ATTACHMENT 10

ONSITE WASTEWATER MANAGEMENT REPORT

Whitehead & Associates
Environmental Consultants Pty Ltd

Onsite Wastewater Management Report for a proposed 3-lot subdivision at 70 Berkeley Road Fountaindale

December 2007

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Client Details	
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Disclaimer

The information contained in this report is based on independent research undertaken by Adam Bishop of Whitehead & Associates Environmental Consultants Pty Ltd. To my knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an honest appraisal of the site's opportunities and constraints, subject to the limited scope and resources available for this project, and follow relevant best practice standards and guidelines where applicable, including:

- Environment & Health Protection Guidelines: On-site Sewage Management for Single Households (Department of Local Government, 1998);
- AS/NZS 1547: *On-site Domestic Wastewater Management* (Standards Australia / Standards New Zealand, 2000); and
- DCP No. 65 – Domestic Wastewater Disposal in Non-Sewered Areas (Wyong Council, 1995).

Copyright Note

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1 Introduction

Whitehead & Associates were commissioned by the property owners, Sentros Pty Ltd & TSM Pty Ltd, to prepare this Onsite Wastewater Management Report (OWMR) for a proposed 3-lot subdivision at Lot 50 DP 755263 (No. 70) Berkeley Road, Fountaindale. The development site occupies land on both the northern and southern sides of Berkeley Road (refer Figure 1). The proposed subdivision involves creation of three new lots with areas as follows:

- Lot 5041 – 4.741 ha;
- Lot 5042 – 0.8964 ha;
- Lot 5043 – 5.230 ha.

Figure 2 shows the layout of the proposed subdivision. It is noted that a past subdivision of the original Lot 50 included the creation of Lots 501, 502 and 503, and a much larger residual lot which is the subject of the current subdivision proposal.

Proposed Lots 5041, 5042 and 5043 are not serviced by town water or sewer. Onsite wastewater management is proposed and potable water will be supplied by onsite roof water collection and tank storage.

Building envelopes, conservation areas and residential asset protection zones have been allocated to each lot based on previous investigations including ecological and bushfire investigations by Conacher Travers Pty Ltd and survey work by Everitt & Everitt Pty Ltd. On each lot a rectangular building envelope (BE) measuring 20 m by 30 m has been allocated. As a fire hazard reduction measure a minimum 20 m asset protection zone (APZ) extends around all sides of the building envelopes.

This OWMR comprises a report and a set of accompanying drawings providing site-specific recommendations for onsite wastewater treatment and land application of effluent on all future lots. Recommendations are supported by conservative design calculations and our designs follow current best management practices as described in the *Environment & Health Protection Guidelines: On-site Sewage Management for Single Households* (DLG, 1998) and AS/NZS 1547:2000 *On-site Domestic-wastewater Management*. Designs also comply with the requirements set out in Wyong Council's *DCP No. 65 –Domestic Wastewater Disposal in Non-Sewered Areas* (Wyong Council, 1995). On all proposed lots there is opportunity for sustainable onsite wastewater management.

The information contained in this OWMR provides assurance that future lots can sustain onsite wastewater management and provides information that will guide future property owners in designing their onsite systems and planning their development as a whole. Section 68 of the Local Government Act states that Council approval is required to install and/or operate a domestic sewage management facility. Therefore, individual "Septic Applications" will need to be lodged with Council for each future residence by future owners / developers. Generally these Septic Applications should be fairly straight forward and provided the recommendations and conditions of this OWMR are followed, and demonstrated to the satisfaction of Council, no further investigations should be required. Further investigation may be warranted if future owners opt for a management system beyond that described or allowed for in this report.

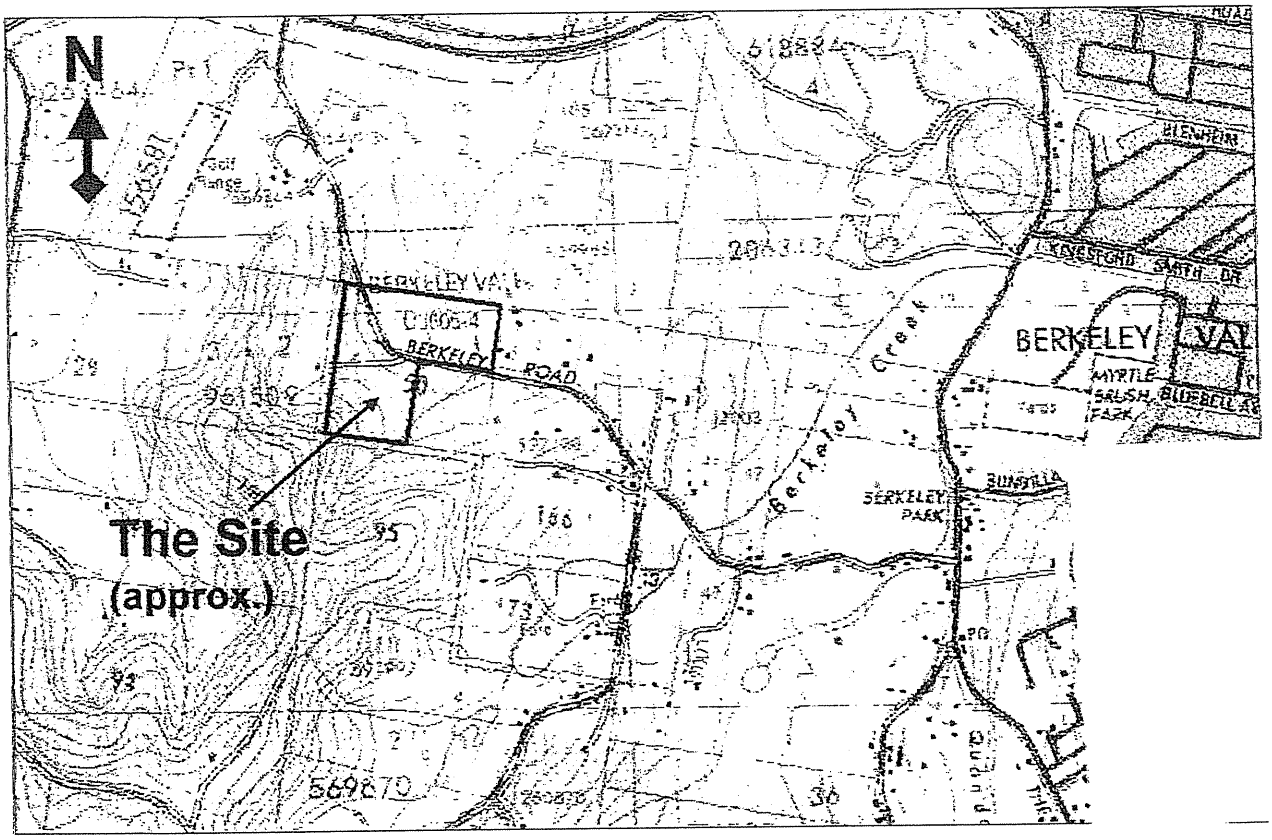
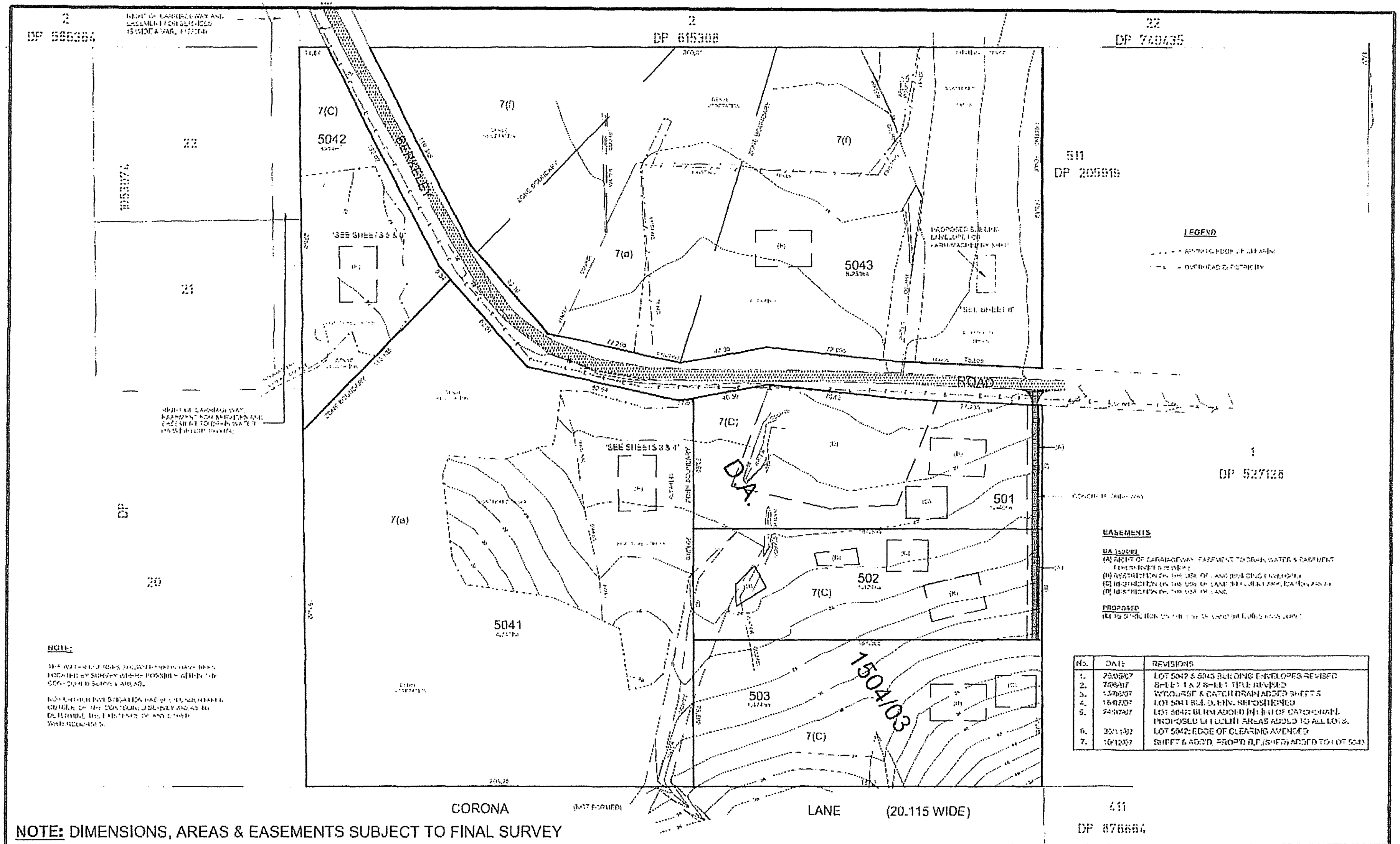


Figure 1 Locality Map

Figure 2 Subdivision Plan



NOTE: DIMENSIONS, AREAS & EASEMENTS SUBJECT TO FINAL SURVEY

Everitt & Everitt CONSULTING SURVEYORS "The Halton Rivers Business Centre" 34-36 Pacific Highway Wyong PO Box 198 Wyong NSW 2259 DX: 7314 Wyong Telephone: (02) 4352 1419 Fax: (02) 43512437 E-mail: admin@everittsurveyors.com.au	PROJECT SENTROS PTY LTD TSM PTY LTD LOT 50 DP 755263 BERKELEY RD FOUNTAINDALE	SHEET OVERALL PLAN OF PROPOSED SUBDIVISION OF PROPOSED LOT 504 (BEING A RE-SUBDIVISION OF LOT 50 IN DP 755263) Sheet 1 / 8 CAD File: 16348NEWSUBR7	SCALE: 1:2000 (A3) DATUM: AHD REFERENCE: 16348 DRAWN: MS CHECKED: BE DATE: 07/05/07

Figure 3 Site Plan of Proposed Lot 5041

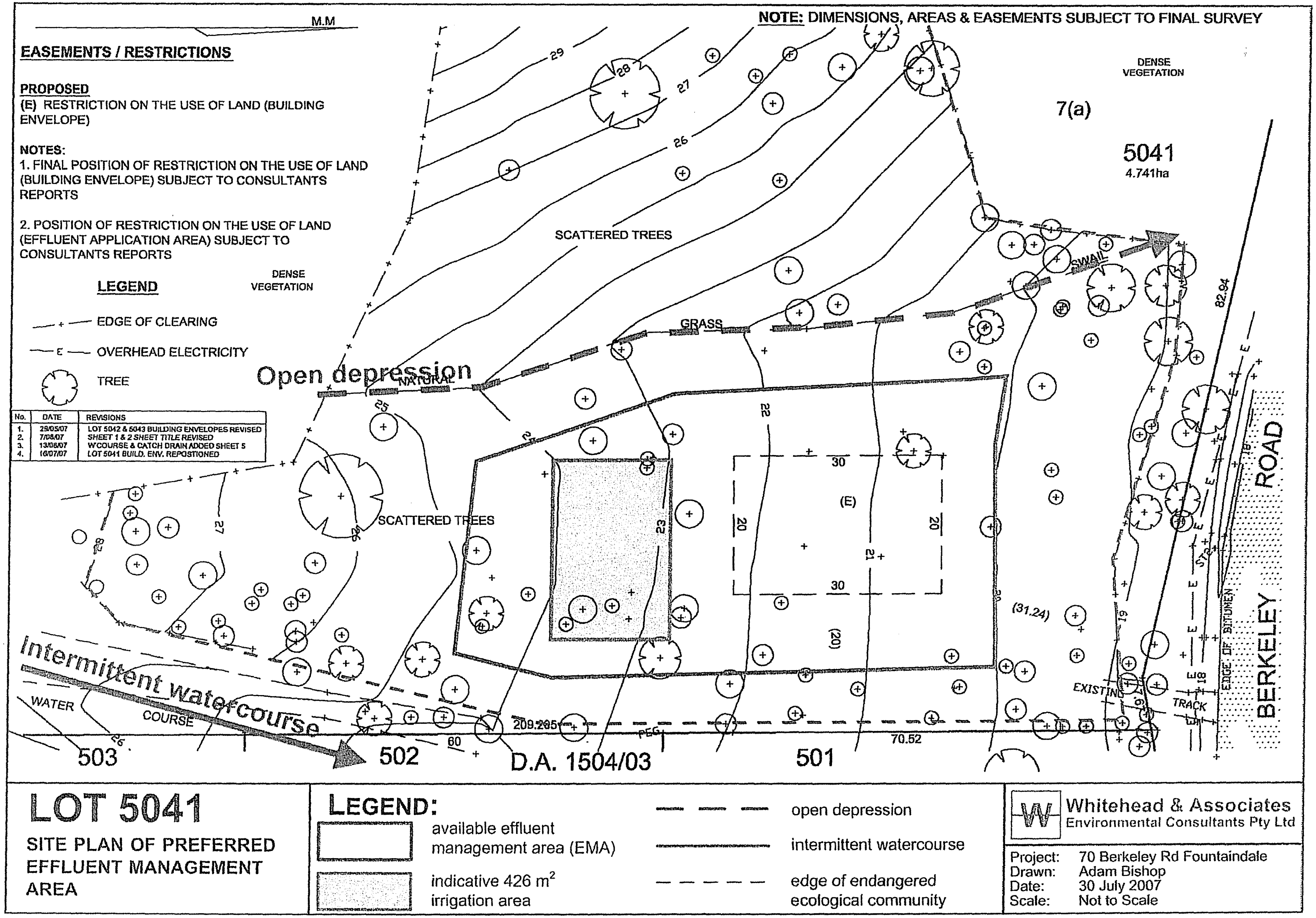
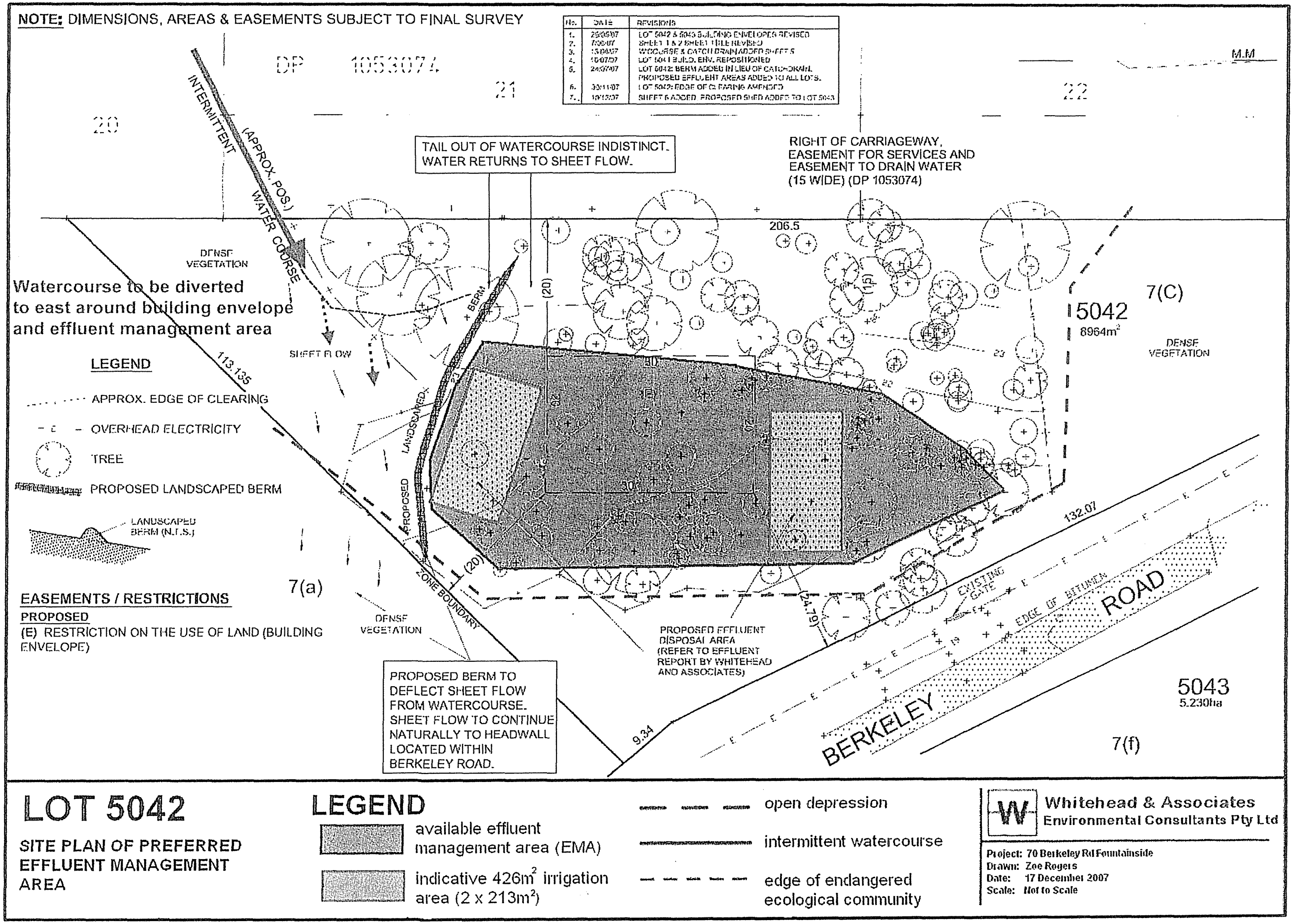


