5

Simplified Sewerage in Practice

The practical aspects of simplified sewerage considered in this Section are construction (Section 5.1) and operation and maintenance (Section 5.2). These are extremely important for the overall sustainability of the system, which is briefly reviewed in Section 5.3.

5.1 SIMPLIFIED SEWER CONSTRUCTION

5.1.1 The need for good construction practice

Good construction of a simplified sewer network is essential as poor construction inevitably leads to major operational problems, and even to system failure (Watson, 1995). Good practice is similar to that used for conventional sewerage (see, for example, Metcalf & Eddy Inc., 1981), but special care has to be given to laying small diameter sewers at shallow gradients. Good construction supervision is essential (lack of supervision generally leads to poor construction) but difficult to guarantee. One option that should be carefully considered is the training of small contracting companies inexperienced in simplified sewer construction. This is likely to be extremely beneficial – such training, combined with construction supervision, is probably the best way to ensure good construction.

5.1.2 Sewer gradient and ground slope

The slope of the ground surface (S, m/m) may be (a) less than, (b) equal to, (c) greater than, or (d) much greater than, the minimum sewer gradient (I_{min}, m/m) calculated from equation 2.25. Furthermore, the depth to the invert of the upstream end of the length of sewer under consideration may be (a) equal to, or (b) greater than, the minimum depth permitted (h_{min}, m), which is given by:

$$h_{\text{min}} = C + D \qquad (5.1)$$

where C = minimum required cover, m (see Figure 5.1)
D = sewer diameter, m

Minimum values of C used in Brazil are 20 cm for in-block sewers and those laid in front gardens, and 40 cm for those laid in pavements (sidewalks). Tayler (1996) recommends minimum values of C between 25 and 50 cm for concrete pipes laid in lanes and roads with 100 mm gravel or brick ballast bedding (Table 5.1).

Table 5.1 Minimum cover for concrete pipes laid in lanes and roads (Tayler, 1996)

Road width (m)	Heaviest vehicle	Minimum cover (cm)
< 3	Motorcycle	25
3 – 4.5	Light car or van	35
4.5 – 6	Cars, horse-drawn carts, small trucks	40
> 6[a]	Occasional trucks	50

[a] Residential areas only

There are six combinations of sewer gradient and ground slope that are likely to be encountered in practice. These are (see Figure 5.2):

Case 1. $S < I_{min}$ and the invert depth of the upstream end of the sewer (h_1, m) $\geq h_{min}$: choose $i = I_{min}$ and calculate the invert depth of the downstream end of the sewer (h_2, m) as:

$$h_2 = h_1 + (I_{min} - S)\,L \qquad (5.2)$$

where L = length of sewer under consideration, m.

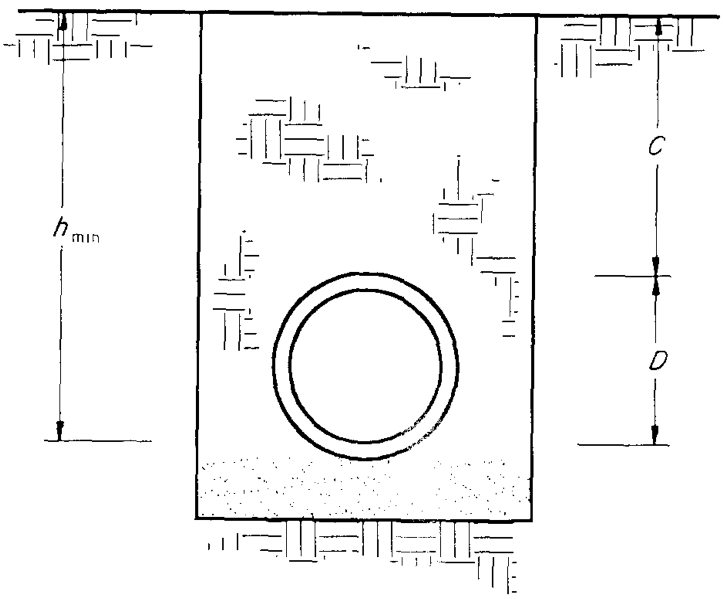

Figure 5.1 The minimum depth (h_{min}) to which a sewer is laid is the sum of the minimum depth of cover (C) and the sewer diameter (D).

