ENVIRONMENT BAY OF PLENTY

BEST MANAGEMENT PRACTICES FOR

ON-SITE WASTEWATER TREATMENT SYSTEMS

BIORESEARCHES

Consulting Biologists & Archaeologists - Est. 1972
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Environment Bay of Plenty

Best Management Practices for On-Site Wastewater Treatment Systems

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FOR : ENVIRONMENT BAY OF PLENTY
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C O N T E N T S

1. INTRODUCTION

Environment Bay of Plenty (EBOP) is concerned about the potential for on-site wastewater treatment systems such as septic tanks, to act as a source of nutrients that may enter groundwater and then adjacent surface waters. Given the sensitivity of surface waters, such as the Rotorua lakes, to additional inputs of nitrogen, and the proximity of domestic on-site wastewater treatment systems (septic tanks) to these lakes, EBOP commissioned Bioresearches to evaluate Best Management Practices (BMP's) that may be applied to on-site wastewater treatment systems such as septic tanks.

This report presents the results of the evaluation of BMP's, in particular the on-site systems that are presently available in the New Zealand, their performance characteristics with particular emphasis on nitrogen removal, and the cost. Information is also presented on BMP's that have been developed overseas, particularly in the United States of America, again particularly in relation to minimising the input of nutrients to surface waters from on-site wastewater treatment systems.

2. GENERAL CHARACTERISTICS OF A SEPTIC TANK WASTEWATER TREATMENT SYSTEM

A septic tank system is a highly efficient, self-contained, underground on-site wastewater treatment system. As septic tank systems treat and dispose of household wastewater on site, they are often more economical than centralised sewer systems in rural areas where lot sizes are larger and houses are spaced widely apart. Septic tank systems are also simple in design, which makes them generally less expensive to install and maintain.

A septic tank system consists of two main parts – a septic tank and a drainfield. The septic tank is a watertight box, usually made of concrete or fibreglass, with an inlet and outlet pipe. Wastewater flows from the house to the septic tank through the sewer pipe. The septic tank treats the wastewater naturally by holding it in the tank long enough for solids and liquids to separate. The wastewater forms three layers inside the tank. Solids lighter than water (such as greases and oils) float to the top forming a layer of scum. Solids heavier than water settle on the bottom of the tank forming a layer of sludge. A middle layer of partially clarified wastewater forms between these upper and lower layers.

The layers of sludge and scum remain in the septic tank, where bacteria found naturally in the wastewater work to break down the solids. The sludge and scum that cannot be broken down are retained in the tank until the tank is pumped. The layer of clarified liquid flows from the septic tank to the drainfield or to a distribution device, which helps to uniformly distribute the wastewater in the drainfield. A standard drainfield (also known as a leachfield, disposalfield, or a soil absorption system) is a series of trenches or a bed lined with gravel or course sand, buried one to three feet below the ground surface. Perforated pipes or drain tiles run through the trenches to distribute the wastewater. The drainfield treats the wastewater by allowing it to slowly trickle from the pipes out into the gravel and down through the soil. The gravel and soil act as biological filters. An alternative to this trenched field is the surface drip irrigation system. This system is designed to maximise evapotranspiration potential through a combination of plant transpiration and surface evaporation, with the drip line being located in bush with natural vegetation or in a bark/mulch garden.

A summary of constituent mass loadings and concentrations in typical US residential wastewater are shown in Table 1.

TABLE 1 CONSTITUENT MASS LOADINGS AND CONCENTRATIONS IN TYPICAL US RESIDENTIAL WASTEWATER [a]

Constituent	Mass loading (grams/person/day)	Concentration [b] mg/L
Total solids (TS)	115-200	500-880
Volatile solids	65-85	280-375
Total suspended solids (TSS)	35-75	155-330
Volatile suspended solids	25-60	110-265
5-day biochemical oxygen demand (BOD_5)	35-65	155-286
Chemical oxygen demand (COD)	115-150	500-660
Total nitrogen (TN)	6-17	26-75
Ammonia (NH_4)	1-3	4-13
Nitrites and nitrates (NO_2-N; NO_3-N)	<1	<1
Total phosphorus (TP)[c]	1-2	6-12
Fats, oils and grease	12-18	70-105
Volatile organic compounds (VOC)	0.02-0.07	0.1-0.3
Surfactants	2-4	9-18
Total coliforms (TC)[d]	-	10^8-10^{10}
Faecal coliforms (FC)[d]	-	10^6-10^8