Figure 4 Site Plan of Proposed Lot 5042



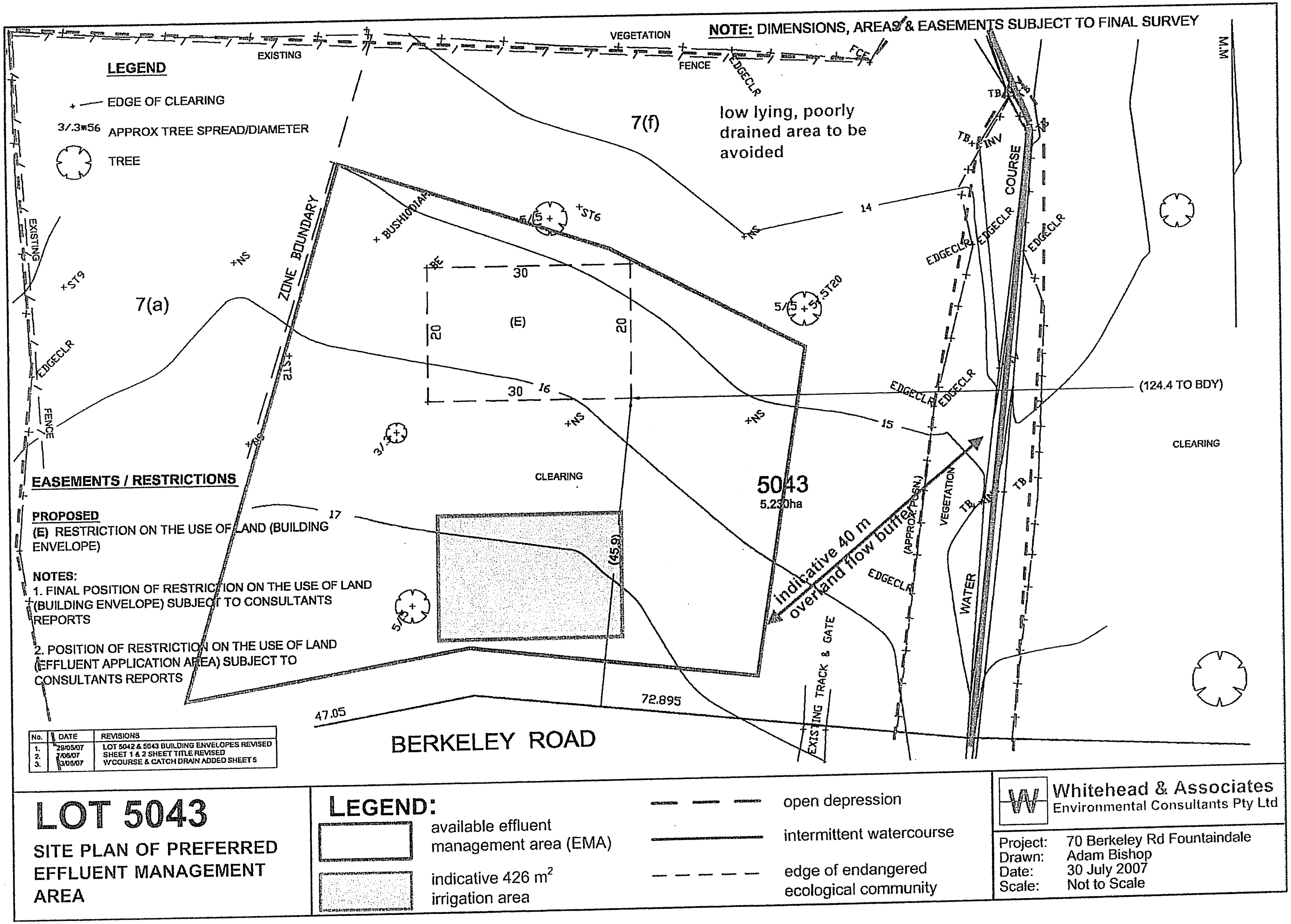


Figure 5 Site Plan of Proposed Lot 5043

2 Site Assessment

A site investigation was undertaken by Adam Bishop on 30 May 2007. In summary, the site contains substantial undisturbed native vegetation, some areas comprising endangered ecological communities (EECs). Areas containing EECs are to be preserved, this achieved through the imposition of positive covenants and careful placement of building envelopes, asset protection zones and effluent management areas within existing clearings. The site landform comprises north to northeast facing sideslopes on Terrigal Formation sediments that are quite steep in the far south, gently sloping in the central parts of the site where building envelopes are proposed, and grading into alluvial flats in the far north.

A range of discrete site constraints were assessed in terms of the degree of limitation they present (i.e. minor, moderate or major limitation) for onsite wastewater management. Reference is made to the rating scale described in Table 4 of DLG (1998). Table 1 summarises the constraints to effluent management across the site, with reference to individual lots as necessary to describe the site variability. Specific comments are made addressing positioning of preferred effluent management areas (EMAs) to overcome particular constraints.

It is evident that constraints to onsite wastewater management are generally minor to moderate and can be overcome by selection of suitable wastewater treatment and effluent management technologies, to achieve sustainable outcomes.

Table 1 Site Constraints

Constraint	Degree of Limitation
Climate: Climate data was sourced from the Bureau of Meteorology (BoM) to provide representative rainfall and evaporation data for the site. Existing records for nearby stations were reviewed. In addition, interpolated data was sourced using the Data Drill facility, principally to obtain representative evaporation data as there are no existing meteorological gauging stations within a reasonable distance of the site that measure pan evaporation. The closest existing gauging station is Wyong Bowling Club (Station No. 61083), approximately 4km northeast of the site. The site has a temperate climate, typical of south-eastern Australia. Median annual rainfall is 1136 mm at Wyong Bowling Club. On average there are 106 rain days per year. Average annual pan evaporation is 1478 mm (Data Drill for the site). Appendix A contains a summary of the climatic data reviewed and in water balance modelling.	Minor

Constraint	Degree of Limitation
Aspect and Exposure: All lots have a north to north-easterly aspect. Lot 5041 has good exposure to sun and wind with only minor shading in the early morning and later afternoon. Lot 5042 is currently very shaded with poor exposure to sun and wind. This will be improved by clearing of vegetation for the BE and maintenance of the recommended APZ. Lot 5043 has excellent exposure to sunlight and wind with minimal shading. Siting of EMAs should be done with an aim to maximise the exposure to sunlight to ensure maximum evapotranspiration. This is especially relevant to Lot 5042 and APZ maintenance activities should proceed with an aim to improve solar exposure to the EMAs.	Minor to Moderate
Vegetation: The original natural vegetation of the site is mainly open forest although this has been cleared in some areas. The site contains endangered ecological communities (EECs) which have been investigated, described and mapped by Conacher Travers Pty Ltd. Lot 5041 contains a clearing approximately 1 ha in area within which the proposed BE is located. The groundcover in the clearing is mulched with woodchip and has a moderate cover of grasses. Lot 5042 is mainly remnant forest with a partial clearing within which the BE is located. The groundcover comprises leaf litter with scattered shrubs and seedlings. Lot 5043 contains a large clearing at least 2.0 ha in area and the proposed BE is located roughly centrally within this. EMAs should be located in clearings away from EECs to minimise any adverse impact on the areas due to application of additional moisture and nutrients. It will be necessary to establish a good surface cover using moisture and nutrient tolerant plant species. Commonly turfing is used, however constructed garden beds containing suitable species can also be utilised.	Minor to Moderate
Landform: The site landform comprises north to northeast facing sideslopes on Terrigal Formation sediments that are quite steep in the far south, gently sloping in the central parts of the site where building envelopes are proposed, and grading into alluvial flats in the far north. All proposed EMAs are on simple sideslopes and footslopes that are capable of supporting household effluent management systems.	Minor
Slope: Approximately slopes within preferred EMAs on each of the lots are: • Lot 5041: 5% to the north; • Lot 5042: 6% to 11% to the east and north-east; • Lot 5043: 4% to 6% to the north and north-east The slopes do not pose any significant constraints to onsite effluent management.	Minor to Moderate
Rocks and Rock Outcrops: Rock outcrop was not observed across the site.	Minor

Constraint	Degree of Limitation
Fill: Natural soil profiles were observed throughout the site, with no sign of imported fill of disturbed profiles.	Minor
Erosion Potential: At present the site is quite stable with little appreciable erosion, due to a good groundcover of leaf litter, woodchip and grasses within existing clearings. The erosion hazard should remain low provided an adequate groundcover is retained, that stormwater is effectively diverted around any future disturbed areas, and by observation of good soil conservation practices.	Minor
Groundwater: Test pits excavated across the site were dug to at least 1.0 m. There were no signs of permanent groundwater tables above 1.0 m depth within proposed EMAs. Shallow perched watertables are expected to occur in response to wet weather, especially in lower lying positions such as in the northern part of Lot 5042 which is near the base of the footslope, and in the north of Lot 5043 which is bordering on a swamp landscape. These perched watertables would be quite transient and probably occur to within about 300 mm of the surface. The more poorly drained areas on each site should be avoided. There is no extraction or use of groundwater for domestic purposes within 250 m of the proposed EMAs. The likelihood of groundwater contamination will be very low in a properly sized and managed land application area.	Moderate
Site Drainage: Site drainage ranges from good to poor depending on position across the site. The most notable areas of poor drainage are in the lower lying parts in the far north of Lots 5041and 5043, indicated by moist to wet soils and moisture tolerant vegetation (e.g. Juncus grass), and in the vicinity of the drainage lines that traverse the property. Effluent management areas should not be located in these poorer drained areas. . Stormwater run-on to the proposed EMAs may be appreciable during large storms and would generally occur as sheet flow. It would be appropriate to incorporate suitable stormwater diversion structures to divert stormwater around the BEs and EMAs. This could include earth banks or grass swales that divert stormwater towards existing drainage lines.	Moderate
Flood Potential: We are not in receipt of any detailed flood hazard information however it would appear that the proposed BEs and effluent management areas are not flood affected. There may be a potential for flooding in the low lying northern parts of Lot 5043 however flood levels would be expected to be well below the level of the proposed BE and EMA.	Minor

Constraint	Degree of Limitation
Proximity to Surface Waters: The property contains several relatively small intermittent drainage lines that drain water off the steep slopes to the south of the site. The Wyong 1:100,000 topographic map (refer Figure 1) shows two "blue lines" on the site. In addition to the two mapped watercourses we observed a north-draining open drainage depression just west of the proposed BE on Lot 5041. These watercourses are shown in greater detail on the subdivision/survey plan (Figure 2) and on the individual site plans (Figure 3, Figure 4 and Figure 5). It is proposed that a 40 m buffer be applied to all mapped intermittent watercourses. A 20 m buffer will be applied to the open depression and any other minor drainage features. It is important to note that the buffers shall be measured as the overland flow path between proposed EMAs and the watercourses, measured perpendicular to the ground contours. The buffers have an impact on the placement of EMAs, however all lots have the ability to provide sufficient EMAs that meet the buffer requirements. Diversion of the watercourse through Lot 5042 is proposed and once in place a 40 m buffer from the EMA will be achieved.	Moderate
Recommended Buffer Distances: When siting land application areas buffer setbacks are provided to sensitive receptors to minimise the risk of environmental, public health or nuisance impacts. The recommended minimum buffers applicable to subsurface land application systems are presented below. Most are taken directly from the DLG (1998) guidelines, except the buffers from "open depressions" and "EECs" which are not prescribed in the DLG (1998) guidelines and have been nominated. All buffers are achievable. • Domestic groundwater wells: 250 m • Permanent watercourses: 100 m [1] • Intermittent watercourses: 40 m [1] • Dams: 40 m [1] • Open depressions 20 m [1] • Boundary of premises: 3 – 6 m [2] • Swimming pool: 3 – 6 m [2] • Driveways: 3 – 6 m [2] • Buildings: 3 – 6 m [2] • Endangered ecological communities (EECs) 5 m Notes: [1] buffers are measured as the overland flow path for runoff from a land application area, not the straight line distance. [2] the larger figure applies if the feature is downslope of the land application area, the lesser figure if upslope or across slope. [3] nominal buffer	Minor

3 Soil Assessment

3.1 Soil Landscape

The Gosford-Lake Macquarie Soil Landscape Map (Murphy & Tille, 1993) indicates the site contains three different soil landscapes:

- Watagan (*wn*) Soil Landscape – colluvial soils located on steep slopes in the south of the site;
- Erina (er) Soil Landscape – an erosional landscape containing soils derived from the Terrigal Formation and located in the central midslopes and footslopes of the site; and
- the Yarramalong (*ya*) Soil Landscape – alluvial soils formed on the floodplains at low elevations in the far north of the site;

Figure 6 shows the relative positions of the three Soil Landscapes. Note that unit boundaries have been transposed from the Soil Landscape Map and are approximate only.

Our site and soil investigations have identified an anomaly with the soil landscape mapping in that the Yarramalong Soil Landscape is not present to the extent indicated over Lot 5043. In reality the Erina Soil Landscape occupies much of the cleared area in the central region of Lot 5043 and the Yarramalong landscape is likely to occupy only a small area in the far north of Lot 5043.

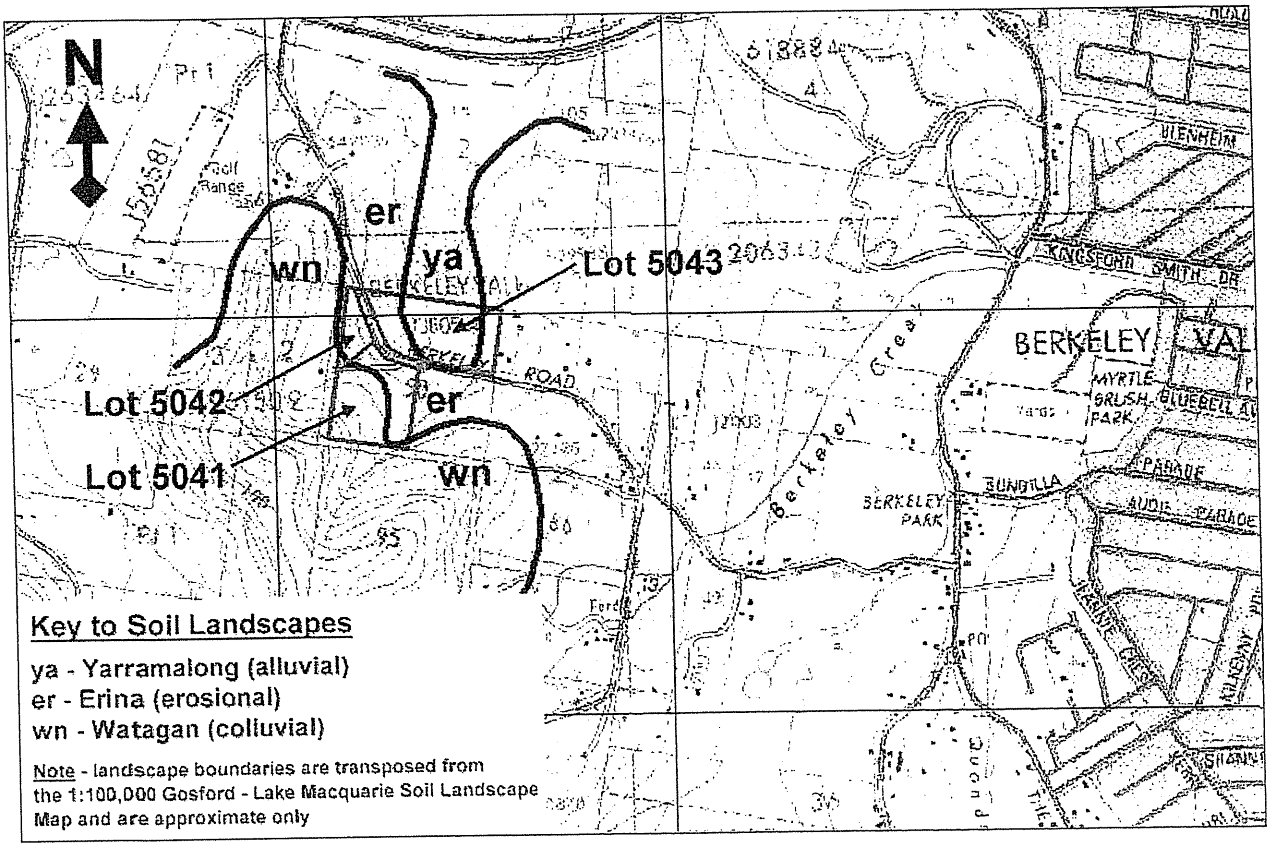


Figure 6 Soil Landscapes Transposed on Topographic Map

The proposed building envelopes and effluent management areas on all three lots are located on the Erina Soil Landscape.

The Erina Soil Landscape is described in the soil landscape map handbook (Murphy, 1993) as:

"undulating to rolling rises and low hills on the Terrigal Formation. Local relief < 60 m; slope gradients < 25%. Rounded narrow crests with moderately inclined slopes. Extensively cleared tall open forest with open-heathland in exposed coastal areas."

