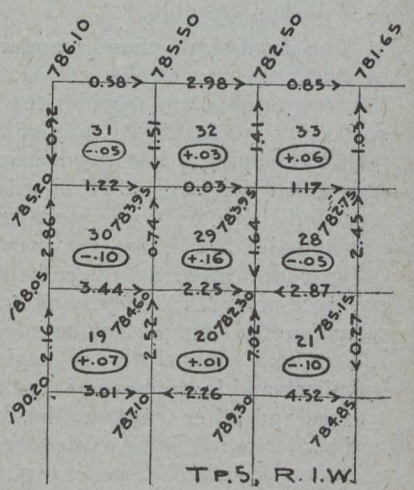
rainfall, about 9 inches falls during the growing season, 5 inches after harvest, which forms a reserve supply for the next season, and 7 inches during the months when the ground is frozen. This last must largely run off the surface or evaporate as it cannot sink in to any extent. Evaporation beyond what is essential to growing crops is undesirable. As it takes heat to boil a kettle, it likewise takes a large amount of heat to boil off an inch of water from an acre. Consequently, land where there is heavy evaporation is more subject to frost than land in good tilth.

With this general introduction we will pass on to a more detailed consideration of the drainage area stretching west from the Red River to the Pembina Mountains, and extending north from the international boundary to within a mile or two of the Assiniboine River. (As previously noted, the watershed of the Assiniboine in this region is very narrow.) There are numerous coulees entering the Red River between its junction with the Assiniboine and the international boundary but they are generally short and of local consequence. Two tributary streams, the Sale and Morris Rivers, form the main outlets for drainage. The watershed comprises slightly over two million acres and of this the Morris River has to take care of some 900,000 acres and the Sale River of some 600,000 acres. The balance is distributed among the various smaller coulees. Several streams which rise in the Pembina Mountains lose themselves on reaching the more level land and previous to the construction of artificial outlets, spread out over the country to form large marshy tracts, one of which, the Boyne Marsh, extended across several townships. In addition to the spring freshets from the slopes of the Pembina Mountains, occasional floods from the Assiniboine inundated large areas, the water following a southwesterly course overland to the Red River. As there are three distinct sources of flooding, (1) local water accumulating on the lower levels from surrounding land, (2) flood water from overflow of streams or drains within the watershed, and (3) flood water from outside the watershed (Assiniboine River) it is to be expected that there might be a diversity of opinion as to cause and remedy. Each phase must be dealt with separately. Both the Morris and Sale Rivers are subject to backwater from the Red River, the former to a much greater extent than the latter.

Bench Monument, Cast Iron Protected by Concrete Ring. Lower View Shows Monument in Place

Drainage is of necessity a local problem. Certain general principles apply everywhere but these are so modified by conditions of climate and soil, by the industries affected and by the nature of the relief required that a study of the question right on the ground itself is imperative. In Manitoba the spring floods occur at a season which is a critical one for the farmer. A little delay in spring seeding may make the difference between a good crop and a failure. Drainage, to be effective, must relieve the land quickly of its surplus water. Even in a dry season it does not pay to have water lie on the surface. It is noticeable in a field of grain that where spots have remained wet until the water sinks in or evaporates, the grain does not germinate readily and weeds get the upper hand, resulting in a poor yield.



Specimen Diagram Showing Closures in Each Square Mile (Eliminated by Adjustment)

Among the general principles which apply to all drainage we may mention the following:—

(1) The capacity of a drain or drainage system should increase and not decrease toward the outlet. In figuring the capacity, actual service conditions must be taken into account. Where the grade is decreased, the width must be correspondingly increased. It is often the practice to widen a shallow portion of a drain and then revert to a narrow cut through a succeeding ridge, forgetting the principle that water will find its level and overflow in the shallow portion before reaching a level of corresponding capacity in the ridge.

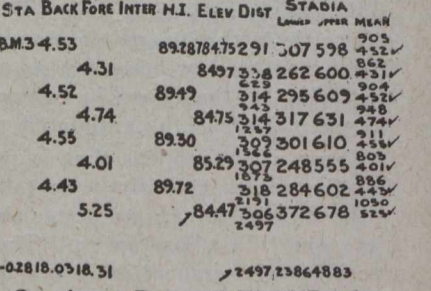
(2) A suitable grade, as uniform as possible, should be chosen to prevent erosion and sedimentation.

(3) A comprehensive survey should be made of the whole area draining or likely to be drained through any part of the proposed system, so that account may be taken of future extensions. The system should be so located as to serve every part of the area to be drained by it, but on no account should water from another watershed be diverted into a system not designed to receive it.

Among the special conditions which affect the district under consideration, two are outstanding:—

(1) The drains at the time they are required to give the most service are full of packed snow and ice, which retards the flow and exaggerates any inequalities in capacity.

(2) The district depends almost entirely on surface water for domestic and farm purposes, the underground supply being saline and unsuitable even for stock. Consequently, all watercourses, both natural and artificial, are dammed at intervals to hold the water. This not only checks the flow but through sedimentation permanently decreases the capacity. The most satisfactory solution of



Specimen Page of Field Book, Showing Checks