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JULY

2005

# TECHNICAL REPORT

## Domestic Greywater Treatment System

## ACCREDITATION MONITORING 2005



for

**AquaReuse Pty Ltd**

**Written by Dr Therese Flapper**

# 1 INTRODUCTION

Domestic greywater treatment systems (DGTS) require accreditation by NSW Health via the DGTS Accreditation Guidelines (February 2005). This guideline includes residential systems treating up to ten persons per day, equivalent to 900 $Ld^{-1}$. The guideline allows nomination by the manufacturer of the included greywater sources, such as kitchen sink – Yes or No.

AquaReuse wish to gain NSW Health accreditation of their peat based biological filter system (Model ADF1), which is designed for a flow of nine persons, or 810 $Ld^{-1}$, including kitchen sink, but not insinkerators. Ecowise Environmental Pty Ltd (Ecowise) were commissioned by AquaReuse to conduct the required monitoring program to gain accreditation.

# 2 SCOPE OF WORK

The scope of work included:

- Test site setup assistance
- Training of onsite test site staff in sampling
- Liaison with NSW Health and local Council
- Sampling and sampling audit
- Laboratory analysis of received samples
- Data management
- Review of data
- Report.

# 3 TEST SITE

A test site facility was confirmed at a caravan park and camping site in Jervis Bay, NSW. The site includes permanent resident cabins and caravans, tourist cabins and caravans, and camping sites with some amenities. This site was chosen due to its ready access to the range of greywater sources wanted for treatment (laundry, bath, sinks, shower, kitchen sink), insitu greywater sump well, ready access to greywater plumbing, guarantee of flow at desired flow rates, proximal location. Site staff were also very interested in the project, and the possibility to reuse greywater for toilet flushing (and possibly laundry use), reducing the need for tank and rainwater.

The test site was setup in October 2004 and commissioned during November 2004. The site installation (Model ADF1) is shown in Figure 1 and Figure 2 shows the biological community within the peat biofilter. The site control PLC was set to deliver an average daily flow of around 820 L to the system, including diurnal flow changes to reflect typical domestic profiles.

Ecowise staff trained the onsite operator of the caravan park in routine site sampling to conduct the weekly sampling. This sampling was audited approximately monthly, and regular email and phone contact was maintained. A Sampling Methods Manual (SMM) was prepared in October 2004, and reviewed in December 2004, with some amendments made due to changes in courier delivery of samples from Jervis Bay to Fyshwick. This manual includes training and audit of site staff for weekly sampling.

**Figure 1: Caravan Park Test Site Installation**

**Figure 2: Biological Community Within Peat Bed Filter at Test Site Installation**

# 4 SAMPLING METHODOLOGY

Table 4.1 lists the equipment used for this sampling program.

| Table 4.1: Summary of Sampling and Field Equipment | | |
|---|---|---|
| **Equipment** | **Use** | **Details** |
| Sample taps onsite, installed by AquaReuse at all sampling points | Collect sample from influent, secondary and effluent | None |
| Esky | Store and keep cool sample jars | None |
| 500mL plastic sample jar (CHEM) | Collect sample for BOD, SS, nutrients | None |
| 500mL plastic sterile sample jar (BACTO), preserved with thiosulphate | Collect sample for thermotolerant coliforms, *Escherichia coli* | None |
| Distilled water | Cleaning of equipment and collecting trip blank samples for QA | Laboratory Type 1 water |
| Disposable gloves | Protects hands and sample from contamination | None |
| Digital camera | Record site visual details | None |

## 4.1 PRE-RUN SETUP

Prior to the commencement of sampling, the following was conducted.

1. All appropriate sample jars were prepared for: Date, Time, Site, Sample ID (see example labels provided). Sample ID will take the following form:
   - Influent IN-DDMMYY-A (example, IN-201104-A, IN-201104-B)
   - Effluent EF-DDMMYY-A (example, EF-201104-A, EF-201104-B)
   - Secondary SY-DDMMYY-A (example, SY-201104-A, SY-201104-B)
2. All sample collection devices were rinsed with water then dried (sample bucket for influent).
3. All field sheets were printed and ready to be completed, and the digital camera was ready for operation (when used).
4. All necessary equipment was made available and checked for good working order, including the items listed in Table 3.1.
5. Freezer bricks or equivalent were placed in the esky's to keep samples cool.
6. All safety required equipment and procedures was checked and followed.

## 4.2 ONSITE SAMPLING PROCEDURE

The following procedure was followed when sampling from the DGTS.

