Reducing Urban Litter in South Africa through Catchment Based Litter Management Plans

Neil Armitage, Mark Marais and Sonja Pithey

South Africa generates in excess of 40 million tonnes of solid waste every year - mostly of domestic origin. More than 780 000 tonnes of this is washed into the drainage system where it ends up entangled amongst the vegetation and sediments along the banks of the streams, rivers and lakes or strewn on the beaches. To remove all the litter from the watercourses without seeking to reduce the quantities involved would cost South Africa at least US\$400 million per annum - or approximately 0.4% of its gross domestic product (GDP). This is clearly not feasible and therefore the Water Research Commission of South Africa and the Cape Metropolitan Council are funding a four year investigation into the reduction of urban litter in the drainage systems through the development of catchment specific litter management plans. Eight stormwater drainage catchments, representing a diversity of land-uses, have been selected for a detailed litter audit. This audit will quantify the amount and type of litter being deposited in the drainage catchments both before and after the implementation of various litter management strategies. The results of the litter audits will measure the effectiveness of the various litter management strategies, which in turn will facilitate the continuous improvement of the litter management plans. It is envisaged that the study will promote the development and implementation of litter management plans for all urban catchments ensuring that litter management is aligned with broader catchment management plans.

Armitage, N., M. Marais and S. Pithey. 2001. "Reducing Urban Litter in South Africa through Catchment Based Litter Management Plans." *Journal of Water Management Modeling* R207-03. doi: 10.14796/JWMM.R207-03.

© CHI 2001 www.chijournal.org ISSN: 2292-6062 (Formerly in Models and applications to Urban Water Systems. ISBN: 0-9683681-4-X)

3.1 Introduction

South Africa generates in excess of 40 million tonnes of solid waste every year (President's Council Report, 1991)- mostly of domestic origin. According to the CSIR (1991) more than 780 000 tonnes of this is washed into the drainage system where it ends up entangled amongst the vegetation and sediments along the banks of the streams, rivers and lakes or strewn on the beaches. The solid waste - alternatively called litter - consists mainly of manufactured materials such as bottles, cans, plastic and paper wrapping, newspapers, shopping bags, cigarette packets, but also includes items such as used car parts, rubble from construction sites and old mattresses. It is ugly, it is a health risk to humans and animals alike, and it costs a lot of money to remove.

It currently costs between US\$240 and US\$600 per tonne (Armitage et al., 1998) to remove litter from the drainage system using the most cost-effective technologies available. In other words, to remove all the litter from the streams without seeking to reduce the quantities involved would cost South Africa at least US\$400 million per annum at current prices - or approximately 0.4% of its GDP. This is clearly not feasible. Prevention is better than cure. It is better that the quantity of litter is reduced.

In an attempt to reduce the quantity of litter, the Water Research Commission of South Africa and the Cape Metropolitan Council are co-funding a four year investigation into the reduction of urban litter in drainage systems through catchment based litter management. The quantity of litter generated depends on a number of land-use factors. Therefore eight stormwater drainage catchments, representing a diversity of land-uses, have been selected for a detailed litter audit. This audit will quantify the amount and type of litter being washed into selected drainage systems both before and after the implementation of various litter management strategies. The results of the audits will measure the effectiveness of different catchment-based litter management strategies which will in turn facilitate the improvement of catchment litter management plans.

3.2 The Socio-Economic Context of the Littering Problem

A key starting point of this study was the assumption that littering is, at least to a certain extent, linked to the socio-economic profile and level of service in a catchment.

The disproportionate distribution of wealth and services in South African cities bears testimony to some of the consequences of the Apartheid policies of the previous government. In South Africa around 10 million people still do not have access to safe drinking water, and at least 20 million do not have access to adequate sanitation (Kasrils, 2000). The study is being undertaken in the Cape Metropolitan Area, which with a population of about 3 million people represents approximately 7% of the country's population. Almost 35% of this metropolitan region's population live in informal settlements and at least 40% of the region's people are unemployed or underemployed, factors which all have an impact on households ability to afford basic services (Cape Metropolitan Council, 1999). Van Deventer (2000), highlights some other demographic aspects of the Cape Metropolitan Area (CMA):

- The population growth rate is 2.6% per annum;
- The HIV infection rate is estimated to be 5.56% - and rising fast (the national rate is estimated to be as high as 22.8%);
- The Metro Gross Geographical Product is R64 billion (US\$10.3 billion), 9.8% of the National GDP; and
- The 1999 economic growth rate was 1.5% - which was greater than the national average - but a growth rate of at least 3% is required to keep unemployment at the current (unacceptable) levels.

