Chapter 8

Operation and maintenance

Once a drainage system has been installed, arrangements have to be made to ensure that it will function properly for a long time to come. For this, a good plan for its operation and maintenance is needed. In this plan, the following issues have to be addressed:

- Why and when is maintenance necessary? What are the objectives? What will be the frequency? What are the costs and benefits?
- Who is responsible for the planning, execution, control, and financing?
- How is it to be done and by whom: the government, the farmers, or contractors?
- How are the costs to be financed? Who will pay and how is the money to be collected?

This manual is restricted to the technical aspects of the operation and maintenance of drainage systems. The institutional aspects will be treated in Training Manual No. 10: *Irrigation Scheme Operation and Management*.

"AS-BUILT" DATA OF DRAINAGE WORKS

Maintaining a technically sound drainage system requires maintaining a good drainage base, making regular inspections of the system, and repairing and cleaning it when necessary. The agency responsible for the operation and maintenance should have available the "as-built" data on the drainage works (i.e. as they were built). These include an accurate map of all the main components such as field drains, collectors, connections, and outlet structures (Figure 59).

In addition, the agency should know the elevations of collector points (outlet, inflow and outflow levels in manholes, longitudinal sections), of field drain outlets, and of reference points on major structures like manholes. Most of the required data will be found in the design specifications, but they may need to be updated, because the actual construction may have deviated from the design.

MONITORING

There are three kinds of checks to be made after a drainage system has been installed: a post-construction check, routine checks, and thorough checking.