[a] For typical residential dwellings equipped with standard water-using fixtures and appliances

[b] Milligrams per litre, assumed water use of 60 gallons/person/day (227 litres/person/day)

[c] The detergent industry has lowered the TP concentrations since early literature studies; therefore Sedlak (1991) was used for TP data

[d] Concentrations presented in Most Probable Number of organisms per 100 milliliters

Source: USEPA Onsite Wastewater Treatment Systems Manual, February 2002, EPA/625/R-00/008

Additional treatment may be obtained by recycling, addition of an aerobic stage, a sand filter and foam or textile filter, each resulting in a reduction in one or more of the wastewater constituents. Typical outputs from a range of treatment options are shown in Table 2.

TABLE 2 WASTEWATER CONSTITUENTS OF CONCERN AND REPRESENTATIVE CONCENTRATIONS IN THE EFFLUENT OF VARIOUS TREATMENT SYSTEMS

Constituents of concern	Example direct or indirect measures	Tank-based treatment unit effluent concentrations					SWIS percolate into ground water at 3 to 5 ft depth (% removal)
		Domestic STE[1]	Domestic STE with N-removal recycle[2]	Aerobic unit effluent	Sand filter effluent	Foam or textile filter effluent	
Oxygen demand	BOD_5 (mg/L)	140-200	80-120	5-50	2-15	5-15	>90%
Particulate solids	TSS (mg/L)	50-100	50-80	5-100	5-20	5-10	>90%
Nitrogen	Total N (mg N/L)	40-100	10-30	25-60	10-50	30-60	10-20%
Phosphorus	Total P (mg P/L)	5-15	5-15	4-10	<1-10 [3]	5-15 [3]	0-100%
Bacteria (e.g. *Clostridium perfringens, Salmonella, Shigella)*	Faecal coliform (organisms per 100 mL)	10^6-10^8	10^6-10^8	10^3-10^4	10^1-10^3	10^1-10^3	>99.99%
Virus (e.g. hepatitis, polio, echo, coxsackie, coliphage	Specific virus (pfu/mL)	0-10^5 (episodically present at high levels	0-10^5 (episodically present at high levels)	0-10^5 (episodically present at high levels)	0-10^5 (episodically present at high levels)	0-10^5 (episodically present at high levels)	>99.99%
Organic chemicals (e.g. solvents, petrochemicals, pesticides)	Specific organics or totals (ug/L)	0 to trace levels (?)	0 to trace levels (?)	0 to trace levels (?)	0 to trace levels (?)	0 to trace levels (?)	>99%
Heavy metals (e.g. Pb, Cu, Ag. Hg)	individual metals (ug/L)	0 to trace levels	0 to trace levels	0 to trace levels	0 to trace levels	0 to trace levels	>99%

[1] Septic tank effluent (STE) concentrations given are for domestic wastewater. However, restaurant STE is markedly higher particularly in BOD , COD, and suspended solids while concentrations in greywater STE are noticeably lower in total nitrogen
[2] N-removal accomplished by recycling STE through a packed bed for nitrification with discharge into the influent end of the septic tank for denitrification
[3] P-removal by adsorption/precipitation is highly dependent on media capacity, P loading, and system operation
SWIS = Subsurface Wastewater Infiltration System

Source: USEPA Onsite Wastewater Treatment Systems Manual, February 2002. EPA/625/R-00/008