Soils that occur across the site within and near proposed effluent management areas are described as:

"moderately deep to deep (50-150 cm) Yellow Podzolic Soils and Yellow Earths on coarse grained parent material with Yellow Earths on footslopes and deep Structured Loams and Yellow Earths along drainage lines." (Murphy, 1993).

The landscape and soil descriptions fit the observed site conditions.

The landscape and soils across the site are reported to possess the following limitations of relevance to onsite wastewater management (Murphy, 1993):

- Very high erosion hazard;
- Mass movement (localised);
- Foundation hazard (localised);
- Seasonal waterlogging (localised);
- High run-on (localised)
- Strongly acid;
- Low fertility;
- Sodicity;
- High potential aluminium toxicity.

3.2 Soil Survey

During the site visit a soil investigation was undertaken which involved the excavation of six test pits using shovel and crowbar. Two test pits were excavated on each lot within the proposed EMAs. Given that a single soil landscape occurs across these areas and the relative homogeneity of the soils, six test pits was sufficient to properly characterise the soils present within the EMAs and assess their suitability for onsite effluent management.

Appendix B contains profile borelogs from the six test pits along with a map showing the test pit locations. Table 2 summarises the observed soil physical characteristics and constraints that affect onsite wastewater management. Reference is made to the rating scale described in Table 6 of DLG (1998).

Table 2 Soil Physical Constraints

Constraint	Degree of Limitation
Soil Depth: Soil profiles were dug to a minimum of 1,000 mm and no bedrock or hardpan was encountered. The total depth to bedrock is not known but is expected to be greater than 1,500 mm in the locations investigated. This is sufficient for properly designed effluent irrigation systems. Soil depth does not present a significant constraint across the site.	**Minor**
Profile drainage and Depth to seasonal watertable: The soils vary in their drainage properties but are generally good in areas proposed for effluent management. The more elevated positions tend to be well drained while the low lying areas in the far north of the site are poorly drained and will be avoided. Soils observed in TP6 were very wet to saturated and show signs of periodic prolonged saturation (e.g. abundance of moisture tolerant vegetation nearby). The landscape does not appear to be prone to spring activity or seepage. Permanent watertables in most areas, including those proposed for effluent management, are expected to be greater than 1,500 mm deep. Shallow seasonal watertables are expected to occur infrequently to depths of about 500-700 mm as evidenced by mottling of some subsoils.	**Moderate**
Coarse Fragments (%): Soils contained relatively few (<5%, by volume) coarse fragments.	**Minor**
Soil Permeability and Design Irrigation Rates: Soil permeability was not directly measured but can be inferred from observed soil properties. AS/NZS 1547:2000 describes conservative Design Irrigation Rates (DIRs – for effluent irrigation systems) and Design Loading Rates (DLRs – for trenches and beds) depending on two important soil properties – texture and structure. Soil depth, colour, mottling and drainage characteristics are also useful in determining appropriate loading rates. The observed soil profiles typically comprise at least 400 mm of sandy loam topsoils (often much deeper) over subsoils that have textures ranging between sandy loam and light sandy clay and most commonly sandy clay loam. The profiles are gradational – they do not have hardpans and any texture increases down profile are gradual. Vertical drainage is generally good. The topsoils are Soil Category 2 (from Table 4.2A4 in AS/NZS 1547:2000) and have an indicative permeability (Ksat) of between 1.4 and 3.0 m/day, with an indicative DIR of 35 mm/day. We recommend a more conservative DIR of 25 mm/week be applied for shallow subsurface irrigation systems.	**Minor**

3.3 Soil Chemical Analysis

Samples of all discrete soil layers were collected for subsequent laboratory analysis. In all 16 samples were analysed in-house for pH, Electrical Conductivity (EC_e) and Emerson Aggregate Class. Six representative samples were sent to Lanfax Laboratories in Armidale, for analysis of pH, Electrical Conductivity (EC), phosphorus sorption capacity and cation exchange capacity. Table 3 provides a summary of the soil chemistry and discussion with respect to soil constraints to onsite effluent management. Reference is made to the rating scale described in Table 6 of DLG (1998). Raw data and interpretation is presented in Appendix C.

Table 3 Soil Chemical Constraints

Constraint	Degree of Limitation
pH: The pH of 1:5 soil/water suspensions was measured in-house using a *Hanna* hand held pH / EC meter. The measured pH of the all soil samples (topsoils and subsoils) ranged between 5.0 and 6.5. Soils are moderately to strongly acid. Soil acidity can be rectified by applying lime during landscaping to raise the pH, which will also reduce potential aluminium toxicity. Further soil testing will be required to determine appropriate lime dosage requirements which will vary from location to location.	**Moderate**
Electrical Conductivity (EC_e): Electrical conductivity of the saturated extract (ECe) was calculated by first measuring the electrical conductivity of 1:5 soil in water suspensions and using appropriate multiplier factors (based on soil texture) to convert EC (1:5) to ECe. *All soil samples are non-saline having ECe values ranging between 0.07 and* 0.43 therefore salinity should not present a problem for onsite effluent management.	**Minor**
Modified Emerson Aggregate Class: The Emerson Aggregate Test is a measure of soil dispersibility and susceptibility to erosion and structural degradation. It assesses the physical changes that occur in a single ped of soil when immersed in water, specifically whether the soil slakes and falls apart or disperses and clouds the water. The test was performed on all soil samples. The topsoils were generally Emerson Aggregate Class 8, which indicates stable aggregates. Subsoils were Class 5 or 2(1), indicating a slight to moderate level of dispersion. Soil dispersion will not present a significant constraint to onsite effluent management.	**Minor to Moderate**

Constraint	Degree of Limitation
Cation Exchange Capacity (CEC): The cation exchange capacity (CEC) is the capacity of the soil to hold and exchange cations. It is a major controlling agent for soil structural stability, nutrient availability for plants and the soils' reaction to fertilisers and other ameliorants (Hazelton & Murphy, 2007). The CEC of the site's soils ranged between 3.0 and 7.2 me/100g which is rated very low to low. With respect to the individual concentrations of calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) we note the following: • Ca is very low to low; • Mg is low to moderate; • K ranges from very low to moderate; • Na is very low to low. The calcium/magnesium ratio is mostly lower than is generally recommended for optimal plant growth. This ratio should be raised to improve soil fertility and lower the risk of dispersion. This can best be achieved by addition of calcium to the soils. An initial application of gypsum is recommended at 5 T/ha, within proposed effluent management areas. The need for follow-up applications should be assessed on an annual basis. This will help to improve the CEC and overall soil fertility by raising calcium concentrations.	**Moderate**
Exchangeable Sodium Percentage (ESP): The exchangeable sodium percentage (ESP) is an important indicator of sodicity, which affects soil structural stability and susceptibility to dispersion. It is calculated as [% Na / CEC] x 100. Hazelton & Murphy (2007) suggest: • ESP values less than 5 and are rated as non-sodic; • ESP values between 5 and 10 are rated as marginally sodic; • ESP values greater than 10 are rated as sodic. Sodium concentrations are generally low and corresponding ESP values range between about 2 and 5, which are non-sodic.	**Minor**

Constraint	Degree of Limitation
Phosphorus Sorption Capacity: The phosphorus sorption capacity of a soil is an important feature that relates to the potential for a soil to bind any phosphorus that may not be utilised by the plants within an effluent management area. In many instances, P-sorption will be the dominant phosphorus removal mechanism when applying effluent to the land. Phosphorus sorption capacity analysis was undertaken for four samples by Lanfax Laboratories, Armidale. 5-point P-sorption isotherms were plotted using equilibrating solutions of approximately 25, 50, 75, 100 and 125 mg/L P. From the isotherms a nominal threshold P-sorption value (in mg/kg) for each soil is estimated as the value that corresponds with 70% of complete sorption. Of the six soils analysed four had moderate P-sorption values of between 170 and 200 mg/kg, while the two samples from TP3 had high P-sorption values of 480 and 500 mg/kg. The soil profile's P-sorption capacity was estimated by adding the relative contribution from each discrete layer, to a depth of 1.0 m. We added the contribution from each of the layers tested and assumed a nominal P-sorption value of 150 mg/kg for any layers not tested, this being lower than all results recorded and hence conservative. A nominal soil bulk density of 1,200 T/m^3 was adopted. Profile P-sorption was converted to an areal sorption capacity assuming 1.0 m depth of soil. For the three profiles that had samples tested for P-sorption (TP1, TP3 and TP5) the P-sorption capacities were: • TP1 – 2,070 kg/ha; • TP3 – 5,900 kg/ha; • TP5 – 2,230 kg/ha The average of the above values is 3,400 kg/ha and this average value is used when undertaking a nutrient balance (refer Section 6.4.2) to determine sustainable effluent loading rates.	**Minor**

3.4 Overall Soil Suitability and Recommendations for Soil Improvement

The soils do not possess any significant constraints and are capable of accepting secondary treated effluent at appropriate rates. Provided the land application area is properly sized and managed, the land should have no trouble assimilating the water and nutrients in domestic effluent.

It is noted that soils are moderately to strongly acid and also have relative low CEC values. To improve soil fertility, assist establishment of vegetation and improve the soils nutrient retention capacity, the following soil improvements are recommended:

1. Incorporate good quality agricultural lime into the existing topsoil at a rate to be determined by further soil testing. This should be done by future owners before or during establishment of the effluent management area. As guidance, samples of topsoil from three locations spread throughout the proposed area should be collected and blended together, then sent to a recognised soils laboratory for a lime requirement test. It is desirable to raise pH by at least 1.0 pH unit over the upper 200 mm or so of the soil profile.

2. Incorporate gypsum into the existing topsoil at a rate of 0.5 kg/m^2. This may be done concurrently with lime application.

4 Wastewater Generation

4.1 Water Supply

The site is not currently connected to a reticulated water supply and we are advised that there is no intention to extend water supply to the site. The main source of potable water will be water tanks collecting roof runoff. Reuse of treated effluent for irrigation is therefore a highly desirable water management strategy for the development.

4.2 Characteristics of Domestic Wastewater

Wastewater generated in a domestic household situation will have characteristics similar to that described in Table 4, which incorporates information taken from DLG (1998).

Table 4 Characteristics of Typical Untreated Domestic Wastewater

Parameter	Loading	Greywater %	Blackwater %
Daily Flow	assume 140 L/person/day	65	35
Biochemical oxygen demand	200-300 mg/L	35	65
Suspended solids	200-300 mg/L	40	60
Total Nitrogen	20-100 mg/L	20-40	60-80
Total Phosphorus	10-25mg/L	50-70	30-50
Faecal coliforms	10^3 - 10^{10} cfu/100mL	medium-high	high

The contaminants in domestic wastewater have the potential to create undesirable public health concerns and pollute waterways unless managed appropriately. As a result, domestic wastewater must be treated appropriately to remove the majority of pollutants and then land applied in a sustainable manner that enables attenuation of the remaining pollutants through soil processes and plant uptake.

4.3 Predicted Wastewater Volume

Appendix 4.2D of AS/NZS 1547:2000 provides indicative per person domestic wastewater flow allowances for domestic residences. We assume a wastewater generation rate of 115 L/person/day, based on installation of standard water reduction fixtures which include dual flush 11/5.5 L WCs (or better), shower-flow restrictors, aerator taps and water-conserving automatic washing machines. If water reduction fixtures are not installed, the design wastewater generation rate is increased to 140 L/person/day.

To determine household flows it is necessary to estimate the likely maximum number of future inhabitants, which is generally done according to the number of bedrooms. Table 5 summarises the estimated daily wastewater loads for a number of future residence types, based on installation of standard fixtures or water-reduction fixtures. The volume of water generated affects the required size of effluent management areas, so reducing water consumption is encouraged to reduced effluent management area sizes.

Table 5 Design Wastewater Volume

Number of bedrooms	Typical maximum occupancy (persons)	Design Wastewater Load (L/day)	
		Tank water supply, with standard water reduction fixtures (@ 115 L/person/day)	Tank water supply, with standard fixtures (@ 140 L/person/day)
2	4	460	560
3	5	575	700
4	6	690	840
5	7	805	980

For the purpose of further design work we assume a typical development will entail a 4-bedroom residence on tank water, with standard water reduction fixtures.

If town water is connected to the site a per person daily flow of 145 L/person/day would be appropriate (with water saving devices) and would further increase the size of the effluent management area for a given household.

4.4 Water Conservation and Improving Wastewater Quality

Good water conservation is an important aspect in the overall management of onsite systems. It is important to the ongoing performance of both the treatment and land application systems that they are not overloaded hydraulically, or by particular chemical constituents contained in wastewater.

AAA rated plumbing is recommended for all water fixtures. Using the following water saving devices, the household's water consumption can be reduced substantially:

- dual flush 6/3 L pan and cistern;
- AAA rated taps, limiting flow to less than 9 L/minute;
- AAA rated shower heads to limit flow to 6 L/minute;
- AAA rated dishwasher, using not more than 18 litres per wash; and
- AAA rated washing machine, front loading, limiting water use to not more than 22 litres per dry kg of clothes.

Organic matter, oils and fats can enter the waste stream from various sources. These pollutants can be reduced by avoiding disposal of food wastes, oils and fats down the sink. Compost food and other organic wastes where possible and place oils and fats in sealed containers for disposal with the Council waste collection system. Never install "Insinkerator" style garbage disposal units;

Bleaches, disinfectants and other cleaning compounds can harm wastewater treatment systems, such as septic tanks, because they kill bacteria that colonise the treatment system and help treat wastewater. Use these products sparingly and always check that they are safe for septic systems.

Avoid placing oil, paint, petrol, acids, degreasers, photography chemicals, cosmetics, lotions, pesticides and herbicides in the wastewater system. Even small amounts of these products can harm the performance of the onsite effluent management system.

Only low sodium detergents should be used to ensure that the soil structure and hence its absorption capacity is maintained as close as possible to a natural condition. Sodium is frequently used in laundry powders as filler and serves no beneficial purpose, but can be highly detrimental to soils. In general, liquid detergents have less sodium and are preferred over powders (Appendix D).

Also, low phosphorus detergents should be used to ensure that optimum plant growth is maintained and that excess phosphorus is not leached into the environment. Detergents that are low in both sodium and phosphorus should be chosen from the table in Appendix D which has been produced by Lanfax Laboratories, Armidale.

5 Wastewater Treatment

5.1 Treatment Standard

Based on the site characteristics and to ensure protection of the sensitive lands on and surrounding the proposed lots, we recommend that wastewater receive at least secondary treatment with disinfection, prior to land application. This will permit reuse of effluent by irrigation. The indicative target effluent quality is:

- BOD < 20 mg/L;
- SS < 30 mg/L;
- TN < 30 mg/L;
- TP < 10 mg/L; and
- Faecal coliforms < 30 cfu/100 mL.

5.2 Treatment Options

Numerous treatment options are available to achieve the above specification, including domestic aerated wastewater treatment systems (AWTS), single pass sand filters, biological filters, and amended soil mounds, among others. Final system selection is ultimately up to the property owner. Once selected, the system supplier should forwarded details of the system to Council for their approval, with a *Section 68 Septic Application*.

General information on some of the available treatment options is provided below.

Aerated Wastewater Treatment Systems (AWTS)

Domestic AWTS are pre-fabricated or pre-engineered treatment systems designed to treat small (< 1,500 L/day) wastewater flows. They are tank-based systems that typically employ the following processes:

- settling of solids and flotation of scum in an anaerobic primary chamber (this stage is omitted in some models);
- oxidation and consumption of organic matter through aerobic biological processes;
- clarification – secondary settling of solids;
- disinfection – usually by chlorination; and
- regular removal of sludge to maintain the process.

Good maintenance of AWTS is essential to ensure a consistently high level of performance. By law, AWTS systems are required to be serviced quarterly by an approved maintenance contractor.

Sand Filters

Sand filters provide advanced secondary treatment to water that has already undergone primary treatment in a septic tank or similar device. They contain approximately 600 mm depth of filter media (usually medium to coarse sand, but other media can be incorporated) within a lined excavation containing an underdrain system.

Selection of the filter media is critical and a carefully designed distribution network is necessary to ensure even distribution across the media surface. A dosing well and pump (or siphon) is normally used to allow periodic dosing. Depending on the desired level of treatment, sand filters can be single-pass or may incorporate partial recirculation.

Sand filters are proven to be an effective and reliable secondary treatment device, consistently capable of achieving BOD < 10 mg/L and SS < 10 mg/L. Although they are able to remove the majority of pathogenic organisms, subsequent disinfection is required to enable effluent irrigation. There are several proprietary sand filter systems available today and detailed sizing and design of these systems is generally undertaken by the chosen manufacturer.

Biological Filters

A fairly recent innovation in onsite wastewater treatment is the biological trickling filter, a popular make being the *Biolytix™* system. These systems use alternating layers of filter media and peat filled bags contained within a plastic tank. Raw wastewater is discharged directly to the top of the filter and a rich humus layer develops. The system is seeded with worms and other micro-organisms creating a passive, biologically-driven treatment process that mimics processes occurring in nature. Test results indicate these systems can achieve secondary treatment quality, and subsequent disinfection is required to enable effluent irrigation.

6 Effluent Management

6.1 Site Suitability and Preferred Effluent Management Areas

Sections 2 and 3 (above) describe the site and soil characteristics and the constraints to domestic effluent management across the proposed subdivision. It is evident that there is good opportunity for onsite wastewater management on all lots. The key constraints are:

- the presence of several minor intermittent watercourses requiring appropriate buffers (affecting all three lots);
- localised poor drainage (mainly affecting Lot 5043);
- localised shading causing poor exposure to sun and wind (mainly affecting Lot 5042);
- presence of remnant native vegetation belonging to endangered ecological communities (mainly affecting Lots 5041 and 5042). There is a goal to minimise clearing and any other impacts on this vegetation.

Soils provide generally low to moderate constraints. Lot 5042 is the smallest and most constrained of the proposed lots, significantly due to the extensive remnant native vegetation on the property. Nevertheless, with some clearing for future building and management of asset protection zones the site will have adequate capacity for onsite effluent management.

