ON-SITE SEWAGE MANAGEMENT IN FEDERAL

Peter Dupen
Aztex Environmental Pty Ltd. Byron Bay. NSW

Abstract

Federal is a small but rapidly growing village in the hinterland of Byron Shire. Aztec Environmental recently completed a study on the local current on-site wastewater management practices, and on what impacts these practices are having on the local waterways. The implications of the new State Guidelines (1998) were considered in relation to the Federal case study, and the outcomes of our modelling will be important in determining how Council will approach wastewater regulation in similar parts of the Shire.

The study incorporated surveys of householders and service providers, detailed site inspections of all available systems, soil sampling and a GIS-based landform assessment to provide a final "land suitability map" for the study area.

The principal outcomes of the study are that most on-site sewage is being poorly managed in Federal, with 90% using septic tanks and small trenches as the management technique. However, the deep, well-structured krasnozem soils developed over the local basalt lava flows are well suited to effluent disposal (and incidental tertiary treatment), which appears to be the main reason that local waterways are not grossly polluted, at least in dry weather.

Byron Shire receives more rainfall than it loses in evapotranspiration. Applying the Federal conditions determined in this study to the State Guideline methodologies leads to impractical requirements for application areas and storage facilities. These requirements are considered unnecessary, implausible and could lead to serious health and environmental risks if implemented. Aztec Environmental's preference is to treat the effluent to a high enough standard that occasional surcharges to surface or groundwaters will not cause adverse impacts.

Keywords

field study, On-site, sewage, water pollution, wastewater

1 Introduction

Federal is a small village perched in the low hills behind Byron Bay, supporting approximately 100 residences and a very small commercial centre. The local climate is subtropical with a wet summer and autumn and dryer winter. Federal is growing rapidly, with a number of urban-style developments occurring in the past eight years. The village is entirely dependent upon on-site systems for all domestic wastewater management. In response to mounting concerns over the impacts that the village's sewage may be having on the local and downstream environments, a study was commissioned by Byron Shire Council (BSC) and the Department of Land and Water Conservation (DLWC). The outcomes of the investigation, undertaken by Aztec Environmental Pty Ltd (Aztec) along with Martens and Associates and Malcolm Scott Town Planning, are summarised in this paper.

2 Study Methodology

The study program comprised a series of integrated components aimed at determining the current status of wastewater management in Federal. The following activities were undertaken for the study:

- Survey of householders in Federal, questioning them on their water usage and details of their wastewater systems. A number of questions were aimed specifically at assessing the householder's knowledge, attitudes and familiarity with their treatment and disposal systems.

- Survey of wastewater service providers who installed and maintain most of the local on-site systems.

- Identification of principal land-units within the survey area, based on air-photo interpretation, analysis of DLWC soil-terrain mapping and ground-truthing. Once the land units were identified, type localities were selected for detailed analysis. Investigation pits were dug to refusal using a back-hoe at six critical locations. Soil profiles were logged in detail and selected samples were sent for chemical analysis.

- An inspection program was conducted by Aztec personnel. All on-site systems within the study area were inspected for size, type and visible performance of their treatment and disposal systems.

- A limited surface and shallow ground-water monitoring program was undertaken by Council and the local community. The water sampling program was designed to complement the Aztec study.

3 Study Results

The principal findings of the study were as follows:

- The study area is characterised by thick sequences of well-structured krasnozem soils over deeply weathered, sub-horizontal basalt layers. The topography varies from undulating to steep, with erosion and mass movement a significant problem on many of the disturbed side slopes.

- Almost all (90%) of on-site systems comprised simple septic tank and percolation trench configurations. The remainder were Aerated Wastewater Treatment Systems (AWTS) with varying irrigation fields, except for one household which utilised septic-tank treatment coupled with a sandfilter/mound disposal system.

- Householders' understanding of wastewater management and system requirements varied from very good to very poor, with the latter predominating.