3. NITROGEN

Nitrogen in raw wastewater is primarily in the form of organic matter and ammonia. In the output from the septic tank, the nitrogen is primarily (more than 85 percent) ammonia. After discharge of the effluent to the infiltrative surface, such as mulched soil, aerobic bacteria convert the ammonia in the effluent almost entirely to nitrite and then to nitrate. This is the predominant transformation that occurs immediately below the infiltration zone. Nitrogen in its nitrate form is mobile and is readily leached from the soil. High concentrations of nitrate (greater than 10 mg/L) can cause methemoglobinemia or "blue baby syndrome," a disease in infants that reduces the blood's ability to carry oxygen, and problems during pregnancy. Nitrogen is also an important plant nutrient that can cause excessive algal growth in nitrogen-limited inland (fresh) waters and coastal waters, which are often limited in available nitrogen. High algal productivity can block sunlight, create nuisance or harmful algal blooms, and significantly alter aquatic ecosystems. As algae die, they are decomposed by bacteria, which can deplete available dissolved oxygen in surface waters and degrade habitat conditions.

4. ENHANCED NITROGEN REMOVAL

The amount of nitrogen removed by any treatment is dependent upon process design and operation. Typical nitrogen removal ranges for managed systems are presented in Table 3.

TABLE 3 TYPICAL NITROGEN REMOVAL RANGES FOR MANAGEMENT SYSTEMS

Process	Percent TN removal
RSF	40 – 50
RSF (with recycle to ST or AUF)	70 – 80
ST–FFS (with recycle to ST or AUF)	65 – 75
SBR	50 – 80
SS and removal	60 – 80
(SS–TT R)	40 – 60
ISF–AUF	55 – 75

Note : RSF = recirculating sand filters; AUF = anaerobic upflow filter; ST = septic tank; FFS = fixed-film system; SBR = sequencing batch reactor; SS = source separation; TT = treatment applied to both systems; R = recombined; ISF = intermittent sand filter.

Enhanced nitrogen removal systems can be categorised by their mode of removal. The most commonly applied and effective nitrogen-removal systems are biological toilets or segregated plumbing options and/or nitrification process combinations.

4.1. Source Separation Systems

Source separation relies on isolating toilet wastes or blackwater from wastewater or greywater. This requires separate interior collection systems. Blackwater discharged directly to a holding tank requires periodic removal for offsite treatment. Greywater wastes can be discharged to a conventional septic tank or subsurface infiltration systems. This system relies on the installation of low-volume discharge toilets.

4.2. Physical/Chemical Treatment Systems

Two types of physical/chemical treatment systems, ion exchange and reverse osmosis, appear to have some promise for single home use, although neither appear to be in use at present.

4.3. **Biological Treatment Systems**

The vast majority of practical nitrogen-removal systems employ nitrification and denitrification biological reactions. Most notable of these are re-circulating sand filters (RSFs) with enhanced anoxic modifications, sequencing batch reactors (SBR), and an array of aerobic nitrification processes combined with an anoxic/anaerobic process to perform denitrification. Some of the combinations are proprietary. Any fixed-film or suspended-growth aerobic reactor can perform the aerobic nitrification when properly loaded and oxygenated. A variety of upflow (AUF), downflow, and horizontal-flow anaerobic reactors can perform denitrification if oxygen is absent, a degradable carbon source (heterotrophic) is provided, and other conditions (e.g. temperature, pH, etc.) are acceptable.

5. SYSTEMS AVAILABLE IN NEW ZEALAND

5.1. Introduction

To determine the availability of on-site (septic tank) treatment systems in New Zealand, their ability to achieve some degree of enhanced nitrogen removal and their cost, local suppliers were contacted. The details of these suppliers are listed in Appendix 1. The specifications were to supply information on a system that would handle 1200 litres per day of domestic wastewater from six people. Of the twelve suppliers contacted, nine provided the design and operational data that are summarised in Table 4. Three suppliers, namely Blivet, Vivendi and Water Systems specialise in large-scale (municipal) systems only. In addition to these suppliers of relatively standard septic tank treatment systems, information was received from two other suppliers of less conventional treatment systems, namely Bioloo and Vortech. These latter two systems are known to reduce nitrogen outputs from domestic wastewater however the actual nitrogen outputs have not been quantified to the extent of the more conventional systems.