The preferred effluent management areas (EMAs) have been identified on each of the proposed lots. They were selected according to the observed constraints as well as the restrictions imposed by ecological and fire safety investigations. In general, the EMAs are contained within existing clearings or otherwise in proposed asset protection zones (APZs) to minimise intrusion into the surrounding native vegetation. It is proposed that a minimum 5 m buffer be applied between EMAs and areas identified as containing endangered ecological communities (EECs).

Figure 3, Figure 4 and Figure 5 show the available EMAs on Lot 5041, 5042 and 5043, respectively. In all cases the areas available exceed the minimum areas required to effectively manage effluent. It is intended that future owners will have some flexibility in the final placement of their effluent management areas. Future EMAs should be located in positions where exposure to sun and wind is optimised, avoiding densely vegetated areas, and maintaining minimum buffers from built features (like buildings and driveways). The final positioning of individual EMAs should be shown on plans submitted with future Section 68 Septic Tank Applications.

6.2 Preferred Land Application System – Subsurface Irrigation

A range of potential land application systems have been considered, such as absorption trenches, evapotranspiration/absorption (ETA) beds, surface and subsurface irrigation, and sand mounds. The preferred land application system is pressure compensating subsurface drip irrigation, that will provide even and widespread dispersal of highly treated effluent within the root-zone of plants and enable beneficial reuse of the wastewater resource.

By properly sizing the irrigation areas to ensure sustainable hydraulic and nutrient loading rates, water and nutrients will be effectively utilised and will not leach to groundwater or run off to surface waters. Subsurface irrigation ensures that the risk of effluent being transported offsite is negligible. Importantly, subsurface irrigation is preferred over conventional surface spray irrigation because of the moderate ground slopes. Surface (spray) irrigation presents a far greater risk of effluent runoff than subsurface irrigation on sloping sites.

Although subsurface irrigation is likely to be the preferred option by most future householders, an alternative option that may also be investigated is the use of Wisconsin Sand Mounds or even amended soil mound systems (e.g. Ecomax). These have a smaller overall footprint than subsurface irrigation (hence their desirability in some situations) but nevertheless still ensure a high level of effluent management to protect the environment and are suited to the site. Sand Mounds will be more expensive to install than irrigation. Mounds are not usually suitable on slopes exceeding about 12 percent. Section 7 provides some information on siting, design and construction of sand mound systems, as guidance only. If a future owner wishes to pursue the Mound option further detailed design must be undertaken and submitted to Council with the Septic Application.

The following sections describe in greater detail the preferred option of subsurface irrigation.

6.3 General Description of Subsurface Drip Irrigation

Subsurface drip irrigation is becoming an increasingly favoured method of irrigating secondary treated effluent. If properly designed, it optimises the take-up of water and nutrients, prevents people contacting wastewater and greatly minimises the risk of effluent being transported away from the designated irrigation area (either as runoff or seepage).

It is important that the equipment used is designed for use with wastewater, as this has very different needs to irrigating with potable water. Examples of suitable drip irrigation products include Wasteflow™ (available from Triangle Filtration & Irrigation, Australia); *Safe-T-Flow* (available from BUI Ebb & Flow Technologies, Australia); and UniBioline (available from Netafim Australia). These products have been specifically designed for use with wastewater and allow for the higher BOD, suspended solids, nutrient and biological loads usually present in wastewater compared to potable water. They contain specially designed emitters that reduce the risk of blockage, also incorporating chemicals that provide protection against root intrusion and biofilm development (e.g. Trifluralin). The drip lines are coloured lilac to clearly identify that they are irrigating treated effluent.

With subsurface irrigation, the laterals should be spaced to provide good and even coverage of the area they service. Generally they should be no more than 0.6 m apart, roughly parallel and along the contour as far as possible. Installation depth will be between 100 and 150 mm.

An in-line 120-micron disc filter will be installed to minimise the amount of solids entering the pipelines and emitters. This must be removed and cleaned regularly (at least 3-monthly). Air release valves will be installed at the high points in individual irrigation areas to prevent soil particles being sucked into the lines at the end of pump cycles as pipelines depressurise. Flushing valves are installed at points most distant to the inlet manifold, to enable periodic flushing of lines and provide for effective long term performance. Figure 7 provides a schematic representation of a generic subsurface irrigation system, courtesy of Netafim Australia. Specialist advice must be obtained for designing and installing the irrigation system.

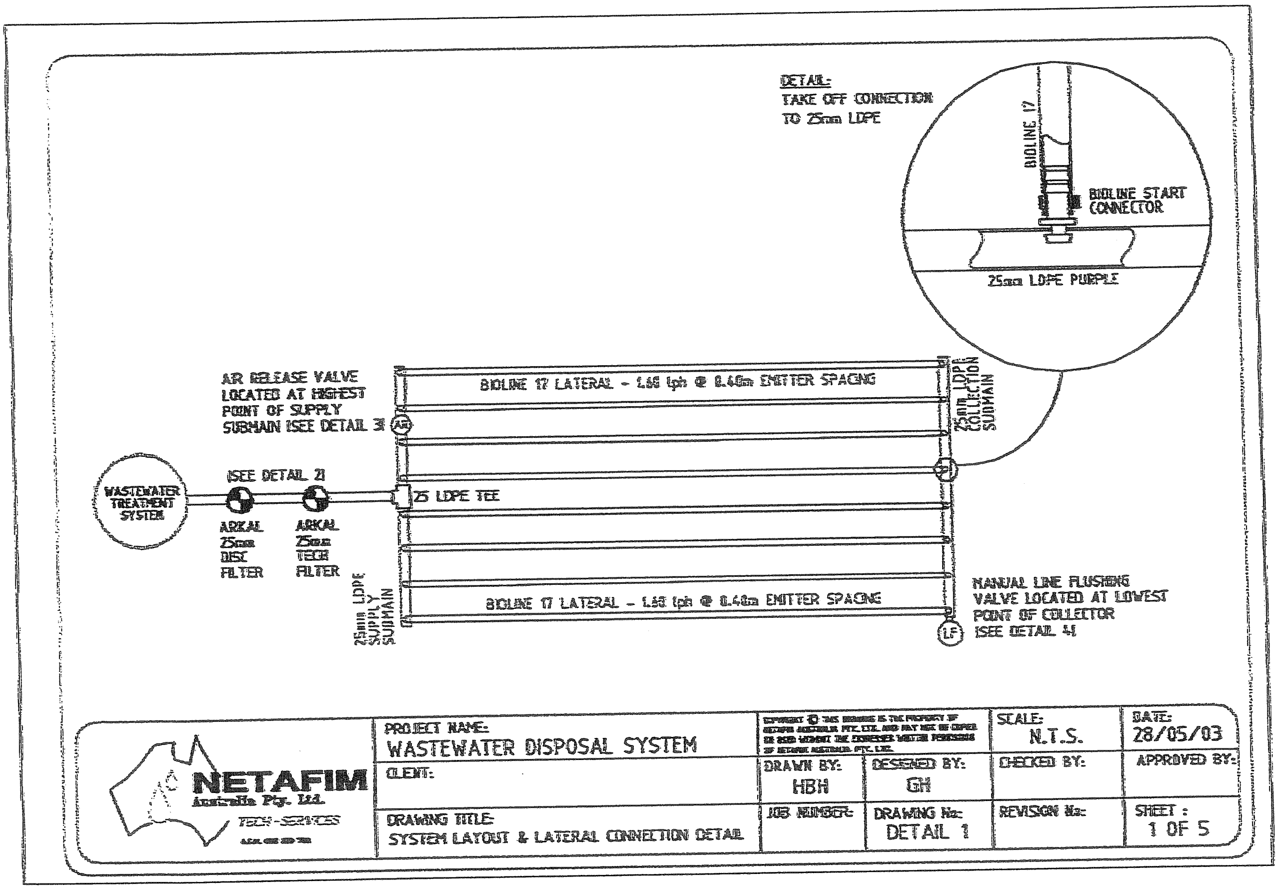


Figure 7 Typical Subsurface Irrigation Detail
(courtesy of Netafim Australia)

6.4 Sizing the Irrigation System

Water and nutrient balance modelling has been undertaken to estimate the necessary size of the irrigation areas to manage the proposed hydraulic and nutrient loads. The procedures for this generally follow the DLG (1998) guidelines. Appendix E contains a sample printout of the model spreadsheets.

6.4.1 Water Balance

The water balance used is a monthly model adapted from the "Nominated Area Method" described in DLG (1998). The water balance can be expressed by the following equation:

$$\text{Precipitation} + \text{Effluent Applied} = \text{Evapotranspiration} + \text{Percolation} + \text{Runoff}$$

Data used in an example water balance is provided in Table 6, based on a 4-bedroom residence with a secondary treatment system such as an AWTS. Ideally, irrigation areas are calculated to achieve no net excess of water and hence zero storage for all months. The results of the water balance are discussed at Section 6.4.3.

Table 6 Data Used and Results of Water and Nutrient Balance Modelling

DATA Parameter	Units	Value	Comments
Average effluent load	L/day	690	4br house, tank water, water saving devices
Precipitation	mm/month	Berkeley Rd Fountaindale mean monthly	From BoM, Data Drill
Pan Evaporation	mm/month	Berkeley Rd Fountaindale mean monthly	From BoM, Data Drill
Retained rainfall	unitless	0.9	Proportion of rainfall that is absorbed by soil, minus interception and runoff
Crop Factor	unitless	0.7 – 0.8	typical annual range
Design percolation rate (DPR)	mm/week	25	Conservative value based on DIR values from AS/NZS 1547:2000
Effluent total nitrogen concentration	mg/L	30	target secondary effluent quality
Nitrogen lost to soil processes (denitrification and volatilisation)	annual percentage	20	Patterson (2002)
Effluent total phosphorus concentration	mg/L	10	target secondary effluent quality
Soil phosphorus sorption capacity	kg/ha	3,400	conservative average for soil profile, based on test data
Nitrogen uptake rate by plants	kg/Ha/yr	250	Conservative estimate, roughly half that expected of effluent irrigated pasture grasses (NSW Agriculture, 1997)
Phosphorus uptake rate by plants	kg/Ha/yr	25	Conservative estimate, roughly half that expected of effluent irrigated pasture grasses (NSW Agriculture, 1997)
Design life of system (for nutrient management)	years	50	reasonable service life for system
RESULTS			
Water Balance	m^2	**426**	**limiting factor**
Nitrogen Balance	m^2	**242**	
Phosphorus Balance	m^2	**425**	

6.4.2 *Nutrient Balance*

A nutrient balance has been undertaken to determine the minimum land application area requirements to ensure nutrients are assimilated by the soils and vegetation. If nutrients are applied at excessive rates there is a risk of nutrient transport to receiving waterways or other sensitive environments, possibly by stormwater runoff or by percolation to groundwater. Due to the presence of native vegetation surrounding the building envelopes it is highly desirable that effluent be retained within the land application areas.

The model used is based on the simplistic DLG (1998) methodology but improves this by using more accurate predictions of nutrient cycling processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as ammonification (the conversion of organic nitrogen to ammonia) and a certain amount will be lost by denitrification, microbial attack and volatilisation (Patterson, 2003). Patterson (2002) estimates that these processes may account for up to 40% loss of total nitrogen. In this case a more conservative estimate of 20% is adopted for the nitrogen losses due to soil processes.

Table 6 presents the key data used in the nutrient balance. The results of the nutrient balance are discussed at Section 6.4.3.

6.4.3 *Results Summary*

Table 6 summarises the results of the water and nutrient balance modelling. The recommended minimum irrigation area that must be installed (denoted the Primary Irrigation Area) is based on the larger of the water and nutrient balance calculations. In this case the hydraulic balance and the phosphorus balance require equivalent areas which far exceed the area required by the nitrogen balance. The area required is approximately **426 m^2** for a 4-bedroom residence with tank water and standard water reduction fixtures.

The water balance suggests that wet weather storage is not required provided the minimum irrigation areas indicated by the hydraulic balance are installed. In light of the conservative design and the climatic conditions of the area we support the modelling outcomes and recommend that wet weather storage is not required.

It is noted that the modelling is very conservative and offers a large factor of conservatism. In the case of the water balance the area is based on the worst month of the year in terms of moisture surplus (rainfall less evapotranspiration). Therefore, for all other months of the year less area is required. In addition, while conventional practice is to use median monthly rainfall data when undertaking domestic water balance assessments (DLG, 1998) we have opted to use **mean** data which is significantly higher than the **median** data for all months of the year (15-45% higher depending on month). This offers a large factor of conservatism.

Irrigation area sizes for different sized residences with both water saving devices and standard water use fixtures are provided in Table 7. If the sites were provided with town water rather than tank water and future residences committed to installing water saving devices throughout the house, the required irrigation areas would be similar to those presented in Table 7 for houses with tank water and standard fixtures.

Table 7 Summary of Land Application Area Requirements

Number of bedrooms	Typical maximum occupancy (persons)	Required Irrigation Area (m^2)	
		Tank water, standard water reduction fixtures	Tank water, standard fixtures
2	4	284	346
3	5	355	433
4	6	426	519
5	7	498	606

6.5 Recommendations for Detailed Irrigation System Design and Operation

A detailed land application system design is beyond the scope of this report; however should be prepared upon receipt of development approval for future residences and before installation of the respective onsite systems. The detailed design should be undertaken by an irrigation specialist experienced with wastewater applications. The design should include consideration of the following matters:

- the irrigation plan must ensure that effluent is applied evenly across the site. The total irrigation area must be broken down into at least two separate irrigation zones that are watered sequentially, using either a manual indexing valve or programmable irrigation controller;
- it is advisable to spread irrigation water widely across the slope so that there is a large wetting front, especially on sloping sites and on ground that possesses restricted vertical drainage. This will enable greater uptake of water and nutrients should lateral (downslope) movement of moisture occur, and will minimise the risk of seepage or resurfacing of effluent.
- a complete plan and specification should be prepared for all new irrigation areas and equipment. This would including details of the type, capacity, operation and maintenance of all irrigation equipment, the irrigation pump/s, distribution pipework, cleaning/flushing valves, irrigation controller/s, filters and distribution valves;
- any mitigation measures required to overcome specific site constraints such as localised stormwater run-on or runoff problems should be included in the irrigation design;
- a description of procedures for monitoring and maintaining the irrigation system should be provided to the property owners or occupiers;
- regular inspection of the irrigation area is advisable to ensure that the system is serviceable, is effectively distributing the water and is not resulting in overloading and soil saturation over all or part of the area;
- stormwater diversion drains should be constructed upslope of effluent irrigation areas to prevent run-on of stormwater, where this is likely to be significant;

- the irrigation lines should be flushed regularly following the installer's recommendations;
- all in-line filters must be removed and cleaned regularly following the installer's recommendations;
- vegetation within the irrigation area should be regularly cut (mown) and removed from the area to maintain nutrient budgets;
- vehicles and stock should be excluded from the irrigation area to prevent soil compaction and damage of irrigation infrastructure;
- no structures should be built or placed within the irrigation area.

6.6 Buffers

When siting land application areas buffer setbacks are provided to sensitive receptors to minimise the risk of environmental, public health or nuisance impacts. The recommended minimum buffers applicable to subsurface land application systems are presented below. Most are taken directly from the DLG (1998) guidelines, except the buffers from "open depressions" and "EECs" which are not prescribed in the DLG (1998) guidelines and have been nominated. All buffers are achievable.

- 250 metres from domestic groundwater bores;
- 100 metres from permanent watercourses;
- 40 metres from intermittent watercourses and dams;
- 20 m from open depressions;
- 6 metres if area up-gradient and 3 metres if area down-gradient of property boundaries, driveways, swimming pools and buildings;
- 5 m from the perimeter of areas of native vegetation comprising endangered ecological communities (EECs).

It is important to note that the buffers from waterways are measured as the overland flow path of any runoff from the EMA, not the straight line distance. The buffers have an impact on the placement of EMAs, however all lots have the ability to provide sufficient EMAs that meet the buffer requirements. Diversion of the watercourse through Lot 5042 is proposed and once in place a 40 m buffer from the EMA will be achieved.

6.7 Landscaping

Irrigation areas must be well vegetated with a complete groundcover to maximise uptake of water and nutrients and to minimise soil erosion within the area. There are many ways that the irrigation area can be landscaped to ensure that effluent is properly managed. An effective grass cover is often preferred as it is simple, cost effective and usually very successful because the turf responds well to the hydraulic and nutrient loads in treated effluent. Moreover, it provides a complete cover to minimise the risk of runoff and erosion. Laying of cultivated turf may be required on degraded sites with poor existing groundcover and in these situations imported topsoil may also be required to assist in turf establishment. Alternately, effluent can be utilised in constructed garden beds or around mulched ornamental tree plantings. Drip lines must be covered by at least 100 mm of soil or mulch.

Effluent irrigation areas must be planted with vegetation that is tolerant of moist and nutrient rich conditions. Certain native species may not tolerate these conditions and should be avoided. Advice from a landscape gardener is always desirable while planning the planting scheme within an effluent irrigation area.

6.8 Protection of Effluent Management Area

It is strongly recommended that the proposed effluent management area be fenced off during construction activities to prevent disturbance and compaction of soils by construction machinery. The area should not be used for stockpiling construction materials. Compaction of the soils could significantly reduce their hydraulic conductivity and adversely effect the operation of the irrigation system once installed.

6.9 Stormwater Management

Stormwater runoff must be intercepted and diverted around effluent management areas (EMAs) to optimise their performance. If there is an appreciable risk of stormwater entering an EMA a surface water collection drain (e.g. open grass swale) should be installed immediately upslope to divert this water. Collected stormwater must be released in an area where it will not re-enter the EMA and will not cause erosion or flooding of adjacent lands. This will need to be determined on a case by case basis with future applications.

