

of ditches at the price the work could be man-handled in New Zealand. This is correct in so far as it goes, but the trouble is to have sufficient labour at the right period in New Zealand.

It is confidently expected that some of the walking-dredges now coming to hand for New Zealand will help to solve the question, as lessons learnt from their use may result in the design of a lighter type. A good cleaning-machine was observed in Alberta, and is also in use in the Imperial Valley, California. It runs on three wheels and straddles the ditch, and its mountings consist of a set of buckets placed transversely. Unfortunately, it is hardly suited to peaty ditches, as it requires a hard shoulder to bite on. The cost of this machine is about \$11,000 in America.

It was observed that annual maintenance is better taken care of in New Zealand than in America. In provinces in Canada, such as Manitoba, where the drainage operations are conducted by the State, maintenance is considered as being absolutely necessary, and a special rate is struck for the purpose.

Projects run by land companies are in a bad position as regards maintenance, the settler being at the mercy of the company.

SEDIMENTATION.

No greater attention is paid to this feature than is the case in New Zealand, and the same problems of silting of lower reaches of ditches and the slacking-off of grade due to light material being carried down-stream are to be witnessed everywhere. Even on very flat gradients the light silt is carried down-stream; and it should be noted that there was not observed in America anything to approach in lightness of weight the pumice soil encountered in much of the Auckland District. The fine silt of the Mississippi River resembles certain of the New Zealand rivers, such as the Clutha and the Taieri.

The general practice is to dredge silt-traps throughout all large ditches, and it is only in rare cases that any attempt is made to catch silt in "paddocks." This can be done where it is possible to obtain an area at a very low price, or where a town is affected and a higher price would be justified.

Siltation is met by dredging in America, and will have to be so met in New Zealand, together with the aid that silt-traps afford.

EROSION OF DITCHES.

Erosion of banks of ditches and canals appears to be a world-wide evil, and generally is met by designing wide berms, easy slopes, and making the channel over size. Easy slopes would appear on the face of it to be the remedy, but frequently they weather more rapidly than, say, $\frac{1}{2}$ -to-1 slopes do. American engineers take this into consideration, but the universal aim is to obtain 1-to-1 slopes. As a matter of fact this is not by any means always obtained, and neither are the wide berms. Few swamp-drainage channels can be seen in America presenting better banks, berms, and slopes than is the case in New Zealand.

It is recognized that these points are extremely important, but it is only by utilization of special plant that broad berms can be obtained. Drag-line excavators provide quite the best class of berm, outside of dredges fitted with long-range booms or jibs, and suction dredges which place hydraulic fills. The toe of berm should not be within a 1-to-1 slope line drawn from the edge of base of ditch.

EROSION OF HILL-LAND AND CONTROL OF HILL-WATER.

Much attention is being paid to this question, as undoubtedly much of the silt that reaches the ditches is composed of water-borne silt from the hills. This is particularly the case in light loamy soils. This problem has been largely tackled in the Carolinas and Georgia by means of terracing, and has been most successful. It should be noted that this is not done altogether to prevent sedimentation of drains, but rather to save the top soil and fertilizer of the cultivated land from being washed away either into ditches or on to the grassed bottom lands. In the latter instance the pasturage is for the time being quite lost. This control system is obviously not one of the direct functions of the drainage authority, although it has been advanced by engineers as being of utmost necessity in many projects.

FLOOD PROTECTION.

The above subject being of great importance, opportunity was taken to learn as much as possible of the measures taken in the United States to meet flooding conditions.

Rivers.—The levees along the Mississippi, Sacramento, and other rivers were closely observed, and the nature and manner of constructing same noted. Construction by such means as hydraulic dredges, long-range clam-shell dredges, tower excavators, drag-line excavators, and last, but not least, horse scrapers and graders, each play their part. The Mississippi levees were visited in many places between St. Louis and New Orleans. The operations on the above major rivers cover the field of best practice.

The very extensive flood-prevention works of the Miami Conservancy District were visited, as they provide quite the most elaborate flood storage-basin system in America. It is a liberal education to have the opportunity of seeing all the ramifications of this project, and at the same time have it personally explained by those in charge. The scheme will cost some £5,000,000, and its main objective is to protect the City of Dayton, Ohio, and its population of 250,000. Complete sets of plans, specifications, and research data were obtained for reference.