North Coast
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Date: 25 May 2008

Bonville Caravan Park
1251 Pacific Highway
BONVILLE NSW 2441

Dear Neil,

On-site Wastewater Disposal Report
Bonville Caravan Park, Bonville

In accordance with your instructions, we have undertaken site and soil investigations at the abovementioned property for the preparation of an on-site wastewater disposal report.

Please find enclosed three copies of this report.

I thank you for your business and look forward to working with you again in the future.

Should you require further information or clarification with respects to this report, please do not hesitate to contact me on 6652 2915 or 0419 481 781.

Regards,

Brett Carlyle
Principal Consultant

On-site Sewage Management
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On-site Wastewater Disposal Report
Bonville Caravan Park, Bonville

Executive Summary

Following a request from our client, site and soil assessments have been undertaken at Bonville Caravan Park, Bonville for a proposed increase in the size and number of occupants of the existing Caravan Park.

A number of site inspections have been undertaken which revealed minor limitations for all parameters. Due to the extent of landscaping and beautifications works being undertaken and the high level treatment of effluent, we have proposed a reduction in the buffer distances to boundaries in areas clear of the watercourse and drainage channels.

Alternatively, the soil analysis revealed moderate to major limitations for on-site wastewater disposal, being pH, cation exchange capacity (CEC) and phosphorus sorption. These limitations do not preclude the installation of an on-site sewage management system; however they shall require site preparations and soil amendments to ameliorate these concerns.

Sufficient area is available for effluent disposal for the proposed increase in the number of sites and occupants. Four means of effluent disposal have been proposed, with the water and nutrient balances requiring minimum area requirements ranging from 4,761m^2 to 9,523m^2.

To enable the dual reticulation of effluent for toilet flushing, washing machine, and outdoor garden use, the recycled water must be treated to a tertiary level by means of an aerated wastewater treatment system (AWTS), dual membrane filtration, chlorination and UV disinfection. The remainder of effluent shall be evenly distributed into a shallow, pressured, sub-surface irrigation system.

Due to the significant reduction in the hydraulic loading for the dual reticulation, an effluent disposal area 4,761m2 is required, with a minimum of 2,300m of sub-surface trenching or 600m of evapotranspiration-absorption (ETA) trenching.

A validation and on-going verification processes are required due to the potential for disease transmission with the dual reticulation system. An information package is required for all persons residing within the caravan park, with warning signs and colour coded pipework required to differentiate between the recycled water and the primary water supplies.

Since amending the layout of the caravan park with the introduction of the 40m buffer to the eastern boundary for bushfire protection, an additional 1,800m^2 effluent disposal has available, which provides sufficient area throughout the park for effluent disposal.

Effluent may also be treated to a secondary level, by means of an AWTS, sand filter, or an equivalent, with the water and nutrient balances calculating a minimum effluent disposal area of 9,532m^2.

As identified in the water and nutrient balances, a minimum of 4,600m of sub-surface drip irrigation is required to adequately dispose of effluent. The length of the sub-surface irrigation system was calculated based on trench specifications of 300mm wide and 300mm deep in accordance with Appendix 4.5C of AS1547:2000.

Effluent may also be disposed of via an ETA system with a minimum of 1,150m of trenching required. The area requirements of the ETA system were calculated in accordance with Appendix 4.5A3, with trench specifications of 1500mm wide and 450mm deep. Spacing of the ETA beds are 2m from sidewall to sidewall with this area extensively vegetated to encourage transpiration.

Table of Contents

1. Introduction

Bonville Caravan Park is located on the 1251 Pacific Highway, Bonville with the expansion taking place adjacent to Bonville Station Road, Bonville. The property is located within the Coffs Harbour City Council (CHCC) Local Government Area (LGA), and is not serviced by a reticulated sewerage system or water supply.

The site is predominantly cleared of vegetation, and gently sloping downwards towards the watercourse and dams which bisect the property from west to east.

Currently, the Caravan Park has approval for 60 sites contained within the 2ha (20,000m^2) property. Upon acquisition of the adjoining properties, there will be approximately 4.86ha (48,562m^2) of land available for expansion, in which 92 sites are proposed, consisting of 81 permanent sites and 11 temporary sites.

A commercial sized AWTS is presently used for on-site wastewater treatment, and effluent disposed of via spray irrigation on vacant land to the rear of the existing site. This AWTS may be utilised upon the expansion Caravan Park for the treatment of effluent for the temporary sites, however would not produce effluent of sufficient quality for residential dual reticulation.

2. References Used

The following references were used in the preparation of this wastewater disposal report:

- Department of Local Government, Environmental Protection Authority, NSW Health, Department of Land & Water Conservation, and the Department of Urban Affairs and Planning, 1998. *"Environment & Health Protection Guidelines; On-site Sewage Management for Single Households."* Department of Local Government
- Bureau of Meteorology (BOM), *"Climate Average for Coffs Harbour MO Weather Station."* http://www.bom.gov.au/climate/averages/tables/cw_059040.shtml
- *CSIRO, 2005. "Water Sensitive Urban Design Engineering Procedures; Stormwater"* CSIRO Publishing, Collingwood, Victoria
- Environment Protection and Heritage Council, Natural Resource Management Ministerial Council, & Australian Health Ministers' Conference, 2006. *"National Guidelines for Water Recycling: Managing Health and Environmental Risks."* Environment Protection and Heritage Council, the Natural Resource Management Ministerial Council & Australian Health Ministers' Conference.
- NSW Government, Department of Water and Energy, 2007. "*Interim Guidelines for Management of Private Recycled Water Schemes."* NSW Government, Department of Water and Energy
- Saunders M, 2004. *"On-site Sewage Management Training Course – Wastewater Characteristics."* Centre for Environmental Training
- Standards Australia, 1994. *"Australian Standard (AS) 1547:1994; Disposal Systems for Effluent from Domestic Premises."* Standards Australia Publishing, Homebush, New South Wales.

- Standards Australia, 2000. *"Australian/New Zealand Standard (AS/NZS) 1547:2000; On-site Domestic Wastewater Management."* Standards Australia Publishing, Strathfield, New South Wales.
- White S, 1998. *"Wise Water Management - A Demand Management Manual for Water Utilities, Water Services Proceedings of Australia Research Report."*

3. Climate

As there are no climate averages for Bonville provided by the Bureau of Meteorology (BOM), figures for the water balance (mean monthly rainfall and daily pan evaporation) were derived from the Coffs Harbour BOM weather station (059040). Whilst limited climate averages are available for Pine Creek Forestry, the figures from the Coffs Harbour weather station allow for a more conservative on-site wastewater disposal design

4. Site and Soil Evaluation

The site investigation revealed minor limitations for all parameters. Considering effluent is being treated to such a high quality (tertiary level) for the purposes of residential dual reticulation, it is proposed that buffer distances be reduced to 1m to boundaries to irrigate the landscaped areas and new plantings. Irrigation within the landscapes areas will consist of sub-surface pressure compensated drip irrigation line in 150mm deep trenching or covered by a minimum of 100mm of mulch.

A watercourse bisects the site west to east, and 2 dams are also situated on-site, requiring the irrigation area to be a minimum of 40m from the watercourse as required by Council's On-site Sewage Management Strategy.

The soil analysis revealed major limitations in the soil's cation exchange capacity (CEC), and moderate limitations for the pH and the phosphorus sorption. These limitations do not preclude the installation on an on-site sewage management system; however it is recommended that organic matter (i.e., mulch, soil, etc.) be applied to the effluent disposal areas to ameliorate these concerns.

Soil investigations revealed loam soils to a depth of 200mm, overlying clay loam soils to depths greater than 1m. Soil was collected for laboratory analysis at a depth of 600mm using a 90mm auger.

An indicative permeability (K_{sat}) of 0.12 – 0.5 metres per day (m/d) has been recommended in AS 1547:2000 for weakly structured clay loams. The recommended design irrigation rate (DIR) for irrigation systems for category 4 soils is 25 millimetres per week (mm/w), whilst the design loading rate (DLR) for evapotranspiration-absorption (ETA) beds is 8mm/d.

Considering effluent is to be treated to a tertiary level, the DLR for the ETA water balance has been increased to 20mm/d, which is consistent with the DLR for trenches and beds as indicated in Note 5 of Table 4.2A1 of AS1547:2000.

For the purposes of preparing water and nutrient balances in accordance with AS1547:1994, the long term acceptance rate (LTAR) has been calculated at 20mm/d with a DIR of 40mm/w.

Photo 1. Bonville Excavated Soil Profile

Table 1. Site Evaluation (Bonville Caravan Park, Bonville)

Site Feature	Minor Limitation		Moderate Limitation		Major Limitation	
Flood Potential	Disposal area above 1:20 year flood contour	✓			Disposal area below 1:20 year flood contour	
	Vents, openings and electrical components above 1:100 year flood contour	✓			Vents, openings and electrical components below 1:100 year flood contour	
Exposure	High wind and sun exposure	✓			Low sun and wind exposure	
Slope (%)	0-10	✓	10-20		>20	
Landform	Hill crest, convex side, slope and plains	✓	Concave side, slopes and foot slopes		Drainage plains and incised channels	
Run-on	None - low	✓	Moderate		High - Diversion not practical	
Erosion potential	No signs of erosion potential present	✓			Signs of erosion, mass movement and slope failure present	

Site Plan Continued (Bonville Caravan Park)

Site Feature	Minor Limitation		Moderate Limitation		Major Limitation	
Site Drainage	No visible signs of surface dampness	✓			Visible signs of surface dampness	
Fill	No fill	✓	Fill present			
Buffer distance	Buffer distances comply	✓			Buffer distances do not comply	✓
Land area	Area is available	✓			Area is not available	
Rocks and rock outcrops	<10%	✓	10-20%		>20%	

Table 2. Soil Evaluation (Bonville Caravan Park, Bonville)

Site Feature	Relevant Systems	Minor Limitation		Moderate Limitation		Major Limitation	
Depth to bedrock or hardpan (m)	Surface irrigation Subsurface irrigation	>1.0	✓	0.5 - 1.0		<0.5	
	Absorption system	>1.5	✓	1.0 - 1.5		<1.0	
Depth to seasonal watertable (m)	Surface irrigation Subsurface irrigation	>1.0	✓	0.5 - 1.0		<0.5	
	Absorption system	>1.5	✓	1.0 - 1.5		<1.0	
pH (CaCl)	All land application systems	>6.0		4.5 - 6.0	✓	>4.5	
Soil permeability category	Surface irrigation Subsurface irrigation	2b, 3 & 4	✓	2a & 5		1 & 6	
	Absorption system	3 and 4	✓			1, 2, 5 & 6	
Coarse Fragments (%)	All land application systems	0 - 20	✓	20 - 40		> 40	
Electrical conductivity	All land application systems	>4	✓	4-8		>8	
Cation exchange capacity	Surface irrigation Subsurface irrigation	>15		5-15		<5	✓
Phosphorus sorption	All land application systems	>6000		2000-6000	✓	<2000	
Modified emersion aggregate test	All land application systems	Class 1	✓	Class 2		Class 3	

5. Wastewater Quantity and Quality

The hydraulic load was calculated based on the typical domestic wastewater flow design allowances presented in Appendix 4.2D of AS1547:2000, additional water reduction measures by means of dual reticulation and on water consumption figures from Caravan Parks of similar size and with a similar distribution of permanent to temporary sites.