6.10 Ground Preparation, Topsoiling and Landscaping

There are many ways that the irrigation area can be landscaped to ensure that effluent is properly managed. For example, a procedure for turfing an effluent management area is as follows:

- lightly scarify (cultivate) the existing topsoil to a depth of approximately 200 mm, working along the contour;
- apply gypsum, lime and other ameliorants, as recommended, to the cultivated surface;
- backfill with existing topsoil to even out the rises and depressions;
- apply a further 50 mm of garden quality, organic rich topsoil. Topsoil should be of loam to sandy loam texture, free of coarse fragments and with a low clay content;
- lay irrigation lines using a small trench digger;
- lay turf over the entire irrigation area and extending at least one metre beyond the perimeter of the irrigation area; and
- water turf regularly, especially during initial establishment and particularly if effluent loads are insufficient to provide adequate water initially.

Alternately, effluent can be utilised in constructed garden beds or around mulched ornamental tree plantings. An effluent irrigation area will ideally be planted with a thick cover of vegetation that is tolerant of moist and nutrient rich conditions. Certain native species may not tolerate these conditions and should be avoided. Advice from a landscape gardener is always desirable while planning the planting scheme within an effluent irrigation area. Turfing EMAs is generally successful because the turf responds well to the hydraulic and nutrient loads delivered in treated effluent and provides an effective groundcover to minimise the risk of runoff and erosion.

7 Alternative Land Application System – Sand Mounds

An alternative land application system known as Wisconsin Sand Mounds is described here, which may be particularly useful if site development restricts the availability of landscaped area within which to manage effluent. Sand mounds offer the benefit of providing sustainable effluent management within a significantly smaller footprint than required for subsurface irrigation.

The use of sand mounds could be considered for any of the lots throughout the subdivision. These systems require design by suitably qualified wastewater professionals and a site-specific design will be required for each site if the option is pursued. The detailed design must include all sizing calculations, design of the dosing chamber and distribution network, and selection of suitable fill materials, advice for positioning and construction, and landscaping. We recommend a suitable secondary treatment system be installed to treat domestic wastewater before application to the sand mound.

7.1 General Description of Sand Mounds

The use of sand mounds is becoming increasingly popular in Australia. They are particularly useful for overcoming specific site and soil constraints such as limited available land application area, shallow depth to watertable or impermeable horizons. Their design is based on the Wisconsin Mound, a system developed in the USA in the 1970s for receiving septic tank effluent on constrained sites.

The design provided here is based largely on information sourced from the USA particularly that contained in Converse & Tyler (2000). However, in recognition of the merits of sand mound systems AS/NZS 1547:2000 now includes information on selection, design and construction of sand mounds that is generally consistent with that published by Converse & Tyler. Appendix F contains a general cross-section and plan view of a sand mound, as well as additional design and construction information taken from AS/NZS 1547:2000.

Sand mounds are raised soil absorption systems comprising layered fill, into which effluent is dosed. Effluent receives further treatment as it percolates down through the mound and is then absorbed by the natural soils below the mound. Before construction the existing ground surface is prepared by scarification, ploughing or deep ripping. This is vital to improve moisture infiltration to the subsoils and reduce the risk of lateral moisture flows, particularly where the natural soils are heavy-textured. Approximately 400 mm of sand, with specific grain size and other characteristics, provides the basal layer. Above this sits a 225 mm gravel distribution bed containing a pressurised effluent distribution system. The gravel bed is covered by a geofabric filter cloth and then a further layer of sand is laid, ensuring that at least 200 mm of material covers the gravel bed at the edges. The mound is finished with good quality topsoil (approx. 100 mm thick) and is then turfed.

7.2 Indicative Size of Sand Mounds

Proper sizing of sand mounds relies on hydraulic and geometric calculations which use a range of important input data such as the effluent load, ground slope, depth of soil, acceptable soil basal loading rate and linear loading rate. Sizing must be undertaken on a site by site basis, as factors like ground slope have a major bearing on the final size. It is critical that sand mounds be subject to detailed design before installation.

We have undertaken a preliminary sizing for a Sand Mound on a 5 percent slope with typical soil conditions, for a 4-bedroom house. A printout of the sizing spreadsheet is provided in Appendix G. A mound of approximately 15.0 m long by 7.0 m wide by 1.0 m high is required.

8 Operation and Maintenance

Maintenance of the treatment and land application systems is important to ensure effective long term operation and various aspects are discussed below. While the system owner must take some responsibility for the continuous successful operation and maintenance (O&M) of the system, through occasional inspection and ensuring that inappropriate wastes are excluded, regular servicing by an authorised maintenance technician is also required. Advice about system servicing should be sought from the system supplier / installer at the time of commissioning. Some general information is contained below and additional information about management of land application areas is contained in Appendix H.

Treatment System:

- have a suitably qualified maintenance contractor service the system as required under the NSW Health Certificate of Accreditation and Council's approval to operate. Servicing should include:
  - checking the structural integrity of the tank/s and lid/s
  - checking the condition and operation of the pumps, timers, alarms and other components, and replacing or repairing any faulty parts
  - assessing liquor characteristics such as colour, odour, pH, clarity and dissolved oxygen, to measure treatment performance
  - assessing overall performance of the system; and
  - making adjustments as required to improve effluent quality.
- use household cleaning products sparingly and check that they are suitable for septic tanks. Never place large quantities of bleaches, disinfectants, fabric softeners or other antibacterial solutions down toilets, sinks or other fixtures that drain to the septic tank;
- use detergents that are low in sodium and phosphorus; and
- conserve water.

Land Application System:

- regularly harvest (mow) vegetation within the land application area and remove this to maximise uptake of water and nutrients;
- monitor and maintain the subsurface irrigation system following the manufacturer's recommendations, including regular flushing of irrigation lines;
- regularly clean in-line filters;
- ensure that the irrigation system is working effectively to ensure good even dispersal of effluent
- if stormwater run-on is a problem, construct and maintain diversion drains on the upslope side of the land application area to divert stormwater. This is especially important where runoff from impervious surfaces such as roads, driveways, and roofs could run on to the area;
- do not erect any structures over the land application area; and
- minimise vehicle access to the land application area, to prevent soil compaction;

9 Conclusions

It is concluded that there is capacity for sustainable onsite wastewater management on each of the lots formed by the proposed 3-lot subdivision. While each of the proposed lots has its limitations, these can be managed by siting effluent management areas in suitable positions and providing suitable buffers from sensitive receptors.

We recommend secondary treatment of wastewater be provided on each lot using either an AWTS, sand filter, biological filter or alternative secondary treatment device. The preferred method of managing treated effluent is by subsurface irrigation. Secondary treatment and irrigation in a properly sized area will be a sustainable solution for the site and will not present a significant risk to either human health or the surrounding natural environment. All proposed effluent management areas meet the required buffers from watercourses and the risk of effluent runoff to waterways is very low.

The required irrigation area has been calculated using a water and nutrient balance. For a 4-bedroom residence on tank water, with standard water saving fixtures installed, the required irrigation area is 426 m^2. Different sized houses may require smaller or larger irrigation areas and the report provides guidance on appropriate sizing of irrigation areas for such situations. Houses without water saving fixtures installed will require proportionally larger irrigation areas. If town water is supplied to the site required irrigation areas will be larger due to the potentially higher water usage. Wet weather storage is not required. Subsurface irrigation provides a high level of protection against effluent transport offsite even during wet weather.

An alternative land application method has also been nominated – the Wisconsin Sand Mound. It is critical that Mounds be subject to detailed design before installation, if this option is chosen. As an indication for this site, a typical Sand Mound on a 5 percent slope servicing a 4-bedroom house, might have approximate overall dimensions of 15.0 m long by 7.0 m wide by 1.0 m high.

Site plans have been prepared for each lot showing the suitable effluent management areas (EMAs) – refer Figure 3, Figure 4 and Figure 5. Selection of the available EMAs is dictated by a number of key factors, including a desire to remain within existing clearings and as close to the building envelopes as possible, as well as avoiding areas of localised poor drainage and watercourses. On all lots there is adequate space for positioning future buildings and EMAs. Provided the recommendations in this report are followed no further investigations into wastewater management should be required by wastewater consultants. Future owners will be required to submit individual Section 68 "Septic Applications", detailing the proposed wastewater treatment system type, make, model and position, as well as the proposed position and construction details for the irrigation area.

10 References

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11 Appendixes

Appendix A

Climate Data

(sourced from the Bureau of Meteorology)

Data Drill data

========= The following information should be kept in the data file ==========

Please read the documentation on the Data Drill at http://www.nrm.qld.gov.au/silo

==

Summary of Data Drill for in 3PG (Decimal degrees), Your Ref: BerkeleyRd

Rainfall averages and percentiles used Data Drill from 1889 to 2006,
evaporation averages and percentiles used Data Drill from 1970 to 2006,
as extracted from http://www.nrm.qld.gov.au/silo/datadrill on

Site	Indice	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
BerkeleyR(	Rainfall: Average	115	125	140	117	116	111	86	72	70	76	82	94	1204
BerkeleyR(	Rainfall: percentile 10	25	20	34	25	19	16	9	7	14	14	14	21	849
BerkeleyR(	Rainfall: percentile 20	41	40	45	38	37	30	18	18	26	27	26	39	912
BerkeleyR(	Rainfall: percentile 30	51	60	66	52	53	42	35	26	36	38	42	51	1048
BerkeleyR(	Rainfall: percentile 40	71	75	94	72	69	60	50	37	42	44	61	60	1099
BerkeleyR(	Rainfall: percentile 50	83	93	115	82	86	80	60	53	51	55	71	75	1177
BerkeleyR(	Rainfall: percentile 60	110	125	138	105	107	95	86	63	64	66	92	90	1238
BerkeleyR(	Rainfall: percentile 70	139	140	169	134	136	120	114	80	78	84	104	105	1321
BerkeleyR(	Rainfall: percentile 80	174	193	212	165	174	181	133	107	105	113	131	129	1438
BerkeleyR(	Rainfall: percentile 90	253	258	299	255	256	274	206	172	163	181	168	213	1617
BerkeleyR(	Evaporation: Average	182	147	131	99	71	59	68	94	120	152	162	193	1478

Please note: The annual percentile does not have to be the sum of the monthly percentiles on the same line
eg. the 90th percentile for May may be from 1955, and the 90th percentile for July from 1949
while the annual percentiles are calculated from the sum of the months for the same year

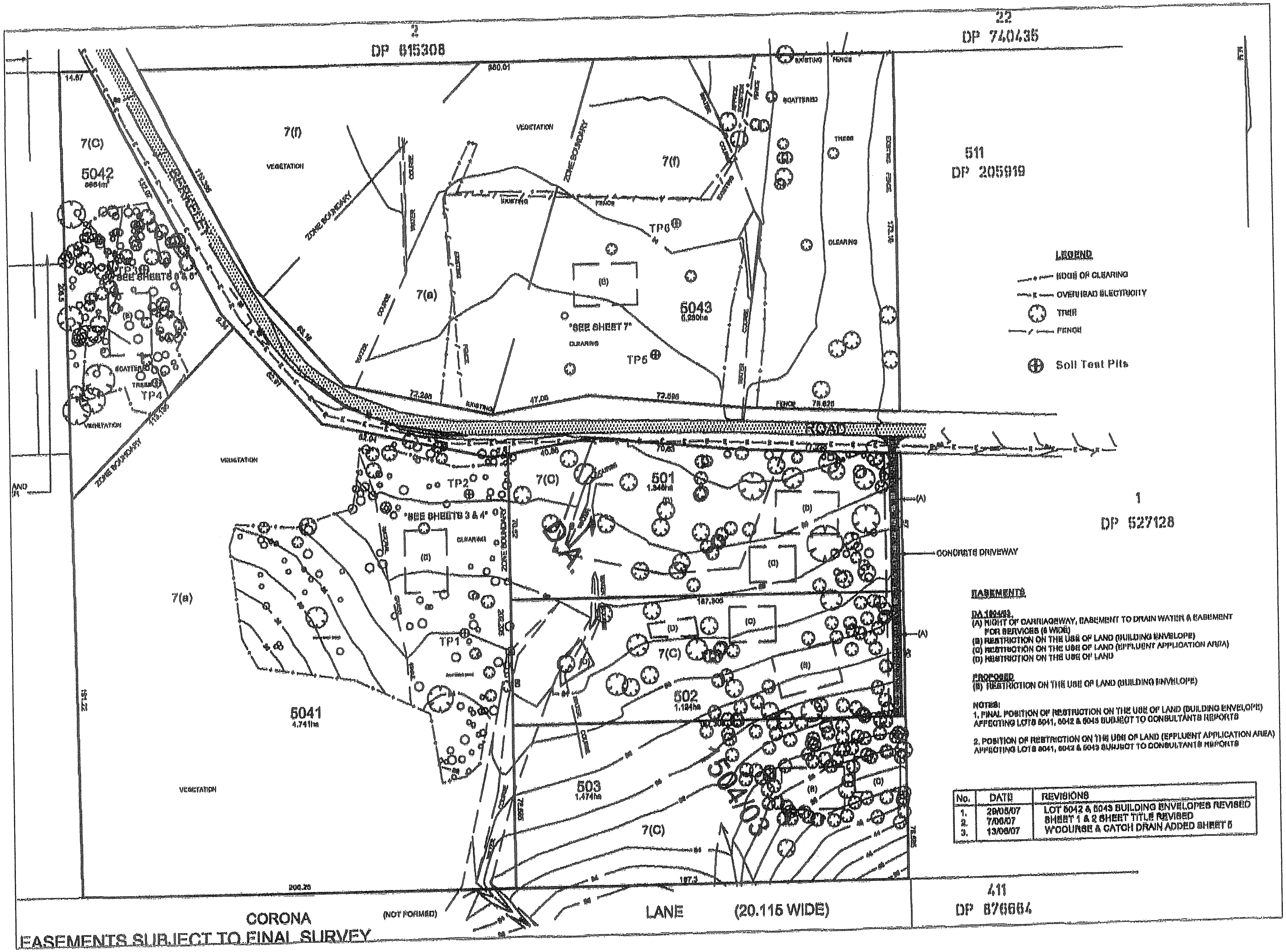
Wyong Bowling Club (Station No. 61083)

Mean	Total Monthly Precipitation (	109.6	118.9	137	113.3	113.3	111.5	82.3	69.1	67.5	70.6	81.8	95.3	1181.4
Median	Total Monthly Precipitation (	76.4	85	106.1	88.8	83.4	73.7	65	45	50.4	53.6	66.8	71.6	1136
75th Perce	Total Monthly Precipitation (	144.5	147.9	186	134.1	153.4	144	119.7	87.8	83.2	89.8	114.9	119.9	1329.4
90th Perce	Total Monthly Precipitation (	248.3	266.3	294.4	218.2	240.8	260.7	182.1	152.5	159.4	151.6	164.4	195	1638
Mean	Number of Rain Days	9	9	10	9	9	9	8	7	8	8	9	9	106

Appendix B

Soil Test Pit Borelogs

PLAN OF TEST PIT LOCATIONS



Whitehead & Associates
Environmental Consultants Pty Ltd

Key to Soil Borelogs

Symbols

W	Watertable depth	•	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry
SM	Slightly moist
M	Moist
VM	Very moist
W	Wet / saturated

Graphic Log and Textures

S - Sand
LS - Loamy sand
CS - Clayey sand

CL - Clay loam
SCL - Sandy clay loam
SiCL - Silty clay loam

Gravel (G)

SL - Sandy loam

LC - Light clay
SC - Sandy clay

Parent material (stiff)

L - Loam
LFS - Loam fine sandy
SiL - Silty loam

MC - Medium clay
HC - Heavy clay

Parent material (weathered)

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP1**
Site:	Proposed Lot 5041, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP1/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	D	many roots good organic matter well drained topsoil
0.3										
0.4										
0.5		• TP1/2	A2	SL	apedal, earthy fabric	grey-brown	nil	nil	SM	
0.6										
0.7										
0.8										
0.9		• TP1/3	B	SL	weakly pedal	yellow-brown	nil	nil	SM	slight increase in clay
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in sandy loam - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP2**
Site:	Proposed Lot 5041, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP2/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	SM	Less well drained than TP1
0.3										
0.4										
0.5		• TP2/2	A2	SCL	apedal	light grey-brown	nil	nil	SM	
0.6										
0.7										
0.8										
0.9		• TP2/3	B	SC	weakly to moderately pedal	light grey-brown	20% orange	nil	M	
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in light sandy clay - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	TP3
Site:	Proposed Lot 5042, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP3/1	A1	SL - LFS	apedal, earthy fabric	dark grey-brown	nil	nil	D	deep, organic rich topsoil
0.3										
0.4										
0.5										
0.6		• TP3/2	A2	SL	apedal, earthy fabric	grey-brown	nil	nil	D	
0.7										
0.8										
0.9										
1.0										
1.1		Test Pit Terminated at 1000 mm in sandy loam - LAYER CONTINUES								
1.2										
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP4**
Site:	Proposed Lot 5042, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP4/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	nil	D	
0.3										
0.4										
0.5										
0.6		• TP4/2		LS	apedal	pale grey-brown	nil	nil	D	
0.7										
0.8		• TP4/2		LS	apedal	yellow-brown	nil	nil	D	
0.9										
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in loamy sand - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP5**
Site:	Proposed Lot 5043, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP5/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	D	
0.3										
0.4										
0.5										
0.6		• TP5/2	A2	SL	apedal	brown	nil	nil	SM	
0.7										
0.8										
0.9		• TP5/3	B	SCL	weakly to moderately pedal	yellow-brown	40% orange	nil	SM	
1.0										
		Test Pit Terminated at 1000 mm in sandy clay loam - LAYER CONTINUES								
1.1										
1.2										
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Sentros Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP6**
Site:	Proposed Lot 5043, Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP6/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	nil	M	waterlogged profile in low lying poorly drained position
0.3										
0.4										
0.5										
0.6		• TP6/2	A2	SL	apedal	pale grey-brown	nil	nil	W	
0.7										
0.8										
0.9										
		Test Pit Terminated at 900 mm in sandy loam - LAYER CONTINUES								
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										

Appendix C

Soil Analytical Results

Sheet 1 - Soil Sampling Schedule and Results of In-House Soil Analysis

Site	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH_f [3]	$pH_{1:5}$ [4]	Rating	$EC_{1:5}$ (µS/cm)	ECe (dS/m) [5]	Rating	Other analysis [6]
TP1	1/1	100	SL	8	Negligible	n/a	5.4	Strongly acid	20	0.22	Non-saline	CEC, Psorb
	1/2	500	SL	2(1)	Mod-High	n/a	5.6	Moderately acid	18	0.20	Non-saline	
	1/3	900	SL	5	Slight	n/a	5.4	Strongly acid	24	0.26	Non-saline	CEC, Psorb
TP2	2/1	100	SL	8	Negligible	n/a	5.3	Strongly acid	7	0.08	Non-saline	
	2/2	500	CL	2(1)	Mod-High	n/a	5.1	Strongly acid	8	0.07	Non-saline	
	2/3	850	CL	2(1)	Mod-High	n/a	5.0	Very strongly acid	8	0.07	Non-saline	
TP3	3/1	100	SL	8	Negligible	n/a	6.5	Slightly acid	30	0.33	Non-saline	CEC, Psorb
	3/2	650	SL	7	Negligible	n/a	5.6	Moderately acid	30	0.33	Non-saline	CEC, Psorb
TP4	4/1	100	SL	8	Negligible	n/a	5.1	Strongly acid	15	0.17	Non-saline	
	4/2	550	S	5	Slight	n/a	5.7	Moderately acid	25	0.43	Non-saline	
	4/3	800	S	2(1)	Mod-High	n/a	5.6	Moderately acid	10	0.17	Non-saline	
TP5	5/1	100	S	8	Negligible	n/a	5.6	Moderately acid	11	0.19	Non-saline	CEC, Psorb
	5/2	550	S	2(1)	Mod-High	n/a	5.7	Moderately acid	5	0.09	Non-saline	
	5/3	750	CL	5	Slight	n/a	5.7	Moderately acid	11	0.10	Non-saline	CEC, Psorb
TP6	6/1	100	SL	8	Negligible	n/a	5.5	Strongly acid	7	0.08	Non-saline	
	6/2	400	SL	n/a	Moderate	n/a	5.9	Moderately acid	17	0.19	Non-saline	

Notes:- (also refer Interpretation Sheet 1)

[1] The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.

