THE ECOMAX ON-SITE SEWAGE TREATMENT SYSTEM

Max Bell
Director, Tech-Treat Pty Ltd

Abstract

The Ecomax system is an innovative technology which treats sewage to a high quality. As the system is passive it requires no power or mechanical maintenance.

The technology, which is referred to here by the Registered Trade Name "ECOMAX" was developed by Ecomax Waste Management Systems Pty Ltd (EWMS), a Perth based developer and supplier of wastewater treatment technology specializing in nutrient removal systems. The EWMS system is based on a patented effluent flow and treatment process developed by the company and proven in sewage treatment since the early 1990's.

Ecomax technology was originally applied to residential dwellings in Perth and surrounding areas where primary treated effluent, containing high nutrient levels was entering the water table of the sand stratum and creating environmental damage to downstream waterways. By high quality, low nutrient content treatment, the effluent entering the water table from an Ecomax system was of much less impact.

Further testing of the technology, at sites in the Blue Mountains of NSW, showed reliable and highly favourable results in that environment, and encouraged Tech-Treat Pty Ltd, as agent for EWMS, to apply the technology to other areas.

Current guidelines for on-site sewage treatment and effluent dispersal systems require that much greater consideration be given to irrigation areas and wet weather storage capacity than in the past. The result of this impetus has been to bring Ecomax to an economically competitive level with other on-site systems, particularly in restrictive and / or environmentally sensitive areas.

Keywords

absorption, ANZECC, Ecomax, evapotranspiration, water balance, Wisconsin mound

1 Introduction

The Ecomax system is an innovative technology which treats sewage to a high quality. As the system is passive it requires no power or mechanical maintenance.

The technology, which is referred to here by the Registered Trade Name "ECOMAX" was developed by Ecomax Waste Management Systems Pty Ltd (EWMS), a Perth based developer and supplier of wastewater treatment technology specializing in nutrient removal systems. The EWMS system is based on a patented effluent flow and treatment process developed by the company and proven in sewage treatment since the early 1990's.

The Ecomax sewage treatment and evapotranspiration mounds are constructed 'above' the natural surface as shown on Figure 1. This construction is similar to a "Wisconsin Mound" concept which provides large surface area exposure both vertically and laterally, and insulated internal temperature.

The Ecomax cell is a lined containment vessel with amended soil fill and top soil covering which has a surface slope of approximately 1:3.5. This grassed sloping surface extends over the boundary area outside the cell to maximize rainfall runoff. Regular mowing of the surface grasses is required to encourage continued effluent and nutrient uptake.

The cell operates in a contained and discreet environment and reacts to both external influences and internal processes in a relatively predictable and controlled manner.

The tunnel length for a cell is based generally on the rate of 200 litres / day / metre length of tunnel, however this will vary depending upon occupancy rates, times of occupancy, severe weather conditions and the types of sand available from which the amended soil mixture is created.

The Ecomax system consists of two cells which are alternately fed from the septic tank on six - monthly cycles. Only the effluent, which is not taken up by evapotranspiration in the operating cell, and which escapes over the barrier, is required to be dispersed by absorption and further evapotranspiration. This effluent is dispersed in the boundary area surrounding both cells.

2 Water balance

2.1 Water movement

The mound concept enhances the effects of evapotranspiration while maximising rainfall run off over the sloping sides of the cell, reducing the opportunity for absorption. Crop uptake of water and nutrients is largely satisfied by the effluent in the cells.

Pore resistance, within the amended soil of the Ecomax cell, limits the rate at which the effluent can flow from the cell tunnel. This delay provides a residence time for both treatment of the effluent and increased opportunity for evapotranspiration prior to any fully treated effluent reaching the outer boundary barrier, and escaping the containment of the lined cell.

Pore resistance in the amended soil, when saturated with effluent, and with an increased hydraulic head in the tunnel from further inflow, results in a sloping “water table” and low rate horizontal flow through the amended soil.

Any inflow rate, to the tunnel of the operating cell, greater than the hydraulic conductivity of the surrounding amended soil and evapotranspiration rate, will cause the level in the cell tunnel to rise to varying degrees. Under extreme conditions, such as low evapotranspiration or shock loads, this rise may continue until the tunnel in the operating cell is “full”. At this time the inflow to this cell from the septic tank will back up and then flow to the resting cell as emergency storage and treatment.

While low evapotranspiration conditions are likely to be combinations of low temperature, low air movement and high humidity, there has been no correlation shown during detailed testing, between treated effluent escaping the cell and rainfall.

Allowance is made in the design of the Ecomax cell for treated effluent which escapes the cell barrier to be then absorbed and evapotranspired through the boundary area outside the barrier.

Where appropriate, cut-off drains divert “upstream” stormwater away from the cell area as shown on Figure 1.