1. Site system checked.
2. The Field Sheet was completed (Appendix A) and a site photograph taken, when appropriate.
3. Greywater influent or effluent sample was collected from the appropriate sample points. Influent was collected using the installed sampling tap into a bucket. Secondary was collected from the installed sampling point, prior to UV direct into sampling bottles. Effluent was collected using the installed sampling tap, post UV direct into sampling bottles. The following bottles were filled in the defined manner:
   - 500mL bottle with preservative (BACTO), for thermotolerant coliforms – fill first, fill only 2/3, leaving an airspace
   - 500mL bottle (CHEM), for BOD, SS – fill completely with no air space
   - 500mL bottle, for nutrients – fill completely with no air space

- EFFLUENT – switch Pump 3 to 'off' around 1 hour before collecting the sample. Then switch to 'manual' and allow to operate for 30 seconds. Open sampling tap and run for 10 seconds. Allow sample to fill bottles as above in point 3 (1 x BACTO and 1 x CHEM). Switch pump 3 back to 'auto' from manual when finished.
- INFLUENT – turn sampling point on and allow to run for around 10 seconds, then into nearby bucket for sample collection. Pour from bucket into sample jars as above in point 3 (1 x BACTO and 1 x CHEM). Discard remaining sample.

4. Sample jars were placed immediately into the esky with ice bricks, to be kept cool.
5. The chain of custody form was completed and placed inside the esky with the samples.
6. The courier procedure was then followed to ensure prompt delivery of samples to the Laboratory.

## 4.3 SAMPLE DELIVERY

All samples were delivered to the laboratory within 24 hours of collection. Samples were kept on ice until delivery. Samples were accompanied by a chain-of-custody form detailing the sample ID, analysis required and delivery and receival details.

Samples were generally couriered using Capital Coast Couriers (phone 02 4472 7000). At times, Ecowise staff onsite then delivered samples to the laboratory. On a few occasions, TNT or Australia Post was used due to public holidays or other matters.

## 4.4 QA SAMPLES

The following QA samples were collected on random sampling runs.

1. Trip Blank sample, being laboratory-grade reagent water, contained within the same type of sample jar being used for greywater samples, and maintained within the esky on ice for the duration of the sampling trip.
2. Field Duplicates, sampled in the same manner and maintained under the same sample conditions as the greywater sample. This is a blind field duplicate to the laboratory and appropriate labelling will be used to guarantee transparency.

## 4.5 SAMPLING AUDIT

The sampling program was audited around once per month. The audit included all procedures and activities in relation to sampling including the onsite Sampling Technician, the Sampling Methods Manual, site sampling work, and sample delivery to the laboratory.

The sampling audit was conducted by the Sampling Manager. The audit process included:

1. Interview of Sampling Technician.
2. Review of Sampling Methods Manual to ensure it reflects actual procedures.
3. Observation of sampling run conducted by Sampling Technician.
4. Review of chain-of-custody, field sheets and relevant database files.
5. Identification of non-compliances and making of recommendations, where required.
6. Follow-up of non-compliances to ensure appropriate and timely rectification.

## 5 ANALYTICAL METHODOLOGY

All analysis was performed at the Fyshwick laboratory of Ecowise. All parameters tested were NATA accredited at this facility. Full laboratory methods procedures can be provided, however tests were in keeping with APHA Standard Methods for the Examination of Water and Wastewater.

## 6 QA AND DQO ASSESSMENT

QA/QC criteria were assessed against data quality objectives (DQO). The defined DQO for this monitoring program included:

- 100% of blanks registering non-detect data
- duplicate sample results ±15%
- spike sample results ±15%
- 90% of control test conditions meet reasonable outcomes for the control.

Table 6.1 summarises the outcomes of the data assessment in terms of the defined DQO. It shows that good quality data was obtained, with all DQO met.

**Table 6.1: DQO Outcomes**

| DQO | Status |
|---|---|
| 100% of blanks registering non-detect data | Met |
| Duplicate sample results ±15% | Met |
| Spike sample results ±15% | Laboratory Met |
| Standard sample results ±10% | Met |
| 90% of control test conditions meet reasonable outcomes for the control | Met |

## 7 RESULTS

All data was analysed via a series of graphs to demonstrate performance. Maximum, minimum, average (50%ile), 90%ile and 10%ile data was used to ensure the test conditions desired were achieved. The data is summarised in Table 7.1 below, and shown in Figures 7.1 to 7.3 for the various tested parameters (BOD, SS, TC respectively).