[2] Ratings describe the likely hazard associated with land application of treated wastewater.

[3] $pH_{1:5}$ measured in the field using Raupac Indicator.

[4] pH_f measured on 1:5 soil:water suspensions using a *Hanna Combo* hand-held pH/EC/temp meter.

[5] Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.

[6] External laboratories used for the following analyses, if indicated:

- CEC (Cation exchange capacity)
- Psorb (Phosphorus sorption capacity)
- Bray Phosphorus
- Organic carbon
- Total nitrogen

Interpretation Sheet 1 - pH, EC & Emerson Aggregate Class

Ratings based on data in *Interpreting Soil Test Results: what do all the number mean?* [2nd ed.] (Hazelton & Murphy, 2007)

Soil pH (1:5 Soil:Water)

pH	Rating #
0.00 to 4.49	Extremely acid
4.50 to 5.00	Very strongly acid
5.01 to 5.50	Strongly acid
5.51 to 6.00	Moderately acid
6.01 to 6.50	Slightly acid
6.51 to 7.30	Neutral
7.31 to 7.80	Mildly alkaline
7.81 to 8.40	Moderately alkaline
8.41 to 9.00	Strongly alkaline
9.01 to 14.00	Very strongly alkaline

preferred range (5.01 to 7.80)

Ece (1:5 Soil:Water)

Ece (dS/m)	Rating #
0.00 to 2.00	Non-saline
2.01 to 4.00	Slightly saline
4.01 to 8.00	Moderately saline
8.01 to 16.00	Highly saline
16.00 up	Extremely saline

increasing hazard ↓

Multiplier Factors for Calculating ECe

Texture Class	Applicable Soil Textures	MF
S	Sand, loamy sand, clayey sand	17
SL	sandy loam, fine sandy loam	11
L	loam, loam fine sandy, silty loam	10
CL	clay loam, sandy clay loam	9
LC	light clay	8
MC	medium clay	7
HC	heavy clay	6

Emerson Aggregate Class
(rating describes likelihood of dispersion)

EAT Class	Rating #
1	Very High
2(1)	Mod-High
2(2)	High
2(3)	Very High
3(1)	Slight
3(2)	Slight
3(3)	Moderate
3(4)	Moderate
4	Negligible
5	Slight
6	Negligible
7	Negligible
8	Negligible

Sheet 2 - Results of External Laboratory Analysis

Site	Sample Name	Depth (mm)	CEC (me/100g)	Rating	Ca (mg/kg)	Rating	Mg (mg/kg)	Rating	Na (mg/kg)	Rating	K (mg/kg)	Rating	ESP (%)	Rating	P-sorp. (mg/kg)	Rating
TP1	1/1	100	5.5	VL	526	L	181	M	25	L	115	L	2.0	NS	195	M
	1/2	500		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	1/3	900	3.0	VL	44	VL	193	M	34	L	23	VL	5.0	NS	173	M
TP2	2/1	100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	2/2	500		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	2/3	850		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP3	3/1	100	4.6	VL	308	VL	174	M	48	L	47	VL	4.6	NS	482	H
	3/2	650	7.2	L	647	L	326	M	50	L	157	M	3.0	NS	502	H
TP4	4/1	100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	4/2	550		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	4/3	800		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP5	5/1	100	3.6	VL	309	VL	64	L	17	VL	53	VL	2.1	NS	189	M
	5/2	550	3.4	VL	412	L	119	L	23	VL		n/a		n/a		n/a
	5/3	750	3.4	VL	412	L	119	L	23	VL	24	VL	2.9	NS	174	M
TP6	6/1	100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	6/2	400		n/a		n/a		n/a		n/a		n/a		n/a		n/a

Interpretation Sheet 2 - External Lab Analysis of CEC, P-Sorption

Ratings based on data in *Interpreting Soil Test Results: what do all the number mean?* [2nd ed.] (Hazelton & Murphy, 2007)

Cation Exchange Capacity (CEC)

Rating #	CEC (me/100g)			Ca (mg/kg)			Mg (mg/kg)			Na (mg/kg)			K (mg/kg)		
VL	0.00	to	6.00	0.00	to	400.00	0.00	to	36.50	0.00	to	23.00	0.00	to	78.20
L	6.01	to	12.00	400.01	to	1000.00	36.51	to	121.50	23.01	to	69.00	78.21	to	117.00
M	12.01	to	25.00	1000.01	to	2000.00	121.51	to	365.00	69.01	to	161.00	117.01	to	274.00
H	25.01	to	40.00	2000.01	to	4000.00	365.01	to	972.00	161.01	to	460.00	274.01	to	782.00
VH	40.01	up		4000.01	up		972.01	up		460.01	up		782.01	up	

VL=very low, L=low, M=medium, H=high, VH=very high

Exchangeable Sodium Percentage (ESP)

Rating #	ESP (%)			Description
NS	0.00	to	6.00	Non-sodic
S	6.01	to	14.00	Marginally sodic to sodic
SS	14.01	up		Strongly sodic

increasing hazard ↓

Phosphorus Sorption Capacity

Rating	P-sorption (mg/kg)			Description
L	0.00	to	125.00	Low
M	125.01	to	250.00	Medium
MH	250.01	to	400.00	Medium-High
H	400.01	to	600.00	High
VH	600.01	up		Very high

↑ increasing hazard

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Soil Scientists and Environmental Engineers

Lanfax Laboratories
ABN 72 212 385 095
Proficiency tested by Aust. Soil & Plant Analysis Council Inc. ASPAC

23rd June 2007

Whitehead & Associates
251 Wallsend Road
Cardiff Heights NSW 2285

Soil Report

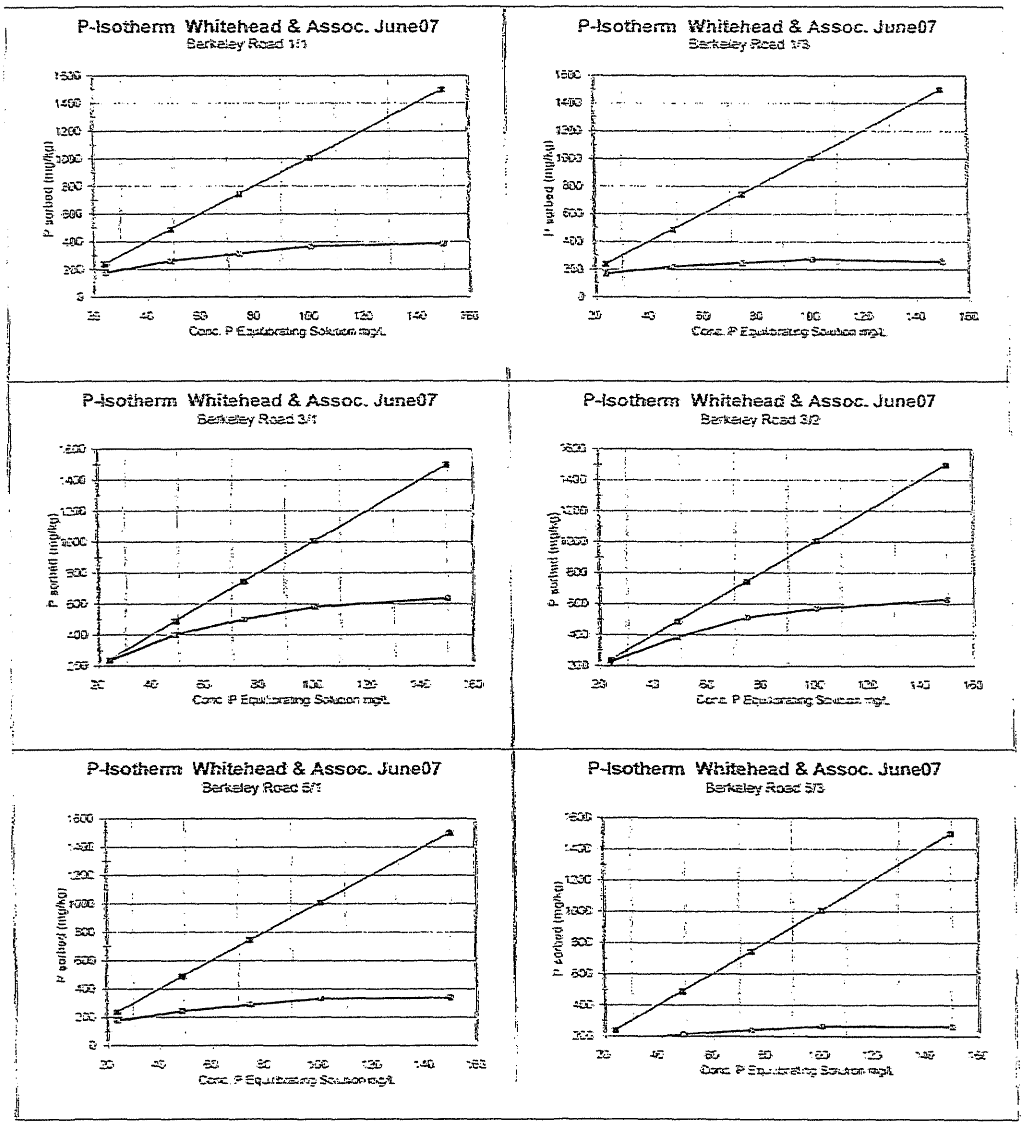
Six soil samples received 18th June 2007
Samples dried to 50°C. crushed and sieved to minus 2 mm prior to analysis

Exc.Al+H	Ca		K		Mg		Na		Base Sat.	ESP	ECEC	Ca/Mg	Site Location
cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	%	%	cmol+/kg	ratio	Sample ID
0.96	526	2.63	115	0.29	181	1.49	25	0.11	82.5	2.0	5.5	1.7	Berkeley Rd 1/1
0.96	44	0.22	23	0.06	193	1.59	34	0.15	67.8	5.0	3.0	0.1	Berkeley Rd 1/3
1.28	308	1.54	47	0.12	174	1.44	48	0.21	72.0	4.6	4.6	1.1	Berkeley Rd 3/1
0.64	647	3.23	157	0.40	326	2.68	50	0.22	91.1	3.0	7.2	1.2	Berkeley Rd 3/2
1.28	309	1.54	53	0.13	64	0.53	17	0.07	64.0	2.1	3.6	2.9	Berkeley Rd 5/1
0.24	412	2.05	24	0.06	119	0.98	23	0.10	93.0	2.9	3.4	2.1	Berkeley Rd 5/3

Site Location	pHw	pHca	EC
Sample ID			uS/cm
Berkeley Rd 1/1	5.33	4.25	57
Berkeley Rd 1/3	5.60	4.40	26
Berkeley Rd 3/1	5.48	4.42	37
Berkeley Rd 3/2	5.76	4.72	46
Berkeley Rd 5/1	5.35	4.25	23
Berkeley Rd 5/3	6.53	4.69	14

Methods: Rayment & Higginson 1992
pH Method 4A1 (water) 4B1 ($CaCl_2$)
EC Method 3A1
Exchangeable acidity (H^+, Al^{3+}) Method 15 G1
Effective Cation Exchange Capacity Method 15D3 plus exchangeable acidity
Exchangeable sodium percentage ratio sodium to ECEC
P sorption modified method 9J1 - elevated equilibrating solutions, ICP determination of P

Soil survey and analytical assessments, landscape analysis and plant nutrient relationships
Qualified IS014000 environmental management systems consultants



Soil survey and analytical assessments, landscape analysis and plant nutrient relationships
Qualified ISO14000 environmental management systems consultants

Sorbed P is the difference between initial and filtrate, calculated in mg/kg
Percent sorbed is the proportion of the initial P sorbed during equilibration

filtrate P mg/L	Initial P mgP/L	sorbed P mg/kg	Sample I.D.	Percent sorbed (%)	70% mg/kg
6.19	23.9	177.5	Whitehead & Assoc	74	195
22.69	48.9	262.2	Berkeley Road 1/1	54	
43.23	74.6	313.2		42	
64.03	100.9	368.7		37	
111.10	149.9	388.0		26	
6.85	23.9	170.9	Whitehead & Assoc	71	173
25.66	48.9	222.5	Berkeley Road 1/3	45	
49.62	74.6	249.3		33	
73.27	100.9	276.3		27	
124.00	149.9	259.0		17	
0.42	23.9	235.2	Whitehead & Assoc	98	452
8.56	48.9	403.5	Berkeley Road 3/1	82	
24.42	74.6	501.3		67	
42.76	100.9	581.4		58	
86.23	149.9	636.7		42	
1.00	23.9	229.4	Whitehead & Assoc	95	502
10.18	48.9	387.3	Berkeley Road 3/2	79	
23.12	74.6	514.3		69	
43.85	100.9	570.5		57	
87.81	149.9	628.9		42	
6.12	23.9	178.2	Whitehead & Assoc	74	169.3
24.43	48.9	244.8	Berkeley Road 5/1	50	
45.47	74.6	290.8		39	
67.53	100.9	333.7		33	
116.00	149.9	339.0		23	
6.82	23.9	171.2	Whitehead & Assoc	72	174
27.54	48.9	213.7	Berkeley Road 5/3	44	
50.39	74.6	241.6		32	
74.22	100.9	266.8		26	
123.40	149.9	265.0		18	

Dr Robert Patterson

Soil survey and analytical assessments, landscape analysis and plant nutrient relationships
Qualified ISO14000 environmental management systems consultants

Appendix D

Laundry Detergent Research

(Reproduced with the permission of Bob Patterson, Lanfax Laboratories Armidale)

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Lanfax Laboratories

Performance certified by Aust. Soil & Plant Analysis Council

LAUNDRY PRODUCTS RESEARCH

Laundry products were purchased by *Lanfax Labs* from supermarkets in Armidale, NSW and a number of boutique products were provided by manufacturers. A total of 41 liquids and 54 powders were tested by mixing each product at the manufacturer's recommended dose for either front loading or top loading automatic washing machines. The dose was calculated at the full cycle load, that is 75 L for front loaders and 150 L for top loaders. The full cycle accounts for the water used in the wash, spin, rinse, deep rinse and spin rinse cycle. The quantities of 75 L for front loaders and 150 L for top loaders were taken from averaged rates for those machines (Patterson, 2004).

Each sample was mixed with cold (20°C) deionised water (to replicate good quality rainwater). Where town water supplies are used, the values reported for sodium concentrations may increase because of sodium in the reticulated water – that will vary from location to location, usually higher in inland than coastal towns. Each sample was shaken for 30 minutes to replicate the washing action.

The concentrations of sodium and phosphorus (and other elements) were measured on the samples using Inductively Coupled Plasma (ICP) technology in accordance with current Good Laboratory Practices at *Lanfax Labs*.

Only sodium (g/wash) and phosphorus (mg/L) are reported in the graphs presented here.

Additional information on this unique research may be obtained at: **www.lanfaxlabs.com.au/laundry.htm**

Other papers on laundry detergents can be found at: www.lanfaxlabs.com.au/publications.html

HOW TO READ THE GRAPHS

Each product is represented by two bars: the top bar (if present) shows the phosphorus concentration (mg/L); while the lower bar shows the sodium load (g/wash). The graph is arranged in ranked order of sodium load. Figure F1 is for 54 detergents at the front loader rate, Figure T1 is for 89 detergents at the top loader rate.

Sodium Load

For all on-site systems that apply the effluent by surface or subsurface application, the levels of sodium in the discharge are critical to long term absorption. Choose the product with the lowest sodium load (g/wash). Levels above 20 g/wash are likely to be detrimental to plants and the soil although plant tolerance and soil types will vary. The shorter the bar, the lower the load. When in doubt, choose the lower sodium load.

The detergents with long sodium bars (greater than 20 g/wash) should not be thrown onto your favourite garden as the sodium may be detrimental to the plants. High pH (see the website for pH data) is also detrimental to plants and soil. The pH of liquids (average pH 8) is generally lower than pH of powder detergents (average pH 10.5).

Phosphorus Concentration

The choice of a suitable level of phosphorus in the greywater (laundry water discharge) will depend upon the soil type and the use of the effluent. In some soils, phosphorus is not a real concern because of the natural ability of the soil to immobilize the phosphorus and limit its leaching from the disposal site. In other soils, phosphorus is likely to build up to high levels and leach from the soil. It is preferable to choose the lower phosphorus values as well as the low sodium values. The load of phosphorus for each product is available in the website data.

