

May 17, 1917.

economize in outlet construction by saving yardage cost and paying compensation to the landowners. This latter method entails a direct valuation of property and also the effect which the drain will have (or has had) may not be clear to the owners and for these two reasons a dispute is almost sure to occur. Therefore, to avoid this difficulty, particular attention should be paid to the termination of the drain.

The amount of main ditching on the wet land and also the number of laterals to be constructed is primarily dependent upon the amount of wet or flooded lands in the watershed; also the slope to the outlet and the feasibility of connecting such lands. If there are numerous sloughs separated from the main body of water or much land to be benefited by connections to the main drain or drains, the engineer should consider the extent of minor work and whether this can be done to best advantage by a contractor or by the land owners. Owing to the lack of knowledge of handling the construction of these laterals by the residents and frequent difficulty in securing local labor to attend to this minor ditching work, it is generally advisable to have all laterals dug as part of the contractor's work. There is one drawback to this by reason that the laterals frequently have to be dug after construction of the main drain and this means delay for the contractor and possibly a higher yardage price for the job. Therefore, full information as to class and cost of local labor as compared to regular contract work is necessary before deciding the extent of ditching.

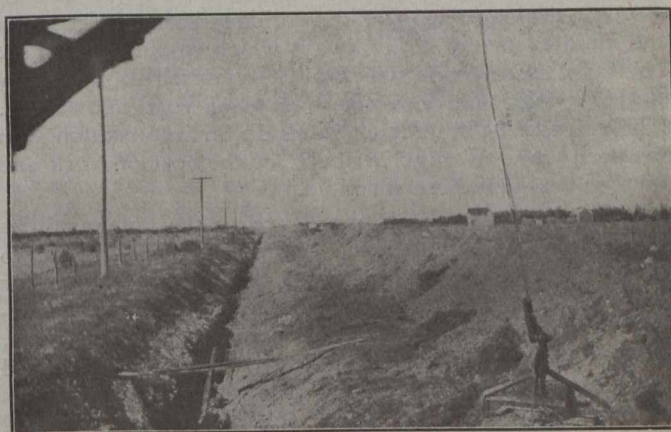
Another difficulty occurs at places where the flow of water in a watershed is interfered with by railway grades. In many cases these grades have been built at times of high water and culverts have been placed too high as well as being omitted where required. The result is that an extra cost in drain crossings of railways is incurred by having to put these improvements on the railway right-of-way. In doing this work the drainage district is put to expense in paying for something that the railway company should have done in their original construction work. It is nearly always difficult to assess the railway company so that they will pay their proper share of such work because of lack of definite information regarding such matters as maintenance-of-way cost in this province. Therefore, the presence of a railway grade is a drawback to the development of drainage work unless the company to appreciate the value of the work and assist in bearing a share of the construction cost as well as facilitating the work around their right-of-way. The rights and attitude of the railway company in each case should always be investigated before finally deciding on details near their grade.

Another factor to be noted is the permeability of the soil. In the case of some bodies of water the percolation is very rapid and by noting this the amount of ditching required may be reduced. If the water levels on unconnected sloughs (that is, on the surface) are the same or very nearly so after heavy rains, it may be safely assumed that the lowering of the water level of one will quickly affect that of the other. Test borings of the soil should be taken to make certain if the engineer is considering whether such ditching is necessary.

The above points, along with the general rule of making all laterals "pay for themselves," will largely help to decide the length of the drains. The capacity and design of the drains, also of the culverts and bridges necessary, is usually the most difficult to determine. These points, along with the grade to be used, are decided by the following: Size of the drainage area or watershed; the topography of the area; information as to rapidity of

run-off obtained by gauging discharge of watercourses in the watershed; the soil, firmness and permeability; presence of timber, brush or vegetation; rainfall and evaporation; availability of means of construction, whether dredge, dry land excavators, ditching plows, teams or manual labor.

In deciding upon the grade it has been noted that as low as .02 per cent. has been used with success. This is on account of head acquired through rapidity of run-off. This is in turn due to absence of timber and brush and a sharp slope of drainage district to the drain or drains. In the case of one drain with above conditions it has several times become filled with fine particles of summer fallow but the first rush of water cleaned it out as thoroughly as if the grade of the drain had been many times as steep and therefore there would be no advantage in this particular case in having a greater fall. The average condition in the province calls for about .05 per cent. and this



Drainage and Road Work at Canora, Saskatchewan.

has been used most frequently with the size of drains so far constructed.

In considering the cross-section area of drain and also size of culverts, it is not at all safe to apply formulæ derived from a knowledge of conditions elsewhere to arrive at the amount of water that will be delivered to the drain from a known watershed area in a given time. By doing this it is altogether likely that the engineer will have the capacity too small, as the early run-off is generally much faster than in the drainage areas from which the standard formulæ were obtained. At present we have not enough data to adjust the formulæ to suit conditions in this province and must therefore rely largely upon information obtained by measuring the discharge of watercourses in the locality and the size of the drain can be computed by a comparison of the respective watersheds.

The above-named points will be important in deciding the details of the plans and profiles, and it is then necessary for the engineer to make up an assessment to cover the cost of the work.

The assessment is an apportionment of cost based upon the benefit received by the owners of the land drained. The method employed is very similar to the Ontario regulations, the main difference being that in Ontario the engineer usually bases his assessment on amount of benefit to be done, together with individual estimates of the cost for doing separate sections. That is, a parcel which is near the outlet on which there are too acres of wet land which might be easily drained, would be assessed considerably less than the same area further away and more difficult to drain. It has been customary in assessments in this province to regard direct benefit