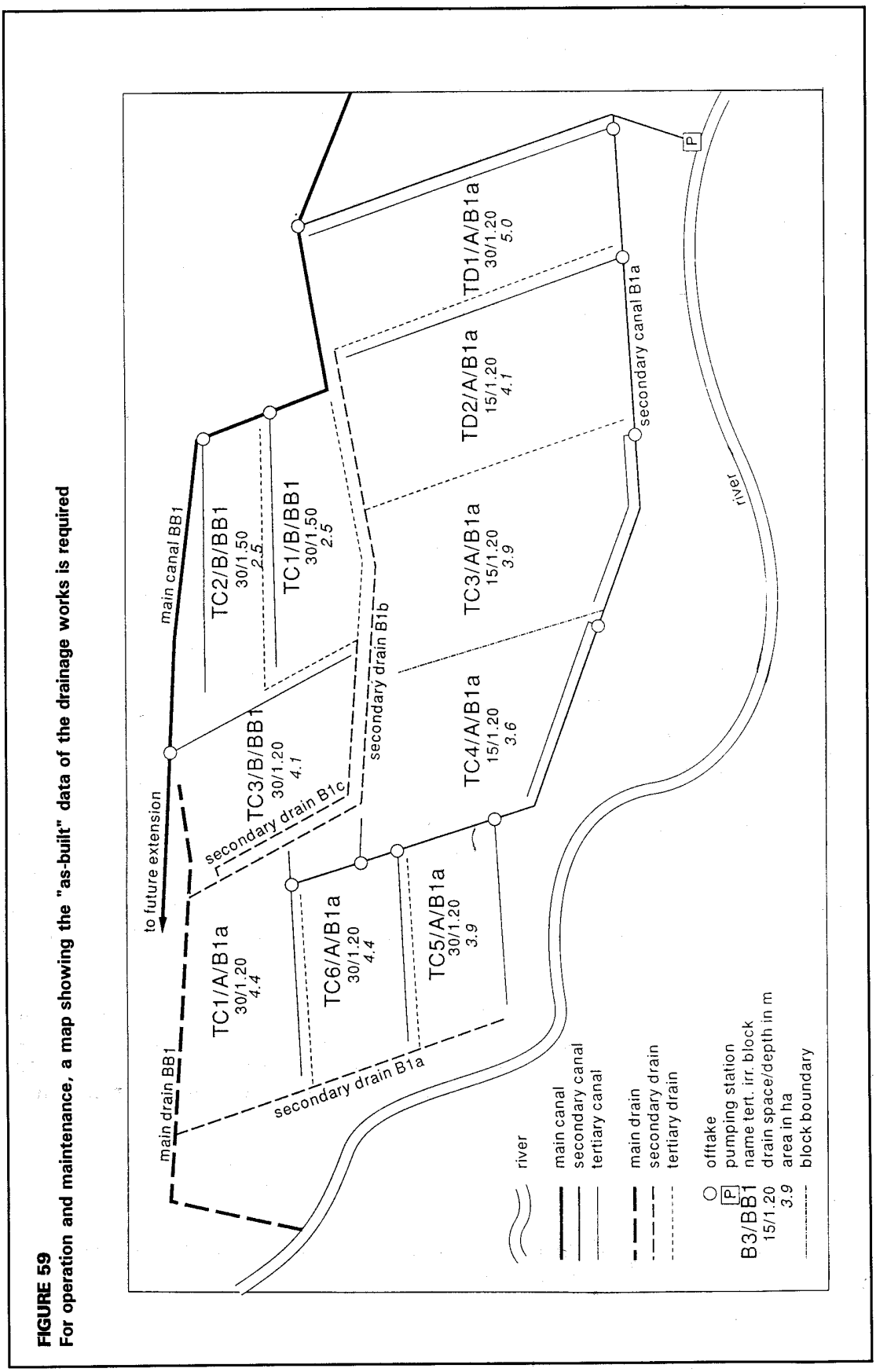

FIGURE 59
For operation and maintenance, a map showing the "as-built" data of the drainage works is required

A post-construction check

A post-construction check is done to find out whether the construction was done to an acceptable standard, and whether the drainage works have been delivered in good functional order. This check is mainly covered under the field supervision discussed in Chapter 7.

Routine checks

Routine checks are simple operation-and-maintenance inspections to verify whether the system is functioning properly, and to see whether there is any need for repairs or cleaning. Simple routine inspections can be done according to a locally suitable checklist. Important points to include in such a list are:

- Check the drainage base, which means checking whether the pipe and open drains have free outflow, especially in a period when drainage is most needed. Note, however, that an occasional, very brief submergence of the outlets is normally accepted. A good drainage base is the first and foremost condition for a drainage system to function satisfactorily. If the drainage base is found to be unsatisfactory, the main drainage system should be maintained or improved.

- Check that drains are discharging during and shortly after rain or irrigation (Figure 60).

- Monitor water levels in field and collector drains. High water levels indicate an obstruction in the drain. When high water levels are found, the water levels along a drain should be compared, which may give a clue as to where the problem lies (Figure 61).

- Check whether sediments or other pollutants have accumulated in the drain, structures, or outlets.

- Look at the land surface for wet spots, as signs of waterlogging, a few days after rain or irrigation (Figure 62).

- Check the depth of the water table, especially where wet conditions are found. The water table can be measured in a auger hole or observation well.

- Look for any damage to pipe outlets and structures: a damaged outlet restricts the functioning of a drain.

Note that the observations on drain outflow, water levels, and wet field spots should, of course, concern the same drainage event and the same drain. A suitable time schedule for the above routine inspections would be to start with a first inspection shortly after the system has been installed, during the first or second drainage event when the drains should be running. Further inspections could follow about once a year, a frequency which, after a few years without problems, could possibly be reduced to once every two years. In an irrigation-drainage project, storage of these data in the operating agency's computer data bank is highly recommended.

FIGURE 60
A drain should be discharging shortly after rain or irrigation

Thorough checking

A thorough check of the functioning of the system may follow after a routine inspection has revealed significant problems. Such a check may also be intended as a monitoring programme, aimed at improving the design of future drainage projects in the region.