The hydraulic load for the permanent sites has been calculated based on 1.5 persons per bedroom residing in each of the 2-bedroom residences. All permanent residences will have full water-reduction facilities (i.e., 6/3 litre water closets, shower-flow restrictors, front-loading washing machines and flow/pressure control valves on water-use outlets) and dual reticulation, whereby tertiary treated effluent shall be reused for flushing of toilets, washing machine use and outdoor garden irrigation.

With bore water being the primary water supply for the park, the loading for the water balance was calculated based on 110L/person/day, however a reduction in this flow allowance was calculated for the dual reticulation.

A number of studies have been undertaken to estimate the total wastewater flow allowance per person and per fixture. Typical water usage figures for households with ordinary fittings on a reticulated water supply are listed below, sourced from White *(1998)*, the Environment & Health Protection Guidelines *(2001)*, Saunders *(2004)*, and the CSIRO *(2005)*.

As shown in table 3, an average of 29% of the total wastewater stream is generated from toilet flushing, whilst an additional 22.3% is generated from laundry usage. Thus a reduction of 51.3% of the total wastewater flow allowance per person specified in AS 1547:2000 is achieved. Conservatively, this reduces the hydraulic loading from 110L/person/day to 55L/person/day.

Therefore, the total quantity of wastewater generated is 13,365 L/day, based on a maximum of 243 persons residing within the 81 permanent residences. This being a significant reduction from the daily flow allowance of 26,730 L/day based on a loading of 110 L/person/day.

Table 3. Wastewater Allowance per Fixture

Fixture	**White L/house/day (% Indoor Use)**	**E & HPG L/house/day (% of Total)**	**Saunders L/house/day (% of Total)**	**CSIRO L/person/day (% of Total)**
Shower	164 (28)			
Bath	30 (6)			
Basin	27 (4)			
Total bathroom	**221 (36)**	**65-85**	**228 (38)**	26 (35)
Toilet	186 (30)	15-35	192 (32)	19 (25)
Laundry	134 (24)		138 (23)	15 (20)
Kitchen	44 (8)		42 (7)	5 (7)
Total Indoor	**586 (100%)**	**100%**	**600 (100%)**	**65 (100%)**

Water consumption within the temporary sites has been calculated based on 65L/person/day, with a maximum occupancy of 5 persons per site. With a maximum of 55 persons accommodating the 11 temporary sites, a daily flow allowance of 3,575L per day has been calculated.

Combining the hydraulic loading from the permanent and temporary sites, the total wastewater flow allowance for the Caravan Park has been calculated at 16,940 L/day.

To permit the reuse of effluent by dual reticulation, it is recommended that effluent is treated to a tertiary level by means of an aerated wastewater treatment system (AWTS), sand filter or an equivalent, with ultraviolet (UV) disinfection.

6. Source and Proposed Use

The source of effluent for the proposed dual reticulation scheme is treated sewage. The Caravan Park is unsewered, and sewage collected on-site from the permanent sites, amenity blocks, community centre, etc., is collected and treated on-site via an ATWS with dual membrane filtration and UV disinfection.

Proposed uses for the tertiary treated effluent include toilet flushing and for washing machine use in permanent sites and amenity blocks, garden use, and irrigation of parks and gardens.

7. Human Health Risk Assessment

7.1 Microbial Quality

Microbial hazards for human health include enteric bacteria, viruses and protozoa. As identified in the *National Guidelines for Water Recycling* (2007), the following micro-organisms of concern are found in raw sewage.

Table 4. Micro-organisms of Concern in Raw Sewage

Pathogen	Examples	Illness
Bacteria	*Salmonella*	Gastroenteritis, reactive arthritis
	Campylobacter	Gastroenteritis, Guillain–Barré syndrome
	Pathogenic *Escherichia coli*	Gastroenteritis, haemolytic uraemic syndrome
	Shigella	Dysentery
	Yersinia	Gastroenteritis, septicaemia
	Vibrio cholerae	Cholera
	Atypical *Mycobacteria*	Respiratory illness (hypersensitivity pneumonitis)
	Legionella spp	Respiratory illness (pneumonia, Pontiac fever)
	Staphylococcus aureus	Skin, eye, ear infections, septicaemia
	Pseudomonas aeruginosa	Skin, eye, ear infections
	Helicobacter pylori	Peptic ulcers
Viruses	Enterovirus	Gastroenteritis, respiratory illness, CNS disorders
	Adenovirus	Gastroenteritis, respiratory illness, eye infections
	Rotavirus	Gastroenteritis
	Norovirus	Gastroenteritis
	Hepatitis A	Infectious hepatitis

Pathogen	Examples	Illness
	Calicivirus	Gastroenteritis
	Astrovirus	Gastroenteritis
	Coronavirus	Gastroenteritis
Protozoa	*Cryptosporidium*	Gastroenteritis
	Giardia	Gastroenteritis
	Naegleria fowleri	Amoebic meningitis
	Entamoeba histolytica	Amoebic dysentery
Helminths	*Taenia (T. saginata)*	Tapeworm (beef measles)
	Ascaris	Roundworm
	Trichuris	Whipworm

Source: *Environment Protection and Heritage Council, Natural Resource Management Ministerial Council, & Australian Health Ministers' Conference (2006).*

7.2 Chemical Quality

As the source of the sewage is from within the Caravan Park, and is not subject to trade wastes, the chemical quality did not represent a significant health risk.

7.3 Preventive Measures

Preventative measures to minimise the potential for disease transmission include:

- primary treatment - the physical treatment process, retention of sewage for solid matter to settle;
- secondary treatment - removes dissolved and suspended organic material by biological treatment and sedimentation; biodegradable organics, volatile organics, some nitrogen and phosphorus removed;
- tertiary treatment – polishing of effluent via membrane filtration, chlorination and UV disinfection;
- backflow prevention devices and cross-connection control on all premises and amenity blocks;
- colour coded pipework and outdoor taps and signage;
- continuous online monitoring of turbidity and free chlorine residual;
- to ensure the effectiveness of disinfection;

- Monitoring requirements in relation to dual reticulation include:
    a. standard AWTS requirements:
        i. biochemical oxygen demand (BOD) ≤20 mg/L;
        ii. total suspended solids (TSS) ≤30 mg/L;
        iii. a thermotolerant coliform count not exceeding 30 cfu/100 ml with no sample exceeding 100 cfu/100 ml; and
        iv. a TKN of no more than 20 mg/L.
    b. turbidity of filtered effluent (continuous) – ≤2 NTU 95% of the time; maximum turbidity 5 NTU;
    c. disinfection (continuous) - free chlorine residual >2 mg/L; detention >90 mg/min/L
    d. weekly sampling and analysis of effluent for *e.coli*
    e. on-site auditing of controls (education, backflow prevention, etc).
- an education program for all occupants and plumbers.

Prominent signage incorporating symbols indicating that the water is not suitable for drinking ('Recycled Water - Do Not Drink') shall be provided wherever the tertiary treated effluent is used, i.e., fixed to the colour coded pipework and taps provided for garden usage within the permanent caravan sites. The warning signage provided shall be designed with reference to AS 1319 (*Safety Signs for the Occupational Environment* 2004) and AS 2416 (*Design and Application of Water Safety Signs* 2002).

7.4 Corrective Action

In relation to public health and the subsequent water quality monitoring, the corrective responses depend on the exceedence. As a minimum, it involves investigation of plant performance records to confirm normal operation and additional testing to both confirm the exceedence and ensure the source has been identified and ameliorated.

An *e.coli* coliform count ≤10 cfu/100mL shall require investigation of:

- the contact time for the chlorination unit to ensure a minimum residual of 2mg/L is maintained;
- membrane filtration and monitoring system to ensure the turbidity of filtered effluent is ≤2 NTU;
- UV disinfection system to ensure it is free from biofilms, resuspension and regrowth.

An *e.coli* coliform count greater than 10 cfu/100mL shall require the dual reticulation system to be immediately stopped, and supply replaced with the primary water supply.

For the treatment system, corrective actions include the following:

- Non-compliance with critical limits results in flow to dual reticulation system being stopped and replaced by the primary water supply. That is, flow stopped if:
    i. turbidity limits (0.5 NTU average, 2 NTU maximum) not met for 60 minutes;
    ii. minimum chlorine contact time (90 mg/min/L not achieved for more than 60 minutes)
- If a cross-connection is detected, flow to individual property stopped at the property boundary.

8. Environmental Risk Assessment

8.1 Microbial Quality

Microbial quality of the recycled water was not considered an environmental issue given the high levels of treatment required to minimise risks to human health for the dual reticulation.