5.2. Systems

In summary all of the systems for which nitrogen output data are available are all biologically based treatment systems and are EBOP compliant, that is they meet the conditions of < 30 mg/L BOD and < 45 mg/L TSS as required by EBOP's Operative On-site Effluent Treatment Regional Plan, incorporating Plan Change No 1 (operative 6 December 2002).

The capacity of the treatment systems ranges from 4500 to 9000 litres with the capability of handling flows from 800 - 3200 litres per day (Table 4). The outputs of total nitrogen from the systems varied from 6 - 45 mg/L, and prices for new systems range from $8000 to $12000 (excluding GST).

TABLE 4 ON-SITE WASTEWATER TREATMENT SYSTEM SUPPLIERS AND SPECIFICATIONS

SUPPLIER	SYSTEM	TREATMENT		PROCESS	EFFLUENT QUALITY			Total Nitrogen (mg/L)	EBOP [1] COMPLIANT	COST (excl. GST)
		FLOW (litres/day)	Capacity (litres)		BOD (mg/L)	TSS (mg/L)	Faecal Coliforms			
Aqua Blue Environmental Systems Ltd (No web site)	Aqua Blue 9000 SH	1000	8200	Extended Aeration/Activated Sludge/Filter/Surface Dripline Irrigation.	15 – 20	20 – 30	0 – 20/100 ml (Disinfected)	6 – 7	yes	$10,000.00
Gould G T Systems (www.gouldgtsystems.com)	Gould GT 8000 RPF	2200	9000	Recirculating Progressive Filtration.	15 – 20	15 – 20	–	35	yes	$8,500 - $9,000
Hydra Tech Drainage and Plumbing (www.onesandtwos.co.nz)	–	1200 - 2000	–	BioCycle – Anaerobic/Aerobic/ Clarification/Irrigation	<20	<30	<30/100 ml	0.5 – 38	yes	$11,000 - $12,000
Hynds Environmental (www.hynds.co.nz)	Lifestyle-Advanced 8500	1800	8513	Anaerobic/Aerated/Biofilter/ Clarification-Recirculation.	20 – 30	30 – 45	Reductions (Unspecified)	mean = 31 (10 – 50)	yes	$8,500 - $9,000
Innoflow Technologies Limited (www.innoflow.co.nz)	AdvanTex AX10 Mode 3	1100	7200	Recirculating Bed Reactor/Low Pressure Effluent Distribution.	<15	<15	10,000 mpn/100 ml	<15	yes	$11,000 – $13,500
Innovative Water Solutions Ltd (www.innovative-water-solutions.com)	IWS 4 – 16 PE	800 – 3200	5300	Submerged Fixed Bed.	20	30	10,000 cfu/100 ml	35 – 45	yes	$8,000.00
Oasis Clearwater Systems Ltd (www.oasisclearwater.co.nz)	SAFE Series 2000	2000	7500	Submerged Aerated Filtered Effluent.	<20	<30	<10 (UV treated)	<10	yes	$11,500 (new) $9,500 (retrofit)
Reflection Treatment Systems [2] (www.septic.co.nz)	Reflection Recirculating Sand Filter Plant	1800	–	Recirculating Sand Filter.	2.5	2.9	14/100 ml	23.7	yes	$10,200 – 11,500
Vortech Eco-technologies (no web site)	Vertical Flow Wetland (VFW)	–	4500	Septic Tank plus Biological Contact Filter.	<10	<10	–	37 – 38	yes	$8,000 - $12,000 (full kit) $1,500 (kitset VFW only)

Note: [1] EBOP Compliant = BOD_5 <30 mg/L; TSS<45 mg/L.
[2] RFS data based on average results for Owhanake WWTP (26 April – 7 August 2001).

D\2003\0313A EQUIPMENT COSTINGS

5.3. **General Comments**

In most instances it appears that the question of reducing the outputs of nutrients, such as nitrogen, from on-site septic tank systems, is only just being addressed by the suppliers of these systems in New Zealand, and therefore in some instances the information supplied on nitrogen outputs was sparse. In a number of cases the suppliers advised that nitrogen reductions over and above those normally possible through septic tank systems could be enhanced by modifying the way in which the wastewater stream was handled or by adding additional treatment capacity to their standard system.