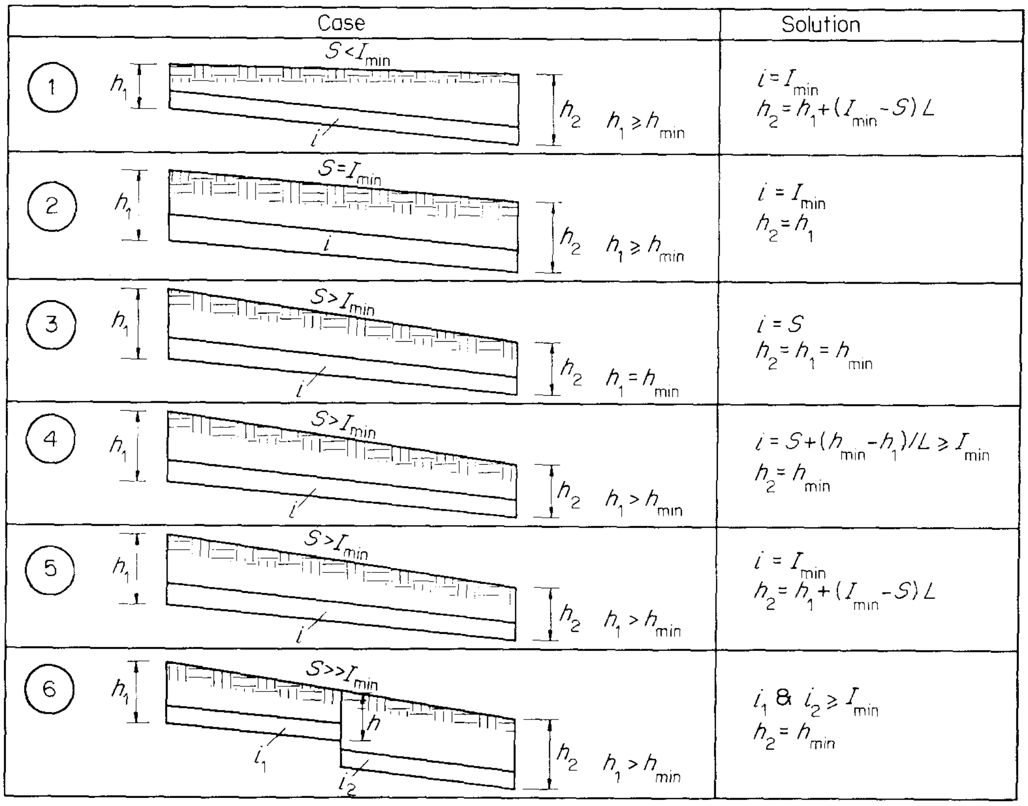

Figure 5.2 Ground slope and minimum sewer gradient: the six commonly encountered cases.

Case 2. $S = I_{min}$ and $h_1 \geq h_{min}$: choose $i = I_{min}$ and $h_2 = h_1$.

Case 3. $S > I_{min}$ and $h_1 = h_{min}$: choose $i = S$ and $h_2 = h_1$.

Case 4. $S > I_{min}$ and $h_1 > h_{min}$: choose $h_2 = h_{min}$ and calculate the sewer gradient from:

$$i = S + (h_{min} - h_1)/L \tag{5.3}$$

subject to $i \not< I_{min}$.

Case 5. $S > I_{min}$ and $h_1 > h_{min}$: as Case 4, but an alternative solution is to choose $i = I_{min}$ and calculate h_2 from equation 5.2. The choice between these alternative solutions is made on the basis of minimum excavation.

Case 6. $S >> I_{min}$ and $h_1 \geq h_{min}$: here, it is usually sensible to divide L into two or more substretches with $h_2 = h_{min}$ and $i << S$ (but obviously $\geq I_{min}$) in order to minimize excavation. A drop manhole is placed at the substretch junction.

5.1.3 Grease/grit traps

If the kitchen wastewater contains an appreciable amount of fat and grease, it is desirable that a small individual household grease trap is installed to intercept the kitchen wastewater before it is discharged into the sewer (Figure 5.3). In Brasília Sarmento (2000) found grease traps functioning well in 90 percent of households in the medium to low-income area of Vila Planalto. However, in general user education may be necessary to ensure people understand their operation and maintenance.

A related problem is that many householders drain water from yards and roofs to the sewer. This practice should be discouraged whenever possible, but it is difficult to avoid completely in areas where there are no alternative storm drainage facilities. Householders should be encouraged to provide a simple gully trap (Figure 5.4) on their property to both attenuate flows to the sewer and catch grit before it enters the sewer. This should ideally be located on a drain carrying only storm water and certainly upstream of the junction with the pipe from the WC. The trap should be built with open-jointed brickwork so that stormwater can percolate away. The base may be earth, no-fines concrete or sand-grouted brickwork, again to increase percolation.