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This research was funded by Lanfax Labs and was independent of any manufacturer or other organisation.

Soil survey and analytical assessments, landscape analysis and plant nutrient relationships
Independent research and commercial analytical laboratories. Environmental management consultants

Figure F1 - FRONT LOADING MACHINE CYCLE
Full wash cycle: Front loader = 75 L

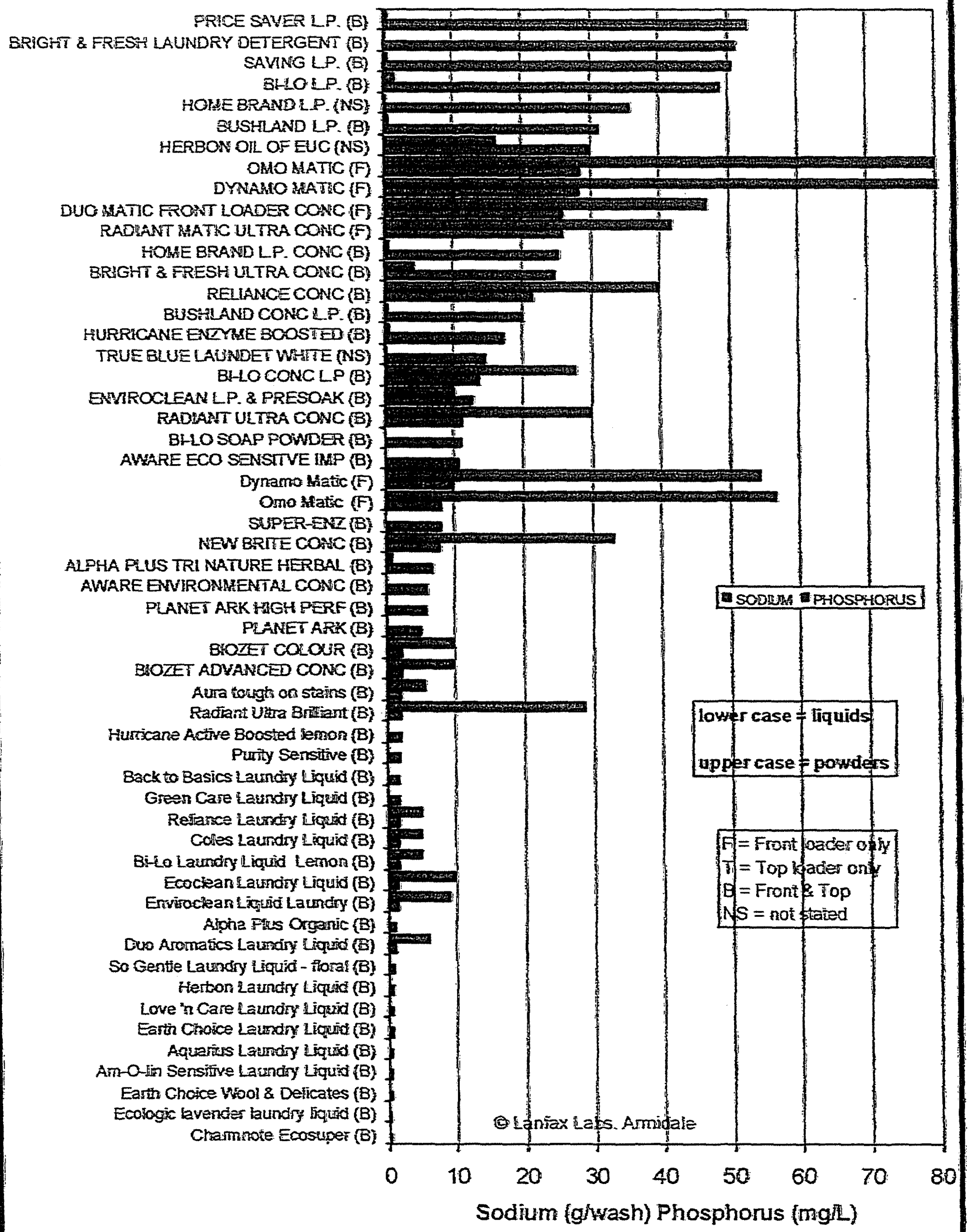

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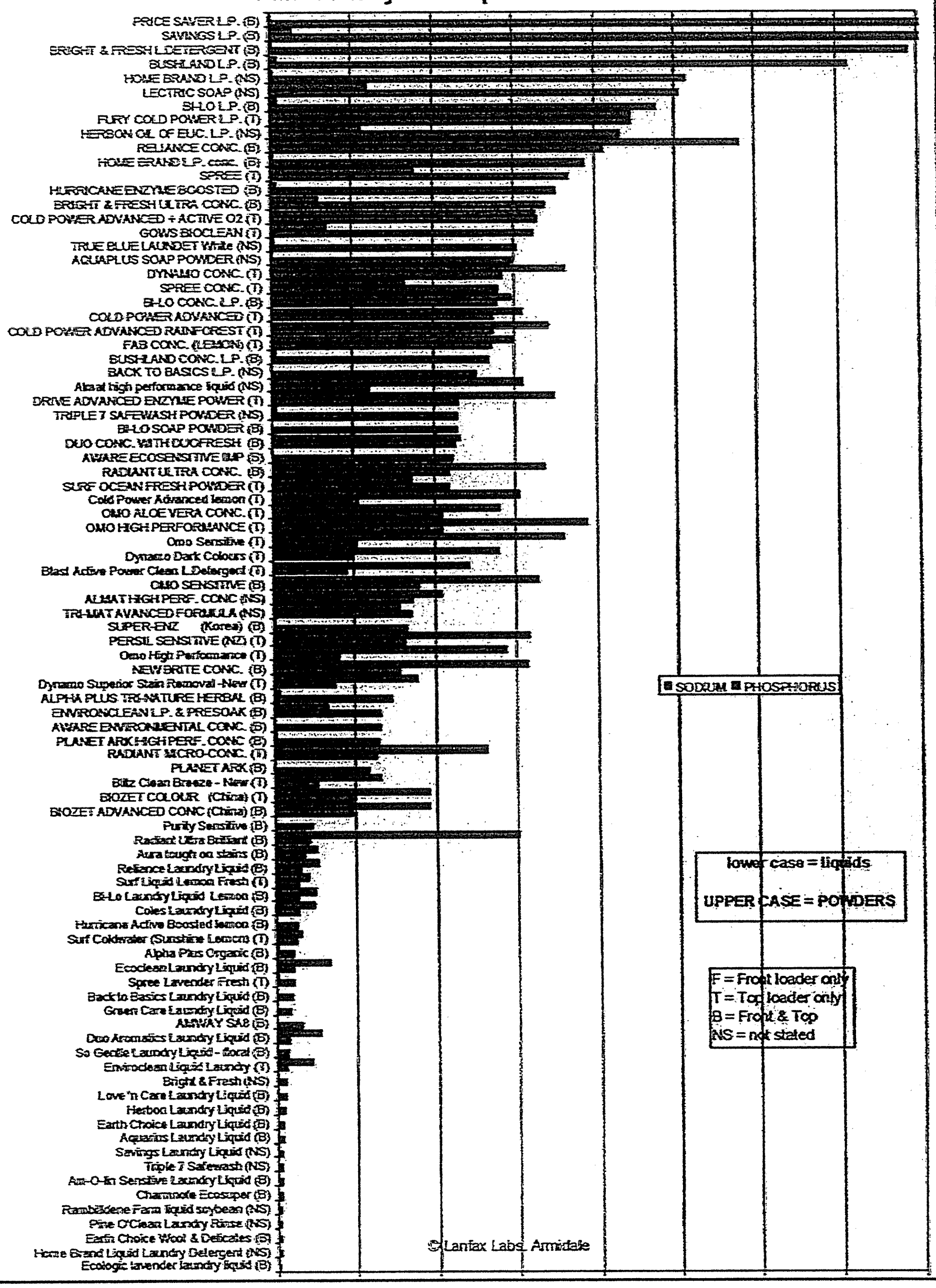
Figure T1 - TOP LOADING MACHINE CYCLE
Full wash cycle: Top loader = 150 L



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Appendix E

Irrigation Area Sizing (Water and Nutrient Balance)

Nominated Area Water Balance & Storage Calculations

Site Address: Berkeley Road Fountaindale

INPUT DATA

Design Wastewater Flow	Q	690	L/day	4br / 6 person house @ 115 L/p/day, tank water, water saving devices
Design Irrigation Rate	DI R	25	mm/week	taken from AS/NZS 1547:2000
Daily DIR		3.6	mm/day	
Nominated Land Application Area	L	450	m sq	
Crop Factor	C	0.7-0.8	unitless	
Retained Rainfall		0.9	unitless	fraction of rainfall that is absorpbed by the soil (less interception and runoff)
Rainfall Data	Berkeley Rd Data Drill, average			
Evaporation Data	Berkeley Rd Data Drill, average			

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R	\	mm/month	115	125	140	117	116	111	86	72	70	76	82	94	1204
Evaporation	E	\	mm/month	182	147	131	99	71	59	68	94	120	152	162	193	1478
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	146	118	105	69	50	41	48	66	84	122	130	154	1131.3
Percolation	B	(DIR/7)xD	mm/month	110.7	100	110.7	107.1	110.7	107.1	110.7	110.7	107.1	110.7	107.1	110.7	1303.6
Outputs		ET+B	mm/month	256.3	217.6	215.5	176.4	160.4	148.4	158.3	176.5	191.1	232.3	236.7	265.1	2434.9
INPUTS																
Retained Rainfall	RR	R*0.75	mm/month	103.5	112.5	126	105.3	104.4	99.9	77.4	64.8	63	68.4	73.8	84.6	1083.6
Effluent Irrigation	W	(QxD)/L	mm/month	47.5	42.9	47.5	46.0	47.5	46.0	47.5	47.5	46.0	47.5	46.0	47.5	559.7
Inputs		RR+W	mm/month	151.0	155.4	173.5	151.3	151.9	145.9	124.9	112.3	109.0	115.9	119.8	132.1	1643.3
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-105.3	-62.2	-42.0	-25.1	-8.5	-2.5	-33.4	-64.2	-82.1	-116.4	-116.9	-133.0	-237.9
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m²	140	164	239	291	382	426	264	191	162	130	127	118	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 426.4 m²

Nutrient Balance

Site Address: Berkeley Road Fountaindale

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 425 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	690	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68	mg/m²/day
Effluent N Concentration	30	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7	mg/m²/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	Phosphorus Sorption					
Total N Loss to Soil	4140	mg/day	P-sorption result	285	mg/kg	which equals	3420	kg/ha
Remaining N Load after soil loss	16560	mg/day	Bulk Density	1.2	g/cm³			
Effluent P Concentration	10	mg/L	Depth of Soil	1	m			
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal			

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	242	m²
Phosphorus	425	m²

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	450	m²
Predicted N Export from LAA	-5.21	kg/year
Predicted P Export from LAA	-0.15	kg/year
Phosphorus Longevity for LAA	55	Years
Minimum Buffer Required for excess nutrient	0	m²

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	450	m²			
Daily P Load	0.0069	kg/day	→ Phosphorus generated over life of system	125.925	kg
Daily Uptake	0.003082	kg/day	→ Phosphorus vegetative uptake for life of system	0.125	kg/m²
Measured p-sorption capacity	0.342	kg/m²			
Assumed p-sorption capacity	0.171	kg/m²	→ Phosphorus adsorbed in 50 years	0.171	kg/m²
Site P-sorption capacity	76.95	kg	→ Desired Annual P Application Rate	2.664	kg/year
			which equals	0.00730	kg/day
P-load to be sorbed	1.39	kg/year			

NOTES

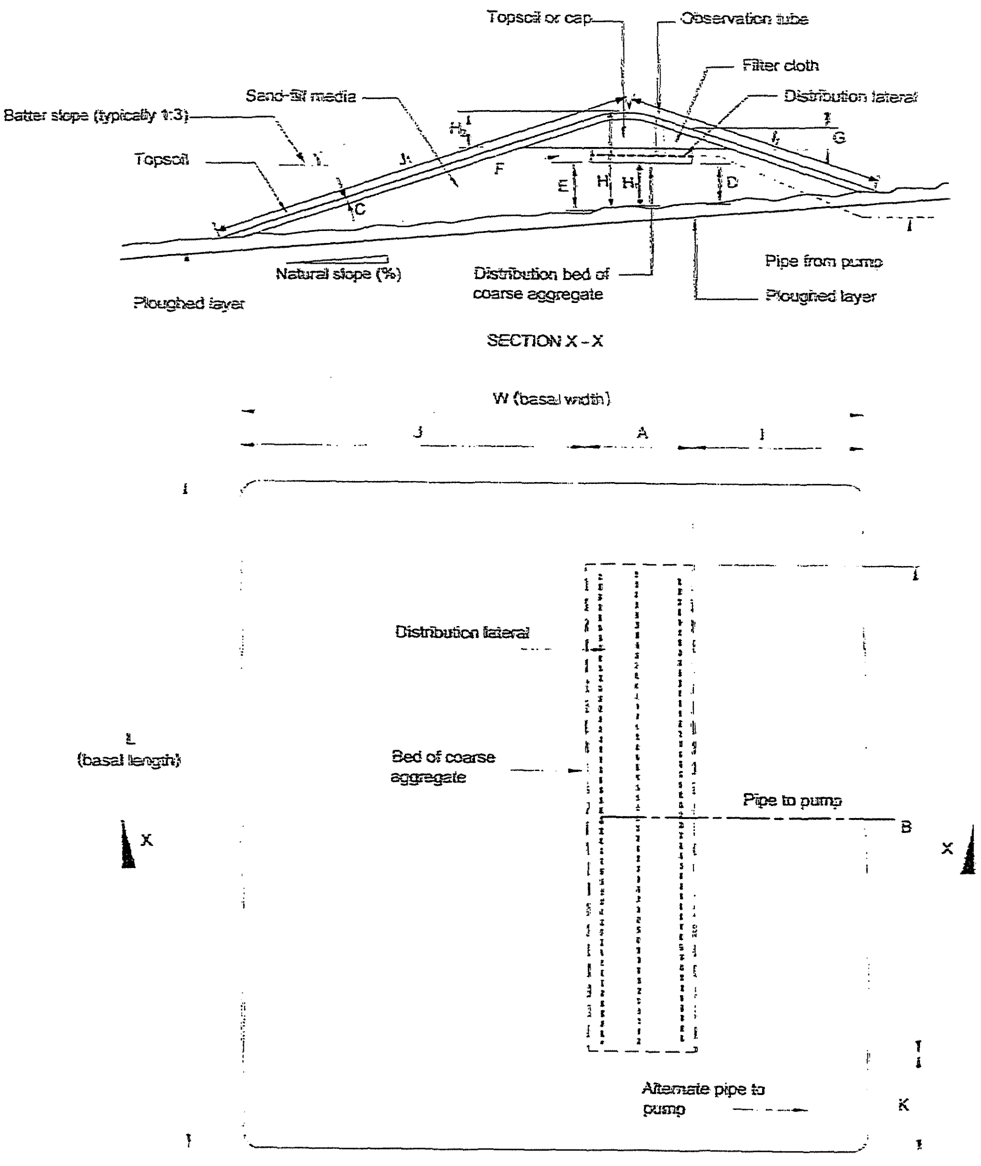
[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual*

[2]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Appendix F

Sand Mounds – General Information
(taken from AS/NZS 1547:2000)



LEGEND

Typical dimensions:

- A 1200 to 2000 mm
- B 6 to 8 times A
- D 400 mm minimum
- E 400 mm on flat ground, >600 mm on sloping ground
- F 225 mm
- G 200 mm minimum
- H 1.0 m minimum
- I Determined by natural slope and batter slope
- J Determined by natural slope and batter slope, equals I on flat ground
- K Determined by mound height and batter slope

* adapted from Figure 4.5B1 in AS/NZS 1547:2000

APPENDIX 4.5B

CONSTRUCTION OF MOUND SYSTEMS

(Normative)

4.5B1 SCOPE

This is an Appendix to Clause 4.5 of this Standard and sets out the construction and installation requirements for mound systems.

4.5B2 PRINCIPLE

An area of aggregate is used to distribute primary effluent onto the surface of the sand-fill media beneath (see Figure. 4.5B1). This sand filters the effluent and provides the within-mound treatment. The basal area of the mound covers the natural soil which then absorbs the filtered effluent.

4.5B3 CONSTRUCTION AND INSTALLATION

4.5B3.1 General

The ground surface and mound shall be constructed with care.

Comment. It is essential that both the ground surface and the mound itself are properly prepared and that attention is given to the details of mound design, if the mound system is to function properly.

4.5B3.2 Site protection

Before on-site construction work is commenced, the site shall be protected from vehicular traffic (to avoid compaction) and shall be isolated or marked out so that other nearby construction activity does not damage the area.

4.5B3.3 Construction preparation

Before construction commences:

(a) The site shall be cleared of shrubs and trees. Trees shall be cut at ground surface and the stumps removed and backfilled to natural surrounding soil conditions.

(b) The mound perimeter and bed shall be marked out in proper orientation.

Comment. Reference stakes set some distance from the mound perimeter are also required in case the corner markers are disturbed.

(c) The area within the mound perimeter shall be ploughed.

Comment. Use a twin or larger mouldboard plough, ploughing 18 – 20 cm deep. Single ploughs should not be used, as the trace wheel runs in every furrow, compacting soil. A chisel plough may be used in place of a mouldboard plough. Roughening the surface with backhoe teeth may be satisfactory. Rototilling is not recommended because of the damage it does to the soil structure.

(d) Ploughing shall not be done when the soil is too wet. This leads to smearing and compacting of the soil.

Comment. If a sample of the soil taken from the bottom of the plough furrow forms a wire when rolled between the palms, the soil is too wet. If it crumbles, ploughing may proceed.

4.5B3.4 Construction of the mound

The mound as illustrated in Figure 4.5B1, is built up of a sand-fill media with a distribution bed of selected aggregate containing the effluent distribution system covered with a fabric and topsoil. It shall be constructed as follows.