Almost all of the suppliers emphasised that the concentration of nitrogen in the discharge was determined in part by the quantity and type of wastewater supplied to the system and optimum nitrogen removal was dependent on the specific characteristics of each site e.g. soil type, height of water table. Basic housekeeping, addressed in Section 6, was also identified as an important component of minimising the amount of nutrients, such as nitrogen, discharged to the environment.

As indicated, with respect to less conventional treatment systems, general information was obtained on two alternative treatment systems, namely Bioloo (www.bioloo.co.nz) and Vortech Vermicomposter.

According to the information supplied, Bioloo is a source separation system, where toilet waste or blackwater is treated separately from other wastewater or greywater. The blackwater is effectively composted aerobically and periodically removed, while the greywater is treated in a modified mini septic/grease trap system, which ultimately discharges via leech field pipes. No information was available on the characteristics of this discharge. The cost of a one dwelling unit (up to six people full time use) is $2350.00.

Vortec Vermicomposter is also a source separation system, which utilises worms to compost the blackwater. Existing septic tank systems may be retrofitted with a kitset ($1500) that comprises a vertical flow filter (cost of full septic tank system plus biological contact filter with a vertical flow wetland is $8000 - 12000, Table 4). The supplier advises that BOD/TSS levels are less than 10 mg/L and up to 95% reduction in nitrogen has been achieved with the Vermicomposter.

As stated no specific data were available on the nitrogen outputs from these two source separation systems. Given that the blackwater, which is the principal source of nutrients, is separated at source, treated and taken off-site, it is anticipated that the nitrogen output from these two systems, that is from the treated greywater, would be significantly less than that of the conventional septic tank system that treats all domestic wastewater on site.

It is evident from the information obtained from the New Zealand suppliers of on-site wastewater treatment systems that systems able to achieve enhanced nitrogen removal are available in New Zealand. However, also evident was the fact enhanced nitrogen removal has only recently been considered by many of the suppliers, as the data available for a number of the systems have only just been collected. This means that while these data have been made available, and are presented in this report, the potential exists for some of the systems to improve this component of their treatment and achieve reductions in nitrogen significantly better those reported.

Discussions with suppliers also indicated that the general performance of their systems, including the removal of nitrogen, would be assisted by education of the users. Concern was expressed about the lack of understanding of the way in which septic tanks systems in general operate and the types and quantities of materials that the systems can process. Several instances were also cited about some of the procedures used in installation of these systems and this appears to be another area where performance of these systems could be improved by correct installation.

It is also important to recognise that with any of these systems their performance is dependent on the composition of the wastewater that enters the system, and the systems overall maintenance programme.

With respect to the raw wastewater, no chemicals, such as paints, thinners and waste oils, that could contaminate the receiving environment (e.g. surface or groundwater) should be allowed to enter that wastewater stream. Items such as coffee grounds, cigarette buts, fat and grease should also not be permitted to enter the septic tank treatment system. All of these types of items can overtax or destroy the biological digestion processes that take place within the treatment system or clog the pumps and pipes.

Maintenance of the system depends on such factors as the number of people using the system, the amount and type of wastewater generated and the volume of solids in the wastewater (e.g. using a garbage disposal unit will increase the amount of solids entering the system). Such maintenance may include the removal (pumping out) of the solids in the septic tank, servicing of the pumps and clearance of the drainfield or surface drip irrigation line.

Also important is the need to ensure that the integrity of the absorption field is maintained, that is no compaction by vehicles or heavy equipment, or invasion of the drainfield or irrigation line by items such as the roots of plants, that may impair the dispersal of the effluent.