Experience often suggests that people are often unaware of the importance of these traps and an effective campaign of user education will be necessary to ensure that they are cleaned at regular intervals. Of the two, the gully/grit trap will probably be of greater importance in ensuring that the sewer operates effectively, except where the sewer connection is from a restaurant or some other business that generates large quantities of grease.

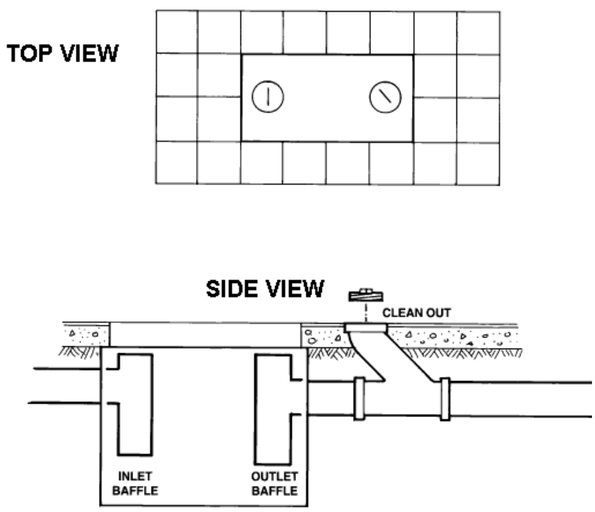

Figure 5.3 Individual household grease trap.

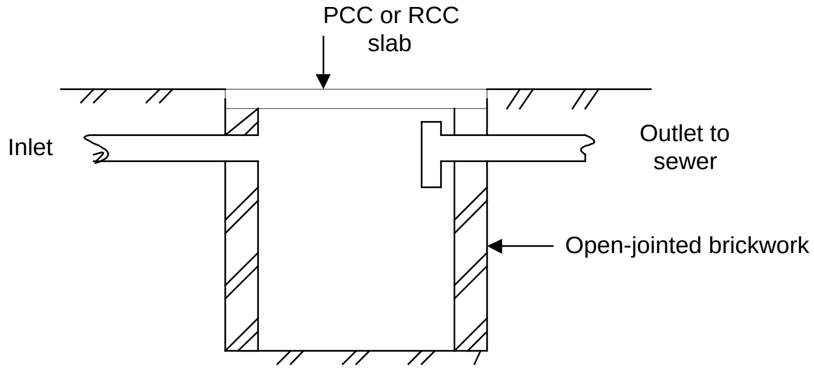

Figure 5.4 Stormwater catchment gully.

5.1.4 Sewer pipe materials

As shown in Appendix 3, hydrogen sulphide generation in simplified sewers can be expected to occur, and thus concrete and asbestos-cement should **not** be used as they will be corroded by the H_2S generated. In practice, therefore, plastic (normally PVC) or vitrified clay pipes should be used. Where possible, plastic pipes are to be preferred as they come in longer lengths and are more easily jointed properly, so that infiltration (i.e. groundwater ingress) is minimised.

5.1.5 Sewer appurtenances

The important point to remember when considering the details of sewer appurtenances is that standards and design details should be related to location and function. Where condominial systems are laid at shallow depths, large expensive manholes can be replaced by simpler inspection chambers or junction boxes. These can be rectangular or circular in shape. Figure 5.4 shows a simple brick inspection chamber as used in Brazil. The Orangi Pilot Project in Pakistan has developed a system based on the use of cast-in-situ cylindrical concrete chambers. Another option is to use pre-cast cylindrical concrete sections, as shown in Figure 5.5. A more recent development is the all-plastic unit shown in Figure 5.6, which is manufactured by Tigre S.A., Joinvile, Brazil.[1]

Junction chambers are normally provided at every connection to the sewer, and inspection chambers at changes in direction and at intervals of no more than 30 m for condominial sewers and 100 m for public collector sewers. At changes of sewer diameter the sewers should be aligned invent to invert in junction/inspection chambers (other than at drop junctions).

[1] Address: Tigre S.A., Rua Xavantes 54, Atiradores, 89203-900 Joinvile, Santa Catarina, Brazil. Email: teletigre@tigre.com.br

Figure 5.4 Simple brick junction chamber for simplified sewerage used in northeast Brazil.

Figure 5.5 Junction chamber for simplified sewerage using larger diameter concrete pipes, used in Guatamala.

Figure 5.6 Plastic junction chamber for simplified sewerage used in Brazil (manufactured by Tigre S.A.).

