57. Surface water drainage — How evaluation can improve performance

This Technical Brief outlines ways in which, by carrying out a simple evaluation, engineers and technicians can make improvements in the performance of drainage systems.

Urban drainage is the removal of unwanted water from cities and large towns. When it rains, part of the rainwater, called *runoff*, runs off the surface and flows along the ground. Surface-water drainage removes this runoff.

Without surface-water drainage, frequent flooding creates many problems:

- floods damage roads, houses, and goods at major cost;
- during floods, runoff mixes with the human wastes inside latrines, septic tanks and sewers, and spreads them wherever the runoff flows; and
- mosquitoes breed in ponds (even small ones!) that are not drained within a week, so contributing to malaria and other diseases.

Flooding can occur where drains are:

- poorly designed;
- poorly built; or
- blocked with solids such as rubbish, or broken brick, bits of concrete, soil, and human wastes.

NO drainage system can protect residents from all storms. In many cases, however, drainage does not work as well as it could, so there is unnecessary flooding.

Why evaluate drainage?

Evaluations can answer such questions as:

- Is flooding a problem in this area?
- Are drains blocked? With what?
- How does the drainage system work in practice?
- Is maintenance a problem? Can it, realistically, be improved?

Drainage evaluation methods

Is flooding a problem in this catchment?

There are two useful approaches: asking residents (resident surveys), and seeing for yourself (direct observation).

Resident surveys

People who have lived in one area for several years know a lot about flooding – they remember when water flooded their homes. You can get an idea of which areas are worst affected by simply talking to people. There are simple rules:

Avoid 'leading' questions
People's answers reflect what and how they are asked. Questions must be open and neutral, allowing each person to express him or herself freely; 'What happens when it rains?' is better than 'Does it flood a lot here?'

Ask more than one person
If just one or two people are asked, they will know some parts of the area better than others. If men work outside the area, and women spend more time in the home, women will know more about minor flooding.

Try to be specific
It is probably better to ask first about last year's flooding, rather than 'how high does water rise?' It is also best if residents find a specific place to show the high water mark, rather than stating that 'water was knee-deep.'

Direct observation

Walking around in a storm can be a good way to see what happens when it floods. It is a fairly limited exercise, however, because:

- you can only do in the rain;
- you cannot be everywhere all the time; and
- you can easily miss the most important part of the storm.

Direct observation during floods is more helpful in getting a feel for how the system works as a whole, than for gauging severity accurately.

Surface water drainage

Are the drains blocked?

The best way of finding this out depends on the type of drain — open drains are much easier to check than closed ones.

Open drains

If open drains are used only for runoff, they are dry in dry weather. A quick walk along the drain can give you a good idea of the extent of the blockage. Frequently, however, open drains carry sewage as well as runoff. While a quick look can find a complete blockage, it cannot tell you much about the solids below the surface. A survey, using simple equipment to gauge the amount of blockage, can be helpful (see Figure 1 below).

In any drain where there are substantial solids, parts of the drain must be cleaned out to find the true depth to the bottom. Forcing a steel rod through deposits until you 'hit bottom' will *not* work, as the rod may lodge itself on top of a rock or brick, rather than at the true bottom of the channel.

Closed drains

Finding blockages in closed drains is more difficult, especially if they also carry sewage. Here are two quick checks:

Standing-water checks in manholes

When water is found standing in a manhole above the bottom ('invert') of the outgoing pipe, then something is holding up the flow (see Figure 2 on page 99).

Lamp-and-mirror checks

Where manholes are spaced less than 30m apart, lowering a powerful lamp down one manhole, and a mirror down another can be helpful (Figure 3). If the pipe is clear, the light can be seen clearly in the mirror; if the pipe is blocked with solids, or is not straight, then the light will be partly or completely blocked. Success depends on having a powerful lamp, which you must keep dry or the batteries will run down too quickly.

How does the drainage system behave in practice?

To get the clearest idea, look at how the system works in a storm.

Problem areas for flooding

Systematic observation is difficult unless problem areas have been identified before the storm. Define these using resident surveys *before*

