

3. Alternative approaches to the removal of litter

3.1 Introduction

In the previous section, the huge variability in the types and amounts of litter coming off different catchments was presented. For example, if the figures are to be believed, South African catchments produce from ten to one hundred times as much litter per hectare as do Australian and New Zealand catchments. If the Australian and New Zealand public are concerned about litter along their waterways and on their beaches - and they are extremely concerned - how much greater should be the concern in South Africa?

What is the solution?

It was pointed out in Section 1 that litter is a problem associated with human habitation. Section 2 concluded with the following points:

1. There isn't a proper environmental ethic in South Africa;
2. The level of litter removal service offered by many local authorities is poor;
3. Plastics are by far the biggest problem;
4. There is likely to be a much greater benefit by trying to reduce the production of litter than by trying to trap it all once it has got into the drainage system;
5. Some litter will always escape into the drains, and for this reason, litter removal structures will always be required in and around urban areas.

Although it would undoubtedly be preferable to prevent littering altogether, this will be an unachievable goal in South Africa for the foreseeable future. Much, however, can and should be done to reduce the quantity of litter that finds its way into the stormwater drainage. In consequence, although it falls outside the strictly defined purpose of this report, some attention will first be given to preventing the litter from entering the stormwater system. Then, acknowledging that some litter will always escape into the drains, attention will be focused on the ideal trapping structure and some of the difficulties experienced in the capture of litter.

The section is set out as follows:

- 3.2 Some ways of preventing litter from getting into the drainage system.
- 3.3 The ideal litter trap.
- 3.4 Some of the difficulties experienced in the trapping of litter.

Some candidate trapping methods are described in later sections of this report.

3.2 Some ways of preventing litter from getting into the drainage system

3.2.1 The use of grids over catchpit entrances

The most obvious method of preventing litter from getting into the drainage system is to ensure that as many entrances as possible are covered by some form of grid. This is the norm in the more developed countries - for example in Europe. In less developed countries, however, this is not always a satisfactory solution. High litter loads together with high rainfall intensities and unreliable maintenance programmes frequently lead to blockages and the associated risk of flooding. The question of who is liable for damages in the event of flooding associated with such an eventuality is unclear, but the local authority is likely to be a focus of attention. For this reason, local authorities in South Africa almost always allow some form of unrestricted overflow even when grids are provided. This is seen most clearly on the standard designs of kerb inlets used in this country. Where unrestricted overflows exist, litter will certainly be found in the drains.

Paradoxically, grids may be the most viable solution in the very high density, low income shanty towns surrounding all the major South African cities, for the simple reason that if the residents can see the grids blocking, and if there is a risk that their own homes will be affected by the consequent flooding, they are likely to take the appropriate action to keep them clear. If the litter trap is hidden away, or if local drainage is unaffected by moderate litter loads, it is unlikely that the residents will intervene, leaving it to the local authority to take full responsibility for maintenance. This has been observed in Khayelitsha near Cape Town (Compion, 1998).

An alternative approach is to place grids over the entrances to high-lying drains, whilst placing litter traps into lower-lying drains. In this situation, the additional flood risk may be limited as stormwater can bypass blocked grids to enter the drains at another point. Traps may then be placed on the reduced number of open entrances.

3.2.2 Reducing the litter load

A more desirable solution to the problem of litter in the drainage system is to reduce the total litter load. Some of the various options that are available to local authorities are listed below. Many of these suggestions come from the pioneering work being carried out in Melbourne (Senior, 1992; Melbourne Water et. al., 1993; Hall, 1996; Allison, 1996) supplemented by some more recent work carried out in Auckland (Island Care New Zealand Trust, 1996).