Beside these checks on the physical performance of a drainage system, the effectiveness of the investment in drainage should also be assessed; in other words: "Is the drainage system working as designed?". A monitoring and evaluation (M & E) programme could make such an assessment and could be used to check the criteria used for the design. Monitoring and evaluation should usually be considered from a long-term viewpoint, and should be based on factors that are relatively easy to evaluate. Consideration should be given to the proper collection, storage and retrieval of data. This is of the utmost importance for the subsequent physical and economic analysis of the project.

FIGURE 61
Testing the performance of a collector drain by comparing the water levels in the manholes: (A) collector is functioning according to the design (= no overpressure); (B) overpressure in manholes 1 and 2 indicates obstruction between manholes 2 and 3

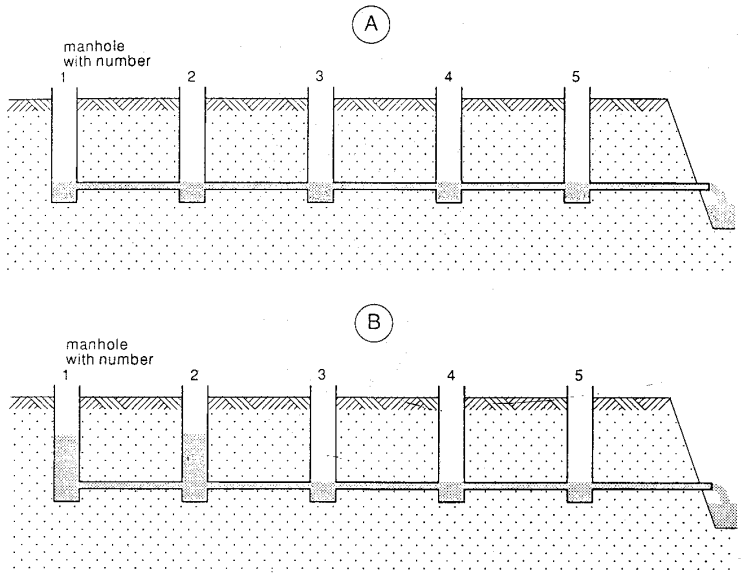

FIGURE 62
Wet spots on the land surface are signs of waterlogging

FIGURE 63
In a monitoring and evaluation programme, data on crop yields are collected

In a drainage monitoring programme, the items to be considered are:

- Crop production (Figure 63).
- Drainage water quantity and quality.
- Groundwater quality and level.
- Soil salinity.

FIGURE 64
Maintenance of the land surface by animal traction

MAINTENANCE

Land surface

The benefits derived from land forming will often depend on good maintenance in the subsequent years. A bedding system requires regular maintenance. Care should be taken to eliminate any obstructions to flow or low points in the drains because they will cause standing water and loss of crops. In graded fields, the land should be smoothed each time a field has been ploughed. A small leveller or plane powered by animal traction (Figure 64) or a farm tractor can be used for this purpose.

Open drains

Major problems in maintaining open drains may be due to erosion, settlement, silting, vegetation and seepage. Before the drainage season, drains should be cleaned (e.g. with a shovel or a V-drag); all vegetation should be removed, and side slopes and banks should be repaired when necessary (Figure 65). Siltation should be monitored and removed when required. The frequency depends on the local situation and no hard and fast rules can be given.

Pipe drains

For the maintenance of pipe drains, the problems may be physical blockages, organic and biological blockages, chemical or mineral sealing, and outlet restrictions.