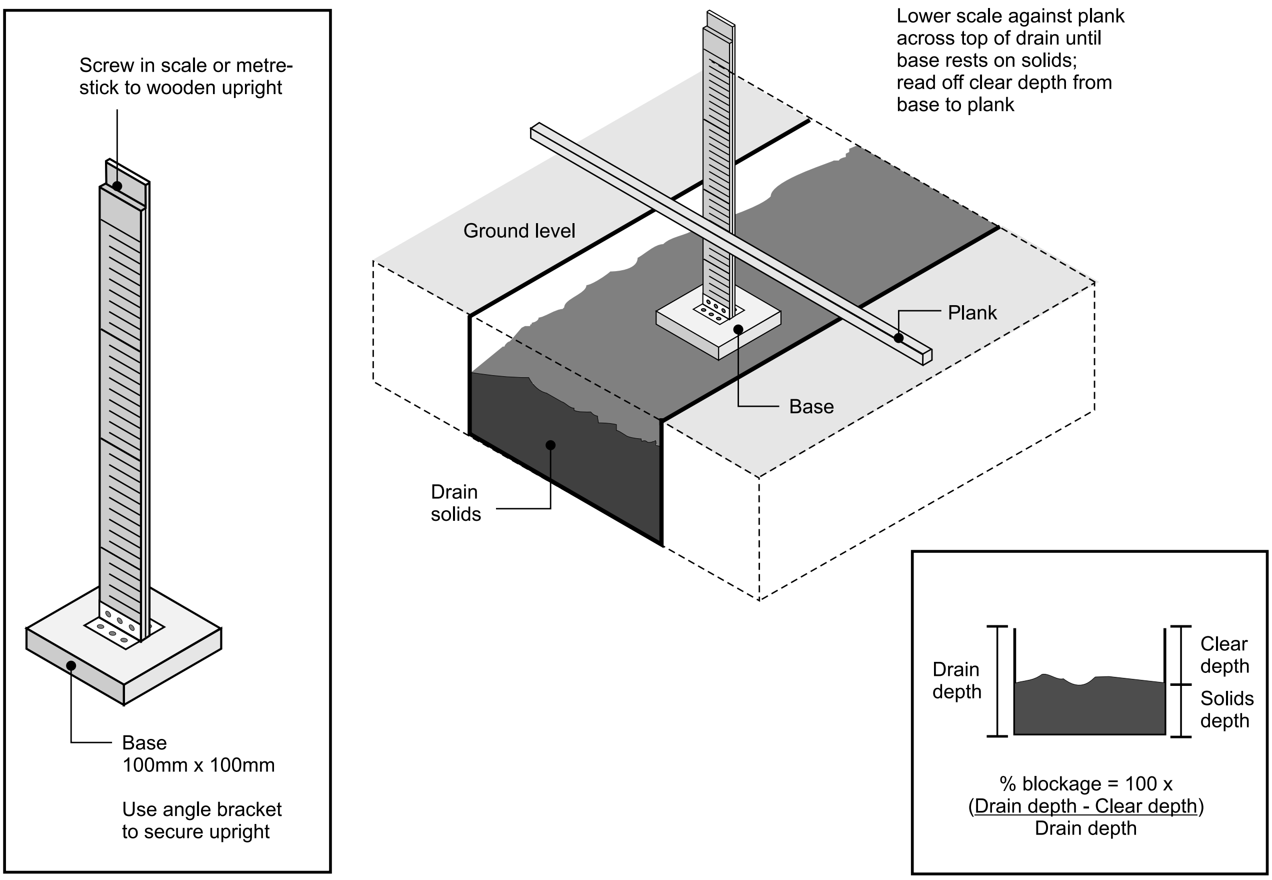

Figure 1. A scale for measuring the depth of solids in an open drain

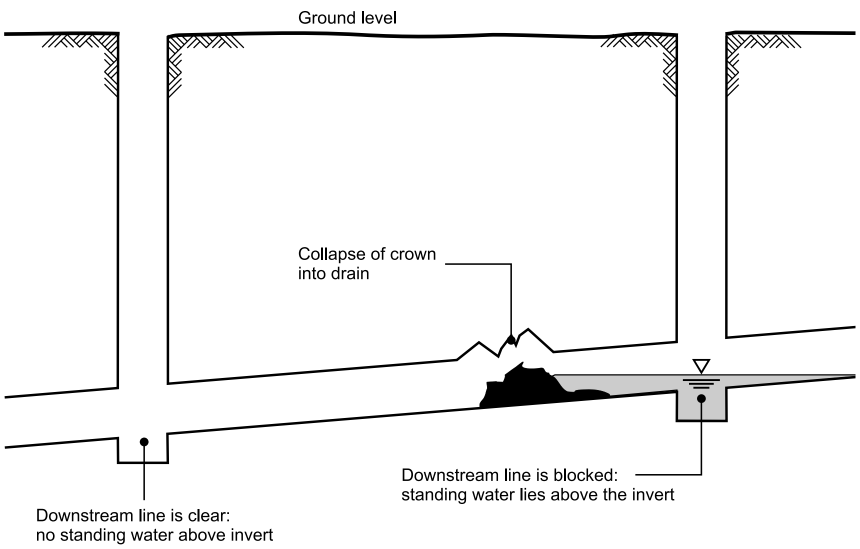

Figure 2: Standing water at manholes — a sign of downstream blockage

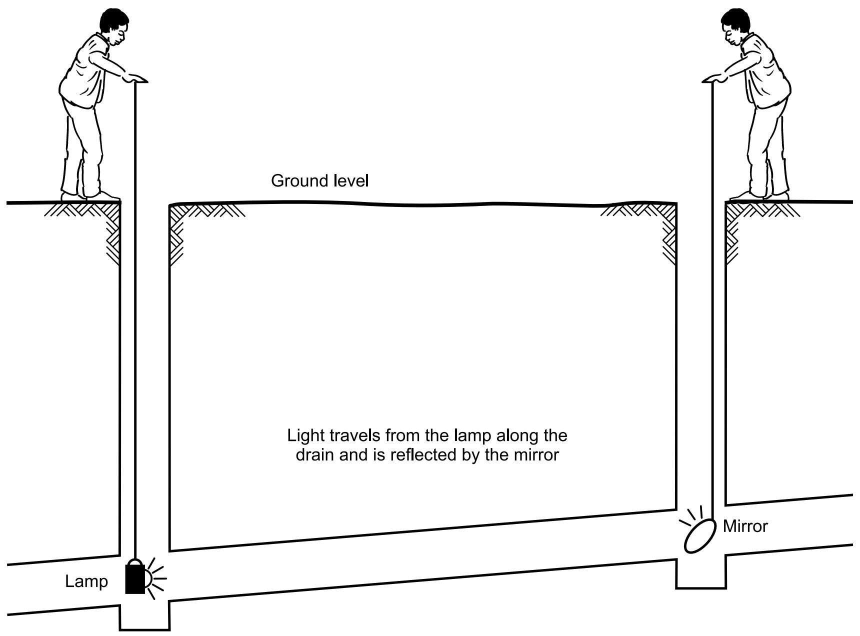

Figure 3: Use of a lamp and a mirror for checking drain clearance

the storm, and assign specific team members to observe them during rain. This can often clarify the cause of the flooding, such as inflows from other areas, or blocked inlets.

The hydraulic performance of the total drainage system

The only way to observe hydraulic performance is to study the drain itself during storms. Such a survey can find:

- overflow locations;
- bottlenecks and high head losses, eg culverts; and
- obstructed entry to the drain, (inlet blockage, poor inlet design, or poor surface grading).

The drainage 'network' is more than just the drain; it includes surface and gutter flow, inlet flow, and whatever is going on downstream, too.

The surface flow routes followed by runoff during floods

Runoff follows surface routes during floods. Study these routes during storms to find out both the impacts on residents, and ways to reduce problems. In some cases, flow leaves one drain and re-enters another with no problem; in other cases, whole areas become flooded.

Sometimes, small changes in such routes, for example, by raising a dyke or removing some soil, can improve the situation significantly. But someone must step back and look around to ensure that the problem of five houses is not being solved at the expense of 20 others!

Working in wet weather

Organizing a team to study drainage during storms

Storms are unscheduled, chaotic, and unpleasant; staff must be organized to work well in bad weather. The manager should assign tasks and responsibilities for the 'next storm' during dry weather – team members then know where they have to go and what they have to do at the start of the next storm *without* having to assemble as a group.

Checking catchment and sub-catchment boundaries

Good maps make this job much easier. Each team member should be allocated a 'beat', and should note on a map the direction of flow along the surface early in the storm. This should be completed within the first storm or two of the season, to define the catchment as early as possible.

Surface water drainage

Summary
Table 1 (right) shows how different data can be gathered at different stages of a storm. In practice, no team can count on a flood occurring, but its members can be ready when a flood takes place.

Improving performance from evaluations