The following actions are suggested:

- **Better placement of rubbish bins;**
- **Place litter traps inside strategically located catch-pits. Use the evidence provided by litter trapped in the catch-pits to identify the polluters who may then be pressurised into changing their ways;**

- **Organise volunteer litter clean-up days** for cleaning the banks of urban streams and lakes. This also helps to raise public awareness of the problem;
- **Organise a public education campaign to highlight the source of litter in urban waterways, its pathway and environmental hazards.** During 1990 a number of small informal public awareness surveys were conducted in offices and schools in Melbourne. It was readily apparent that a majority of children and adults in that city either did not appreciate that there are separate stormwater and sewerage systems, or did not understand that catch-pits in streets and surface grates in private properties connect to the drainage and stream systems. Even after an extensive radio and poster campaign, a more comprehensive market survey undertaken in 1991 revealed that at least a third of the population in Melbourne were still ignorant of the drainage systems role and its connection to waterways. Subsequent to this, a television advertising campaign was prepared, whilst kits were put together to educate school children (Senior, 1992);
- **Encourage the formation of public interest / action groups** to brain storm new ideas and to act as environmental watch-dogs;
- **Force businesses to become responsible for the proper reduction and disposal of litter generated on their premises;**
- **Evaluate street sweeping and street flushing operations currently undertaken by metropolitan authorities.** A survey carried out by the Board of Works, Melbourne in 1990 revealed that 67% of 54 councils in the metropolitan area used street flushing to some extent. Of these about half regularly and extensively used flushing equipment or street hydrants to clean shopping centres and similar litter accumulation areas. The Board then commenced discussions with a representative number of councils to review methods, equipment and programmes (Senior, 1992).

Use the results of similar evaluations to develop guidelines and recommendations which would minimise the amount of litter entering the stormwater drainage system;
- **Study the behaviour of litter in the stormwater drainage system through the tracking of tagged litter items.** Information from this study could be used to devise better ways of controlling litter in waterways as well as raising public awareness of the pathway of litter;
- **Encourage commerce and industry to move to more environmentally friendly packaging.** In 1991, the Board of Works, Melbourne staged a small exhibit as part of the Plastic Institute's Annual Conference in Melbourne. The display featured before and after polystyrene and plastic items - that is unused, and recovered from river litter traps, respectively. Also prominent among a number of large litter photographs was an enlarged close-up of a litter boom which illustrated many recognisable items. This was provocatively captioned "Do you really want your product advertised in this way?" (Senior, 1992).

- **Try to prevent businesses from imposing unwanted packaging or advertising on unwilling consumers;**
- **Set up proper solid-waste collection services in those urban areas which do not yet have such a service;**
- **Ensure that there is no loss of litter once it has been collected eg. from inadequate disposal facilities or open collection vehicles;**
- **Force shops to institute a deposit on all containers.**
- **Place an “environment tax” on plastic shopping bags. Encourage the move back to large reusable bags provided by the customer.**
- **Employ the unemployed to collect rubbish from more remote areas.**
- **Institute and enforce effective penalties to act as a deterrent to offenders.**
- **Encourage the formation of interest groups that will adopt areas / reaches of streams etc. and help keep them free of litter.**

At present it is very difficult for the Government to institute effective control measures (Davies 1991). A basic requirement for the success of any new environment management system is the support of the majority of citizens.

Unless South Africans adopt a new credo with respect to nature, no new policy or programme, no matter how good, will succeed in protecting our natural heritage (President’s Council Report, 1991).

3.3 The ideal litter trap

Since, at this stage anyhow, litter cannot be eliminated from the drainage system, attention must now be focused on the possibility of placing traps in the waterways in such a way that the litter is efficiently trapped and removed. According to Nel, 1996, the ideal trap should have the following features:

- it should be economical to construct and operate;
- it should have a simple operation;
- it should have no moving parts;
- it should not require an external power source;
- it should be robust;

- it should be able to handle widely varying flow-rates;
- it should have a high removal efficiency;
- it should never block;
- it should be reliable;
- it should be safe eg. for children playing in the vicinity;
- it should not constitute a health hazard eg. by providing a breeding spot for mosquitoes and flies;
- it should not increase the flood hazard in the vicinity of the structure ie. it must not cause substantial damming of the water;
- it should only require minimal maintenance;
- it should require minimal water head ie. it can be used in association with flat gradients;
- it should be easy to clean, eg. by collecting all the litter in a central point for removal by the local authority; and
- it should be unattractive to vandals.

