WASTEWATER MANAGEMENT IN NATIONAL PARKS

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Abstract

Camping grounds and day use areas within National Parks are often located at or close to sites with aesthetic, cultural or ecological values. Protection of these values from the impact of visitors is increasingly an issue of concern for park management. As sites are usually isolated, it has been found essential to provide toilet facilities and often shower amenities at the sites to avoid human wastes being indiscriminately deposited in the immediate area. The concentration of visitors to the most valuable sites results in a concentration of waste materials that must be managed. Unless the wastes are removed entirely or treated effectively there is the potential over time to cause a local build up of contaminants, including nutrients and pathogens. Where the site has ecological value, any local build up of nutrients or contaminants will run counter to the conservation objectives for the National Park, and generally run counter to the legislation governing conservation within National Parks.

Park use throughout Australia has increased significantly over the past decade. Today many parks have overloaded facilities relying on outmoded or inappropriate wastewater technology. The impact of inappropriate or overloaded wastewater facilities may not be observable over the short term, however it is clear that numerous sites around this country are slowly degrading through impact from inappropriate wastewater management.

This paper sets out an approach for achieving sustainable management of wastewater in ecologically sensitive National Parks. Systems which have been found to be most effective are systems which have the simplest operational and maintenance requirements and are designed to handle specific loading patterns associated with National Parks visitation. Inappropriate systems usually place excessive time demands on park staff and potentially result in ecological damage. The paper looks at the specific issues that relate to wastewater management in National Parks and provides an assessment of strengths and limitations of available system types.

Key words

composting toilets, hybrid toilet systems^{tm}, septics, national parks, wastewater management.

1 Introduction

National Parks are created for the purposes of conserving sites with cultural, aesthetic, recreational or ecological values and many combinations of these. The reason for their creation is to conserve and protect the values for future generations. It is perhaps human nature that those areas of greatest value also attract the greatest interest, evidenced by visitation rates.

As National Parks sites are usually isolated and visitors usually spend some hours at each site, or have taken some hours to get there, it has been found essential to provide toilet facilities and often shower facilities to avoid human wastes being indiscriminately deposited in the

immediate area. The concentration of visitors to the most valuable sites results in a concentration of waste materials to be managed at these sites. Unless the wastes are removed entirely or treated effectively there is the potential over time to cause a local build up of nutrients and contaminants. This build up may threaten the very values that attract the visitors in the first place.

This paper looks at the issues that make design for National Parks different to that of other sites, and offers direction for solving some of the more common problems confronting National Parks infrastructure designers.

2 Common Issues Associated with Wastewater Management in National Parks

The following issues commonly constrain the provision of infrastructure in National Parks, including wastewater management. The lists are not in order of priority.

2.1 General Issues

- Isolation from services (electricity, water supply, service personnel, pump out services, access roads);
- High costs associated with isolation;
- Lack of funding for capital works and even less funding for maintenance;
- Existing facilities of differing ages and capabilities;
- Staff turn-over resulting in a short 'corporate' memory;
- Extreme visitor level fluctuations;
- Need to treat shower water as well as toilet waste;
- Lack of permanent site staff ;
- Scattered facilities; and
- Vandalism, theft and abuse of systems.

2.2 Site Specific Issues

- Sites often in poor soils &/or with topographic limitations (ie location on rock);
- Sites located close to sensitive areas but have limited opportunity for buffers;
- Provision of level of infrastructure in accord with the rating objectives for the site; and
- Accessibility for and availability of a pump-out truck

3 Typical Objectives for Wastewater Management in National Parks Sites

Wastewater Management should:

- Be ecologically sustainable;
- Have minimal environmental footprint;
- Incur minimal capital and operational cost;
- Be simple to operate with minimal time requirement by Ranger staff;
- Be able to be operated and maintained by Ranger staff;
- Have minimal energy requirements;
- Be designed for the site conditions and usage patterns, including projected growth over the life of the system;
- Be compatible with the overall management objectives for visitor management within the site, including factors such as location, accessibility, aesthetic considerations and functionality; and
- Satisfy the expectations of most users.