South Africa is currently ranked 101 out of 174 countries on the United Nations (UN) Human Development Index and 47 out of 59 countries on the World Economic Forum Global Competitiveness Report (only the seventh most competitive country in Africa).

There are some positive factors: the number of tourists visiting Cape Town increased at a rate of 8% per annum over the 1996-1999 period and now amounts to over half a million tourists per annum. Unfortunately, for many people in South Africa, the struggle for survival takes precedence over the environment and the tourist industry is likely to be the industry most sensitive to littering.

3.3 The Main Sources of Litter

Hall, 1996 suggests that the most common sources of litter are the following:

- the anti-social behaviour of individuals in dropping litter on footpaths, throwing it from vehicles, and dumping household wastes;
- excessive packaging;

- the failure of street sweeping services to rid pavements and public areas of litter;
- inadequate disposal facilities, including a breakdown in litter collection practices or the provision of inappropriate bins. Open bins and collection vehicles may provide an opportunity for litter to be blown into the public domain; and
- the failure by the authorities to enforce effective penalties to act as a deterrent to offenders.

It is obvious that litter is a problem associated with human habitation.

It is also obvious that, to a point, the problem rapidly increases with population density and level of development. As a rule, traditional African villages do not have a litter problem. The inhabitants do not have access to many of the accoutrements of modern civilisation, and those they do have, they look after. Also, much of what they have is biodegradable.

Even the cities of so-called “less developed” countries are often cleaner than those of “more developed” countries. The streets of Harare and Bulawayo (in neighbouring Zimbabwe) appear to be cleaner than Cape Town, Johannesburg and Durban (South Africa). This is probably because brown paper packets are used in place of polyethylene shopping bags, beverages are supplied in returnable glass bottles instead of disposable polyethylene sachets or bottles, and food is bought fresh instead of in tins. Unfortunately, as Zimbabwe becomes more developed, its streets are likely to become as polluted as those in South Africa.

A higher level of development does not always result in increased littering. The streets of many developed countries are noticeably cleaner than those of South African cities. One reason for this could be a greater environmental ethic in those countries. Public pressure is rapidly brought to bear on the more obvious polluters and they are soon brought into line. An example from Australia graphically illustrates what a strong environmental lobby can do. In South Africa, a well-known international fast food company supplies its hamburgers in polystyrene containers. In Australia, public pressure forced the same company to replace the polystyrene with cardboard (Allison, 1996).

It seems therefore that the problem of litter in the stormwater drainage system is relatively speaking at its worst in countries which:

- are developed enough to have the sophistication of modern technologies, such as a plastics industry, but
- not so developed that there is a strong environmental lobby in place to police the disposal of waste.

South Africa falls into this category. Furthermore, as its population grows and becomes more urbanised, the problem is likely to get worse before it gets better.

According to Armitage et al. (1998), 96 kg/ha.yr of litter is currently finding its way into the drainage system of the central business district (CBD) in Springs, a typical South African town near Johannesburg, and much higher quantities are possible in the urban fringes where services have broken down or never existed. By way of comparison, 6 kg/ha.yr was measured in Coburg, Australia with a similar climate and land-use to Springs (Allison, 1997), whilst the figure drops to 1.35 kg/ha.yr for another similar area (although with a different climate) in Auckland, New Zealand (Island Care New Zealand Trust, 1996). One feature that was common to all studies was that *plastics are by far the single biggest problem*.

It is clear that much can and should be done to reduce the quantity of litter that finds its way into the stormwater drainage system.

3.4 The Main Factors Influencing the Quantity of Litter Finding its Way into the Waterways

The rate at which litter is deposited on the catchment is highly variable and appears to depend on a large number of independent factors including:

- *the type of development*, i.e. commercial, industrial, residential;
- *the density of development*;
- *the income level* of the community - very poor people don't have access to many products, hence are not in a position to waste them or their containers;
- *the type of industry* - some industries tend to produce more pollutants than others;
- *the rainfall patterns*, i.e. does the rain come in one season only or year-round? Litter will build up in the catchment until it is either picked up by refuse removal, or is swept into the drains by a downpour. Long dry spells give greater opportunity to the local authority to pick up the litter, but also tend to result in heavy concentrations of accumulated rubbish being brought down the channels with the first rains of the season - the so-called "first flush". In Cape Town, most of the rainfall occurs during the winter months - May through to September;
- *the type of vegetation* in the catchment - in Australia for example, leaves form the major proportion of "litter" collected in traps. Some species of trees cause more problems than others e.g. London Plane trees have relatively large leaves which are slow to decompose and are mostly shed over a very short period in

autumn. The natural vegetation of Cape Town comprises largely the Fynbos biota - hardy evergreen shrub-like plants with small leaves adapted to the long dry summers. Unfortunately fynbos only exists in protected pockets within the CMA and large swathes are almost devoid of vegetation. The exception to this is in the middle and upper income residential areas, and on the slopes of the mountain chains surrounding the city, which are generally covered in alien species imported from Europe, North America and Australia;

- *the efficiency and effectiveness of refuse removal by the local authority* - it is important that the local authority not only clean the streets and bins regularly, but also that sweepers do not, for example, sweep or flush the street litter into the stormwater drains. Unfortunately, in the CMA, as in most of South Africa, lack of funds means that the streets are only swept in the central CBDs;
- *the level of environmental concern in the community* - leading to, for example, the reduction in the use of certain products, and the recycling of others. The CMA has numerous environmental interest groups and a growing recycling industry. This is however concentrated in the middle and upper income parts of the city which accounts for a very small percentage of the population; and
- *the extent of legislation* prohibiting or reducing waste, with which is associated the *effectiveness of the policing of the legislation*, and *the level of the fines*. The problem here is that the small, under-trained, over-worked police force has no resources available to cope with pollution control.

The variability in the nature of the litter coming off different catchments has been identified by a number of researchers, e.g. Allison and Chiew (1995). They showed that for a fully urbanised catchment at Coburg, which is situated about 10 km north of Melbourne's CBD, so-called garden debris made up 85% of the litter collected from a residential site, but only 36% from a light industrial site. "Paper" and "plastics" made up 64% of the litter from the light industrial site, but only 13% from the residential site. Similar profiles have been obtained for Auckland (Cornelius et al., 1994; Island Care New Zealand Trust, 1996).

Often, a single shop or factory e.g. a fast food outlet, a bank, or a plastic recycling factory, is responsible for a large percentage of the litter collected in the drains. In this case, the amount of litter can be substantially reduced once the situation has been brought to the attention of the offending company (Island Care New Zealand Trust, 1996; Allison, 1996).

There is an infinite variety in the types and quantities of litter washed off a catchment. In fact, each catchment has a unique litter “footprint” which is indicative of the state of the catchment at the time of measurement.

3.5 The Proposed Methodology of the Study

This study proposes to carry out a detailed litter audit of a number of drainage catchments covering a range of different land-uses and income levels. The audit will seek to determine the amount and type of litter being deposited in the catchments both before and after the imposition of various litter management strategies. This will determine the effectiveness of different approaches to catchment litter management, which will in turn facilitate the development of more effective catchment litter plans.

Eight stormwater drainage catchments comprising a range of land-uses and income levels have been selected. They include:

1. Cape Town CBD open-air market, bus stop and row shops;
2. Cape Town CBD office blocks and hotels;
3. Montague Gardens industrial park;
4. Welgemoed high income (> US\$50,000 per household per annum), low density residential area;
5. Fresnaye high income, medium density residential area (including apartments);
6. Summer Greens medium income (US\$15,000 - 25,000 per household per annum), medium density residential area;
7. Ocean View low income (<US\$5,000 per household per annum), high density residential area;
8. Imizamo Yethu low income, high density residential area.

The approximate location of the drainage catchments is indicated in Figure 3.1.

The catchments range in area from 3.4 ha (for the market and row shops in the Cape Town CBD) to 25.4 ha (Fresnaye) with an average area of 10.8 ha. With the exception of Fresnaye, each stormwater catchpit is equipped with a litter trap. The number of catchpits varies from 20 (draining the open-air market and row shops in the Cape Town CBD) to 35 (Welgemoed) at an average density of 3 per ha. In the event of a spill from the catchpit litter traps (they are equipped with an emergency overflow, see Figure 3.2), the litter should be caught in nets placed inside the catchpit outlet pipes. These outlet pipes vary in diameter from 375 mm (Cape Town CBD) to 750 mm (Fresnaye, Montague Gardens). Only the lower portion of Fresnaye is equipped with catchpit traps although the outlet pipe is netted. This means that those areas of Fresnaye along the main access

Figure 3.1 The CMA and the location of the study areas.