Nothing fulfilling all these criteria currently exists. All known structures represent some sort of compromise. It is the designer's task to choose the most appropriate structure to fit the circumstances. Ideally this should fit into a total litter removal strategy which takes into account a number of actions in line with those suggested in 3.2 above.

3.4 Some of the difficulties experienced in the trapping of litter

The biggest problem faced by anyone trying to design a structure to trap litter is that litter can be just about anything - any size, any shape, any density, any hardness. Furthermore, the characteristics of a single item often change as it moves through the drainage system.

Consider, for example, the behaviour of plastic shopping bag, probably the biggest contributor to the pollution of our waterways. When discarded by its owner - or displaced from a rubbish bin - it is generally more or less rectangular and full of air. Therefore it is readily blown by the wind or washed away into the stormwater system.

Once in the drain, the turbulence along its passage causes the air to be displaced and partly replaced by water. In consequence, the bag starts to float lower and lower and on more and more occasions is dragged below the surface. It starts to deform in such a way as to present the most streamlined profile to the ever-changing fluid flow. Interaction with other objects might also tear it into shreds, or weigh it down so that in calmer waters it is deposited temporarily on the bottom of the channel.

By the time it reaches the trapping device, it can have virtually any shape, and its effective density can vary over a wide range. It is capable of flattening itself over several bars causing considerable blockage or “blinding”. Alternatively it may wind itself around one bar - or distort itself into the form of a streamer and slip between the bars.

Similar sorts of patterns are exhibited by other litter elements. Bottles may be full of air, full of water, or broken. Aluminium cans may change their shape as they are knocked around. Branches of trees break up and so forth....

For convenience, litter moving down an open channel is often considered as belonging to one of three fractions:

- **Bed-load** - ie. rolling or sliding along the floor of the channel,
- **Suspended material** - ie. drifting somewhere in-between the floor of the channel and the surface of the stream, and
- **Flotsam** - ie. material floating on the surface.

This division is somewhat arbitrary, as it can be shown (eg. Rooseboom, 1992) that solids carried in a water matrix can adopt just about any position depending on the power applied by the stream. In simpler terms, at any particular moment a piece of litter is either more or less dense than water so it will either tend to sink or float respectively. However, the turbulence that is always present in running water tends to force everything into suspension. If it is also remembered that many forms of litter continuously change their effective densities as they are transported through the drainage system, virtually any combination of the above fractions is possible.

It therefore appears that the division of material into bed-load, suspended material and flotsam is not a particularly helpful classification. Although metallic objects generally move along the bottom, and pieces of polystyrene generally float, virtually everything else can be anywhere in the water column depending on the applied stream-power.

Three more useful characteristics are size, density and settling velocity.

- The **size** of a particular type of litter eg. an aluminium can, plastic bottle, or plastic shopping bag - is reasonably constant except, of course, when it is broken.

- Although the **density** of a particular item of litter often changes as it moves down the drainage system, it generally tends asymptotically to some reasonably constant value which will determine whether, in slow moving water, it will either float to the surface or sink to the bottom.
- **Settling velocity** is a function of size, density and shape factor (which is a measure of how streamlined a particular object is), electrical charge, viscosity and concentration (see for example Raudkivi, 1990). The higher the settling velocity, the more likely the object under consideration is to be found near the bottom of the water column. The more negative it is, the more likely it is to be found near the surface. Although settling velocity is clearly highly variable, it is probably the single parameter that is the most useful and easiest to measure.

It is the high degree of variability that makes it extremely difficult for the designer to design a structure that will cater for every eventuality. Many structures work extremely well in low flows, but not in high - or vice versa - or work well with certain types of litter, but not others. Some pose major maintenance problems. Most structures constructed in South Africa to date have achieved limited success.

Attention is now turned to candidate trapping devices.