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.

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 it 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.

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.
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 17).

Lamp-and-mirror checks
Where manholes are spaced less than 30m apart, lowering a powerful lamp down one manhole, and a mirror at 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

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

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.

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Further reading

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