- Most of the disposal systems were undersized by current standards and many of the treatment systems exhibited serious operational problems. Despite this, the observed failure rate for trenches was remarkably low (10%). This was partly attributed to the suitability of the krasnozem soils for effluent disposal, but was undoubtedly also due to the fact that the study was undertaken during a prolonged dry period.

- The most common problems observed in septic tanks were: tanks not being regularly emptied leading to oversludging and high solids carry-over; greasy, thin or absent crusts, blockages at inlets from roots, and poor accessibility for maintenance.

- Most of the AWTSs appeared to be functioning quite well, which was partly attributed to the flurry of servicing activities that occurred before the inspection appointments. Most in-line filters had been removed however, and chlorine disinfection was not occurring in some systems. Poor or partial aeration was noted in a number of systems.

- Greywater management, where separated, often comprised little more than a hose running out of a single discharge point in the yard or garden.

Domestic grease-traps were rarely (6%) in evidence.

4 Impacts from Domestic Wastewater

Evidence of deteriorating water quality has become a serious issue in North Coast waterways in recent years. A State Government audit of river health in the region showed that many creeks and waterways were seriously degraded with respect to nutrients and biological pathogens (NRAC, 1996). More recently, a CSIRO study using "sterol biomarkers" found that human faecal contamination can be detected in the nearby Brunswick River, even at points remote from sewage treatment plant (STP) outfalls (Leeming, 1998). These poor water quality results have been attributed to a number of causes, including emissions from sewage from centralised and on-site treatment systems as well as agricultural and stormwater inputs.

The receiving waterways in the Federal study area fell neatly into three separate catchments, as shown in Fig. 1. Each catchment had contrasting land-uses: most of the dense urban development fell westwards into the Stony Creek catchment, and the eastern catchment received waters affected mainly by rural residential properties, while the northern catchment was dominated by agricultural activities (cattle-grazing and plantation timber). A total of nine stations were systematically sampled over four monitoring rounds, including one after a small storm event.

Water quality around Federal was generally found to be moderate to poor, and is regularly unsafe for swimming and certainly for drinking. Unfortunately, the limited sampling results were somewhat ambiguous, and it was not possible to draw firm conclusions about the relative contributions of the principal pollution sources, i.e. sewage effluents, greywater and urban stormwater management, agricultural practices and wildlife. Trend analysis did support the broad conclusions that the more urbanised Stony Creek Catchment contained the worst stream water quality in the study area and that water quality in all catchments predictably worsened following rainfall.

5 Implications of State Government Guidelines

New State legislation (Local Government Approvals Amendment [Sewage Management] Regulation 1998) and "Environment and Health Protection Guidelines: On-Site Sewage Management for Single Households" (DLG, 1998) were recently introduced in NSW, drastically altering local government's responsibilities for regulating on-site wastewater management. The State Guidelines will enable major improvements in providing comprehensive wastewater management in NSW. The Guidelines are however, considered unrealistic in assuming that a single set of formulae can adequately model sustainable disposal yields in the wide range of soil and climatic conditions found across the State.

The formulae provided in the State Guidelines (1998) set out the prescribed method of calculating minimum sustainable irrigation areas with respect to nutrients and hydraulic loads. The State Guidelines (1998) include a calculation for minimum storage requirements for domestic residences.

Applying the State Guideline (1998) methodology to the average conditions observed in the Federal Study, we found that the minimum acceptable area with respect to nitrogen disposal was 1,150 m^2 and for phosphorous was 470 m^2. Example calculations are set out in Tables 1 and 2. More detailed modelling for similar conditions to Federal conducted by other consultants (Martens & Associates, 1998; Craven, *pers. comm.*, 1999) found that minimum sustainable disposal areas for nutrients in typical AWTS effluents are in the order of 850 m^2, so the State Guideline methodology is considered conservative.

Determining acceptable disposal field sizes and effluent storage requirements based on hydraulic loadings is more problematic. Federal, like most of the NSW North Coast region, regularly receives more precipitation than evapotranspiration for many months of the year. Average precipitation and evapotranspiration figures for the local area are provided in Tables 1 and 2.