6. OVERSEAS EXPERIENCE

6.1. Introduction

During the course of this investigation information was also obtained on the types and performance of on-site wastewater treatment systems primarily in use in North America, and the approaches used by communities to minimise the discharge of nutrients to the receiving environment. To supplement the information presented on systems available in New Zealand, reference is made to several examples of the approaches adopted by communities in North America, to provide an insight only into these approaches to the problem of nutrient input to receiving waters, both ground and surface. As a number of the systems available in New Zealand appear to be sourced from North America the actual treatment systems used in North America are similar to those available in New Zealand.

6.2. Performance Based Requirements

6.2.1. Probability of impact

This approach to setting performance levels for on-site wastewater treatment systems, an example of which is presented in Appendix II, relies on estimating the probability that treated water discharged from an on-site system will reach an existing or future point of use in an identified water resource. Use is then made of this probability of impact to define acceptable treatment performance standards based on the water quality standards set to protect the receiving environment.

For instance, if the receiving environment is an aquifer that supplies drinking water then the use of water quality standards for drinking water, and knowledge of such site aspects as soil type and degree of renovation anticipated, will enable the acceptable level of treatment to be defined.

6.2.2. **Florida's performance-based permit program**

Florida has adopted provisions for permitting residential performance-based treatment systems (Florida Administrative Code, 2000). Discharges under these permits must meet treatment criteria for secondary, advanced secondary, and advanced wastewater treatment, depending on system location and the proximity of protected water resources. Performance requirements for each category of treatment are as follows:

- *Secondary treatment:* annual arithmetic mean for BOD and TSS ≤ 20 mg/L, annual arithmetic mean for faecal coliform bacteria ≤ 200-cfu/100 mL.

- *Advanced secondary treatment:* annual arithmetic mean for BOD and TSS ≤ 10 mg/L, annual arithmetic mean for total nitrogen ≤ 20 mg/L, annual arithmetic mean for total phosphorus ≤ 10 mg/L, annual arithmetic mean for faecal coliform bacteria ≤ 200 cfu/100 mL.

- *Advanced wastewater treatment:* annual arithmetic mean for BOD and TSS ≤ 5 mg/L, annual arithmetic mean for total nitrogen ≤ 3 mg/L, annual arithmetic mean for total phosphorus ≤ 1 mg/L, faecal coliform bacteria count for any one sample ≤ 25-cfu/100 mL.

Operation and maintenance manuals, annual operating permits, signed maintenance contracts, and biannual inspections are required for all performance-based systems installed under these provisions. The operating permits allow for property entry, observation, inspection, and monitoring of treatment systems by state health department personnel.

6.2.3. **Rhode Island's treatment performance requirements**

The town of New Shoreham, Rhode Island identified that on-site wastewater treatment systems contributed approximately 72 percent of the nitrogen that entered ground water recharge areas and that nitrogen removal technologies could effectively maintain nitrogen inputs close to the existing levels even with continued growth of the area. Modelling indicated that such technologies were not necessary throughout the Island but would be most beneficial in "hot spots" where the risk of system failure and sensitivity to additional nitrogen were the highest.

Actions implemented were regular inspections of on-site systems, septic tank pumping schedules and other maintenance requirements based on inspection results. Inspection schedules had the highest priority in public drinking water supply reservoirs, community wellhead protection zones and "hot spots", such as wetland buffers. In new development areas, sensitive or vulnerable areas were identified and the level of treatment required was defined. Three treatment levels were established:

T1 primary treatment with water tight septic tanks and effluent screens,
T2N nitrogen removal required to meet < or = 19 mg/L,
T2C faecal coliform removal < or = 1,000 MPN/100 ml

6.2.4. **Wisconsin's ground water quality rule**

Wisconsin's ground water quality rule establishes both public health and public welfare ground water quality standards for substances detected in, or having a reasonable probability of entering, the ground water resources of the state. Preventive action and enforcement limits are established for each parameter included in the rule. The preventive action limits (PALs) inform the Department of Natural Resources (DNR) of potential threats to ground water quality. When a PAL is exceeded, the Department is required to take action to control the contamination so that the enforcement limit is not reached. For example, nitrate-nitrogen is regulated through a public health standard. The PAL for nitrate is 2 mg/L (nitrogen) and its enforcement limit is 10 mg/L (nitrogen). If the PAL is exceeded the DNR requires a specific control response based on an assessment of the cause and significance of the elevated concentration. Various responses may be required, including no action, increased monitoring, and revision of operation procedures at the facility, remedial action, closure, or other appropriate actions that will prevent further ground water contamination. In contrast to the other examples presented, in this example there may be situations where a specific response includes no action as the contamination or elevated levels of a potential contaminant are unlikely to pose a threat to the quality of the receiving environment.