8.2 Chemical Quality

The preliminary risk assessment identified groundwater, surface water, aquatic biota, landscape and garden plants, turf and lawns as potential environmental hazards.

A comprehensive Site and Soil Assessment has been undertaken as identified in Tables 1 & 2, in accordance with AS1547:2000 and the Environment & Health Protection Guidelines.

8.3 Environmental Preventive Measures

Water and nutrient balances have been used to calculate the minimum area requirements for the effluent disposal area. As shown in the water balance calculations, phosphorus was the critical factor as its minimum area requirement of 4,761m^2 was the largest of the three balances assuming a concentration of 10mg/L in the tertiary treated effluent.

Buffer distances to environmentally sensitive areas have been maintained in accordance with CHCC's On-site Sewage Management Strategy.

An education guide is to be provided to all occupants providing information on the benefits of dual reticulation, and the impacts of deliberate or inadvertent misuse of recycled water. The dual reticulation education guide is designed to ensure all persons within the Caravan Park are well-informed of the recommended usage of the recycled water, and on the operation and maintenance requirements of the treatment system and recycled water. The following are examples of questions addressed to improve its image.

- Is recycled water safe to drink?
- Is recycled water safe for my garden?
- Can I fill a swimming pool with recycled water?
- What kind of testing is done on the treated water?
- Has the recycled water you're delivering ever been contaminated?
- Where does the water come from?
- How much water do you treat?
- Where does the recycled water go?
- What are the benefits of water recycling?
- How much did it cost to build the water recycling scheme?
- How much does the water recycling scheme cost to operate?
- What organisations support the project?
- How do I learn more about your company and water recycling?
- Can I be shown the treatment system?

9. Framework Elements Applied to a Dual Reticulation System

The following table outlines the qualitative risk assessment for potential hazardous events which may jeopardise public and environmental health within the dual reticulation scheme. Hazards italicised were deemed to be critical control points for which monitoring and preventative measures have been established.

Table 5. Potential Hazardous Events Qualitative Risk Estimation

Hazard	Likelihood	Impact	Risk
Treatment systems			
Chemical kill of AWTS micro-organisms	*Possible*	*Catastrophic*	*Very High*
Chemical dosing failures	*Likely*	*Catastrophic*	*Very High*

Hazard	Likelihood	Impact	Risk
Disinfection malfunctions	*Possible*	*Catastrophic*	*Very High*
Equipment malfunctions	*Possible*	*Catastrophic*	*Very High*
Failure of alarms and monitoring equipment	Likely	Moderate	High
Formation of disinfection by-products	Unlikely	Insignificant	Low
Inadequate backup for key processes	Unlikely	Insignificant	Low
Inadequate equipment or unit processes	Likely	Moderate	High
Inadequate filtration and backwash recycling	*Likely*	*Major*	*Very High*
Inadequate mixing of treatment chemicals	*Likely*	*Catastrophic*	*Very High*
Poor reliability of processes	Unlikely	Moderate	Medium
Power failures	Possible	Moderate	Medium
Sabotage and natural disasters	Rare	Moderate	Low
Significant flow variations	Possible	Minor	Medium
Use of unapproved treatment chemicals	Rare	Minor	Low
Distribution systems, application and receiving environments			
Biofilms, resuspension and regrowth	*Likely*	*Catastrophic*	*Very High*
Build-up of sediments and slimes	Likely	Minor	Medium
Change in biodiversity from increased nutrients applied in recycled water	Rare	Minor	Low
Deliberate or inadvertent misuse of recycled water	Certain	Moderate	High
Eutrophication of receiving waters	Unlikely	Moderate	Medium
Failure to identify recycled water systems (below and above-ground components)	Possible	Minor	Medium
Failure to maintain buffer zones and other access controls (eg fencing and signage)	Rare	Minor	Low
Flow variability, inadequate pressures	Rare	Moderate	Low
Formation of disinfection by-products	Unlikely	Minor	Low
Groundwater intrusion (salinity)	Rare	Moderate	Low
Human or livestock access, absence of exclusion areas	Unlikely	Insignificant	Low
Inadequate repair and maintenance, inadequate system flushing and reservoir cleaning	*Possible*	*Catastrophic*	*Very High*
Lack of separation between recycled water and drinking water systems	Unlikely	Major	High
Inappropriate materials and coatings or material failure	Rare	Minor	Low
Pipe bursts or leaks	Unlikely	Minor	Low
Poor cross-connection control and backflow protection (eg outdoor water users)	Possible	Major	High
Raised watertable, salinisation, soil structure decline	Rare	Minor	Low
Sabotage and natural disasters	Rare	Moderate	Low
Soil, groundwater or surface water contamination by recycled water	Possible	Minor	Low
Toxicity to plants, terrestrial or aquatic biota	Rare	Minor	Low
Waterlogging of plants	Possible	Minor	Medium
Users of recycled water			
Cross-connections to, and lack of backflow protection (eg drinking water)	*Possible*	*Catastrophic*	*Very High*
Inadequate education and information about permitted uses	*Likely*	*Major*	*Very High*
Leaching of metals from piping and fittings	Rare	Minor	Low
Over watering	Possible	Minor	Medium
Potential for unauthorised use	Possible	Minor	Medium
Use of inappropriate plumbing and construction materials	Rare	Minor	Low

