A REVIEW OF ON-SITE WASTEWATER PRACTICES IN SOUTH-EAST QUEENSLAND

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Abstract

This paper presents results from a ‘census’ of the status of on-site wastewater treatment systems (OWTS) management practices in the SEQ region as part of the Healthy Waterways initiative. The current number of on-site systems is estimated to be 127,000 with septic systems accounting for 80%. Key management issues were highlighted during the project, notably the frequency of greywater failure and inappropriate greywater discharge. Septic system failures were reported mainly in the newer combined septic systems that receive 100% of household water compared with the split blackwater systems that receive about 20%. Aerated systems were inadequately maintained. However, to date, no “smoking guns” of poor water quality from non-sewered catchments have been clearly identified. A clear outcome of this survey was the need for all SEQ Local Authorities to audit every on-site system. Predictions and assessment of catchment water quality risks from on-site systems would be greatly facilitated if data obtained from these audits could be used in catchment water quality modelling and risk assessment.

Introduction

Several years ago the Moreton Bay Waterways and Catchment Partnership (MBWCP) identified the need to assess and manage water quality in Moreton Bay into which drains a large area of south-east Queensland, including the city of Brisbane. As a result the MBWCP developed the programme ‘Healthy Waterways’. The report from which this paper has been derived is the first stage of the Healthy Waterways initiative “Audit of Non-Sewered Areas in South-east Queensland”. Despite significant failure rates for both septic and aerated systems there was very little evidence of surface and groundwater contamination. However, there is a need for Local Authorities to audit on-site systems.

The questionnaire covered number and type of OWTS, pre-installation procedures such as approval process, design and construction and post-installation procedures such as inspections, record keeping, monitoring and complaints handling. The relevant section of each Local Authority (e.g. plumbing department) was targeted for the interview. However, as the management of OWTS often crossed over departments, we always attempted to include a representative from each department that had involvement with OWTS management. Interviews were also conducted with other key stakeholders that have a strategic role in OWTS management, such as the Queensland Environmental Protection Agency (EPA), SEQ Water and Department of Natural Resources and Mines (DNRM).

Results and Discussion

A summary table of the responses from all surveyed Local Authorities (see Figure 1 for participating Councils) was compiled and is presented in the report (Beal et al., 2003). The following is a summary of the results.

Current Non-Sewered Population

Based on data obtained from each SEQ Local Authority, the current number of on-site systems was estimated to be 127,000, septic systems accounted for ~ 102,000 (or 80%), aerated wastewater systems (AWTS) accounted for ~ 20,900, sand filters (SF) - 5,600 and about 325 known “other” systems (compost, wetlands).

OWTS Proportions

The proportion of on-site system types is shown in Figure 2. The majority of systems were some form of septic system. Other treatment systems such as composting...
toilets and wetland systems have not been separately identified as they were uncommon. A majority of the septic systems in SEQ were split systems, where the blackwater (toilet waste only) and greywater (all other wastewater) are separated. The number of split blackwater/greywater systems is also shown in Figure 2. The split system comprised a large proportion of all septic system types that were installed prior to the introduction of specific legislation and standards concerning on-site system design (1993-4). As a result the split system remains the predominant on-site system type actually in the ground in SEQ, although since the late 1990s it is not as commonly installed.

Aerobic treatment systems have grown in popularity over the last 10 years, due largely to the perceived improved treatment of effluent that the systems can offer, and the ability to collect and reuse the treated effluent on lawns or garden beds via surface or subsurface irrigation. The number of aerobic systems installed in SEQ is about 21,000 (Figure 2).

Projected On-Site System Distributions

The projected number of on-site systems in 10 years time is approximately 177,000 (compared with the current installation of 127,000). The current and estimated future proportion of on-site system types is shown in Figure 3.

A decline in the installations of septic systems is expected for all Local Authorities except Esk. Although the costs of alternative treatment systems are usually greater than for septic systems, the increase in demand for aerobic systems suggests a consumer preference towards public health and environmental concerns rather than economics. Apart from consumer choice, there is also a tendency for regulatory authorities to favour alternative on-site systems in areas where a high density of non-sewered allotments is proposed. In this situation, a treatment technology (as distinct from a manufacturer) is stipulated as part of the approval conditions for new subdivisions.

Allotment Sizes

An important aspect of OWTS management is allotment size - which in turn determines OWTS density in a catchment. Clearly a low density of OWTS is preferable to minimise cumulative water quality impacts from effluent pollutants (nutrients and pathogens). The average lot size for non-sewered dwellings in SEQ generally indicated the trend for larger lot sizes in the rural areas and smaller lot sizes in peri-urban, coastal areas. Brisbane City Council was an exception with many of the non-sewered allotments in the peri-urban regions of Brisbane averaging 10,000m² (1 hectare). Average lot sizes ranged from 800m² in Noosa Shire to 20,000m² in Nanango Shire.