In summary, these examples outline the approaches various communities in North America have made to minimising the effects of on-site wastewater treatment systems have on the receiving environment. These approaches are based on the understanding that the technology is available to control the amount of nitrogen discharged by such systems, and that this technology is applied primarily in those areas considered to be sensitive to additional inputs of nitrogen.

7. BEST MANAGEMENT PRACTICES

The Best Management Practices for on-site wastewater treatment systems include:

- definition of the resource requiring protection
- the setting of standards that would protect the resource
- identification and installation of system(s) able to meet those standards
- implementation of an inspection system to ensure that all new systems and additions are correctly installed
- implementation of a regular maintenance programme, including the removal of solids, servicing of pumps and clearance of the disposal lines
- maintenance of the integrity of the absorption field
- education of the users of on-site systems, to ensure that they understand the capabilities of such systems.

With respect to the Rotorua lakes, it is clear that Environment Bay of Plenty has identified that specific lakes, and perhaps specific areas within some of the lakes, are sensitive to the addition of nitrogen. In these cases then the initial stages of the BMP's may have been met. In other areas, more information may be required to determine whether these areas are sensitive to the addition of nitrogen. As indicated in the examples of approaches implemented overseas, there may be some areas, for example where the water table is deep or the flow of groundwater is away from sensitive surface waters, where minimal action is required in relation to the removal of additional nitrogen from the wastewater. In such instances the BMP's may just include implementation of a management programme and education of the users, to ensure that the performance of the existing system is optimised.

Comments received from the suppliers indicate that should additional nitrogen removal require the installation of new or additional systems, then to ensure that these perform as specified the users should be educated so that they understand the capabilities of their on-site wastewater treatment systems, and a regular maintenance programme be implemented to ensure that the systems operate to their full potential. It is clear that on-site systems capable of enhanced nitrogen removal are available in New Zealand, however it appears that this aspect of the available technology will need to be refined before the high nitrogen removal rates, that are required in nitrogen sensitive areas, will be consistently available.

8. APPENDICES

8.1. Appendix I

On-Site Wastewater Treatment Systems – New Zealand Suppliers Database

APPENDIX I ON-SITE WASTEWATER TREATMENT SYSTEMS – NEW ZEALAND SUPPLIERS DATABASE

NAME OF ORGANISATION	CONTACT PERSON	POSTAL ADDRESS	E-MAIL ADDRESS	FAX NUMBER	TELEPHONE NUMBER
Biocycle	Mr Mark Ferris	Hydra Tech Drainage and Plumbing P O Box 21 324 Henderson	info@onesandtwos.co.nz	(09) 813 63401	(09) 813 63410
● Blivet Aerotor (New Zealand) Ltd	Mr Rob McLennan	1 Nikau House 33 Nikau Cres Mt Maunganui	robblivet@xtra.co.nz	(07) 575-4501	(07) 575-7511
Environflow Waste Water Treatment Systems Ltd	Mr John Simmiss	P O Box 8686 Havelock North Hawke's Bay	simmiss@xtra.co.nz	(06) 877-8903	(06) 877-5966
● Gould GT Systems	Mr Warrick Gould	P O Box 4196 Palmerston North	gouldsystems@xtra.co.nz	(06) 353-3020	(06) 353-6157
● a Humes	Mr Wayne Langdon (Engineer)	–	waynel@humes.co.nz	–	(09) 299-6740
Hynds Environmental	Ms Jane High	6 Cowley Place Rosedale Albany Auckland	janeh@hyndsenv.co.nz	(09) 415-4531	(09) 415-4530
● Innoflow Technologies Ltd	Mr James Young Mr Mark Andrews	P O Box 300-572 Albany Auckland	innoflow@xtra.co.nz	(09) 415-5889	(09) 415-5880
Innovative Water Solutions	Dr Alexander Rodionov	P O Box 7041 New Plymouth	alexrod@innovative-water-solutions.com	(06) 755-2345	(06) 755 9400
Lord Enterprises – (Biocycle)	Mr Gary Lord	P O Box 28 353 Remuera	lord-ent@xtra.co.nz	(09) 522-0074	(09) 522-4409
Oasis Clearwater Systems	Mr Lewis Austin	P O Box 16276 Hornby Christchurch	oasiscws@inet.net.nz	(03) 344-0267	(03) 344-0262
● Vivendi Water	Mr Peter Pritchard	5 Hill St Onehunga	sales@vivendiwater.co.nz	(09) 622-0175	(09) 622-1829
Water Systems	Mr Kevin Napier	Unit D 15 Collard Place Henderson	wsts@watersystems.co.nz	(09) 836-8733	(09) 836-7933

