

Executive Summary

During a moderate to heavy rainfall event, it is not unusual for the sewer infrastructure in cities to become completely overloaded. The excessive flow within the sewer pipes results in surcharging sewer manholes which subsequently overflow, pump stations that cannot manage the extra flow and ultimately the overburdening of the Waste Water Treatment Works (WWTW). When this occurs, untreated sewage finds its way onto streets, into stormwater drains and into streams and rivers. The primary reason for the overloading of sewerage infrastructure during rainfall events is the large quantity of stormwater that finds its way into the sewer reticulation network. This ingress of stormwater into the waste water collection system is termed infiltration/inflow (I/I for short). The need to reduce the quantity of I/I in South African sewer systems is increasingly being recognised as a priority for a number of reasons, including:

- It is unhealthy for both the environment and humans to be exposed to repeated overflows of untreated sewage.
- Holding untreated sewage in stormwater retention dams creates other human and environmental health risks.
- There are cost related implications (the more effluent a works receives, the higher the treatment costs; also bulk sewer lines have to be upsized, which is highly capital intensive).
- Capital expansion programmes may need to be considered at waste water treatment works if they are to be able to deal effectively with storm surges as the works needs capacity to absorb peak flow and not average flows if spillages are to be completely avoided.
- It is illegal in terms of the National Water Act for a municipality or Wastewater Treatment Works to discharge untreated or partially treated sewage into receiving waters.

This study looks at the different sources of rain water in the sewage system, and shows that the amount of rain water entering the sewer line because of illegal direct connections (mainly through the diversion of roof guttering directly into the sewer) can easily become a significant contributor to the problem. It goes on to discuss what our legislation says about the problem, and compares contrasting approaches to giving effect the legislation. It then reviews how the matter of stormwater ingress is being dealt with in different parts of the world. Finally a community based inspection programme is tried and evaluated, and a public education programme is discussed.

While the international literature and South Africa's local experience suggests that stormwater ingress in sewers is a problem to a greater or lesser degree (usually greater) in all sewered areas, this study has focused more particularly on the situation in the Msunduzi Municipality, KwaZulu-Natal.

Infiltration is subsurface flow, or groundwater that seeps into sewers through holes, breaks, joint failures, defective connections and other openings. Infiltration occurs throughout the year, but volumes are greatest following wet periods

Inflow is stormwater that rapidly flows into sewers via roof and foundation drains, downspouts and manhole covers *Earth Teach Team, 2004* Stormwater ingress in South African sewer systems Pietermaritzburg, Buffalo City, Cape Town and East Rand Water Municipalities all report peak inflows during the rainy season that exceed the average dry weather flows by as much as 300 to 400 percent. Pietermaritzburg's council ceased to monitor stormwater ingress in 1992 and overloading of the sewer system causes significant pollution of the uMsunduzi River. This is one of the most significant environmental problems the city has. New residential and industrial areas in the Eastern Cape have resulted in a significant escalation of stormwater ingress into the municipal sewers. The allowance built into these sewers' design for inflow and infiltration is quite inadequate with instantaneous ingress pointing to gutter connections or direct inflow through manhole covers as the source.

National legislation regulates the quality of effluent that may be discharged by a WWTW into receiving waters and encourages local municipalities to formulate bylaws to protect their WWTWs. The legislation also provides default regulations for the drainage of properties. Most municipalities have bylaws prohibiting the routing of stormwater into drainage installations as well as to protect drainage installations from the ingress of floodwater. These bylaws typically follow DWA's model Water Services bylaws.

In order to reduce direct inflows, inspection and enforcement is required, and for this to happen effectively political will and a workable enforcement system is needed. In this study it is found that there is unanimity in the prohibition of stormwater to sewer connections in the municipal by-laws and

the building regulations in South Africa. However, it was also found that the prosecution of offenders using a formal rights based legal approach is enormously difficult, expensive and time-consuming. For this reason the Msunduzi Municipality, which has a particularly bad stormwater ingress problem, effectively gave up policing this by-law more than ten years ago. A more practical alternative seems to be that previously used by the City of Cape Town, which charged a fee for allowing property owners to connect their stormwater to the sewer. In 2007/2008 this fee was R2.84 per square metre drained into the sewer network for private property, and R7.94 per square metre for commercial property. This fee gave the property owner the incentive to stop using the municipal sewer network to drain away stormwater, and to come up with a more environmentally appropriate solution. The property owner was also incentivised to make the changes without delay, and to not drag the municipality through a lengthy formal process to force them to make the change.

Builders and plumbers who are found to have installed illegal stormwater connections should also be sanctioned. This could involve the payment of fines, or blacklisting.

A reason sometimes used for the lack of enforcement of stormwater by-laws is that municipalities lack sufficient building inspectors. However, a person does not have to be a fully trained building inspector to be able to detect an illegal stormwater connection. In the course of field work carried out for this project it was shown that community-based stormwater inspectors could be relatively easily recruited and trained, and their work, given the short time frame, was very useful. This has proven the costeffectiveness and value of inspectors with a limited scope of work, in this case specifically that of direct stormwater to sewer connections.

Stormwater ingress in South African sewer systems

A sewer storm flow monitoring exercise carried out during the course of this study showed that peak flows after heavy rainfall were up to five times normal sewer flow, that the time taken for the sewer flow to go from normal to the storm peak was a matter of minutes, and that the peak flows could be more than accounted for by the incidence of direct connections in the surveyed area. Sewer flow then remained elevated for several days after the rainfall, indicating that groundwater continued to contribute to the flow long after the rain had ceased.

The stormwater ingress problem is therefore due to a combination of both illegal direct stormwater to sewer connections and infiltration through breaks in an ageing sewer network. The nature and characteristics of the flow records indicates that the problem may be fairly evenly divided between inflow and infiltration. In order to reduce infiltration and inflow, flow monitoring and CCTV work is required to determine which sections of the network are most in need of repair and rehabilitation, and thereafter that work must be carried out.

Stormwater ingress can be reduced by upgrading the infrastructure and by reducing the water load at source. Measures to upgrade the infrastructure can range from the less expensive such as replacing missing manhole covers to more expensive such as replacing defective sewers. Upgrading the capacity of the waste water treatment works is the most expensive solution. The cost of the elimination of direct connections at source should be borne by property owners and is therefore the cheapest intervention measure.

It is recommended that any municipality with a serious stormwater ingress problem should set up a dedicated inspection team of purpose trained contract stormwater inspectors. These contract inspectors would work under one fully qualified inspector, who would have the necessary authority to act on any direct connections that are found. Allocating work to inspectors away from their home neighbourhoods may address the risk of bias. In order to gain access to properties this work will mostly have to be done outside of normal working hours and therefore it would be cost effective to outsource the work to NGOs, CBOs or private companies.

Public awareness and community education campaigns can serve to reduce the stormwater load at source and provide an alternative to upgrading infrastructure which is capital intensive and time consuming. Information on stormwater ingress was included in a pamphlet and distributed to a sample of residents for this report, and this was found to increase awareness of stormwater ingress by up to 20% in the targeted areas relative to nearby areas which were not targeted. This was significant given the limited duration and scope of the intervention. For an awareness and education campaign to be really effective, however, it would need to be part of a co-ordinated city wide

campaign followed up by extensive inspections and backed up by the political will to deal with transgressors. Education programmes should be focused on a particular community and should involve a visit from a municipal officer who provides instruction on how to rectify direct connections and information on alternative, environmentally friendly stormwater drainage solutions.