FIGURE 65
Maintenance of open drains should be done before the drainage season

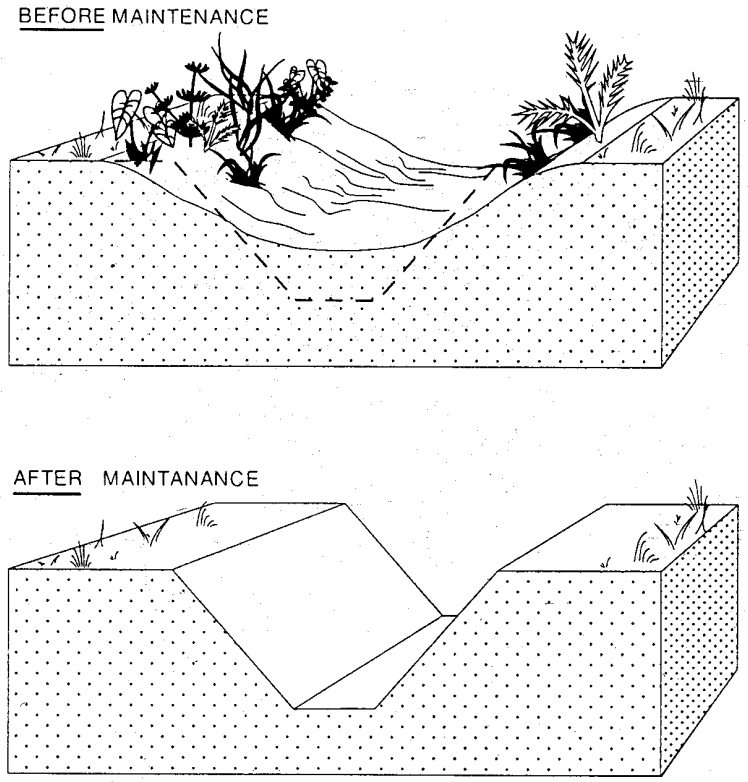

FIGURE 66
Flushing machines are used to clean pipe drains

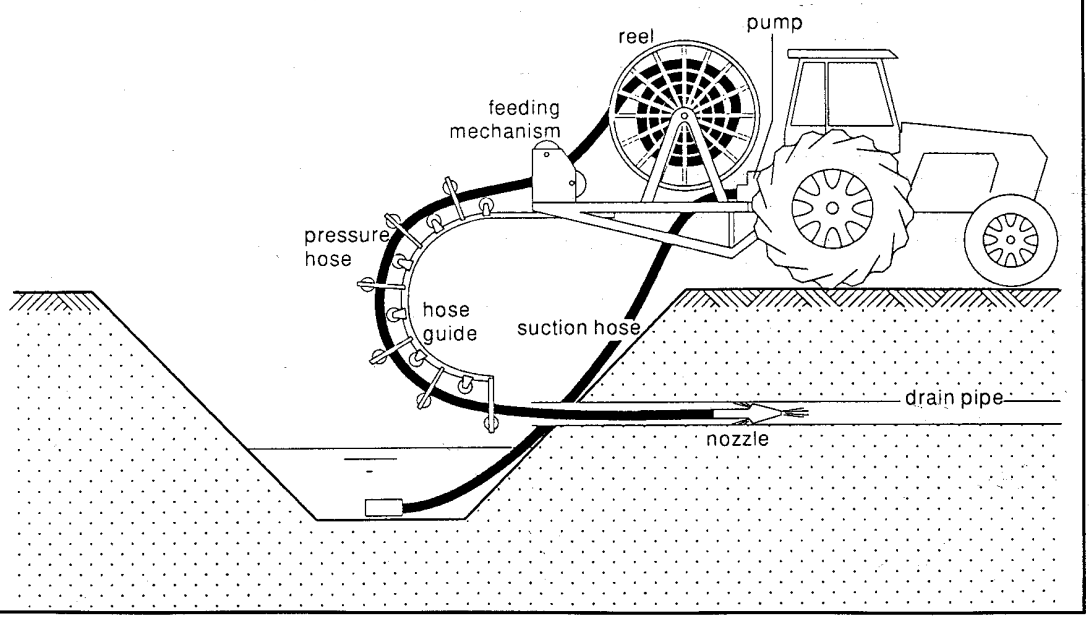

FIGURE 67
Scouring and sedimentation in a drop structure after a high discharge

Before the drainage season, a visual inspection of all outlets should be done, and water levels in manholes should be monitored to check for obstructions or siltation in the pipe sections. Pipe lines can be cleaned with specialized flushing machines which remove sediment from the pipes (Figure 66).