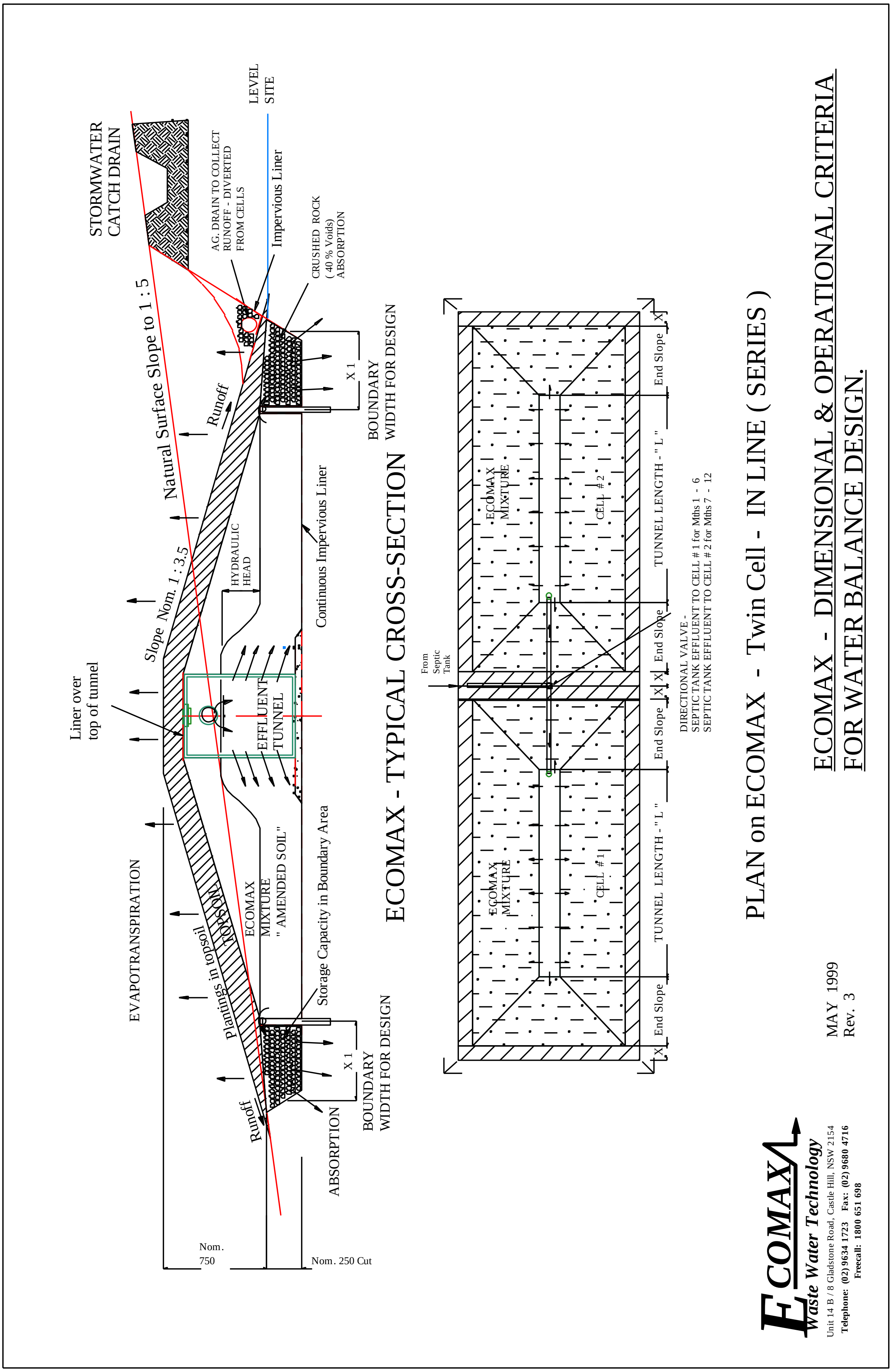

Figure 1 **Plan and cross-sectional elevation of typical Ecomax cells**

2.2 Boundary area absorption and evapotranspiration

The boundary area of both cells are connected as shown in Figure 1, such that each cell operates for six months while the other rests and rejuvenates. The boundary area of both cells operates continuously.

By applying both the long term absorption rate (LTAR) for the soil, and the evapotranspiration rate of the boundary surface, an area requirement and consequent boundary width can be developed. The calculation includes consideration of the soil and weather pattern for a given effluent flow rate per month. The LTAR for Ecomax effluent is suggested to be much higher than that shown in AS1547 (Standard Australia, 1994).

The amount of treated effluent which escapes the barrier is based on generally accepted methods of water balance tabulation, using varying factors as shown in the example - Table 1.
While this calculation does not reflect all operational features of the cells, it provides a conservative figure on which to base the boundary width “ x ” calculation. Boundary widths for Ecomax systems recently constructed have varied from 500mm (minimum), to 1100mm depending upon the LTAR and weather patterns.