5.2 OPERATION AND MAINTENACE

For successful operation of a simplified sewerage scheme, there must be an effective partnership between the community served and the sewerage authority (see Watson, 1995). In particular, it is important that both parties are clear about their duties and responsibilities.

As originally conceived by CAERN in northeast Brazil (see section 1.2), this meant that, early in the project planning stage, community meetings were organised by CAERN so that it could explain to the community how the system would work, and how responsibilities for operation and maintenance were to be allocated between the community and CAERN. In essence, the community members were to be responsible for O&M of the in-block sewer, and CAERN would assume responsibility for all ex-block (i.e. street) collector sewers and subsequent wastewater treatment. The community usually allocated each block resident the responsibility for sewer O&M for the length of sewer passing through his or her land, and this included the O&M of any junction boxes, and the clearance of any blockages.

However, this system of community O&M has not proved successful in the long term (see Watson, 1995), and currently different O&M procedures are used. For example, in the state of Pernambuco, COMPESA now contracts a small local contracting company to provide a maintenance team (often a technician engineer and two labourers) for a given periurban area served by simplified sewerage. This team works full-time in the designated area, and residents report any blockages, or other problem, to the team, which then attends to the problem. In Brasília and the

Federal District, CAESB organises its own maintenance teams, and these have vehicle-mounted water-jet units (Figure 5.7) to clean the sewers.

In villages in the state of Ceará covered by the KfW-funded Integrated Rural Sanitation Programme (SISAR), maintenance of the simplified sewer system and wastewater treatment plant (a single primary facultative waste stabilization pond) is done by one of the village residents after training by the Programme. The operator, who is paid one minimum salary (R$ 120, around US$ 70, per month) by the community, is also responsible for O&M of the piped water supply network – abstraction, treatment (including chlorination) and distribution. Village residents pay around R$ 3 (~ US$ 2) per household per month for both water and sewerage. The system works well if the operator is conscientious and if he is properly supervised by the President of the Residents' Association. Technical support is available from the SISAR office in the nearby city of Sobral. The programme currently covers 35 villages.

A slightly different approach is advocated by the Orangi Pilot Project in Pakistan. Here, the initiative to provide sewerage came from communities rather than the government. A key factor here was that government had failed to provide services so that people were used to taking responsibility for providing and managing local facilities. The OPP philosophy is that community members should take responsibility for financing and managing local `internal' facilities, while the government is responsible for all aspects of public `external' facilities. This approach can work reasonably well provided that all the stakeholders accept, and the charging structures reflect, this division of responsibilities. There is a need to define connection charges and tariffs in a way that recognises the costs incurred by both the central provider and the community groups that manage the local `internal' systems. In practice, however, most water and sanitation authorities in Pakistan have not formally accepted this division of responsibilities and few community-built systems are officially recognised.

Figure 5.7 Vehicle-mounted water-jet unit used for simplified sewer O&M in Brasília.

These examples suggest that community involvement in local sewerage facilities connected to higher order facilities managed by government is not without its problems. This aspect of sewer planning should be considered very carefully and it should not be assumed that community involvement will just happen. However, community management has such obvious advantages, in terms both of local `ownership' of sewerage and making the best use of limited resources, that it should always be considered as early on in the project cycle as possible.

5.3 SYSTEM SUSTAINABILITY

The long-term sustainability of simplified sewer systems can be ensured by:

- a good partnership between the community served by simplified sewerage and the sewerage authority;
- good design;
- good construction;
- good maintenance; and
- an adequate, but affordable, tariff structure.

A good partnership between the community and sewerage authority is really essential, especially in periurban areas (Watson, 1995). Community education is almost always necessary (especially in relation to what residents should *not* dispose of via the simplified sewers; maintenance of any household grease or stormwater gully traps; how to report blockages and leaks). It is helpful if there is a well organised Residents' Association which can act as the primary point of contact between the sewerage authority and the community.

With regard to the tariff structure, `adequate' refers to the sewerage authority receiving sufficient income from the monthly charges levied (see Section 1.2), although the authority may choose to operate a system of cross-subsidies whereby it levies higher charges for conventional sewerage so that it can charge less in poor areas served by simplified sewerage. Initial connection fees are likely to cause payment problems in poor areas, and these should be subsumed into the monthly charges. `Affordable' refers to the ability of the residents to pay for the simplified sewerage service. In Brazil, for example, the Federal Government recommends that combined water and sewerage charges should not be greater than 7 percent of income; if this is taken as one minimum salary (R$ 120 per month), then water and sewerage charges should be no more than R$ 8 (~ US$ 5) per month.