Two alternative methodologies are provided in the State Guidelines for determining minimum hydraulic storage requirements (Nominated Area Method and Minimum Area Method) and minimum irrigation area size (Minimum Area Method only). Worked examples of each method are provided in Tables 1 and 2. The results of the modelling with respect to conditions at Federal indicate that minimum irrigation areas are in the order of 4,000 m^2, and minimum storage requirements average 146 m^3. Neither of these results is considered realistically plausible. The modelled requirements are inconsistent with Aztec Environmental's findings that the deep, well-structured and well-drained krasnozem soils present over much of the study area present few real long-term acceptance problems for normal domestic hydraulic loads.

Under these conditions, Aztec's recommendation is that higher standards of sewage treatment should be provided as a trade-off for reductions in storage and disposal area requirements back to those previously calculated as being compatible with sustainable nutrient disposal (i.e. 1,150 m^2).

A number of perceived shortcomings in the State Guideline methodology were identified in the study:

- The Guideline Nominated Area Method requires that sufficient storage be provided for both effluent and rainfall. In reality, only effluent is stored. Table 1 is amended to account for this.

- The Nominated Area Method has no realistic solution in regions where rainfall exceeds evapotranspiration over the year. The model does not take account of soil permeability or chemical characteristics.

- Even where very large application areas are nominated, the Guideline formulae applied to high rainfall areas require that extraordinary volumes of effluent storage be provided. This is an environmentally undesirable outcome, as the stored effluents would require re-treatment and could present significant risks to public health and the downstream environment.

6 Conclusions and Recommendations

The principal findings of this study are that on-site sewage management is likely to be sustainable in Federal, thanks largely to the deep, well-structured krasnozem soils which underlie the area. Major improvements in current and future wastewater treatment and disposal will be required however, and specific recommendations for improvements in treatment technology, disposal methods, local government regulation and householder understanding are made in the report.

The recently released NSW State Guidelines (DLG, 1998) are to be commended for their breadth and detail, but some of the requirements for disposal area size and wet-weather storage are considered unrealistic and unnecessarily draconian. Despite the guideline modelling results, Aztec Environmental suggests that on-site wastewater management is sustainable even in high rainfall areas such as the NSW North Coast region, provided that the local soils exhibit suitable properties to provide long term acceptance capacity and that sufficiently high standards of treatment and disposal are maintained.

References

Aztec Environmental, 1999. *On-site Wastewater Assessment for Federal, NSW.* Aztec Environmental Pty Ltd, prepared for Byron Shire Council and NSW Department of Land and Water Conservation.

Department of Local Government, 1998. *Environment and Health Protection Guidelines: On-site Sewage Management for Single Households.* NSW Department of Local Government, NSW Environment Protection Authority, NSW Health, Land and Water Conservation, Department of Urban Affairs and Planning.

Leeming R, 1998. *Tracing faecal pollution using sterol biomarkers and microbial faecal indicators in the Brunswick River, NSW.* CSIRO, Marine Research Unit, Hobart.

Martens and Associates, 1998. *On-Site Wastewater Management Assessment for Areas 1, 2 and 3, West Byron.* Prepared for Byron Shire Council.

Natural Resources Audit Council, 1996. *The Northern Rivers - A Water Quality Assessment.* Prepared for and published by NSW Environment Protection Authority.