Diagram 1. Dual Reticulation Processes Flow Chart

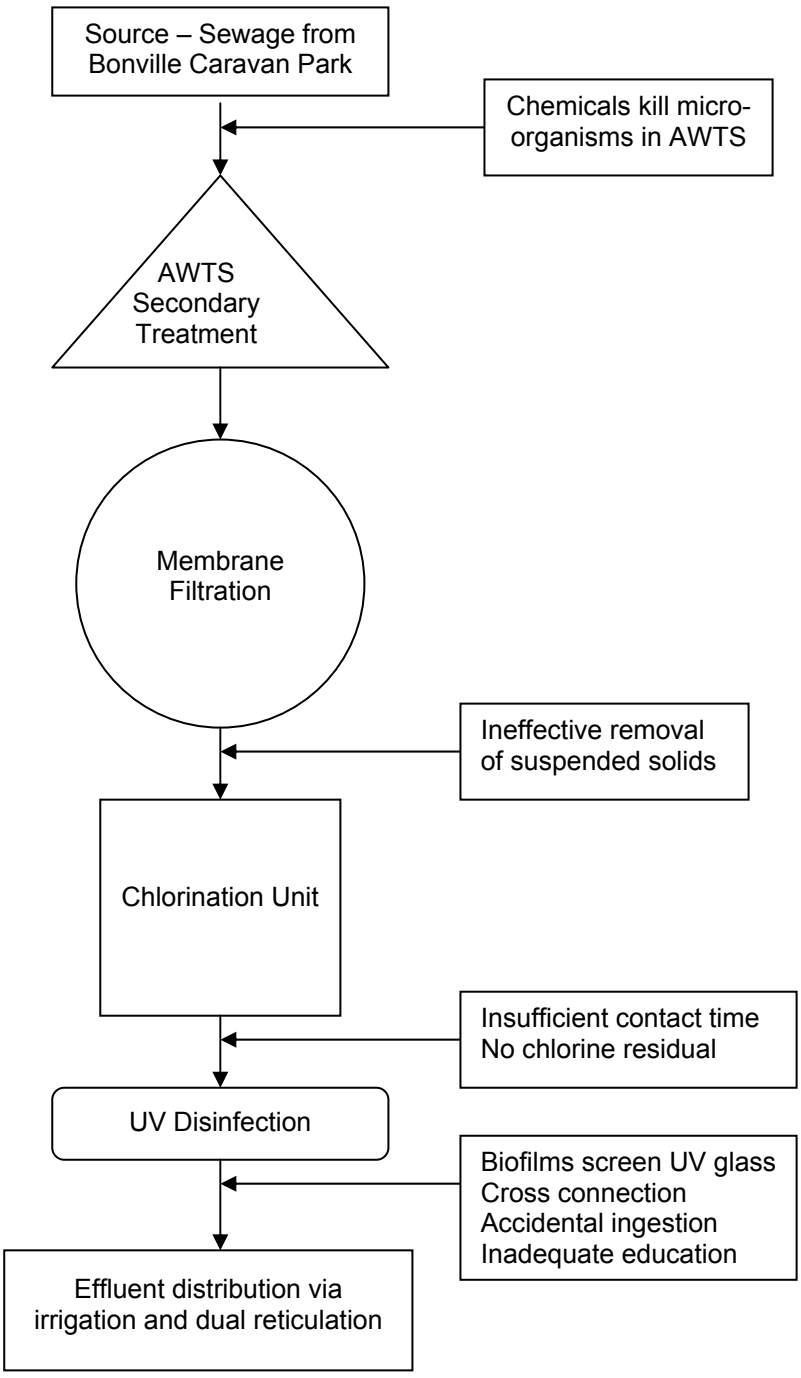


Table 6. Critical Control Points and Operational Criteria

Hazard	Potential critical limits	Monitoring	Corrective action
Chemical kill of AWTS micro-organisms	A reduction of 5 log bacteria, 6.5 log viruses, and 5 log protozoa.	Weekly *e.coli* laboratory analysis of effluent.	AWTS Service Agent to identify source and take action (eg, add actizyme to reinstate micro-organisms, stop dual reticulation if necessary)
	Information to be provided to all occupants within the Caravan Park of the operation and maintenance requirements of the Dual Reticulation Scheme	Signed acknowledgement from permanent and temporary occupants for receipt of Dual Reticulation Information Pack	Information to be provided immediately
Chemical dosing failures	Total chlorine residual >2 mg/L; detention >90 mg/min/L	Continuous online monitoring and alarms with automatic feedback to chlorine dosing	AWTS Service Agent to increase contact time, ensure free chlorine residual, and stop dual reticulation if necessary
Disinfection malfunctions	Total chlorine residual >2 mg/L; detention >90 mg/min/L	Continuous online monitoring and alarms with automatic feedback to chlorine dosing	AWTS Service Agent to increase contact time, ensure free chlorine residual, and stop dual reticulation if necessary
	Effluent turbidity ≤2 NTU 95% of the time; maximum turbidity 5 NTU	Continuous turbidity online monitoring	AWTS Service Agent to clean / replace membrane filtration, ensure minimum retention time, and stop dual reticulation if necessary
Equipment malfunctions	Zero equipment malfunctions	Continuous online monitoring,	AWTS Service Agent to determine the source of the malfunction and repair. Dual reticulation to be stopped in necessary
Inadequate filtration and backwash recycling	Effluent turbidity ≤2 NTU 95% of the time; maximum turbidity 5 NTU	Continuous turbidity online monitoring	AWTS Service Agent to clean / replace membrane filtration, ensure minimum retention time, and stop dual reticulation if necessary
Inadequate mixing of treatment chemicals	Total chlorine residual >2 mg/L; detention >90 mg/min/L	Continuous online monitoring and alarms with automatic feedback to chlorine dosing	AWTS Service Agent to increase contact time, ensure free chlorine residual, and stop dual reticulation if necessary
Biofilms, resuspension and regrowth	Quarterly servicing and cleaning of AWTS, chlorination unit, and UV system	Council and Caravan Park Owners / Management to ensure 3 Monthly servicing and cleaning.	Remove all biofilms / growth from the glass of the UV system to ensure transparency
Inadequate repair and maintenance, inadequate system flushing and reservoir cleaning	Quarterly servicing and cleaning of AWTS, chlorination unit, and UV system	CHCC and Caravan Park Owners / Management to ensure 3 Monthly servicing and cleaning.	Alternate AWTS service agent to be contacted where 3 monthly servicing not be undertaken.
Cross-connections to, and lack of backflow protection (eg drinking water)	Zero cross-connections and backflow prevention provided at property boundaries	Owners and Council to receive backflow prevention deceive certification from licenced plumber connecting the dual reticulation supply to premises	Licenced plumber to install cold water supply and backflow prevention devices from the dual reticulation system.
Inadequate education and information about permitted uses	Information to be provided to all occupants within the Caravan Park of the operation and maintenance requirements of the Dual Reticulation Scheme	Signed acknowledgement from permanent and temporary occupant for receipt of Dual Reticulation Information Pack	Information to be provided immediately

10. Validation of Treatment Processes

A commercial Aqua Nova AWTS is being utilised for the secondary treatment of effluent, following which, membrane filtration, chlorination and UV disinfection shall occur. Considering Everhard Industries have previously undertaken validation testing to ensure their commercial Aqua Novas treat effluent to a secondary level, a reduced validation process is proposed.

Upon commissioning of the AWTS, membrane, chlorination and UV disinfection systems and following certification from the service agent that the system is operating satisfactorily, effluent sampling shall commence for the validation process.

In accordance with the NSW Guidelines for Management of Private Recycled Water Schemes *(2007)*, two *e.coli*, one coliphages and *clostridia* samples shall be collected weekly from each of the four sample points identified in Table 7.

A total of 8 *e.coli* samples and 4 coliphages and *clostridia* samples shall be collected weekly, over a four week period to enable calculations of averages and standard deviations. Effluent is to be collected for analysis during high, medium and low flow rates to determine the efficiency of the treatment system.

Table 7. Validation Requirements for Microbial Health Risks

Process step to be validated	**Validation monitoring**	**Associated monitoring (items to be routinely monitored)**
Secondary treatment system	Inlet and outlet microbial indicator concentrations (monitoring shall include *E. coli*, coliphage and clostridia)	• Flow rate through the system • Sludge blanket depth
Membrane plant	Inlet and outlet microbial indicator concentrations (monitoring shall include *E. coli*, coliphage and clostridia)	• Turbidity upstream and downstream of system • Head loss across system • Particle counts on outlet
Chlorination plant	Inlet and outlet microbial indicator concentrations (monitoring shall include *E. coli*, coliphage and clostridia)	• Turbidity upstream of disinfection system • Free chlorine, temperature and pH at downstream monitoring point, certainly well after the point at which the immediate chlorine demand has been satisfied, and ideally at a point representing a significant proportion of the total required contact time • Flow rate to enable calculation of Ct
Ultraviolet plant	Establishment of operational envelope with respect to factors such as lamp age, lamp power, flow, UV transmissivity and turbidity. Inlet and outlet microbial indicator concentrations (monitoring shall include *E. coli*, coliphage and clostridia)	• Turbidity upstream of disinfection system • UV transmissivity • UV intensity • Flow rate to enable calculation of retention times • Ballast functionality, lamp power and lamp status

Process step to be validated	Validation monitoring	Associated monitoring (items to be routinely monitored)
Cross-connection control	Check every drinking water property connection by turning off the drinking water supply at each property in series, leaving the recycled supply turned on; then check all drinking and recycled water outlets to confirm that only the recycled water outlets on the property are live and that no drinking water outlets are live	
Accidental ingestion control	Confirm that labelling, colouring, threads and fittings are in use by inspecting all connected properties and their outlets	• Inspection of labels and fittings

11. Water Balance Calculations

Water, nitrogen (N) and phosphorus (P) balances have been calculated to determine the size of the irrigation area and the effluent disposal area. In the calculations of the N and P balances, concentrations of 25mg/L of N, and 10mg/L of P were used for tertiary treated effluent.

In accordance with AS 1547:2000 the length of the ETA system has been calculated based on trench specifications of 1500mm wide and 450mm deep, whilst the length of the sub-surface irrigation has been calculated based specifications of 150mm x 150mm.

For tertiary treated effluent associated with the dual reticulation and irrigation system, the minimum disposal area requirements based on the water and nutrient balances varied significantly, with 3,710m^2 required for N, 4,761m^2 for P, and 2,965m^2 for the hydraulic loading. Therefore the phosphorus loading is the limiting factor as its area requirement of 4,761m^2 is the largest of the three balances.

For secondary treated effluent with the significantly increased hydraulic loading, the water and nutrient balances identified minimum area requirements of 5,929m^2 for the hydraulic loading, 7,420m^2 for N, and 9,523m^2 for P. Therefore the phosphorus loading is the limiting factor as its area requirement of 9,523m^2 is the largest of the three balances.

Bonville Caravan Park (Dual Reticulation and Irrigation System) Water Balance - AS 1547

Number of Sites (Including Residence) =	92	
Number of Permanent Sites =	81	
Number of Temporary Sites =	11	
Number of Occupants in Permanent Sites =	243	Persons
Number of Occupants in Temporary Sites =	55	Persons
Daily Flow in Permanent Sites =	13,365	L/day
Daily Flow in Temporary Sites =	3,575	L/day
Runoff Coeff =	0.2	percentage runoff
Crop Factor (Cf) =	0.75	crop transpiration rate
DIR (AS1547:1994) =	40.0	mm/week
Daily Flow =	16,940	L/day
DIR / DRL (AS1547:2000) =	25.0	mm/week
Effluent disposal area =	2,965	m^2
Trench dimensions (mm) Width =	300	Depth = 300
Length of trench required (AS1547:2000) =	2,259	metres
Nitrogen balance (secondary treatment) =	3,710	m^2 effluent disposal area
Phosphorus balance (secondary treatment) =	4,761	m^2 effluent disposal area

Table G1 - Size of Area for Each Month

1			2	3	4	5	6	7	8	9
Month	Days / month	Daily pan evap	Monthly pan evap	Evapo-transpiratio	Rainfall / month	Retained rainfall	LTAR / month	Disposal rate/month	Effluent applied per month	Size of area
	N	Et	Eo	Et	P	Rr		(3)-(5)+(6)		(8)/(7)
		mm	mm	mm	mm	mm	mm	mm	L	m2
Jan	31	6.5	201.5	151	180.3	144.2	1240	1246.9	525140	421.2
Feb	28	5.9	165.2	124	215.3	172.2	1120	1071.7	474320	442.6
Mar	31	5.2	161.2	121	245.2	196.2	1240	1164.7	525140	450.9
Apr	30	4.1	123.0	92	179.7	143.8	1200	1148.5	508200	442.5
May	31	2.9	89.9	67	167.1	133.7	1240	1173.7	525140	447.4
Jun	30	2.5	75.0	56	112.9	90.3	1200	1165.9	508200	435.9
Jul	31	2.7	83.7	63	74.7	59.8	1240	1243.0	525140	422.5
Aug	31	3.6	111.6	84	78.1	62.5	1240	1261.2	525140	416.4
Sep	30	4.8	144.0	108	60	48.0	1200	1260.0	508200	403.3
Oct	31	5.6	173.6	130	88	70.4	1240	1299.8	525140	404.0
Nov	30	6.2	186.0	140	129.8	103.8	1200	1235.7	508200	411.3
Dec	31	6.5	201.5	151	146	116.8	1240	1274.3	525140	412.1
		Total Eo	**1716.2**	**Total P**	**1677.1**					

Table G2 - Depth of Stored Effluent

1	2	3	4	5	6	7			8	9
month	first trial area	application rate	Disposal rate	(3)-(4)	Increase depth of stored effluent	Depth effluent for month	Increase depth effluent +(6)	Maximum depth of effluent (X)	Reset if evap deficit exceeded	Length of trench (m)
	(m2)	(8)/(2)	per month (above)'		(5)/0.3			0.0		
	m2	mm	mm	mm	mm	mm	mm	mm		
Dec	2964.5							0.0		457.9
Jan		177	1246.9	-1070	-3566	0	-3566	-3566	0	468.0
Feb		160	1071.7	-912	-3039	0	-3039	-3039	0	491.8
Mar		177	1164.7	-988	-3292	0	-3292	-3292	0	501.0
Apr		171	1148.5	-977	-3257	0	-3257	-3257	0	491.7
May		177	1173.7	-997	-3322	0	-3322	-3322	0	497.1
Jun		171	1165.9	-995	-3315	0	-3315	-3315	0	484.3
Jul		177	1243.0	-1066	-3553	0	-3553	-3553	0	469.4
Aug		177	1261.2	-1084	-3614	0	-3614	-3614	0	462.6
Sep		171	1260.0	-1089	-3629	0	-3629	-3629	0	448.1
Oct		177	1299.8	-1123	-3742	0	-3742	-3742	0	448.9
Nov		171	1235.7	-1064	-3547	0	-3547	-3547	0	457.0
Dec		177	1274.3	-1097	-3657	0	-3657	-3657	0	457.9