4 Several Useful Principles

The following principles have been found useful in designing facilities in National Parks

- **Each site will have entirely different characteristics**. Each site must be considered as unique and investigated accordingly.
- **Design for wastewater management should not be undertaken in isolation from the overall design of the site**. Design should be undertaken with input from a multi-disciplinary design and management team. Ideally the team should meet on the site over a period of a day or more, experience the site as a visitor, and brainstorm an overall design concept taking into account factors such as:
    - the ecological sensitivity of the surrounding area,
    - recreational use of nearby water courses,
    - type of visitors to be serviced,
    - site layout efficiencies,
    - available treatment and disposal options and their costs,
    - maintenance requirements and relative characteristics.
- Amenities blocks should be located no more than 100 m from major areas of concentration or campsites unless unavoidable because of terrain. Often several small toilet blocks will be required.
- **Design for minimal wastewater production.** The less water required to be treated the lower the cost of treatment systems and disposal areas. Systems that use the most water (septic systems) generally produce poor wastewater quality unless attached to expensive secondary or tertiary treatment processes.
- **Sustainability should be a major design criterion**. This will usually mean a low risk of system failure and a level of nutrient and pathogen emission that will not cause a reduction in the environmental values of the surrounding area (including groundwater).
- **Keep it Simple.** Simple systems have low energy needs, require little maintenance and require infrequent major attention (such as a pump-out). For larger treatment systems application of lower power consumption passive systems (eg aerobic sand filter units) are generally more suitable than active higher tech package plants.
- **Design for Growth.** The hardest part of the process of obtaining new facilities is often obtaining funding. It is important to ensure that the system obtained will have a long life and not exceed its design capacity over the projected life.
- **Larger sites economies of scale may support centralised schemes**. Larger campsites with significant hydraulic loads from shower blocks may be suitable for centralised collection schemes with final treatment by a centralised secondary or tertiary treatment plant. In the design of these systems the principles listed above should also be applied.

5 Treatment Options

Treatment options range from pit toilets of varying sophistication, to composting systems, Hybrid Toilet^{TM}, septic systems and package treatment plants. Table 1 sets the limitations and strengths of the various systems based on the author's experience.

Table 1: Treatment Systems Disadvantages and Advantages

TREATMENT SYSTEM TYPE	DISADVANTAGES	ADVANTAGES	APPLICATION
Pit Toilets	• Unsuitable for high water table areas • Unsuitable in more permeable soils • Suitable for low usage rates • Difficult to clean out • May cause odour unless well ventilated	• Easy to install unless in rock • Low maintenance if low usage rate • Passive systems	Sites where water tables are low and leakage to the water table is negligible. For isolated low usage trails
Composting Toilets	• May become temporary waste holding systems rather than composting systems unless over-designed & well maintained • Relatively high maintenance requirement • Most types difficult to remove uncomposted wastes when overloaded • Removed uncomposted waste must be carted and stored elsewhere in safe location (Environmental and health issues) • Require regular dosing with shavings or organic material to be added • Not suitable for sites with significant peak loads, or where sites attract large numbers of day visitors for short periods of time, resulting in high urine loadings.	• -do not require water supply • -do not require disposal of large volumes of water • Passive systems with low energy requirements	Locations where visitor loading does not suffer extreme peaks, water supply is limited, suitability for disposal of wastewater on-site is restricted, and vehicular access to the facility for cleaning is available.
Hybrid Toilet System™	• Systems must be located above water table • Small effluent volume, but must still be disposed of appropriately • 1 to 3 year pump out required for primary tank	• Low effluent volume (1.2 to 2.25 L/day per EP) • Effluent quality is very good if systems not overloaded • Passive system • zero power requirement • Minimal maintenance requirements	Wide range of applications. May also be fitted with micro flush systems.
Septic Systems	• Require water supply • Large volumes of effluent (35 to 50 L/EP per day) to be disposed of • Effluent quality is poor • Odour problems may arise during peak periods	• Systems may also take shower water • Flush toilets give the perception of a cleaner system than dry systems	Wide application where there is a water supply and effluent disposal may be carried out sustainably.
Package Treatment Plants	• Non-passive systems will require power supply • Higher level of maintenance expertise required than other systems	• Allow for centralised collection and secondary or tertiary treatment • Range of systems available depending on requirements	• Larger sites where a higher level of treatment is required to meet environmental objectives. • Sites where there is an associated village or commercial camp area.

6 Disposal Options

Disposal options range from pit toilets, absorption trenches, evapotranspiration/absorption beds, subsurface and surface irrigation, to total removal from the site as wastewater, sludge or dry material. Disposal methods will be dictated by site characteristics and waste quality. A thorough site investigation is required to assess suitable options, with the final option selected as being able to achieve the environmental objectives for sustainability. If sustainability cannot be achieved by any on-site disposal option then wastes may need to be removed from the site altogether.