Patterson, R.A. 1997. *Lecture Notes: Domestic Wastewater Disposal Training Course , Cleveland Q.*

Table 1 Water balance calculations using Nominated Area method for average monthly rainfall

Design Wastewater Flow	(Q)	l/day	600													
Design Percolation Rate	(R)	mm/wk	5	(Based on State Guidelines (1998) advice)												
Land area	(A)	m2	1152	(Based on minimum application area estimated for nitrogen capacity)												
Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Days in month	(D)	-	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	(P)	(Federal Mean)	mm/month	188	221	252	611	183	130	94	76	54	181	122	166	1700
Evaporation	(E)	(Alstonville Mean)	mm/month	174	142	135	135	106	85	72	83	115	137	155	179	3089
Crop Factor	(C)	-	-	0.8	0.8	0.8	0.8	0.8	0.6	0.6	0.6	0.8	0.8	0.8	0.8	-
Inputs																
Precipitation	(P)	-	mm/month	188	221	252	611	183	130	94	76	54	181	122	166	2278
Effluent Irrigation	(W)	(Q x D)/A	mm/month	16	15	16	16	16	16	16	16	16	16	16	16	190
Inputs	(I)	P + W	mm/month	204	236	268	627	199	146	110	93	69	197	138	182	2468
Outputs																
Evapotranspiration	(Et)	E x C	mm/month	139	114	108	108	85	51	43	50	92	110	124	143	1166
Percolation	(B)	R/7 x D	mm/month	22	20	22	21	22	21	22	22	21	22	21	22	261
Outputs	(O)	ET + B	mm/month	161	134	130	129	107	72	65	72	113	132	145	165	1427
Storage required?	(S1)	I - O	mm/month	42	102	138	497	92	73	45	21	-44	66	-8	17	-
Amount to store	(S2)	W* (if S1 > 0)	mm/month	16	15	16	16	16	16	16	16	-44	16	-8	16	-
Cumulative storage	(M)	-	mm	16	31	47	63	79	94	110	127	83	99	91	107	-
Storage	(V)	Largest M	mm	127												
		(VxA)/1000	m3	145.8												

* Guidelines use precipitation + effluent as storage input. In reality, only effluent would be stored.

Table 2 - Water balance using Minimum Area Method for average monthly rainfall

Design Wastewater Flow	(Q)	L/day	600	
Design Percolation Rate	(R)	mm/wk	5	(Based on State Guidelines (1998) advice and textural assessment of Federal soils)

Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Days in month	(D)	-	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	(P)	(Federal Mean)	mm/month	188	206	213	142	145	68	55	54	33	81	107	128	1700
Evaporation	(E)	(Alstonville Mean)	mm/month	174	142	135	135	106	85	72	83	115	137	155	179	3089
Crop Factor	(C)	-	-	0.8	0.8	0.8	0.8	0.8	0.6	0.6	0.6	0.8	0.8	0.8	0.8	-
Outputs																
Evapotranspiration	(Et)	E x C	mm/month	139	114	108	108	85	51	43	50	92	110	124	143	1166
Percolation	(B)	R/7 x D	mm/month	22	20	22	21	22	21	22	22	21	22	21	22	261
Outputs	(O)	Et + B	mm/month	161	134	130	129	107	72	65	72	113	132	145	165	1427
Inputs																
Precipitation	(P)	-	mm/month	145	206	213	142	145	68	55	54	33	81	107	128	1700
Possible Effluent Irrigation	(W)	O - P	mm/month	17	-72	-83	-12	-38	5	10	18	80	50	38	37	52
Actual Effluent Irrigation	(I)	H/12	mm/month	4	87	87	87	87	87	87	87	87	87	87	87	965
Inputs		P + I	mm/month	149	293	300	229	232	155	142	141	120	169	195	216	2340
Storage required?	(S1)	I - O	mm/month	149	293	300	229	232	155	142	141	120	169	195	216	-
Amount to store	(S2)	W* (if S1 > 0)	mm/month	4	87	87	87	87	87	87	87	87	87	87	87	-
Cumulative storage	(M)	-	mm	4	92	179	266	354	441	528	616	703	791	878	965	-
Irrigation Area	(A)	365 x Q/H**	m^2	4186	*** Note H = Sum of W*											
Storage	(V)	Largest M	Mm	965												
		(VxA)/1000	m3	4041												

* Guidelines use precipitation + effluent as storage input. In reality, only effluent would be stored.