Bonville Caravan Park (Dual Reticulation and ETA System) Water Balance - AS 1547

Number of Sites (Including Residence) =	92	
Number of Permanent Sites =	81	
Number of Temporary Sites =	11	
Number of Occupants in Permanent Sites =	243	Persons
Number of Occupants in Temporary Sites =	55	Persons
Daily Flow in Permanent Sites =	13,365	L/day
Daily Flow in Temporary Sites =	3,575	L/day
Runoff Coeff =	0.2	percentage runoff
Crop Factor (Cf) =	0.75	crop transpiration rate
LTAR =	20	mm/day
Daily Flow =	16,940	L/day
DIR / DRL =	20	mm/day
Effluent disposal area =	1,928	m^2
Maximum depth of stored effluent =	0	mm depth
Trench dimensions (mm) Width =	1500	Depth = 450
Length of trench required (AS1547:2000) =	565	metres
Nitrogen balance (secondary treatment) =	3,710	m^2 effluent disposal area
Phosphorus balance (secondary treatment) =	4,761	m^2 effluent disposal area

Table G1 - Size of Area for Each Month

1			2	3	4	5	6	7	8	9
Month	Days / month	Daily pan evap	Monthly pan evap	Evapo-transpiratio	Rainfall / month	Retained rainfall	LTAR / month	Disposal rate/month	Effluent applied per month	Size of area
	N	Et	Eo	Et	P	Rr		(3)-(5)+(6)		(8)/(7)
		mm	mm	mm	mm	mm	mm	mm	L	m2
Jan	31	6.5	201.5	151	180.3	144.2	620	626.9	525140	837.7
Feb	28	5.9	165.2	124	215.3	172.2	560	511.7	474320	927.0
Mar	31	5.2	161.2	121	245.2	196.2	620	544.7	525140	964.0
Apr	30	4.1	123.0	92	179.7	143.8	600	548.5	508200	926.5
May	31	2.9	89.9	67	167.1	133.7	620	553.7	525140	948.3
Jun	30	2.5	75.0	56	112.9	90.3	600	565.9	508200	898.0
Jul	31	2.7	83.7	63	74.7	59.8	620	623.0	525140	842.9
Aug	31	3.6	111.6	84	78.1	62.5	620	641.2	525140	819.0
Sep	30	4.8	144.0	108	60	48.0	600	660.0	508200	770.0
Oct	31	5.6	173.6	130	88	70.4	620	679.8	525140	772.5
Nov	30	6.2	186.0	140	129.8	103.8	600	635.7	508200	799.5
Dec	31	6.5	201.5	151	146	116.8	620	654.3	525140	802.6
		Total Eo	**1716.2**	**Total P**	**1677.1**					

Table G2 - Depth of Stored Effluent

1	2	3	4	5	6	7			8	9
month	first trial area	application rate	Disposal rate	(3)-(4)	Increase depth of stored effluent	Depth effluent for month	Increase depth effluent +(6)	Maximum depth of effluent (X)	Reset if evap deficit exceeded	Length of trench (m)
	(m2)	(8)/(2)	per month (above)'		(5)/0.3			0.0		
	m2	mm	mm	mm	mm	mm	mm	mm		
Dec	1928							0.0		334.4
Jan		272	626.9	-355	-1182	0	-1182	-1182	0	349.0
Feb		246	511.7	-266	-885	0	-885	-885	0	386.3
Mar		272	544.7	-272	-908	0	-908	-908	0	401.7
Apr		264	548.5	-285	-950	0	-950	-950	0	386.1
May		272	553.7	-281	-938	0	-938	-938	0	395.1
Jun		264	565.9	-302	-1008	0	-1008	-1008	0	374.2
Jul		272	623.0	-351	-1169	0	-1169	-1169	0	351.2
Aug		272	641.2	-369	-1229	0	-1229	-1229	0	341.2
Sep		264	660.0	-396	-1321	0	-1321	-1321	0	320.8
Oct		272	679.8	-407	-1358	0	-1358	-1358	0	321.9
Nov		264	635.7	-372	-1240	0	-1240	-1240	0	333.1
Dec		272	654.3	-382	-1273	0	-1273	-1273	0	334.4

Bonville Caravan Park (Secondary Treatment and Irrigation System) Water Balance - AS 1547

Number of Sites (Including Residence) =	92	
Number of Permanent Sites =	81	
Number of Temporary Sites =	11	
Number of Occupants in Permanent Sites =	243	Persons
Number of Occupants in Temporary Sites =	55	Persons
Daily Flow in Permanent Sites =	13,365	L/day
Daily Flow in Temporary Sites =	3,575	L/day
Runoff Coeff =	0.2	percentage runoff
Crop Factor (Cf) =	0.75	crop transpiration rate
DIR (AS1547:1994) =	40.0	mm/week
Daily Flow =	33,880	L/day
DIR / DRL (AS1547:2000) =	25.0	mm/week
Effluent disposal area =	5,929	m^2
Trench dimensions (mm) Width =	300	Depth = 300
Length of trench required (AS1547:2000) =	4,517	metres
Nitrogen balance (secondary treatment) =	7,420	m^2 effluent disposal area
Phosphorus balance (secondary treatment) =	9,523	m^2 effluent disposal area

Table G1 - Size of Area for Each Month

1			2	3	4	5	6	7	8	9
Month	Days / month	Daily pan evap	Monthly pan evap	Evapo-transpiratio	Rainfall / month	Retained rainfall	LTAR / month	Disposal rate/month	Effluent applied per month	Size of area
	N	Et	Eo	Et	P	Rr		(3)-(5)+(6)		(8)/(7)
		mm	mm	mm	mm	mm	mm	mm	L	m2
Jan	31	6.5	201.5	151	180.3	144.2	1240	1246.9	1050280	842.3
Feb	28	5.9	165.2	124	215.3	172.2	1120	1071.7	948640	885.2
Mar	31	5.2	161.2	121	245.2	196.2	1240	1164.7	1050280	901.7
Apr	30	4.1	123.0	92	179.7	143.8	1200	1148.5	1016400	885.0
May	31	2.9	89.9	67	167.1	133.7	1240	1173.7	1050280	894.8
Jun	30	2.5	75.0	56	112.9	90.3	1200	1165.9	1016400	871.8
Jul	31	2.7	83.7	63	74.7	59.8	1240	1243.0	1050280	844.9
Aug	31	3.6	111.6	84	78.1	62.5	1240	1261.2	1050280	832.7
Sep	30	4.8	144.0	108	60	48.0	1200	1260.0	1016400	806.7
Oct	31	5.6	173.6	130	88	70.4	1240	1299.8	1050280	808.0
Nov	30	6.2	186.0	140	129.8	103.8	1200	1235.7	1016400	822.6
Dec	31	6.5	201.5	151	146	116.8	1240	1274.3	1050280	824.2
		Total Eo	**1716.2**	**Total P**	**1677.1**					

Table G2 - Depth of Stored Effluent

1	2	3	4	5	6	7			8	9
month	first trial area	application rate	Disposal rate	(3)-(4)	Increase depth of stored effluent	Depth effluent for month	Increase depth effluent +(6)	Maximum depth of effluent (X)	Reset if evap deficit exceeded	Length of trench (m)
	(m2)	(8)/(2)	per month (above)'		(5)/0.3			0.0		
	m2	mm	mm	mm	mm	mm	mm	mm		
Dec	5929							0.0		915.8
Jan		177	1246.9	-1070	-3566	0	-3566	-3566	0	935.9
Feb		160	1071.7	-912	-3039	0	-3039	-3039	0	983.6
Mar		177	1164.7	-988	-3292	0	-3292	-3292	0	1001.9
Apr		171	1148.5	-977	-3257	0	-3257	-3257	0	983.3
May		177	1173.7	-997	-3322	0	-3322	-3322	0	994.2
Jun		171	1165.9	-995	-3315	0	-3315	-3315	0	968.6
Jul		177	1243.0	-1066	-3553	0	-3553	-3553	0	938.8
Aug		177	1261.2	-1084	-3614	0	-3614	-3614	0	925.3
Sep		171	1260.0	-1089	-3629	0	-3629	-3629	0	896.3
Oct		177	1299.8	-1123	-3742	0	-3742	-3742	0	897.8
Nov		171	1235.7	-1064	-3547	0	-3547	-3547	0	914.0
Dec		177	1274.3	-1097	-3657	0	-3657	-3657	0	915.8

Bonville Caravan Park (Secondary Treatment and ETA System) Water Balance - AS 1547

Number of Sites (Including Residence) =	92	
Number of Permanent Sites =	81	
Number of Temporary Sites =	11	
Number of Occupants in Permanent Sites =	243	Persons
Number of Occupants in Temporary Sites =	55	Persons
Daily Flow in Permanent Sites =	13,365	L/day
Daily Flow in Temporary Sites =	3,575	L/day
Runoff Coeff =	0.2	percentage runoff
Crop Factor (Cf) =	0.75	crop transpiration rate
LTAR =	20	mm/day
Daily Flow =	33,880	L/day
DIR / DRL =	20	mm/day
Effluent disposal area =	1,928	m^2
Maximum depth of stored effluent =	0	mm depth
Trench dimensions (mm) Width =	1500	Depth = 450
Length of trench required (AS1547:1994) =	989	metres
Length of trench required (AS1547:2000) =	1,129	metres
Nitrogen balance (secondary treatment) =	7,420	m^2 effluent disposal area
Phosphorus balance (secondary treatment) =	9,523	m^2 effluent disposal area