NOTES :

- ● Experience in Rotorua area.
- **a** No performance data available.

8.2. <u>Appendix II</u>

Establishing performance requirements by assessing the probability of impact

APPENDIX II ESTABLISHING PERFORMANCE REQUIREMENTS BY ASSESSING THE PROBABILITY OF IMPACT

The “probability of impact” method estimates the probability that treated water discharged from an onsite system will reach an existing or future point of use in an identified water resource. By considering the relative probability of impact based on existing water quality standards (e.g. drinking water, shellfish water, recreational water), acceptable treatment performance standards can be established. The pollutants and their concentrations or mass limits to be stipulated in the performance requirements will vary with the relative probability of impact estimated, the potential use of the water resource, and the fate and transport characteristics of the pollutant.

As an example, the assessment indicates that a ground water supply well that provides water for drinking without treatment might be adversely affected by an onsite system discharge. Soils are assumed to be of acceptable texture and structure, with a soil depth of 3 feet. Nitrate-nitrogen and faecal coliforms are two wastewater pollutants that should be addressed by the performance requirements for the treatment system (i.e. constructed components plus soil). With a relative probability of impact estimated to be “high,” the regulatory authority considers it reasonable to require the treatment system to achieve drinking water standards for nitrate and faecal coliforms before discharge to the saturated zone. The drinking water standards for nitrate and faecal coliforms in drinking water are 10 mg/L for nitrate and zero for faecal coliforms. Considering the fate of nitrogen in the soil, it can be expected that any of the nitrogen discharged by the pre-treatment system will be converted to nitrate in the unsaturated zone of the soil except for 2 to 3 mg/L of refractory organic nitrogen. Because nitrate is very soluble and conditions for biological denitrification in the soil cannot be relied on, the performance standard for the onsite system is 12 mg/L of total nitrogen (10 mg/L of nitrite + 2 mg/L of refractory organic nitrogen) prior to soil discharge. In the case of faecal coliforms, the natural soil is very effective in removing faecal indicators where greater than 2 feet of unsaturated natural soil is present. Therefore, no faecal coliform standard is placed on the pre-treatment (i.e. constructed) system discharge because the standard will be met after soil treatment and before final discharge to the saturated zone.

If the probability if impact is estimated to be “moderate” or “low,” only the nitrogen treatment standard would change. If the probability of impact is “moderate” because travel time to the point of use is long, dispersion and dilution of the nitrate in the ground water is expected to reduce the concentration in the discharge substantially. Therefore, the treatment standard for total nitrogen can be safely raised, perhaps to 20 to 30 mg/L of nitrogen. If the probability of impact is “low,” no treatment standard for nitrogen is necessary.

If the probability if impact is “high” but the point of ground water use at risk is an agricultural irrigation well, no specific pollutants in residential wastewater are of concern. Therefore, the treatment required need be no more that that provided by a septic tank.