The overall average across Local Authorities was ~5,100m². A sustainable lot size in non-sewered areas of 2000-4000m² has been suggested by Geary and Gardner (1998). Data on allotment sizes were usually based on estimates from planning officers, or more frequently, plumbing inspectors. As a result, the figures have not been confirmed by a cadastral database.

Local Authority On-Site System Management

Almost all the Local Authorities had no accurate records for septic system numbers (both split systems and combined) installed prior to 2000. Record keeping became a more serious process after the release of the Qld Interim Code of Practice for On-site Sewerage Facilities in 1999 and the 1994 Australian Standard AS1547:1994 Disposal systems for effluent from domestic premises. and later AS/NZS 1547:2000 The AS/NZS 1547:2000 was not an enforced document in Queensland until the gazettal of the On-site Sewerage Code in 2003. The Plumbing and Drainage Act 2002 is now the overarching legislation in Queensland and this incorporates the On-site Code. The incomplete records of on-site systems, particularly the older ones, meant that providing quantitative data for this survey was a difficult process for many of the Local Authorities. Consequently data presented here is as accurate as the records and the estimates of Council officers will allow.

There are several local on-site laws and policies throughout Queensland and Australia-wide that have been written by Local Authorities, examples include the Gold Coast City Council’s Local Law 42, and many of these refer to the AS/NZS1547: 2000 for technical detail.
On-Site System Inspection and Monitoring Protocols

To ensure compliance to the required effluent quality standard, an effluent monitoring programme is often implemented by Local Authorities. This is separate to the maintenance programme which is legally required to be carried out by on-site system manufacturers on their systems - usually every 3 months for AWTS and yearly for sand filter systems. There is a statutory requirement for a regular operational maintenance check of each system by the manufacturer (or nominated service agent). There is no statutory requirement for monitoring the effluent quality of an on-site system. The On-site Code does not stipulate that monitoring must be undertaken by the Local Authority, although it is considered “desirable” for Councils to do so. A Council inspection generally involves sampling of secondary treated effluent from the system and testing against criteria listed in the On-site Code. The purpose of ongoing Council inspections on systems is two-fold: to monitor the operational performance of the system and to monitor the treatment performance of the system. Obviously they are linked since a poorly operating system will usually produce poor quality effluent.

Local Authorities that conduct regular effluent monitoring are the better resourced ones where on-site system density is greater (eg. coastal/hinterland ‘resort’ areas) and/or there is a presence of sensitive environmental receptors. Figure 4 shows the breakdown of Council monitoring and inspection programmes across the SEQ. Only about 12,000 septic systems (12%) are being regularly serviced in SEQ. The systems that are being serviced are part of an auditing process that is being undertaken by Logan City and Caboolture Councils. Three more Councils are also planning to undertake audit programmes that will result in a further 15,100 septic systems being monitored by Council. However, the majority of septic systems (~75,000) are not inspected regularly by Council as part of a structured program but on a complaint basis only. About 20,000 (or 80%) of aerobic systems are being regularly monitored by Council. Ninety-five percent of Councils felt that there were inadequate resources for managing on-site system related issues.

On-Site System Performance

Septic Systems

Major failure categories identified by Local Authorities are shown in Figure 5 with absorption trench surcharge being the dominant failure mode identified. The circumstances leading to trench clogging and subsequent surcharge of effluent were also classified as failures by Local Authorities. These include broken baffles/outlet filters and infrequent septic tank desludging both of which allow solids carry-over into the trench (Figure 6), thereby reducing its ability to “leak” effluent into the soil.

AWTS and Sand Filters

A commonly identified mode of failure with AWTS and SF was lack of maintenance and odour. This is of particular concern for systems that surface irrigate the effluent where exposure to environmental and public health risks are increased. Apart from generating odour, discoloured effluent is more likely to be inadequately disinfected whether by chlorine or UV.

Reported Septic System Failures

The number of reported failures from Council officers and public complaints (Figure 7) did not reflect the general perception of widespread septic system failure. All Council officers that were interviewed believed there was a substantial disparity between reported failures and actual incidences of failure that they have experienced. For example, 200 septic failures reported in the Gold Coast City Council equated to around 2% of their septic systems. This percentage is not realistic as far more systems were likely to be failing in one of categories shown in Figure 5. Similar studies performed elsewhere in Australia suggest that poorly performing septic systems are common. A 17 month survey completed by householders was carried out in the South Australia between 1999 and 2001, to identify the performance of on-site systems in this important water supply catchment (Arnold & Gallasch, 2001). The results of the survey suggested that almost 50% of septic systems were underperforming, with 12% (151 systems) exhibiting visible surface surcharging of effluent. Jelliffe (1994) also reported a high number (67%) of poorly operating, broken or surcharging septic systems in a study of septic systems in Maroochy Shire, north of Brisbane.

