AN APPROACH TO ON-SITE MANAGEMENT OF SEASONAL FLUCTUATIONS IN WASTEWATER AT CARAVAN PARKS

Ben Kele, David J. Midmore, Keith Harrower & Robert Lowry
Plant Sciences Group, Central Queensland University, Rockhampton, Queensland

Abstract

Some caravan parks, especially in isolated areas, have marked fluctuations in occupancy due to seasonal trade. For example, in Central Queensland the majority of caravan tourists visit during the cooler months of the year. The seasonal production of wastewater varies greatly, with some parks having an average of over one hundred vans a night during winter, and one van a night during summer. Most on-site wastewater systems have trouble dealing with large seasonal variations. This, coupled with the desire by some clean-water-limited isolated caravan parks to re-use wastewater, has led the Central Queensland University (CQU) to develop an on-site wastewater system able to deal with seasonal variations in the wastewater load. The system uses existing on-site treatment processes, such as septic tanks and grease-traps, in conjunction with an innovative recirculating transpiration and filtration bed.

CQU is working with two-isolated caravan parks, one in St Lawrence and the other in the Willows gem fossicking area. Both have large seasonal variations in resident numbers, and the Willows site is severely clean-water-limited. Careful plant selection for the transpiration beds can improve their sustainability. Choosing plant species that can be pruned during late spring with regrowth in late summer/early autumn ensures reduced amounts of water are required to keep the plants in the evapotranspiration bed alive during low occupancy times. The project aim is to allow these parks to re-use their water in an economically feasible, water-wise and environmentally friendly fashion.

Keywords

Hydraulic surge, plants, retrofit, re-use, soil-bed, underground, water-balance

1 Introduction

On-site treatment technology is essential for wastewater management in many parts of rural and regional Australia. While the majority of installations are attached to houses, on-site systems are also used for public amenities, commercial, and industrial properties. Goonetilleke et al. (1999) reviewed the performance of onsite treatment techniques and found that the performance criteria of septic tanks as well as aerobic wastewater treatment systems (AWTS) were often not met.

The failure of on-site systems is a concern due to the potential for environmental pollution and the risks to public health (Hoover et al. 1998). The failure of an on-site treatment system in a caravan park or camping area is of great concern because the volume of wastewater can be periodically larger and the pollutant and pathogen load higher. Campers are also more likely to come into contact with the effluent, especially if it is used for irrigation.

Camping areas often have large variations in occupancy rates. If the on-site system has been designed to deal with an average daily flow, there may be large deviations in the treatment performance due to the variation in camper numbers throughout a year (Arnade 1999). For

example, the St Lawrence recreation area has an average summer occupancy of two vans/tents a night, but the winter average is 15 vans/tents a night. A treatment system set up on the yearly average is over-engineered for the summer, and inadequate to cope with the volume of wastewater produced in the winter.

CQU has developed a form of on-site wastewater treatment that minimises risks to public health and lessens environmental impacts (Kele et al. 2000). The CQU system uses existing primary treatment technology combined with an innovative self-contained recirculating gravel-filter, soil-bed, and transpiration channel. The system treats wastewater to a high degree and contains the effluent underground, isolating it from the public. It is believed that the use of carefully selected plants in the transpiration channel will enable an on-site system to cope with the variation in wastewater volume common in certain camping areas.

An on-site treatment and reuse facility at the St Lawrence recreation area was installed by CQU in February 2001. A similar system will be established at the Gem Air caravan park during September 2001, after the peak tourist season.

2 The St Lawrence Recreation Area

St Lawrence is a small rural township situated halfway between Rockhampton and Mackay in Central Queensland. All wastewater treatment in the town uses on-site technology. On the outskirts of the township, just off the Bruce Highway, is the St Lawrence recreation area. While this area is used by the townspeople for sporting events, particularly horse sports, its major use is from tourists as an overnight camping area or short-stay rest-stop.

An amenities block is the source of the wastewater produced at St Lawrence recreation area. The blackwater is produced by 11 toilets, 1 urinal, and 7 hand-basins. Greywater production occurs from 7 showers, and one large outside sink used for the washing of clothes. During the summer there may be only infrequent use of the recreation area by tourists/travellers. However during the cooler times of the year use of the amenities block increases markedly and can have an average greater than 20 equivalent people (EP) per day. Special events held at the sports area can draw crowds of well over 100 people, resulting in a relatively large hydraulic surge.

3 Environmental Impact Study

Before the CQU system was installed, a performance trial was conducted on the existing wastewater treatment technology at the St Lawrence recreation area. The potential impacts of on-site system failure on the surrounding environment were also studied.

The wastewater at the recreation area was primarily treated in a 22 000 litre all-waste two-part (baffled) septic tank. The effluent was pumped into a 10 EP AWTS. After treatment the effluent was pumped to an irrigation line of aboveground drippers. In January 2001 the soil under the drippers was analysed for heavy metals, nutrients, pH, sodium, microbial ecology, chlorinated hydrocarbons, and electrical conductivity. The water collected was tested for pH, electrical conductivity, total dissolved salts, microbial ecology and heavy metals. Plants in the recreation area were also tested for carbon-nitrogen leaf ratios, and for heavy metals.

The environmental impact study showed several site characteristics that were of concern. The soil type is inappropriate for on-site disposal with poor drainage (silty clay loam) and pH ranges between 5.9 and 4.8, indicating a potential for acid-sulphate conditions. The slope of the land also meant that runoff from the AWTS irrigation line could contaminate a nearby freshwater wetland.