Table G1 - Size of Area for Each Month

1			2	3	4	5	6	7	8	9
Month	Days / month	Daily pan evap	Monthly pan evap	Evapo-transpiratio	Rainfall / month	Retained rainfall	LTAR / month	Disposal rate/month	Effluent applied per month	Size of area
	N	Et	Eo	Et	P	Rr		(3)-(5)+(6)		(8)/(7)
		mm	mm	mm	mm	mm	mm	mm	L	m2
Jan	31	6.5	201.5	151	180.3	144.2	620	626.9	1050280	1675.4
Feb	28	5.9	165.2	124	215.3	172.2	560	511.7	948640	1854.0
Mar	31	5.2	161.2	121	245.2	196.2	620	544.7	1050280	1928.0
Apr	30	4.1	123.0	92	179.7	143.8	600	548.5	1016400	1853.1
May	31	2.9	89.9	67	167.1	133.7	620	553.7	1050280	1896.7
Jun	30	2.5	75.0	56	112.9	90.3	600	565.9	1016400	1796.0
Jul	31	2.7	83.7	63	74.7	59.8	620	623.0	1050280	1685.8
Aug	31	3.6	111.6	84	78.1	62.5	620	641.2	1050280	1637.9
Sep	30	4.8	144.0	108	60	48.0	600	660.0	1016400	1540.0
Oct	31	5.6	173.6	130	88	70.4	620	679.8	1050280	1545.0
Nov	30	6.2	186.0	140	129.8	103.8	600	635.7	1016400	1599.0
Dec	31	6.5	201.5	151	146	116.8	620	654.3	1050280	1605.1
		Total Eo	**1716.2**	**Total P**	**1677.1**					

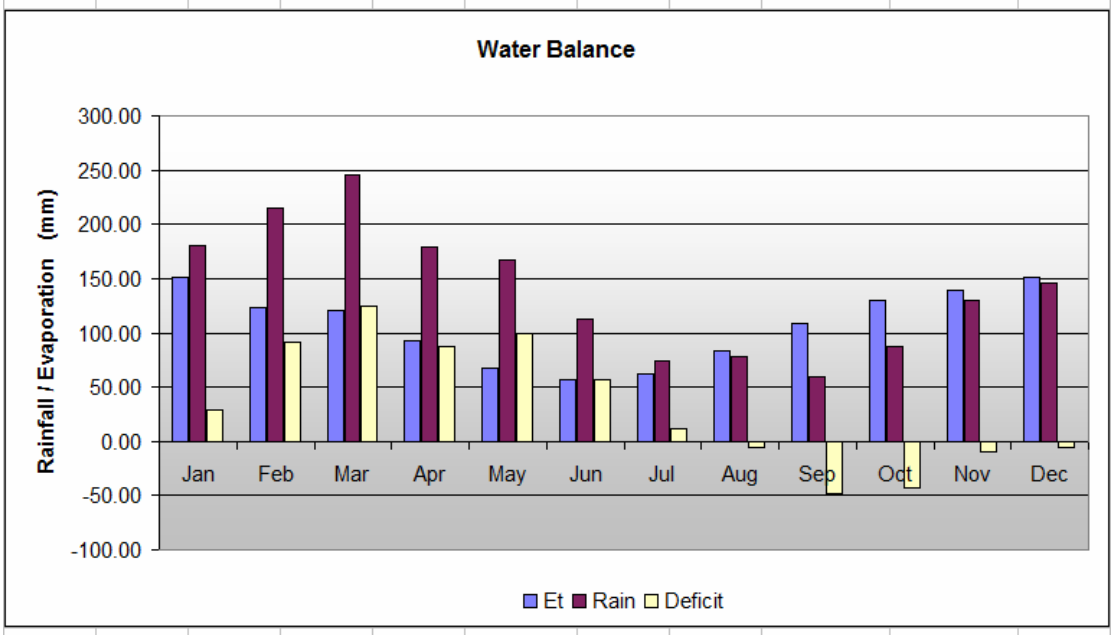
Table G2 - Depth of Stored Effluent

1	2	3	4	5	6	7			8	9
month	first trial area (m2)	application rate (8)/(2)	Disposal rate per month (above)'	(3)-(4)	Increase depth of stored effluent (5)/0.3	Depth effluent for month	Increase depth effluent +(6)	Maximum depth of effluent (X) 0.0	Reset if evap deficit exceeded	Length of trench (m)
	m2	mm	mm	mm	mm	mm	mm	mm		
Dec	1928							0.0		668.8
Jan		545	626.9	-82	-274	0	-274	-274	0	698.1
Feb		492	511.7	-20	-65	0	-65	-65	0	772.5
Mar		545	544.7	0	0	0	0	0	0	803.3
Apr		527	548.5	-21	-71	0	-71	-71	0	772.1
May		545	553.7	-9	-30	0	-30	-30	0	790.3
Jun		527	565.9	-39	-129	0	-129	-129	0	748.3
Jul		545	623.0	-78	-261	0	-261	-261	0	702.4
Aug		545	641.2	-96	-322	0	-322	-322	0	682.5
Sep		527	660.0	-133	-443	0	-443	-443	0	641.7
Oct		545	679.8	-135	-450	0	-450	-450	0	643.7
Nov		527	635.7	-108	-362	0	-362	-362	0	666.2
Dec		545	654.3	-110	-365	0	-365	-365	0	668.8

Water Balance (Supplementary Information) - AS 1547

	Et	Rain	Deficit
Jan	151.13	180.3	29.18
Feb	123.9	215.3	91.4
Mar	120.9	245.2	124.3
Apr	92.25	179.7	87.45
May	67.43	167.1	99.68
Jun	56.25	112.9	56.65
Jul	62.78	74.7	11.93
Aug	83.7	78.1	-5.6
Sep	108	60.0	-48.0
Oct	130.2	88.0	-42.2
Nov	139.5	129.8	-9.7
Dec	151.13	146.0	-5.13

	Primary	Secondary	
Annual P production =	185.49	123.66	Kg
Annual excess or shortfall =	183.84	122.01	Kg
P sorption =	4993	4993	Kg/ha
P sorption area =	275	274.61	Kg
P sorption by annual excess P =	1.49	2.25	Years
P Sorption each year for 50 years =	100	99.86	Kg/ha/yr
Total annual uptake =	130	129.86	Kg/ha/yr
Area required =	14284.30	9522.9	m^2



12. Proposed Systems

12.1 Tertiary Treatment of Effluent with Dual Reticulation and Sub-surface Irrigation

Sufficient area is available for effluent disposal to facilitate the proposed redevelopment of the Caravan Park. Effluent collected from within the Caravan Park shall be treated to a secondary level by means of a commercial AWTS, following which; tertiary treatment is achieved by dual membrane filtration, chlorination and UV disinfection.

Due to the extent of landscaping being undertaken, it is recommended to dispose of effluent via a sub-surface irrigation system rather than ETA beds. The irrigation system will be used to irrigate the vegetated and landscaped areas around the perimeter of the Park, and within the designated effluent disposal area located in the north-east corner of the property.

As identified in the water and nutrient balances, a minimum of 2,300 metres of sub-surface trenching is to be installed within the 4,761m^2 irrigation area. The trenches

are to be excavated to an accurately level depth of 300mm, and installed in accordance with Appendix 4.5C of AS1547:2000. Spacing of the sub-surface trenching is 500mm from sidewall to sidewall with this area extensively vegetated to encourage transpiration.

Due to the high quality of effluent being produced, it is recommended that buffer distances be reduced to 1m from the park boundaries and 1m to the boundaries of the caravan sites. A 40m buffer to watercourses has been maintained as specified in CHCC's On-site Sewage Management Strategy. Where effluent disposal areas are located within the 3m buffer between the property boundary and site boundaries, 3 lengths of trenching are to be installed at 500mm centres.

A reserve area is to be provided should the treatment system fail to treat effluent to the minimum requirements for dual reticulation.

The dual reticulation system shall provide tertiary treated effluent via a colour coded low pressure reticulation system to each of the permanent sites, the community centre and the amenity blocks. Effluent provided for outdoor garden usage, shall be connected to a colour coded tap, to provide differentiation from the primary water supply, and be signed accordingly. The tap handle is to be removable to ensure that children and persons unknown do not inadvertently consume the tertiary treated effluent.

12.2 Tertiary Treatment of Effluent with Dual Reticulation and ETA System

As an alternative to the sub-surface irrigation system with dual reticulation, an ETA system may also be utilised for effluent disposal. In accordance with Appendix 4.5A3 of AS1547:2000, an ETA system 600m in length may be installed, based on trench specifications of 1500mm wide and 450mm deep.

Spacing of the ETA beds is 2m from sidewall to sidewall with this area extensively vegetated to encourage transpiration. Layout of the ETA beds is indicated in the site plans in Appendix C.

A reserve area is to be provided should the treatment system fail to treat effluent to the minimum requirements for dual reticulation.

The dual reticulation system shall provide tertiary treated effluent via a colour coded low pressure reticulation system to each of the permanent sites, the community centre and the amenity blocks. Effluent provided for outdoor garden usage, shall be connected to a colour coded tap, to provide differentiation from the primary water supply, and be signed accordingly. The tap handle is to be removable to ensure that children and persons unknown do not inadvertently consume the tertiary treated effluent.

12.3 Secondary Treated Effluent with Sub-Surface Irrigation System

Since amending the layout of the Caravan Park and providing a 40m buffer from the permanent sites and to the eastern boundary, an additional 1,800m^2 area has become available for effluent disposal. Accordingly, effluent treated to a secondary level via an AWTS, sand filter, or an equivalent, may be disposed of entirely within a sub-surface irrigation system.

A minimum of 4,600 lineal metres of pressure compensated drip irrigation is to be installed within a 9,523m^2 irrigation area. The trenches are to be excavated to an accurately level depth of 300mm and 300 wide, and installed in accordance with Appendix 4.5C of AS1547:2000. Spacing of the sub-surface trenching is 500mm from sidewall to sidewall with this area extensively vegetated to encourage transpiration.