Figure 3.2 Cross-section through a typical side-entry catchpit trap.

routes and amongst the blocks of flats can be studied in greater detail, but the residential areas situated on the steep mountain slopes cannot. This exception was made for reasons of economy in the installation and cleaning of the traps.

The supply of the catchpit traps (at an average cost of US\$17 per trap) and outlet nets (at a cost of US\$200 per net) was substantially complete at the end of 1999. The monitoring of the traps thus effectively commenced in January 2000. The traps and nets undergo a routine clear out at least once a month and after every major storm event. Initially, this has been defined as a storm where more than 2 mm precipitation is recorded and where the duration of the rainfall is greater than half an hour. The following data is recorded:

- the date of the clear-out;
- the duration and depth of the precipitation (if any) during the period preceding the clear-out;
- the total volume of litter removed from the streets and from the dustbins in the catchment during the same period;
- the volume of litter contained in the catchpit (generally this is assessed visually using a numerical scale where 0 indicates empty, 1 indicates 25% full, 2 indicates 50% full, 3 indicates 75% full and 4 indicates 100% full). Each catchpit is uniquely identified.

During the April to September winter period, the wet season in the CMA, a *Waste Auditor* will be recruited from among one of the Non-Government Organisations (NGOs) working with waste issues. This *Waste Auditor* will conduct a detailed study of the contents of the traps. It is envisaged that the partnership with the NGOs will create future opportunities for capacity building in waste management strategies. Working with one catchment at a time, the *Waste Auditor* will help collect the contents of catchpits and nets in a typical clean out and make a detailed study of their contents including:

- the exact mass and volume trapped;
- the trap contents by type, amount, density and size; and
- the likely sources of the litter.

The *Waste Auditor* will carry out a similar study on the types, amounts, density and size of the litter removed by the present street-cleaning programme (if any).

Over the six-month winter rainfall period, the *Waste Auditor* should be able to carry out an in-depth investigation of the contents of about 6 clean-outs per catchment (at an average of about two clean-outs per week). The objective is to establish an accurate database of the most probable sources, volumes and types of litter being deposited in the catchment areas and being transported by the drainage systems over the full year cycle ending December 2000.

Towards the latter part of 2000, when much of the above information will already be available, an attempt will be made to develop catchment litter management strategies for each of the eight drainage sub-catchments. The intention is to align litter management strategies with the existing catchment management strategies and to use the emerging Catchment Management Forums as a platform for involvement of interested and affected parties. As representation on these forums consists of all tiers of government and NGOs, an ideal opportunity exists for catchment based identification of polluters and potential mitigatory strategies. These strategies will be implemented by the end of the year and a second full year monitoring programme, identical to that described above, will be used to determine the effectiveness of the strategies. A review, to be carried out towards the end of 2001, will determine the success of the strategies.

On the assumption that some of the strategies might not be very successful and to expand the range of alternatives, improved catchment litter management strategies will then be developed and monitored over a third year during 2002. By the end of this period it is hoped that the research team will have come up with practical solutions to reducing the levels of littering in South Africa which will then be fed into catchment litter management plans.

3.6 The Classification of Urban Litter

Many different types of litter have been identified by researchers e.g. Allison and Chiew (1995), Island Care New Zealand Trust (1996), or Armitage et al. (1998). For the purposes of this study, a simplified classification system is proposed:

- *Plastics* : e.g. shopping bags, wrapping, containers, bottles, crates, straws, polystyrene blocks, straps, ropes, nets, music cassettes, syringes, eating utensils;
- *Paper* : e.g. wrappers, newspapers, advertising flyers, ATM dockets, bus tickets, food and drink containers, cardboard;
- *Metals* : e.g. foil, cans, bottle tops, and number-plates;
- *Glass* : e.g. bottles, broken pieces;
- *Vegetation* : e.g. branches, leaves, rotten fruit and vegetables;
- *Animals* : e.g. dead dogs and cats, sundry skeletons;
- *Construction material* : e.g. shutters, planks, timber props, broken bricks, lumps of concrete;
- *Miscellaneous* : e.g. old clothing, shoes, rags, sponges, balls, pens and pencils, balloons, oil filters, cigarette butts, tyres.

3.7 Potential Catchment Litter Management Strategies

The most obvious method of preventing litter from getting into the drainage system is to ensure that some form of grid covers as many entrances as possible. 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, most local authorities in South Africa allow some form of unrestricted overflow even when grids are provided. Where unrestricted overflows exist, litter will certainly be found in the drains.