**Table 7.1: Summary of Influent and Effluent Data**

| Sample | BOD ($mgL^{-1}$) | Suspended Solids ($mgL^{-1}$) | Thermotolerant Coliforms (cfu/100mL) |
|---|---|---|---|
| **Influent (n=16)** | | | |
| Maximum | 550 | 440 | 5,800,000 |
| Minimum | 110 | 42 | 120,000 |
| 50%ile | 245 | 130 | 1,100,000 |
| 90%ile | 410 | 270 | 2,700,000 |
| **Effluent (n=28)** | | | |
| Maximum | 3 | 4 | 1 |
| Minimum | 0 | 0 | 0 |
| 50%ile | 0 | 2 | 0 |
| 10%ile | 0 | 0 | 0 |
| *10%ile represents the number whereby 90% of all samples are less than. This relates to the performance criteria required to be met by the NSW health Guidelines.* | | | |

The average flow per day over this full data range was 617 $Ld^{-1}$, with a maximum of 1,189 and minimum of 0 (when a valve blocked and was subsequently cleared). However, it should be noted that the 80%ile figure was 858 $Ld^{-1}$, demonstrating the skewness of the data, and that higher flows than the 617 $Ld^{-1}$ average were generally apparent. The average flow to end April was 822 $Ld^{-1}$, which is prior to the downturn in tourist numbers at the facility. The PLC for the facility was set to deliver an average daily flow of 820 L, which was generally achieved.