Due to the high quality of effluent being produced, it is recommended that buffer distances be reduced to 1m from the park boundaries and 1m to the boundaries of the caravan sites. A 40m buffer to watercourses has been maintained as specified in CHCC's On-site Sewage Management Strategy. Where effluent disposal areas are located within the 3m buffer between the property boundary and site boundaries, 3 lengths of trenching are to be installed at 500mm centres.

12.4 Secondary Treated Effluent with ETA System

Following the secondary treatment of effluent, effluent may also be disposed of via an ETA system 1,150m in length. In accordance with Appendix 4.5A3 of AS1547:2000, the ETA system may be installed within the 9,523m^2 effluent disposal area based on trench specifications of 1500mm wide and 450mm deep.

Spacing of the ETA beds is 2m from sidewall to sidewall with this area extensively vegetated to encourage transpiration. Layout of the ETA beds is indicated in the site plans in Appendix C.

Due to the high quality of effluent being produced, it is recommended that buffer distances be reduced to 1m from the park boundaries and 1m to the boundaries of the caravan sites. A 40m buffer to watercourses has been maintained as specified in CHCC's On-site Sewage Management Strategy. Where effluent disposal areas are located within the 3m buffer between the property boundary and site boundaries, 3 lengths of trenching are to be installed at 500mm centres.

Excavation work is only to be done when the weather is fine and the soil is not wet or damp.

Excavation work must not damage the soil by:

- Smearing, where the soil surface is smooth, filling cracks and pores.
- Compacting, where soil porosity is reduced.
- Puddling, where washed clay settles on the base of the trench to form a relatively impermeable layer.

The irrigation and effluent disposal areas are to be vegetated with plants that have a high evapotranspiration capacity and should be selected on the basis of local experience, or failing this from the list compiled in Table 8. Vegetation is to be planted prior to the application of effluent to the disposal areas.

Table 8. Suitable Nutrient & Water Scavenging Plant Species

Grasses/Reeds/Groundcovers	***Common Name***
Baumea acuta	Sedge
B. articulata	Sedge
B. juncea	Sedge
B. nuda	Sedge
B. rubignosa	Sedge
B. teretifolia	Sedge
Brachyscome diversifolia	Native Daisy
Carex appressa.	Tussock Sedge
Cyprus spp.	Sedge
Hibbertia scandens	Guinea Golden Vine
Juncus articulatus	Jointed rush
J. polyanthemos	Sedge
J. prismatocarpus	Sedge
J. usitatus	Common rush
Lomandra longifolia	Lomandra
Phragmites australis	Bull Rushes
Schoenoplectus spp.	Sedge
Typha latifolia	Bulrush
Shrubs under 2m	***Common Name***
Angiozanthus flavidus	Kangaroo Paw
Austromyrtus inopholia	Thread Barbed Myrtle
Backea spp Dwarf	Dwarf Backea
Banksia aemula	Banksia
Blandfordia grandifoia	Christmas Bell
B. nobilis	Christmas Bell
Bornia parvifloria	Swamp Boronia
Callistemon citrinus	Austraflora Firebrand
C. pachyphyllus	Bottlebrush
C. viminalis Little John,	Little John, Captain Cook and Rose
Opal varieties	Opal varieties
Crinum campanulatum	Crinum Lily
Dianella caerulea	Blue Flax Lily
Doodia aspera	Rasp Fern
Hibiscus diversifolius	Swamp hibiscus
Hymenosporum flavuum	Native Frangipani
Leptospermum flavescens	Tea Tree
L. juniperinum	Tea Tree
L. laevigatum	Coast Tea Tree
L. semibaccatum	Tea Tree
Melaleuca decussata	Cross Leaved Honey Myrtle
Syzygium australe	Aussie compact Lilly Pilly

Should you require further information or clarification with respects to this report, please do not hesitate to contact me on 66522 915 or 0419 481 781

Regards,

Brett Carlyle
Principal Consultant
North Coast Environmental Health Services

Appendix A

Laboratory Analysis of Soil Sample for

Bonville Caravan Park, Bonville

Sydney Environmental & Soil Laboratory

Effluent Subdivison Profile

CLIENT: **North Coast Environmental Health Services**
PO Box 1490
COFFS HARBOUR NSW 2450
Attn: Brett Carlyle

PROJECT: Name: **On-Site Wastewater Disposal**
Location: **Bonville Caravan Park**
SESL Quote N°: Client Job N°: Order N°:
Date Received: **27/03/2008**

Quality Endorsed Company
AS/NZS ISO 9001: 2000 QEC 21650

Sydney Environmental and Soil Laboratory
Specialists in Soil Chemistry, Agronomy and Contamination Assessments

Sydney Environmental & Soil Laboratory Pty Ltd
ABN 70 106 810 708
16 Chilvers Road
Thornleigh NSW 2120
Australia
Address mail to:
PO Box 357
Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

SAMPLE: Batch N°: **6057** Sample N°: **1**
Name: **Bonville Caravan Park**
Test Type: **SS-25EFF - NO PSA. [EFF, mEAT, Text, WBD, St]**

Tests are performed under a quality system certified as complying with ISO 9001: 2000. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Total No Pages: 1 of 1

TEST	RESULT	COMMENTS
pH in water 1:5	6.2	Slight Acidity
pH in $CaCl_2$ 1:5	5.2	Strong Acidity
EC mS/cm 1:5	.03	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium			.14	6.70	Elevated
Potassium			.13	6.20	Slightly Low
Calcium			1.35	64.30	Acceptable
Magnesium			.44	21.00	Acceptable
Aluminium					
		ECEC	2.10		Very Low
		Ca/Mg	3.10		Normal

Phosphate Retention Index % 45.60 Medium PRI mgP/kg 2360.7 PRI kg/ha 4992.9 to 150mm

PHYSICAL CHARACTERISTICS

Texture: Clay Loam Field Density g/mL: 1.41
Structure: Weak Crumb
Emerson Stability Class : H20 2 Low SAR 2 High SAR 2

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

For the purpose of onsite effluent disposal report, this soil shows slight acidity and very low salt content. The soils ability to absorb phosphorus is medium, and at depth of 150 mm the soil can absorb a considerable amount, increasing the longevity of the effluent disposal system.
The soil aggregates show some dispersion and susceptibility to erosion and tunneling, with the stability remaining unchanged with the application of high ionic strength solution (ie effluent).

The slight acidity and very low salinity make this soil ideal for effluent application.

If any further assistance is required please contact me at the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). **Exchangeable Cations, ECEC:** Method 15A1 Rayment & Higginson (1992) **Chloride:** Vogel (1961). **Aluminium:** Method 3500 APHA (1992). **Phosphate:** Method 9E1 Rayment & Higginson (1992). **Wax Block Density:** Method 30-4 Black (1983). **Texture:** Charman & Murphy (1991). **Emerson's Aggregate Test:** Charman & Murphy (1991). **Particle Size Analysis:** Modified Black (1983) Method 43-1 to 43-6.

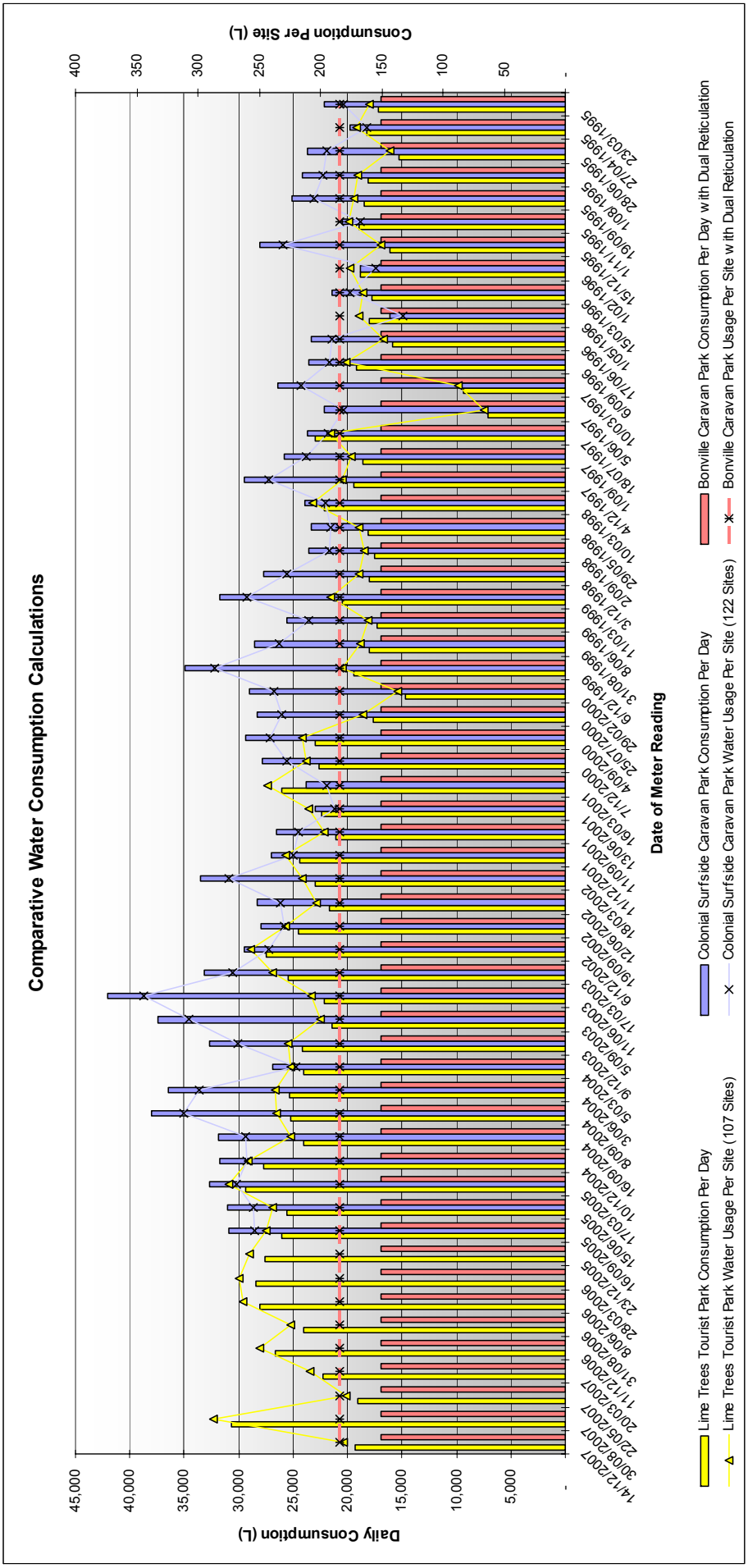
Checked by: Murray Fraser

Consultant: Ryan Jacka

Date of Report 17/04/2008

Appendix B

Comparative Water Consumption Figures and Graph


Comparative Water Consumption Calculations
Daily Consumption (L)
Consumption Per Site (L)
Date of Meter Reading
Lime Trees Tourist Park Consumption Per Day
Colonial Surfside Caravan Park Consumption Per Day
Bonville Caravan Park Consumption Per Day with Dual Reticulation
Lime Trees Tourist Park Water Usage Per Site (107 Sites)
Colonial Surfside Caravan Park Water Usage Per Site (122 Sites)
Bonville Caravan Park Usage Per Site with Dual Reticulation