A more desirable solution 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, 1993; Hall, 1996; Allison, 1997) supplemented by some more recent work carried out in Auckland (Island Care New Zealand Trust, 1996):

- *Better placement of litter bins;*
- *Place litter traps inside strategically located catchpits. Use the evidence provided by litter trapped in the catchpits 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 most 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 and 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).
- *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 a number of polystyrene and plastic items - both unused and recovered from river litter traps. Also prominent was an enlarged photograph of the material trapped behind a litter boom which illustrated many recognisable items. This was provocatively captioned: "Do you really want your product advertised in this way?" (Senior, 1992).
- *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 e.g. from inadequate disposal facilities or open collection vehicles;*
- *Force retailers 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 jobless to collect rubbish from more remote areas;*

- *Institute and enforce effective penalties to act as a deterrent to offenders; and*
- *Encourage the formation of interest groups that will adopt areas and reaches of streams etc. and help keep them free of litter.*

3.8 Conclusions

The following conclusions can be made concerning the amount of urban litter in waterways:

- litter in the waterways is a major environmental problem that will be costly to address (estimated to be in the order of US\$400 million per annum in the absence of effective catchment litter management);
- litter is a direct result of human behaviour, therefore it ought to be possible to substantially eliminate littering by targeting the polluters themselves. This should be more cost effective than removing the litter from the drains once it has got there;
- it is necessary to attempt an accurate audit of the quantities of litter currently finding its way into the drains and identify the most appropriate forms of catchment litter management - almost certainly dependent on land use, level of service and income level - that will reduce this.

Acknowledgments

The information contained in this chapter emanates from a project co-funded by the Water Research Commission of South Africa and the Cape Metropolitan Council entitled: *The Removal of Urban Litter in Drainage Systems through Integrated Catchment Management* (WRC Project No. 1051).

References

- Allison RA and Chiew FHS (1995) Monitoring of stormwater pollution from various land uses in an urban catchment. *Proc. of the 2nd Internat. Symp. on Urban Stormwater Management*, Melbourne pp 551-516.
- Allison RA (1996) Personal communication. Ph.D. student, Department of Civil and Environmental Engineering, University of Melbourne.

- Allison RA (1997) Effective Gross Pollutant Removal from Urban Waterways. Ph.D. thesis, University of Melbourne.
- Armitage N, Rooseblom A, Nel C and Townshend P (1998) The Removal of Urban Litter from Stormwater Conduits and Streams. WRC Report No. TT 95/98, Pretoria, ISBN 1 86845 367 7.
- Cape Metropolitan Council (1999) *Strategic Evaluation of Bulk Wastewater: Report on Land Use and Demographics* (Report 23 of 37), Cape Wastewater Consultants
- Compion JK (1998) Personal communication. Liebenberg & Stander Western Cape (Pty) Ltd, Consulting Engineers, Cape Town.
- Cornelius M, Clayton T, Lewis G, Arnold G and Craig J (1994) *Litter Associated with Stormwater Discharge in Auckland City New Zealand*. Island Care New Zealand Trust, Auckland.
- CSIR (1991) The Situation of Waste Management and Pollution Control in South Africa. Report CPE 1/91 to the Department of Environment Affairs by the CSIR Programme for the Environment, Pretoria.
- Hall M (1996) Litter Traps in the Stormwater Drainage System. Unpublished M.Eng. paper, Swinburne University of Technology, Melbourne.
- Island Care New Zealand Trust (1996) *Reducing the Incidence of Stormwater Debris and Street Litter in the Marine Environment - A co-operative Community Approach*. Auckland.
- Kasrils R (2000) (SA Minister of Water Affairs and Forestry). *Keynote address 3rd Bi-annual Symp. on Urban Catchment Management*, Cape Town.
- Melbourne Water and Melbourne Parks & Waterways (1993) *Backyard to Bay Program*. Melbourne.
- President's Council Report (1991) *Report of the Committee of the President's Council concerning a National Environment Management System*. State Press, Cape Town.
- Senior JC (1992) Litter control in urban waterways. *Proc. Internat. Symp. on Urban Stormwater Management* 234 - 239, Sydney.
- Van Deventer K (2000) Co-operative Urban Catchment Management in the CMA: Goals and Background Concepts: Social and Economic Considerations. *Proc. 3rd Bi-annual Symp. on Urban Catchment Management*, Cape Town