The underestimation of failures in this study was believed to be due to the unwillingness of the public to report a failure, the lack of knowledge as to when a system is actually failing and, in large allotments, the low risks perceived by householders from a “small puddle in a big area”. The figures we report should only be considered approximate as many Local Authorities records are not complete or updated regularly.

Poorly designed older septic (blackwater) systems and the more recent combined (black and greywater) systems, were the most problematic septic systems reported by plumbing inspectors. Many Local Authorities found that older septic (blackwater) systems that had been properly designed i.e. with suitable trench length, were the least prone to fail. Newer combined septic system, designed post-AS1574:1994, were reported to be the most common type to fail. This was largely attributed to the larger volumes of water that enters the trench in combined systems. In blackwater-only septic systems, approximately 20% of the internal household volume is diverted to the trench.

Figure 5. Classification of major septic system failure classifications identified by Local Authorities.

Figure 6. Surcharging of effluent (right) that can result from trench ‘clogging’ (left).
The remaining fraction is greywater (e.g. 80%) and is usually surface irrigated via a manually moved sprinkler. As noted previously with the older split systems, the inappropriate discharge of greywater is of particular concern to Local Authorities.

**Reported AWTS and Sand Filter Failures**

The breakdown of reported AWTS and SF system failures per year in SEQ is shown in Figure 8. ‘Failure’ varied from 0 systems to 700 systems per year. The data presented in Figure 8 needs to be considered in the context of the failure classification used by each Local Authority, and whether or not aerobic systems are inspected regularly. For example, Kilcoy reported no AWTS and SF system failures for the last year, however they classify a failure as ‘lack of maintenance’ and do not carry out a regular monitoring programme. Therefore the likelihood of system failure being detected is much lower than other more proactive Councils, such as Caloundra.

Although effluent quality monitoring of AWTS and SF systems is not a statutory requirement, some Councils that monitor aerobic system effluent often rated ‘non-compliance’ as a form of failure. However, some Councils acknowledged that non-compliance with effluent quality criteria was not necessarily an accurate gauge of a system’s performance. Errors in sampling and the inherent temporal variability in wastewater quality are factors that could cause effluent quality data to be an unreliable guide to the system’s treatment capabilities.

Furthermore, the criteria of 20mg/L BOD and 30mg/L suspended solids ([On-site Sewerage Code 2003](#)), which were the most commonly tested parameters by Councils, relates to direct discharge into waterways, and therefore may not be especially relevant for discharge onto vegetated areas.

A survey of 216 aerobic systems in Queensland by Tully and Beavers (2001) indicated an underperformance of aerobic systems with only 30% of systems achieving the effluent quality criteria for BOD, suspended solids and faecal coliforms. Khalife and Dharmappa (1996) found a majority of the AWTS tested in NSW exceeded the effluent quality guidelines, with only 50% of systems satisfying the limit for faecal coliforms (i.e. <30cfu/100mL).

Although a small number of systems were sampled (27), results from the study suggested a trend toward poor performance in systems that were not user-friendly and irregularly maintained. This trend was also observed by Local Authorities who believed that lack of appropriate maintenance caused most of the system failures reported. Also the peak or shock loads into ATWS were associated with poor effluent quality or poorly functioning mechanical parts. Several Local Authorities stated that the septic system was not necessarily the most problematic system in regards to surface water contamination. They argued that when AWTS and sand filters fail, they will surface-irrigate poorly treated effluent making them a similar if not greater environmental and public health risk than poorly performing septic systems. There was often little Local Authority confidence in service agents as inadequate maintenance or lack of care by the agents was commonly observed by Plumbing Inspectors.

**Greywater Systems**

As identified earlier in the text, split greywater/blackwater (septic) systems comprise the majority of complaints and failures reported by Local Authority officers. Inappropriate greywater discharge was singled out as one of the most problematic issues associated with on-site systems. Many greywater systems disperse effluent via surface irrigation using a movable hose and sprinkler. It was reported that sprinklers were not being moved frequently and/or were located in unsuitable areas (gutters, stormwater drains).

The volume of water being discharged via greywater systems is up to four times greater than that going into blackwater trenches (i.e compare 20% to 80% of household water), however, the concentrations of pathogens, nutrients, solids and BOD are likely to be much less than in surcharging septic tank effluent. Figure 9 shows that almost 70% of the Local Authorities believe that the frequency of inappropriate discharge of greywater systems was medium or high. Some examples include hoses discharging greywater being directed into gutters, stormwater drains, kerb-side grass verges, roadways or the neighbours’ properties. Other surveys have also identified inappropriate greywater discharge as an issue (Arnold & Gallasch, 2001; Rawlinson, 1994). The other common definition of greywater failure used by Local Authorities was odour from blocked or overflowing grease-traps.