The greatest concern identified by the environmental impact study was the failure of the existing on-site treatment facility. Effluent from the septic and the AWTS were tested in two separate runs, at sample ports along the irrigation line (a and b), one week apart (see Table 1).

Table 1. Microbial Water Values for the Septic and AWTS at the St Lawrence Recreation Area

SAMPLE	Non Fastidious Heterotrophic per 100 ml at 28ºC/48 hrs	Escherichia coli per 100 ml at 37ºC/48 hrs	Total coliforms per 100 ml at 37ºC/48 hrs	*Salmonella* spp. per 100 ml at 37ºC/48 hrs
Run 1: Septic	$5.15 * 10^8$	$6.4 * 10^5$	$1.89 * 10^6$	$7.8 * 10^6$
Run 1: AWTS (a)	$4.45 * 10^8$	$1.95 * 10^6$	$3.5 * 10^6$	$7.25 * 10^6$
Run 1: AWTS (b)	$6.45 * 10^8$	$5.05 * 10^5$	$3.305 * 10^6$	$1.05 * 10^6$
Run 2: Septic	$2.6 * 10^8$	$1.4 * 10^4$	$7.364 * 10^6$	$3.6 * 10^4$
Run 2: AWTS (a)	$2 * 10^8$	$3.9 * 10^4$	$6.59 * 10^5$	$3.6 * 10^4$
Run 2: AWTS (b)	$2.7 * 10^8$	$2.35 * 10^5$	$8.3 * 10^5$	$2.4 * 10^4$

The septic tank in both runs was performing within the average treatment range (Tchobanoglous and Burton 1991). The AWTS system failed in both runs, with microbial performance criteria exceeded by orders of magnitude. The tests runs were undertaken during the summer when occupancy of the camping area was low. Camping occupancies for run 1 and run 2 were six and three people respectively. Chlorine levels in the AWTS effluent was measured for each run and was shown to be present (0.5-1 mg/L^{-1}). Sediment and pH may have made the chlorine less effective. In addition to the water analysis, three microbial soil tests were performed at three points along the irrigation line (Table 2).

Table 2. Microbial Analysis of the Soil of the AWTS Irrigation Line

AWTS Irrigation Surface Soil Sample	Heterotrophic Colony Forming Units per g at 37ºC/48 hrs	Total Coliforms MPN/g	Faecal Coliforms MPN/g	Faecal Streptococci MPN/g
1	2.6×10^8	54 000	24 000	11 000
2	5×10^7	2 300	2 300	2 300
3	3.6×10^7	160 000	54 000	79

The irrigation line showed high numbers of coliforms, and the presence of faecal streptococci proved that at least some had a sewage origin. The poor drainage of the soil along the irrigation line also meant that effluent quite often pooled for considerable lengths of time.

The CQU treatment and reuse system was retrofitted to the existing wastewater treatment facilities at the St Lawrence recreation area.

4 CQU System

The CQU retrofitted installation comprised a 4500 litre holding tank and 24 three-metre long, one-metre wide concrete troughs. The troughs were installed as three separate channels, two of which were six troughs long, and the last twelve troughs long. After installation, each channel was mounded over so that the depth from the top of the mound to the bottom of the trough was approximately 600 mm.

A water-balance model has been developed that incorporates the selection of specific plants to deal with the large fluctuations in wastewater production experienced at the recreation area. Twelve of the troughs were planted with ornamental trees, shrubs, and vines. These plants were selected to give a 'background' rate of effluent reuse.

The remaining twelve troughs were planted with six fast growing species of bamboo. The selected bamboo species are all commercially valuable for wood and/or paper production. Bamboo species require relatively large amounts of water and nutrients to maintain a high growth rate (Kleinhenz and Midmore 2001). Bamboo is a suitable plant type to influence water usage because older culms can be harvested at the beginning of summer, thus reducing water demand. The fast growth rate of bamboo means that the new shoots will have reached sufficient size by the cooler months to reuse the increased amount of wastewater produced at the recreation ground.

5 Conclusion

The CQU treatment and reuse system should minimise environmental impacts on the site and eliminate potential human contact with the effluent and provide an ecologically sustainable and safe method of on-site technology. Through the manipulation of the transpiration rates through a bamboo harvest cycle the fluctuations in wastewater production at the St Lawrence recreation area can be managed.

Acknowledgements

We would like to recognize the contributions of the QWRS, NHT, Emma Yates, Tony Kodel, Henry Hausen, Charmain Elder, Liz Dobson, Gary Walsh, the Broadsound Shire Council, Emerald Shire Council, McCracken's Water Services, Fitzroy Nurseries, and S. W. Kele & Co Pty Ltd.

References

Arnade, L. J. (1999). "Seasonal Correlation of Well Contamination and Septic Tank Distance." Ground Water 37(6): 920-923.

Goonetilleke, A., B. Ridgen and L. Dawes (1999). Performance Evaluation of Onsite Sewage Treatment. Brisbane, Queensland University of Technology: 1-106.

Hoover, M. T., A. Arenovski, D. Daly and D. Lindbo (1998). On-site Wastewater System Siting, Design, and Management. On-Site Wastewater Treatment - Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems, USA.

Kele, B., D. J. Midmore and V. Kleinhenz (2000). A Bio-Engineering Solution to Rural Domestic Wastewater Reuse. Xth World Water Congress, Melbourne, Australia, Launchpad Multimedia.

Kleinhenz, V. and D. J. Midmore (2001). Proposed Management Procedures for Culinary Bamboo. Canberra, Australia, RIRDC.

Tchobanoglous, G. and F. L. Burton (1991). Wastewater Engineering - Treatment, Disposal, Reuse. Singapore, McGraw-Hill Book Co.

`