As preliminary observations show that for certain months of the year very little effluent escapes to the boundary area compared with the standard water balance predictions, further tests are being carried out to determine actual volumes which escape to the boundary area. While various theories suggest such effects as higher internal temperatures in the cell and the elevated Wisconsin Mound “effect”, the most practical result at this time will be to quantify the actual amount escaping the cells for given weather and inflow records.

3 Effluent quality

Detailed analysis of Ecomax effluent quality parameters has been carried out over many years in Perth, WA and NSW.

Table 2 provides the criteria for various levels of water quality as set out in the ANZECC (1992) Water Quality Guidelines. The last two columns show respectively, the Ecomax quality for each parameter and its compliance level with these guidelines.

Of particular note is the low levels of total P (0.05) and total N (< 10) in the Ecomax effluent. Units for all parameters are mg/litre except for pH, EC and temperature.

4 Maintenance and life expectancy

Construction of the cells consists of non corrosive components, the Ecomax amended soil and overlaying grassed topsoil.

Maintenance is limited to ensuring that the grass or ‘crop’ continues maximum uptake of effluent and nutrients by regular mowing, and that the directional valve changes effluent flow to the resting cell each six months.

While the ability of the system to continue to remove P has been projected to many decades, the two cell concept of operating and resting, for alternating six-monthly periods, has shown little deterioration in effluent quality during accelerated testing. Consequently, a life expectancy in excess of 40 years is indicated.

Table 1 Water Balance Calculation

	1	2	3	4	5	6	7	8	9	9 a	10	11		12
Mth	Precip.	Run Off	Nett Precip.	Pan Evapor	Crop Factor	Nett Evapor	3 - 6 Nett	Applied Effl.	Excess Escape	Equiv. Depth	Absorp't To Soil	Storage Equiv.		Max. Boundary Storage Depth
	mm	%	mm	mm		mm	mm	mm	Litres	mm	mm	mm		+ mm (actual)
J	70.00	75	17.50	195.00	0.90	175.50	-158.00	862.71	30387	879.58	-930	-521.04	Prog.	
31													Cum.	
F	70.00	75	17.50	160.00	0.90	144.00	-126.50	779.22	28145	814.70	-840	-379.51	Prog.	
28													Cum.	
M	75.00	75	18.75	140.00	0.80	112.00	-93.25	862.71	33179	960.40	-930	-157.12	Prog.	
31													Cum.	
A	55.00	75	13.75	115.00	0.80	92.00	-78.25	834.88	32626	944.39	-900	-84.65	Prog.	
30													Cum.	
M	60.00	75	15.00	90.00	0.70	63.00	-48.00	862.71	35130	1016.88	-930	97.20	Prog.	97.20
31													Cum.	
J	60.00	75	15.00	85.00	0.70	59.50	-44.50	834.88	34081	986.51	-900	105.04	Prog.	105.04
30													Cum.	
J	40.00	75	10.00	95.00	0.70	66.50	-56.50	862.71	34764	1006.27	-930	49.43	Prog.	49.43
31													Cum.	$\boxed{251.67}$
A	35.00	75	8.75	125.00	0.70	87.50	-78.75	862.71	33804	978.50	-930	-75.62	Prog.	
31													Cum.	
S	50.00	75	12.50	150.00	0.80	120.00	-107.50	834.88	31365	907.88	-900	-249.05	Prog.	
30													Cum.	
O	55.00	75	13.75	165.00	0.90	148.50	-134.75	862.71	31390	908.60	-930	-390.37	Prog.	
31													Cum.	
N	60.00	75	15.00	180.00	0.90	162.00	-147.00	834.88	29661	858.58	-900	-471.05	Prog.	
30													Cum.	
D	55.00	75	13.75	205.00	0.90	184.50	-170.75	862.71	29837	863.67	-930	-592.70	Prog.	
31													Cum.	
												" X " =		
	685.00			1705.00								0.5635		

VARIABLES : WEATHER STATION LOCATION(S) PRECIPITATION : -------- EVAPORATION : ------

L (Tunnel Length) :	m	6	(to nearest 0.4m)	Boundary Area Width ("X")m	0.5635
CELL AREA	m2	43.12		Absorption mm/day	30
BOUNDARY AREA HEIGHT	mm	250	(= col.12 Cum. max.)		
VOID FACTOR OF FILL	---	0.4			
RUN OFF %	%	75	(nett after allowance for 10% aborption to cell & boundary area)		
CROP FACTOR	---	---	(individual monthly factors)		

5 Conclusion

Application of the Ecomax technology to the local conditions of NSW, in the form of the cell construction described, has seen installations in various Shires, particularly those in sensitive areas such as Great Lakes, Kangaroo Valley, Blue Mountains, Hawkesbury River and Nelson Bay.