**Rented Properties and Commercial Systems**

The number of rental dwellings with OWTS was difficult to quantify although forty-five percent of Local Authorities rated the frequency of OWTS installed in rented dwellings as medium or high.
Managing and maintaining OWTS in rented dwellings is more challenging than in owner-occupied dwellings as householders are often transient, and ill-informed of the requirements of an OWTS (such as desludging septic tanks and changing chlorine tablets in AWTS). Almost 85% of Local Authorities identified the incidence of failure in OWTS installed in rented dwellings as either medium or high. Council attributed these failures to a lack of knowledge about the system from the tenant, and irregular use followed by sudden high water use (shock loads).

Although larger (>20 EP) and commercial OWTS are the jurisdiction of the EPA, several Local Authorities identified performance problems and a lack of regular maintenance in these systems. Around 22% of Local Authorities rated failures in larger OWTS as high.

Evidence of Water Quality Impacts from OWTS

Previous on-site system studies have identified a varied degree of OWTS performance (Jelliffe, 1994; Kinhill, 1997; Goonetilleke et al., 2002) but have not clearly linked poor stream water quality with pollution from on-site systems. There were no water quality studies identified by Local Authorities that specifically targeted impacts from non-sewered catchments. To date, only a few Australian investigations demonstrate conclusive evidence of OWTS-sourced pollution, and these have utilised tracers to track the contaminant plume originating from the effluent dispersal zone (Gerritse et al., 1995; Whitehead and Geary, 2000; Geary, 2004).

Stream water quality impacts from on-site systems was the key driver for this Healthy Waterways sponsored project and, to date, there is very little evidence demonstrating this. Of course, with the “silo” nature of Local Authority administrative structures, knowledge of waterway contamination from OWTS may have been overlooked during the survey. However, it is likely that if on-site system pollution had been detected by a Local Authority, most of their Council officers would be aware of this, and it would have been raised during the questionnaire or interview process.

Figure 9. Frequency of greywater ‘failure’. Pie slice ~% of Local Authorities in SEQ rating each frequency of failure as high, medium or low.

Evidence of Water Quality Impacts from OWTS

Flow, Level Sensors & Indicators

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A further step in this project was to conduct an initial desktop mass balance assessment on non-sewered areas using a catchment located in the SEQ region. Results from this study suggest that non-sewered areas contribute relatively small pollutants loads to catchments, with the exception of nitrogen in groundwater from septic absorption trenches (Neumann et al., 2004).

Stakeholder On-Site System Management Issues

The role of government and public institutions in on-site systems was varied in both detail and technical standard. In Queensland, DNR&M were previously responsible for the on-site legislation and approval of on-site systems. This has now been passed onto the Department of Local Government and Planning. DNR&M has authority to produce a code of guiding principles for preserving the water quality in declared catchments (e.g. water supply catchments). The EPA are responsible for the larger systems (>20 EP) and also have the power to encourage Local Authorities to consider “cumulative impact” under Section 33 of the Queensland Environmental Protection Policy (Waters) 1997, although this is not explicitly considered by the EPA or Local Authorities in SEQ. The most proactive organisation is SEQ Water, who supply the bulk (>75%) of raw water in south-east Queensland. Cumulative impact of non-sewered subdivisions in water supply catchments is of particular interest to SEQ Water and their comments under the “material change of use” process of IPA (1997) strongly influence the conditions that the Local Authorities impose on developers. However, SEQ Water have no legislative power and they influence more by persuasion and informed comment. This is in contrast to Sydney Catchment Authority, say, who have a greater level of statutory power to enforce water quality protective measures.

Conclusions

Of the 127,000 OWTS in SEQ, the majority (80%) were septic systems, of which 75% were split blackwater/greywater. Blackwater systems were often installed with shorter trench lengths as they treat only 20% of the household water. Aerobic systems are gaining in Council and homeowner popularity, and are likely to form the bulk of the OWTS to be installed in SEQ over the next 10 years. Failure rates in septic systems were largely attributable to poor septic tank condition, trench length underdesign (some older blackwater systems as well as combined systems that receive 100% of household water) and infrequent desludging - leading to solids carry-over. In aerobic systems, failures related to non-compliance with effluent criteria, odour and system disrepair. Most septic systems were not regularly inspected or maintained. The actual number of failing systems was believed to be substantially greater than reported to Council officers, but still lower than expected.

The impact on stream water quality from on-site systems was the key driver for this Healthy Waterways sponsored project but, to date, there is very little evidence demonstrating deterioration in non-sewered areas.

It is recommended that all Local Authorities conduct audits on every non-sewered allotment in their jurisdiction. Five SEQ Local Authorities are in the process of auditing. These audits present an excellent opportunity to compile valuable biophysical data required in OWTS risk assessments.

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References