7 Water Conservation

In terms of achievement of the principles set out above it has been found advantageous to apply water conservation principles to activities within National Parks. Where showers are provided, shower water may be a substantial proportion of the total wastewater production. In a recent study at a Fraser Island campsite the ratio of shower water to toilet water was 19:1. Reducing shower water use may be more difficult than reducing toilet water usage. For example, several options exist for waterless toilets. Shower usage cannot be reduced below a reasonable threshold. Typical daily shower usage in National Parks will range from the 10 L bucket to 65 L per EP. As a principle shower water usage should be controlled. Control methods include coin operation, automatic shut-off taps, low-pressure water delivery, and low water use shower roses.

8 The Ideal Treatment System!

There is no ideal system. However, systems that have low water usage and have low pollutant mass will always top the options assessment. These are limited to composting systems and the Hybrid Toilet System™. Composting toilets tend to have a high maintenance requirement unless they have steady low usage rates. Cleaning out uncomposted wastes is frequently required when systems suffer peak loading. This is not a preferred task by Rangers and carries health risks. It is the experience of the author after auditing numerous systems across Queensland that few composting systems in National Parks actually work as such. Most become holding systems for uncomposted waste which must then be removed by the Rangers. The relative performance of the range of commercially available composting systems will differ. When a composting system is to be used in a National Park, care should be taken to select a system which allows the wastes to be cleaned out efficiently and with little health risk to the cleaner. Systems with removable containers are more suitable than systems requiring use of a shovel.

Provided Hybrid Toilet Systems™ are accessible to a septic pump-out truck at reasonable cost, and are designed with a degree of conservatism (i.e. over designed), these systems will achieve an adequate level of pollutant reduction with minimal maintenance, and produce a comparatively small volume of effluent for disposal. Effluent volumes are less than 5% of that produced by septic systems, even with the microflush system installed.

The mass of nutrients exported in effluent from a conventional septic tank is of the order of 100 times that from properly operating Hybrid Toilet System. For example, median total phosphorus (TP) and total nitrogen (TN) concentrations reported for a Hybrid Toilets system at Edmund Kennedy NP were 2.2 mg/L and 12.6 mg/L respectively (Compliance test results for the Edmund Kennedy NP, ALS and Townsville City Council Environmental Laboratory, 1998-1999). Typical values for septic effluent are reported in the NSW Environmental and health Protection Guidelines – Onsite Wastewater Management for Single Households (1998) as 10 mg/L and 50 mg/L for TP and TN respectively. Assume that daily volumes produced

per day are 1.2 L per EP for a Hybrid Toilet System and 35 L per EP for septic systems. The total mass of TP and TN exported in Hybrid Toilet Effluent is then 2.64 mg TP and 15 mg TN, compared with 350 mg TP and 1750 mg TN in septic effluent per person per day. The long detention time of the Hybrid Toilet system (generally > 50 days) results in a high rate of TN and TP removal within Hybrid Toilet systems and very low faecal coliform levels in effluent compared to effluent from septic tanks. The median value for Hybrid Toilet system effluent from the Edmund Kennedy NP system was 2 cfu/100 mL. This is between 10^5 and 10^7 times less than septic effluent.

The designer of wastewater systems in sensitive ecological settings should be prepared to accept that there will be some locations where it will be necessary to remove all waste from the site. In such locations, systems which produce the smallest volume of waste, or which have handling advantages, will be the preferred option. The small volume of effluent produced by the Hybrid Toilet System™, favours these systems where pump-out trucks are economically available. If a pump-out truck is not available, composting systems may be a more practical option.

9 Conclusion

Advances in treatment systems have been fairly rapid over the past decade. There are many different systems now available, each with its strengths and limitations. At the time of writing the author has found that the system with the widest application within National Parks is the Hybrid Toilet System™. However, it is emphasised that a thorough examination of site characteristics and constraints should be undertaken before recommending a particular treatment of disposal system as there will be situations where other treatment systems may be better suited to site conditions and usage. The essential principle is to ensure that the scheme provided is ecologically sustainable.

Disclaimer

The content of this paper is based on the author's experience. The author has no commercial interest in or affiliation with the manufacturers of any of the products mentioned in this paper.

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Laboratory compliance test results for Hybrid Toilet Systems™, Edmund Kennedy NP. Provided by Gough Plastics Pty Ltd.