the region of the head-waters of the Harricanaw River, in North-western Quebec, whence has come the rumor of important mineral discoveries. Another party will continue the inventory of iron resources, which was begun last year. These two parties will be respectively in charge of Dr. Bancroft, professor of Geology at McGill University, and Mr. E. Dulieux, professor of Mining Engineering at Polytechnic School of Laval University.

STREET RAILWAY ENGINEER WANTED.

The City of Brandon are calling for applications up to June 10th, for the position of Street Railway Engineer. Applicants for the position must have constructing and operating experience in street railways, and must be prepared, if necessary, to form a part of a public utility commission for the City of Brandon. The advertisement for the position will be found in this issue of The Canadian Engineer.

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.

16435—May 3—Approving location of G.T.P. station to be erected at Fraser Lake, B.C., mileage 359 from Prince Rupert.

16436—April 23—Authorizing G.T.P. B.L. Co. to cross highway and divert road on its Cutknife Branch, Saskatchewan.

16437—May 2—Dismissing complaint of J. O. Hall, of Toronto, re G.T.R. train connection at Belleville for Madoc, Ont.

16438—May 2—Refusing application of C.P.R. to vary terms of Order 15777, Jan. 8th, 1912, re Goderich interchange.

16439—May 2—Dismissing application of Ontario Malleable Iron Co., Ltd., Oshawa, re C.N.O. Ry. spur for manufacturers.

16440-41—April 26—Approving by-law of Kootenay and Alberta Railway Co authorizing S. T. Maines, Traffic Manager, to prepare and issue tariffs of tolls and approving Standard Freight Tariff, C.R.C., No. 1.

16442—May 3—Extending for six months time for filing by Esquimalt & Nanaimo Ry. revised Standard Tariff of freight tolls.

16443—May 3—Authorizing Algoma Central & H. B. Ry. to construct branch line on Michipicoten Branch.

16444—May 2—Directing that C.P.R. protect Lansdowne Ave. crossing, Toronto, Ont., with gates within 30 days, 30 per cent. by city, 30 per cent. railway, 20 per cent. by Canada Foundry Co., and 20 per cent. from Railway Grade Crossing Fund.

16445—May 3—Authorizing C.P.R. to construct spur for Messrs. Skinner & Miquelon, Calgary, Alberta.

16446—May 4—Authorizing C.P.R., and approving location of station to be erected at Craven, Sask.

16447—May 6—Authorizing C.N.R. to connect its lines temporarily, during construction, with C.P.R. near Dalziel Station, in Twp. of Lyon, and Dist. of Thunder Bay.

16448—May 4—Approving plan "A" of G.T.R. crossing of Burford and Mount Pleasant Roads, near Brantford, Ont.

16449—May 1—Authorizing C.N.R. to cross with its Swift Current Extension 14 highways in Saskatchewan.

16450—May 6—Authorizing town of Welland to construct Major Street across G.T.R.

16451—May 3—Directing that C.N.R. pay cost of changes in interlocking plant near Ottawa, operating and maintaining to be divided equally among N.Y. & O.; C.P.R.; G.T.R.; C.N.R.

16452—May 6—Rescinding Order No. 15994, dated Feb. 17, 1912, and naming revision in express delivery and collection limits for Kamloops, B.C.

16453—May 6—Directing Railway Companies to charge certain rates on coke in carloads of 30,000 minimum, tariffs to become effective not later than June 1st, 1912.

16454—May 6—Approving revised location of Campbellford, Lake Ontario & Western (C.P.R., mileage 134.68 to 155.66.)

16455—May 7—Approving location of Niagara, Welland & Lake Erie Ry. between G.T.R. tracks on East Main St., Welland, and M.C.R. tracks on South Main St., same town, 1½ miles.

16456—November 7—Authorizing C.N.O. Ry. to cross with its tracks the C.P.R. spur to Mimico, in Twp. of Etobicoke, interlocker to be installed; whole cost by C.N.O. Ry.

16457—May 7—Authorizing G.T.B. B.L. Co. to cross with its Calgary Branch 2 highways in Alberta.

16458—May 6—Approving location of 8 stations of G.T.P. B.L. Co. Biggar-Calgary Branch.

16459—May 6—Authorizing C.P.R. to re-construct bridge 83.2 and 79.1 on its London and Windsor S.D. Ontario Division.

16460—Authorizing C.P.R. to construct spur for Inland Coal and Coke Co., Ltd., at Merritt, B.C.

16461—May 7—Authorizing C.P.R. to use and operate bridges Nos. 2.6 and 10.6 on Crow's Nest Division.

16462—May 7—Approving location of Central Rly. Co. of Canada, from village of St. Eustache to village of Oka, mileage 16 to mileage 31, in County of Two Mountains, Que.

16463—May 7—Authorizing Campbellford, Lake Ont. & Western Ry. (C.P.R.) to cross with tracks at mileage 87.86 from Glen Tay over C.N.O. Ry. spur line in town of Trenton, Ont.

16464—May 7—Authorizing C.P.R. to construct its track across highway at mileage 5, Mission S.D., B.C.

16465—May 7—Authorizing C.P.R. to construct spur into premises of George Minger, at Titian, Alberta.

16466—May 7—Authorizing Central Vermont Ry. to make connection with C.P.R. spur line into Farnham Military Camp, Farnham, Que.

16467—May 7—Authorizing C.N.O. Ry. to cross Weston Plank Road, Toronto, by means of a subway.

16468—May 6—Naming express delivery and collection limits for Toronto, Ontario.

16469—May 6—Authorizing Thomas Davies, of Toronto, to construct over-head crossing over C.P.R., in Lot 6, Twp. of Nipigon, Dist. of Thunder Bay, Ont.

16470—May 9—Approving location of C.N.R. through Twps. 16-17, Range 26, west 2nd M., and part of city of Moose Jaw, Sask., mileage 84.25 to 87.13.

16471—May 4—Approving Campbellford, Lake Ont. & Western (C.P.R.) location, mileage 124.83 to 125.5, and revised location from mileage 127 to 134.68, Twp. of Hope, Ct. Durham, Ont.

16472—May 9—Authorizing C.P.R to cross with its Pheasant Hill Branch 19 highways in Manitoba.

16473-74—May 8—16475-76—May 9—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur Line), through Twp. of Davis, Dist. of Nipissing, and of C.N.O. Ry. revised location at Callander, Twp. of Ferris, and Dist. of Nipissing; and of C.N.O. Ry. (Montreal-Port Arthur Line), through Twp. of Pedley, Dist. of North Bay; and C.N.O. Ry. (Sudbury-Port Arthur Line), through unsurveyed territory in District of Thunder Bay, mileage 149.85 to 161.03 from Port Arthur.