Here are a few examples from experience in the Madhya Pradesh city of Indore:

Understanding the catchment better
The designer may have missed some of the area that contributes runoff. Field evaluations can establish this quickly, and suitable diversion strategies can then be developed.

Solids-depth monitoring
The initial survey of solids depths can identify the first priorities for cleaning. Follow-up surveys can monitor how quickly solids build up after cleaning, and whether cleaning needs to be more frequent.

Table 1. Wet weather observations and timing

	Beginning (or small storms)	Middle (flood)	End (flood-water drainage)
Catchment boundaries	Directions of flow in streets	Catchment boundaries	Catchment boundaries
Flood-prone areas		Bottlenecks, causes of flooding	
Hydraulic performance	Inlet performance, blockages, high head losses	Outflows from drains	Problems of grading, slow drainage, high head losses
Surface routes		Location, direction, and magnitude of surface routes	Location, direction and magnitude of surface routes
Nuisance and hazards		Observe, discuss with residents	Observe, discuss with residents

Blockages
A lamp-and-mirror survey can be a quick and efficient way to get an idea of the condition of old drains. One of the Indore surveys identified several problems within a few hours.

Surface routes of flow
Drainage designers usually focus on the routes of the pipes and channels, and not on the way water flows over the ground during a flood. Minor changes in some street levels can make a big difference to how quickly they drain after a storm.

Acknowledgements

These findings grew out of Research Project R5477, *Performance-Based Evaluation of Surface Water Drainage in Low-Income Communities,* of the Engineering Division of the Department for International Development (DFID). DFID, however, does not accept any responsibility for any of the information provided, or views expressed.

The author acknowledges the help of Dr David Butler, Mr Jon Parkinson, Professor T.A. Sihorwala and the staff of the Indore Drainage Evaluation Project in the development and testing of these approaches.

Further reading

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WATER AND ENVIRONMENTAL HEALTH AT LONDON AND LOUGHBOROUGH (WELL) is a resource centre funded by the United Kingdom's Department for International Development (DFID) to promote environmental health and well-being in developing and transitional countries. It is managed by the London School of Hygiene & Tropical Medicine (LSHTM) and the Water, Engineering and Development Centre (WEDC), Loughborough University.

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