Reading Date	Lime Trees Tourist Park Consumption Per Day	Colonial Surfside Caravan Park Consumption Per Day	Bonville Caravan Park Consumption Per Day AS1547:2000	Bonville Caravan Park Consumption Per Day with Dual Reticulation	Lime Trees Tourist Park Water Usage Per Site (107 Sites)	Colonial Surfside Caravan Park Water Usage Per Site (122 Sites)	Bonville Caravan Park Consumption Per Site AS1547:2000	Bonville Caravan Park Usage Per Site with Dual Reticulation
14/12/2007	19,358.49		30,305.00	16,940.00	180.92		329.40	184.13
30/08/2007	30,720.00		30,305.00	16,940.00	287.10		329.40	184.13
22/05/2007	19,111.11		30,305.00	16,940.00	178.61		329.40	184.13
20/03/2007	22,262.63		30,305.00	16,940.00	208.06		329.40	184.13
11/12/2006	26,696.08		30,305.00	16,940.00	249.50		329.40	184.13
31/08/2006	23,988.10		30,305.00	16,940.00	224.19		329.40	184.13
8/06/2006	28,125.00		30,305.00	16,940.00	262.85		329.40	184.13
28/03/2006	28,442.11		30,305.00	16,940.00	265.81		329.40	184.13
23/12/2005	27,581.63		30,305.00	16,940.00	257.77		329.40	184.13
16/09/2005	26,107.53	30,915.66	30,305.00	16,940.00	244.00	253.41	329.40	184.13
15/06/2005	25,544.44	31,076.09	30,305.00	16,940.00	238.73	254.72	329.40	184.13
17/03/2005	29,391.75	32,739.58	30,305.00	16,940.00	274.69	268.36	329.40	184.13
10/12/2004	27,670.59	31,736.26	30,305.00	16,940.00	258.60	260.13	329.40	184.13
16/09/2004	24,000.00	31,821.78	30,305.00	16,940.00	224.30	260.83	329.40	184.13
8/09/2004	25,237.11	38,023.81	30,305.00	16,940.00	235.86	311.67	329.40	184.13
3/06/2004	25,333.33	36,456.52	30,305.00	16,940.00	236.76	298.82	329.40	184.13
5/03/2004	24,045.98	26,853.93	30,305.00	16,940.00	224.73	220.11	329.40	184.13
9/12/2003	24,178.95	32,642.86	30,305.00	16,940.00	225.97	267.56	329.40	184.13
5/09/2003	21,395.35	37,454.55	30,305.00	16,940.00	199.96	307.00	329.40	184.13
11/06/2003	22,186.05	42,000.00	30,305.00	16,940.00	207.35	344.26	329.40	184.13
17/03/2003	25,514.85	33,130.43	30,305.00	16,940.00	238.46	271.56	329.40	184.13
6/12/2002	27,525.64	29,500.00	30,305.00	16,940.00	257.25	241.80	329.40	184.13
19/09/2002	24,464.65	28,000.00	30,305.00	16,940.00	228.64	229.51	329.40	184.13
12/06/2002	21,709.30	28,321.84	30,305.00	16,940.00	202.89	232.15	329.40	184.13
18/03/2002	23,020.62	33,462.96	30,305.00	16,940.00	215.15	274.29	329.40	184.13
11/12/2001	24,428.57	27,047.62	30,305.00	16,940.00	228.30	221.70	329.40	184.13
11/09/2001	21,088.89	26,561.80	30,305.00	16,940.00	197.09	217.72	329.40	184.13
13/06/2001	22,370.79	23,010.99	30,305.00	16,940.00	209.07	188.61	329.40	184.13
16/03/2001	26,070.71	23,755.81	30,305.00	16,940.00	243.65	194.72	329.40	184.13
7/12/2000	22,617.02	27,776.70	30,305.00	16,940.00	211.37	227.68	329.40	184.13
4/09/2000	23,024.39	29,372.09	30,305.00	16,940.00	215.18	240.75	329.40	184.13
25/07/2000	17,687.07	28,285.71	30,305.00	16,940.00	165.30	231.85	329.40	184.13
29/02/2000	14,647.06	28,962.26	30,305.00	16,940.00	136.89	237.40	329.40	184.13
6/12/1999	19,474.23	34,894.74	30,305.00	16,940.00	182.00	286.02	329.40	184.13
31/08/1999	17,964.29	28,527.47	30,305.00	16,940.00	167.89	233.83	329.40	184.13
8/06/1999	17,258.43	25,576.09	30,305.00	16,940.00	161.29	209.64	329.40	184.13
11/03/1999	20,540.82	31,726.19	30,305.00	16,940.00	191.97	260.05	329.40	184.13
3/12/1998	18,032.61	27,723.40	30,305.00	16,940.00	168.53	227.24	329.40	184.13
2/09/1998	17,520.83	23,527.47	30,305.00	16,940.00	163.75	192.85	329.40	184.13
29/05/1998	18,075.00	23,329.67	30,305.00	16,940.00	168.93	191.23	329.40	184.13
10/03/1998	22,125.00	23,866.67	30,305.00	16,940.00	206.78	195.63	329.40	184.13
4/12/1997	19,457.45	29,531.25	30,305.00	16,940.00	181.85	242.06	329.40	184.13
1/09/1997	18,644.44	25,839.08	30,305.00	16,940.00	174.25	211.80	329.40	184.13
18/07/1997	55,511.63	23,670.45	30,305.00	16,940.00	518.80	194.02	329.40	184.13
5/06/1997	7,103.45	22,106.38	30,305.00	16,940.00	66.39	181.20	329.40	184.13
10/03/1997	9,400.00	26,382.98	30,305.00	16,940.00	87.85	216.25	329.40	184.13
6/09/1996	19,197.53	23,522.73	30,305.00	16,940.00	179.42	192.81	329.40	184.13
17/06/1996	15,829.79	23,285.71	30,305.00	16,940.00	147.94	190.87	329.40	184.13
1/05/1996	18,042.55	16,127.66	30,305.00	16,940.00	168.62	132.19	329.40	184.13
15/03/1996	17,720.93	21,489.36	30,305.00	16,940.00	165.62	176.14	329.40	184.13
1/02/1996	18,791.67	18,837.21	30,305.00	16,940.00	175.62	154.40	329.40	184.13
15/12/1995	16,159.09	28,122.45	30,305.00	16,940.00	151.02	230.51	329.40	184.13
1/11/1995	18,930.23	20,441.86	30,305.00	16,940.00	176.92	167.56	329.40	184.13
19/09/1995	18,489.80	25,069.77	30,305.00	16,940.00	172.80	205.49	329.40	184.13
1/08/1995	18,147.06	24,102.04	30,305.00	16,940.00	169.60	197.56	329.40	184.13
28/06/1995	15,322.58	23,722.22	30,305.00	16,940.00	143.20	194.44	329.40	184.13
27/04/1995	18,257.14	19,766.67	30,305.00	16,940.00	170.63	162.02	329.40	184.13
23/03/1995	17,137.93	22,142.86	30,305.00	16,940.00	160.17	181.50	329.40	184.13
24/01/1995	17,083.33		30,305.00	16,940.00	159.66		329.40	184.13
19/12/1994	17,129.63		30,305.00	16,940.00	160.09		329.40	184.13
26/10/1994	32,020.41		30,305.00	16,940.00	299.26		329.40	184.13
7/09/1994	34,975.00		30,305.00	16,940.00	326.87		329.40	184.13
29/07/1994	27,681.82		30,305.00	16,940.00	258.71		329.40	184.13
15/06/1994	27,255.32		30,305.00	16,940.00	254.72		329.40	184.13
29/04/1994	27,578.95		30,305.00	16,940.00	257.75		329.40	184.13
22/03/1994	24,020.00		30,305.00	16,940.00	224.49		329.40	184.13
31/01/1994	30,488.89		30,305.00	16,940.00	284.94		329.40	184.13
17/12/1993	22,019.61		30,305.00	16,940.00	205.79		329.40	184.13
27/10/1993	26,681.82		30,305.00	16,940.00	249.36		329.40	184.13
13/09/1993	21,469.39		30,305.00	16,940.00	200.65		329.40	184.13
26/07/1993	22,718.75		30,305.00	16,940.00	212.32		329.40	184.13
24/06/1993	20,781.82		30,305.00	16,940.00	194.22		329.40	184.13
30/04/1993	19,250.00		30,305.00	16,940.00	179.91		329.40	184.13
17/03/1993	21,590.91		30,305.00	16,940.00	201.78		329.40	184.13

Appendix C

Bonville Caravan Park Site Plan

Irrigation and Effluent Disposal Areas