Effluent quality from recently constructed Ecomax systems has been confirmed as predicted. It is anticipated that the system will be favoured as a solution for high quality sewage treatment on sites that not only have a requirement for low health risks and highly reliable protection of the environment, but will also be used to make more economical use of land areas in both domestic and commercial applications. The passive operation, requiring no mechanical equipment or power, simplicity of maintenance and reliability of effluent quality, are added benefits of the Ecomax system.

Table 2 Comparison of Ecomax Final Effluent Quality with ANZECC Water Quality Guidelines - ANZECC (1992)

PARAMETER	A AQUATIC	B RECREATIONAL	C IRRIGATION	D LIVESTOCK	ECOMAX EFFLUENT	COMPLIANCE
Micro-biol Primary Contact	No guidelines	<150 cfu/100ml	<1000 cfu/100ml	<1000 cfu/100ml	0 - 60 cfu/100ml (iii)	Meets ABCD
Colour & Clarity	<10% change ED	<20% Reduction	No guideline	No guideline	Clear - Odourless (iii)	Meets ABCD
pH	6.5 - 9.0	5.0 - 9.0	No guideline	No guideline	7.5 - 8.5 (iii)	Meets ABCD
EC	<1500 uS/cm		Low salinity	No guideline	2000 - 6000 us/cm (i)	Meets BCD (Note 1)
Susp. Solids	<10% change SM	No function Reduction	No guideline	No guideline	10(i)	Meets ABCD
Diss. Oxygen	>6mg/L		No guideline	No guideline	4 - 7 (iii)	Meets ABCD
Total P	Variable	No guideline	No guideline	No guideline	0.05 (i)	Meets ABCD
Total N	Variable	No guideline	No guideline	No guideline	<10 (i)	Meets ABCD
Temp.	<2°C incr.	15 - 35°C	No guideline	No guideline	15 - 24 (iii)	Meets ABCD
BOD 5	No guideline	No guideline	No guideline	No guideline	<10 (i)	Meets ABCD
Chloride	No guideline	No guideline	30 - 700	No guideline	90 (i)	Meets ABCD
Sodium	No guideline	No guideline	<20	No guideline	120 (i)	(Note 2)
Aluminium	<0.1		5	5	0.03 (ii)	Meets ABCD
Ammonia	0.02 - 0.03	All toxic, irritating	No guideline	No guideline	<5 (iii)	(Note 3)
Arsenic	0.05	or mucous	0.1	0.5	0.015 (iii)	Meets ABCD
Cadmium	0.002 - 0.02	membrane	0.01	0.01	0.02 (ii)	Meets A
Chromium	0.01	damaging values	1	1	<0.02 (ii)	Detection Limit
Iron	1	not suitable	1	No guideline	<0.01 (iii)	Meets ABCD
Lead	0.001 - 0.005		0.2	0.1	No Data	No Data
Mercury	0.0001		0.0002	0.0002	<0.0005 (ii)	Detection Limit
Nickel	0.015 - 0.15		0.2	1	No Data	No Data
Selenium	0.005		0.02	0.02	0.002 (ii)	Meets ABCD
Zinc	0.005 - 0.05		2	20	<0.01 (iii)	Meets ABCD
				Calcium <1000	100 (ii)	Meets D
				Nitrate <30	30 (ii)	Meets D
				Nitrite <10	No Data	No Data
				Sulphate <1000	20 (ii)	Meets D

ED - Eutrophic depth
SM. - Seasonal
Mean
No Data - Never Measured
(I) - Soured from Sydney Water Study
(ii) - Hem Centre WA data
(iii) - Sheen Analytical data

Note 1 - Calcium compounds are incorporated in the treatment medium and impart slightly elevated concentrations of dissolved solids.
Calcium is benign in the environment at the concentrations in Ecomax effluent. Infiltration processes are improved by the presence of calcium in the outflow.

Note 2 - Sixfold dilution would render this concentration suitable for stock consumption.

Note 3 - Ongoing ammonia oxidation following subsoil discharge to soils can be expected to continue.

6 References

ANZECC (1992). *Australian Water Quality Guidelines for Fresh and Marine Waters.* Australian and New Zealand Environment and Conservation Council, Canberra.

Coote B., Marzella M. and Swanson P. (1995) *Performance Evaluation of On-Site Wastewater Treatment Systems for Single Households.* AWT Ensight Report No. 96/026, November 1995, prepared for Sydney Water Corporation.

Bowman M. (1997). *Barriers to Commercialisation of New Technology*. United Nations Environment Program Workshop, December 1997, Perth W.A.

Standards Australia (1994) AS1547 - 1994 Disposal systems for effluent from domestic premises.