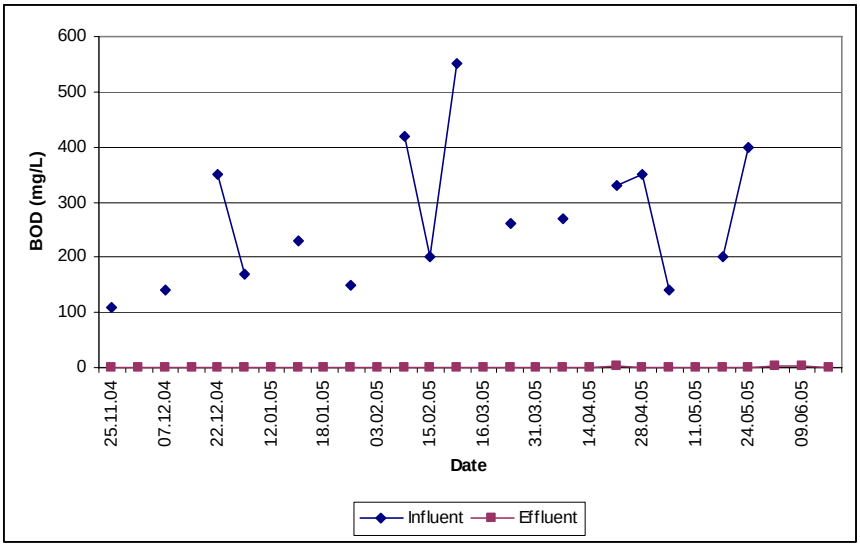


**Figure 7.1: BOD Over Time for Influent and Effluent**

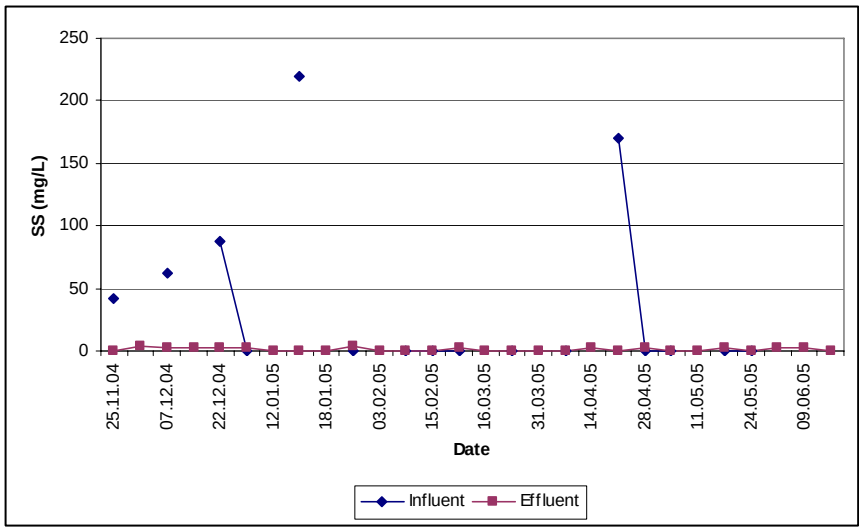


**Figure 7.2: Suspended Solids Over Time for Influent and Effluent**

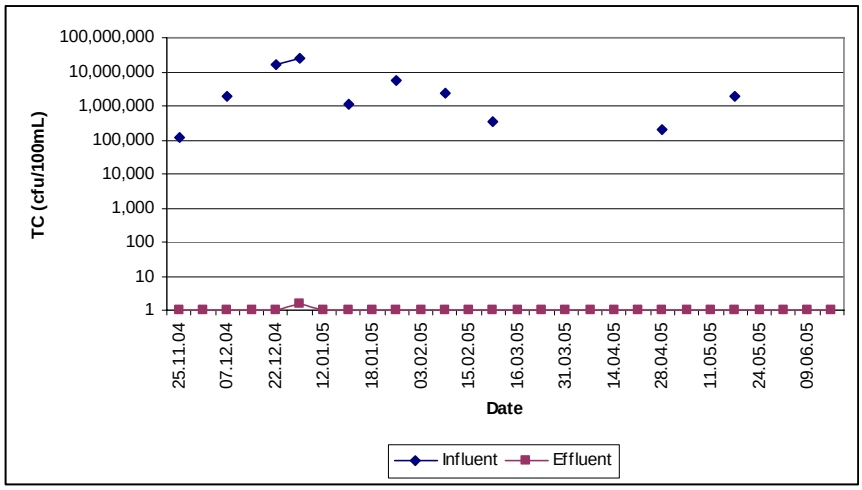


**Figure 7.3: Thermotolerant Coliforms Over Time for Influent and Effluent (log scale)**

## 8 SITE OBSERVATIONS

Throughout the monitoring program, records were maintained as to issues / aspects of the system operation, by Ecowise and the site operator of the caravan park. Few issues were noted during the six month program. One inlet pump valve started to get clogged, and was replaced for a more efficient system, under Ecowise supervision. This design change had already been recognised in final system drawings as an improvement.

No significant odour was generated during operation. No major outages were experienced, except due to power failures and interruptions. No loss of flow was experienced to the system, and no samples were missed or excluded from the data presented. No process unit failures were noted. The system did not undergo any maintenance of any kind – neither routine or reactively. The UV unit did not have a lamp change or other interference. The site operated in a safe and transparent manner. The site tanks and infrastructure experienced all weather elements and did not show any signs of detriment.

## 9 FINDINGS

Table 9.1 summarises the findings with repsect to the defined effluent compliance criteria. It can be seen that the AquaReuse system (Model ADF1) readily meets the effluent performance criteria for all disposal methods. Therefore this system configuration may be used for toilet flushing and laundry reuse at a domesctic scale, according to the NSW Health guidelines.

**Table 9.1: Test Site Effluent Data Compared to Compliance Criteria for Effluent Quality from DGTS According to Disposal / Utilisation Method**

| | Analyte | | | | | | |
|---|---|---|---|---|---|---|---|
| **Disposal Method** | **BOD mg/L** | **SS mg/L** | **T. coliforms cfu/100mL** | **TKN mg/L** | **TN mg/L** | **TP mg/L** | **Free $Cl_2$ mg/L *** |
| **Effluent Quality from Test Site** | | | | | | | |
| 90% of Samples | 0 | 0 | 1 | | | | |
| Maximum threshold | 3 | 4 | 0 | | | | |
| **Sub-surface irrigation** | | | | | | | |
| 90% of Samples | < 20 | < 30 | | TBN | TBN | TBN | |
| Maximum threshold | < 30 | < 45 | | TBN | TBN | TBN | |
| **Surface irrigation** | | | | | | | |
| 90% of Samples | < 20 | < 30 | < 30 | TBN | TBN | TBN | >0.2-<2.0 |
| Maximum Threshold | < 30 | < 45 | < 100 | TBN | TBN | TBN | <2.0 |
| **Toilet / Washing Machine reuse** | | | | | | | |
| 90% of Samples | < 10 | < 10 | < 10 | TBN | TBN | TBN | >0.5-<2.0 |
| Maximum Threshold | < 20 | < 20 | < 30 | TBN | TBN | TBN | <2.0 |

*TBN to be nominated, by manufacturer*
** where chlorine is the disinfectant*

The AquaReuse system (Model ADF1) treated an average greywater flow of around 820 $Ld^{-1}$, which is equivalent to a nine person system, and routinely received kitchen sink waste (not insinkerator). Therefore the monitoring program findings relate to the approval of a nine person DGTS, including kitchen sink but not insinkerator. It was found that the system readily met the performance criteria, and that accreditation is warranted.

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