Structures

Structures normally have a higher safety factor than the drains, and in general need less maintenance. Nevertheless, regular and timely inspection is required to identify problems and maintenance needs. This concerns visual inspection as well as regular hydraulic surveys. Moving parts in doors and gates should be checked for wear and tear, and inflow and outflow openings should be cleaned of debris and checked for scouring and damage to banks and the structure itself (Figure 67). In tidal areas and in rivers and drains with high sediment loads, regular flushing and/or dredging might be required.

Without maintenance, a drainage system will not function properly and no sustainable agriculture can be achieved (Figure 68).

FIGURE 68
Good maintenance benefits the farmers

Suggested further reading

FAO. 1976. Drainage testing. *Irrigation and Drainage Paper 28*. FAO, Rome. 172 pp.
This publication gives guidelines on how to test the functioning and adequacy of single drains and drainage systems.

FAO. 1970. Drainage materials. *Irrigation and Drainage Paper 9*. FAO, Rome. 122 pp.
This paper discusses the materials used in the construction of pipe drainage systems.

FAO. 1980. Drainage design factors. *Irrigation and Drainage Paper 38*. 1980. FAO, Rome. 52 pp.
This paper, which is based on an expert consultation, gives 28 questions and answers on drainage design factors.

FAO. 1983. *Guidelines for the Preparation of Irrigation and Drainage Projects.* Revised Edition. FAO, Rome. 31 pp.
Gives guidelines for a feasibility study, which provides the answers to questions that might be raised in the course of project appraisal.

Framji, K.K., Garg, B.C. and Kaushish, S.P. 1984. *Design Practices of Open Drainage Channels in an Agricultural Land Drainage System: A Worldwide Survey* . International Commission on Irrigation and Drainage, New Delhi. 343 pp.
This volume consists of two parts. Part I reviews the design of open drainage channels: system layout, design capacity, channel shape, roughness coefficient, permissible channel velocity, longitudinal channel slope, side slope. Part II contains the country reports of Australia, Bangladesh, Canada, Colombia, Czechoslovakia, Egypt, France, Germany, Greece, India, Iraq, Ireland, Japan, Malaysia, Morocco, Portugal, Saudi Arabia, Sudan, UK and the USA.

Ritzema, H.P. (ed.). 1994. *Drainage Principles and Applications*. Second (completely revised) edition. ILRI, Wageningen. 1994. 1125 pp. ILRI Publication 16.
This completely revised second edition of *Drainage Principles and Applications* is based on lectures delivered at the International Course on Land Drainage, which is held annually by the International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. The book covers all the various topics useful to those engaged in drainage engineering. Includes a glossary.
Also available is a Spanish version published in 1977, entitled: *Principios y Aplicaciones del Drenaje* (in four volumes).

Schultz, B. 1990. *Guidelines on the Construction of Horizontal Subsurface Drainage Systems*. International Commission on Irrigation and Drainage, New Delhi. 236 pp.
This book starts with an inventory of subsurface drainage systems and then briefly reviews their design. It discusses drainage materials and equipment to install the drains.

It then recommends construction methods, and advises on operation and maintenance. Finally, it treats the cost-benefit analysis of projects. Includes a glossary.

Smedema, L.K. and Rycroft, D. 1983. *Land Drainage : Planning and Design of Agricultural Drainage Systems*. Batsford, London, UK. 376 pp.
This book discusses the diagnosis of agricultural drainage problems and their solutions, based on an understanding of the physical principles involved. Land drainage is treated as being a field of applied soil physics and applied hydrology. All major drainage problems are covered, each in its particular environment and field of application: Groundwater Drainage; Water Table Control; Surface Drainage of Sloping and Flat Lands; Shallow Drainage of Heavy Land; Drainage for Salinity Control in Irrigated Land; Drainage and Reclamation of Polders; Drainage for Seepage Control; Main Drainage: Design Discharges, Canal Design, Outlets.
The book stresses the universal relationships between the main design variables and soil, climatology, and other relevant environmental conditions.