Structural measures can also be expensive, largely because they have to be built on a large scale if they are to be at all effective. Many may only be used at long intervals, perhaps decades long, when high floods occur and without regular maintenance it is easy for the installations to fall into disrepair and fail when required. These structures are most effective when they form part of a well-thought out flood control strategy and are combined with the non-structural measures, such as land-use regulation and flood forecasting, described in the next chapter.

Dykes

These are earth banks built along both sides of the river to contain the flood flow. Other terms for dykes include levees, bunds, stopbanks, flood banks. Confining the spread of flood flows by dykes means and that the river level will flow deeper and faster with increased risk of scouring of the main river channel. Also if the dykes are too near the river bank, the foot of the dyke can be eroded, leading to its collapse. These effects can be avoided by spreading the dykes further apart, but then less of the flood plain would be protected and any pre-existing structures in this area would not be protected unless special ring dykes were built around them.

Dykes are designed to contain some design flood, usually set as the flood with a given return period, say, the 100-year flood. Any higher floods would overtop the dykes and nominally protected properties would again suffer flood damage. For this reason, it is sometimes required that even properties protected by dykes should be floodproofed. The Province of British Columbia in Canada has required this in a number of instances. To contain the flood fully, the dykes need to run the full length of the flood plain, perhaps several hundred kilometres, and can thus be extremely expensive structures. Much of the detailed engineering design concentrates on reducing the costs. An alternative is to dyke the more important areas, such as towns and cities, with the dykes being carried back to the higher land off the flood plain so as to keep the flood from these areas. This compromise is hydraulically sensible. The flood spreading over the unprotected land means lower floods around the protected areas. In the Great Flood of 1993 in the United States many low dykes protecting agricultural land collapsed and this eased the pressure on the dykes protecting cities.

The dyke is constructed by using earth from the site. In many respects a dyke is a very long earth dam, but in the case of an earth dam it is possible to seek the best materials, even from some distance away. However, the great length of the dyke precludes this and the materials available near at hand have to be used. To compensate for the poorer materials the dyke must be made wider, with flatter side slopes to ensure stability even though this requires more material. Once built the dyke needs to be maintained. Regular inspection is required to ensure that parts have not collapsed or been eroded by the passage of humans and animals. After each flood some remedial work is almost certain to be required.

Dykes can fail by overtopping, by seepage eroding the front face of the dyke, and by a form of localized erosion called piping. As the flood approaches the top of the dyke, certain low spots will be the first to be at risk of overtopping and they can be temporarily reinforced by using sandbags. Any overtopping of the dyke must be avoided as it will rapidly lead to erosion of the dyke and an ever widening breach allowing flood waters free access to the protected area. Con-