4.5B3.4.1 *Delivery pipe*

Install the delivery pipe from the dosing chamber so it may drain after dosing. Backfill and compact the soil around the pipe.

4.5B3.4.2 *Sand-fill media*

The sand-fill media shall be:

(a) Medium sand free of clay, limestone or organic material. It shall have a grain size of 0.3 to 1.0 mm with a uniformity coefficient of 4.

(b) Carefully placed onto the ploughed area and moved into place either manually or by using a small truck-type tractor with a blade.

Comment. It is essential to keep vehicles off the ploughed area and to have a minimum of 150 mm of material beneath the tracks of the tractor to minimize compaction of the natural soil.

(c) Built up until its height reaches the elevation of the top of the distribution bed.

4.5B3.4.3 *Distribution bed*

The distribution bed shall be:

(a) Formed in the top of the fill media. It shall have a level base and sides shaped to the specified slope. The base shall be at the design elevation.

Comment. The tractor blade may be used to form the distribution bed, which is then usually levelled and sides shaped by hand.

(b) Carefully filled with graded river run aggregate (20 to 60 mm, non-crushed, rounded) and levelled at a minimum depth of 150 mm.

Comment. In working the aggregate, do not create ruts in the bottom of the distribution bed.

4.5B3.4.4 *Effluent distribution network*

The effluent distribution network shall be assembled and connected to the delivery pipes (see Figure 4.5B1).

Comment. Assemble the distribution network on the aggregate. The manifold should be placed so it will drain between doses, either out of the laterals or back into the pumping main. The laterals should be laid level.

Polyethylene pipe complying with AS 2439, AS 2698, AS/NZS 4129 (Int), or AS/NZS 4130, or PVC Class 12 pipe complying with AS/NZS 1477 are suitable materials.

4.5B3.4.5 *Pre-commissioning tests*

A pre-commissioning test shall be carried out after all on-site components including the pump, have been installed but prior to covering the effluent distribution system in the distribution bed (see also Clause 4.5.6.2):

(a) Fill pump to 'pump-on' level with water;

(b) Start pump;

(c) Check effluent distribution pipework to ensure water flows uniformly from all perforations;

(d) Record time taken to pump from 'pump-on' level to the 'pump-off' level. This shall be approximately 3 minutes. Record time in the on-system log.

(e) Follow pump manufacturer's recommendations for commissioning pump;

(f) Check pumping main to ensure there are no leaks and that the air-release valve is functioning.

4.5B3.4.6 *Finish of distribution bed*

To finish the distribution bed:

(a) Additional aggregate shall be placed on the distribution bed to a total depth of 225 mm.

(b) A suitable backfill barrier shall be installed over the aggregate such as a filter cloth.

(c) A fine textured soil material such as silt loam shall be placed over the top of the distribution bed to a depth of approximately 300 mm with thickness reducing towards the sides.

(d) A further 150 mm (minimum) layer of good quality topsoil shall be placed over the entire mound surface.

(e) The mound surface shall be grassed using grasses adapted to the area. Shallow rooting ground cover can be planted around the base and up the side slopes.

Comment. Shrubs planted around the base of the mound should be tolerant of moisture, as mound perimeter may become moist. Planting on top of the mound should be drought-tolerant, as the upper portion of the mound can become dry.

4.5B4 COMMISSIONING

The on-site wastewater system shall be inspected, checked and commissioned according to Clause 4.5.6.

4.5B5 REPORTING

An installation and commissioning report shall be produced to include the 'as-built' details following construction, the results of construction inspections and the commissioning process. This report shall be provided to the owner of the wastewater system and to the approval authority, if required (see Clause 4.5.6.4).

Appendix G

Sand Mounds – Sizing Information

Sand Mound Sizing Sheet

Site Address: Berkeley Rd Fountaindale

Scenario:

Notes for using this Sheet:
1. The reference notes numbered below are provided in the accompanying explanation sheet.
2. User-input variables are in green cells. Values in red text are calculated - do not modify!

Notes	Site Data	Symbol	Formula	Value
	Daily wastewater load (L/day)	W		690
	Effluent Quality (P = primary, S = secondary)	Q		S
	Soil texture (topsoil)			Sandy loam
1	Soil depth to limiting layer (m)	SD		0.5
2	Natural slope across basal area (%)	NS		5.0
3	Natural slope in radians (rad)	α		0.0
4	Recommended basal loading rate (mm/day)	BLR		24.0
5	Recommended linear loading rate (L/m/day)	LLR		70.0
6	Recommended minimum separation from limiting layer (m)	SLL		0.6
7	Sand loading rate at gravel-sand interface (mm/day)	SLR		50.0
	Calculations	**Symbol**	**Formula**	**Value**
8	Recommended mound batter slope (H:V) (e.g. 3, 2.5)	BS	nominated	3.00
	Batter slope in radians (rad)	ϕ		0.32
	Gravel bed dimensions:			
	Length (m)	B	W / LLR	9.86
	Width (m)	A	LLR / SLR	1.40
	Thickness (m)	F	nominated	0.30
9	Minimum capping over gravel at the edges (m)	G	nominated	0.15
10	Topsoil cover all over (m)	C	nominated	0.10
11	Recommended minimum sand depth (upslope) (m)	D_u	SLL - SD; min. 0.6 for primary effluent (0.4 for secondary)	0.40
	Downslope mound fill depth (m)	D_d	D_u + (NS × A)	0.47
	Fill depth at centre of gravel bed (m)	D_c	$(D_u + D_d) / 2$	0.44
12	Theoretical capping depth at centre of peaked mound (m)	P_t	G + [(A/2) / BS]	0.38
	Acceptable minimum capping depth for a slightly rounded crest (m)	P	nominated	0.30
	Total mound height for a perfectly peaked mound (m)	H_t	$D_c + P_t + F$	1.12
	Total mound height with minimum capping depth (m)	H	D_c + P + F	1.04
13	Upslope mound width, from geometry (m)	I_g	geometric calculation	2.22
14	Upslope mound width, from hydraulics (m)	I_h	If NS=0, I_h=(LLR/BLR-A)/2, IF NS>0, calc. I from geometry	n/a
15	Upslope mound width - larger of I_g and I_h (m)	I		2.22
	Endslope mound width, from geometry (m)	K	BS × (D_c + F + G)	2.66
16	Downslope mound width, from geometry (m)	J_g		3.25
17	Minimum downslope mound width, from hydraulics (m)	J_h	If NS=0, J_h=I_h; If NS>0, J_h=(LLR / BLR) - A	1.52
18	Downslope mound width - larger of J_g and J_h (m)	J		3.25
	Mound Dimensions (all in m)			
	ABSORPTION BED:			
	Absorption bed width:	A		1.4
	Absorption bed length:	B		9.9
	Absorption bed thickness:	F		0.3
	MOUND:			
	Basal width:	W	I + A + J	6.9
	Basal length:	L	B + (2 × K)	15.2
	Total height:	H	D_c + P + F	1.0
	Upslope mound width:	I		2.2
	Downslope mound width:	J		3.2
	Endslope mound width:	K		2.7

Explanation of Factors in the Sand Mound Sizing Sheet	
Note	**Details**
1	Average depth of natural soil over limiting layer, which may be bedrock (>50%), clay horizon, hardpan or high watertable.
2	Record the average slope within the likely footprint of the mound.
3	Slope angle is converted to radians for subsequent trigonometric calculations.
4	The basal design loading rate (DLR) should be selected from AS/NZS 1547:2000, Table 4.2.A3. Normally this will be based on the hydraulic properties of the topsoil, but if topsoils are shallow subsoil properties may be more appropriate. The BLR is used to size the basal area, which equals A + J on a sloping site and A + I + J on a flat site (where I=J).
5	The linear loading rate (LLR) relates to the hydraulic loading rate across the slope, parallel to the donwnslope toe of the mound. The acceptable LLR is a function of the land slope and vertical infiltration characteristics. On sites where the movement of water beneath the mound will be primarily vertical (i.e. free draining soils and relatively shallow sloeps), a relatively high value is acceptable. On sites where vertical infiltration is restricted and horizontal (lateral) movement may be expected, a lower LLR is required. The range of normally acceptable LLR values is 50-125 mm/m/day.
6	The recommended separation distance between the absorption area (the base of the gravel bed) and a limiting layer is 1.5m for primary treated effluent and 1.0m for secondary treated effluent. By adding sufficient depth of sand to the depth of natural soil, the required separation distance is acheived.
7	The recommended loading rate for sand at the gravel/sand interface is 35 mm/day for primary treated effluent and 50 mm/day/ for secondary treated effluent. These values are taken from AS/NZS 1547:2000.
8	If batters are to be mown batter slopes should not exceed 3(horizontal):1(vertical). Steeper batters may be considered as long as appropriate landscaping is undertaken and the area can be properly maintained. Under no circumstances should the batter angle exceed 2:1.
9	A minimum thickness of material is required over the gravel bed to prevent its accidental exposure and also to ensure that wastewater does not escape out the side of the mound. AS/NZS 1547:2000 suggests a nominal minimum thickness of 300 mm, although 200 mm would be acceptable in many cases and will help to keep the mound size down.
10	A minimum topsoil depth of 100 mm is recommended over the entire mound. This provides growing media for the vegetation on the mound (turf). A garden quality topsoil should be used that is high in organics, sandy loam to loam texture, low in clay and free of coarse fragments. The topsoil will almost certainly have to be imported.
11	The minimum depth of filter sand beneath the gravel bed is 400 mm for mounds receiving secondary treated effluent, and 600 mm for primary effluent.
12	The capping depth assumes the mound is formed to a peak. Alternately, the mound can be rounded off to some extent but should retain sloping sides to maximise shedding of rainfall. Flat surfaces on top of the mound are not recommended.
13	Calculated by geometry, based on the slope of the batters, mound height and natural slope.
14	Only relevant on flat slopes where I = J and the basal area equals A + I + J. I does not contribute to the basal area on sloping sites.
15	The upslope width is normally based on geometry.
16	Calculated by geometry, based on the slope of the batters, mound height and natural slope.
17	On sloping sites the basal area is A + J. The figure calculated by geometry will normally be larger than the area determined hydraulically.
18	The downslope width is selected as the larger of that required by the hydraulic balance (to ensure adequate basal absorption area) and from the mound geometry.

Appendix H

Advice for Managing Your Land Application Area

(reproduced from DLG, 1998)

* Information taken from DLG (1998)

Maintaining your land application area

The effectiveness of the application area is governed by the activities of the owner.

DO

- ✓ Construct and maintain diversion drains around the top side of the application area to divert surface water.
- ✓ Ensure that your application area is kept level by filling any depressions with good quality top soil (not clay).
- ✓ Keep the grass regularly mowed and plant small trees around the perimeter to aid absorption and transpiration of the effluent.
- ✓ Ensure that any run off from the roof, driveway and other impermeable surfaces is directed away from the application area.
- ✓ Fence irrigation areas.
- ✓ Ensure appropriate warning signs are visible at all times in the vicinity of a spray irrigation area.
- ✓ Have your irrigation system checked by the service agent when they are carrying out service on the treatment system.

DON'T

- ✗ Don't erect any structures, construct paths, graze animals or drive over the land application area.
- ✗ Don't plant large trees that shade the land application area, as the area needs sunlight to aid in the evaporation and transpiration of the effluent.
- ✗ Don't plant trees or shrubs near or on house drains.
- ✗ Don't alter stormwater lines to discharge into or near the land application area.
- ✗ Don't flood the land application area through the use of hoses or sprinklers.
- ✗ Don't let children or pets play on land application areas.
- ✗ Don't water fruit and vegetables with the effluent.
- ✗ Don't extract untreated groundwater for potable use.

Warning signs

Regular visual checking of the system will ensure that problems are located and fixed early.

The visual signs of system failure include:

- surface ponding and run-off of treated wastewater
- soil quality deterioration
- poor vegetation growth
- unusual odours

Volume of water

Land application areas and systems for on-site application are designed and constructed in anticipation of the volume of waste to be discharged. Uncontrolled use of water may lead to poorly treated effluent being released from the system.

If the land application area is waterlogged and soggy the following are possible reasons:

- Overloading the treatment system with wastewater.
- The clogging of the trench with solids not trapped by the septic tank. The tank may require desludging.
- The application area has been poorly designed.
- Stormwater is running onto the area.

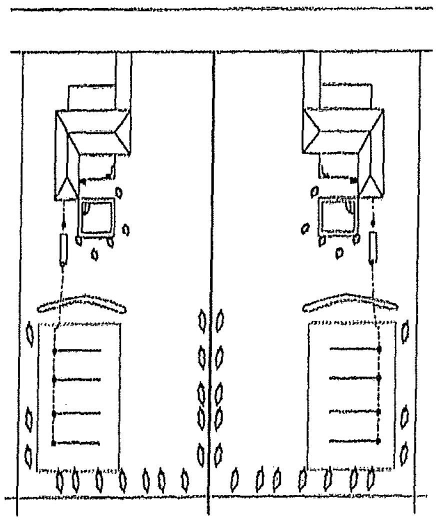
HELP PROTECT YOUR HEALTH AND THE ENVIRONMENT

Poorly maintained land application areas are a serious source of water pollution, and may present health risks, cause odours and attract vermin and insects.

By looking after your sewage management system you can do your part in helping to protect the environment and the health of you and your family.

For more information please contact:

Your Land Application Area



* Information taken from DLG (1998)

LAND APPLICATION AREAS

The reuse of domestic wastewater on-site can be an economical and environmentally sound use of resources.

What are land application areas?

These are areas that allow treated domestic wastewater to be managed entirely on-site.

The area must be able to utilise the wastewater and treat any organic matter and wastes it may contain. The wastewater is rich in nutrients, and can provide excellent nourishment for flower gardens, lawns, certain shrubs and trees. The vegetation should be suitably tolerant of high water and nutrient loads.

How does a land application area work?

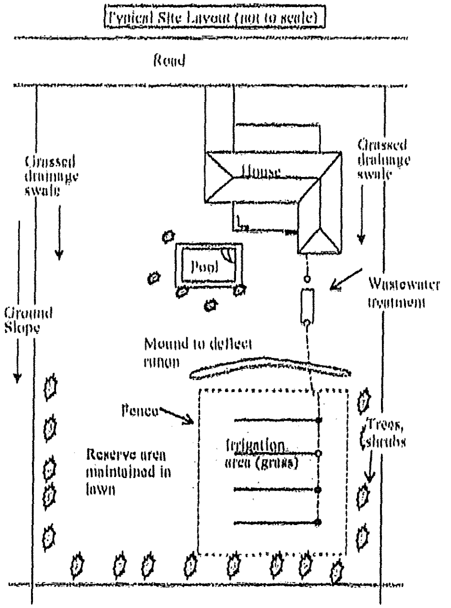
Treated wastewater applied to a land application area may be utilised or simply disposed, depending on the type of application system that is used. The application of the wastewater can be through a soil absorption system (based on disposal) or through an irrigation system (based on utilisation).

Soil absorption systems do not require highly treated effluent, and wastewater treated by a septic tank is reasonable as the solids content in the effluent has been reduced. Absorption systems release the effluent into the soil at a depth that cannot be reached by the roots of most small shrubs and grasses. They rely mainly on the processes of soil treatment and then transmission to the water table, with minimal evaporation and up-take by plants. **These systems are not recommended in sensitive areas as they may lead to contamination of surface water and groundwater.**

Irrigation systems may be classed as either subsurface or surface irrigation. If an irrigation system is to be used, wastewater needs to be pre-treated to at least the quality produced by an aerated wastewater treatment system (AWTS).

Subsurface irrigation requires highly treated effluent that is introduced into the soil close to the surface. The effluent is utilised mainly by plants and evaporation.

Surface irrigation requires highly treated effluent that has undergone aeration and disinfection treatments, so as to reduce the possibility of bacteria and virus contamination.



The effluent is then applied to the land area through a series of drip, trickle, or spray points which are designed to eliminate airborne drift and run-off into neighbouring properties.

There are some public health and environmental concerns about surface irrigation. There is the risk of contact with treated effluent and the potential for surface run-off. Given these problems, subsurface irrigation is arguably the safest, most efficient and effective method of effluent utilisation.

Regulations and recommendations

The design and installation of land application areas should only be carried out by suitably qualified or experienced people, and only after a site and soil evaluation is done by a soil scientist. Care should be taken to ensure correct buffer distances are left between the application area and bores, waterways, buildings, and neighbouring properties.

Heavy fines may be imposed under the Clean Waters Act if effluent is managed improperly.

At least two warning signs should be installed along the boundary of a land application area. The signs should comprise of 20mm high Series C lettering in black or white on a green background with the words:

RECLAIMED EFFLUENT
NOT FOR DRINKING
AVOID CONTACT

Depending on the requirements of your local council, wet weather storage and soil moisture sensors may need to be installed to ensure that effluent is only irrigated when the soil is not saturated.

Regular checks should be undertaken of any mechanical equipment to ensure that it is operating correctly. Local councils may require periodic analysis of soil or groundwater characteristics

Humans and animals should be excluded from land application areas during and immediately after the application of treated wastewater. The longer the period of exclusion from an area, the lower the risk to public health.

The householder is required to enter into a service contract with the installation company, its agent or the manufacturer of their sewage management system, this will ensure that the system operates efficiently.

Location of the application area

Treated wastewater has the potential to have negative impacts on public health and the environment. For this reason the application area must be located in accordance with the results of a site evaluation, and approved landscaping must be completed prior to occupation of the building. Sandy soil and clayey soils may present special problems.

The system must allow even distribution of treated wastewater over the land application area.

ATTACHMENT 11

WATER SERVICE EXTENSION INVESTIGATION

Chris Oliver

From: Matt Smith [matt@everittsurveyors.com.au]
Sent: Monday, 18 July 2011 1:19 PM
To: optima developments; optima developments
Subject: FW: Watermain extension - Lot 23 DP1159704 - Berkeley Road, Fountaindale
Attachments: 16984wsc.lt3.pdf

Chris

Please find attached our letter to Council regarding water servicing at Berkeley Rd, and below Council's response.

Regards

Matthew Smith
Registered Surveyor B.Surv.(Hons.)

Everitt & Everitt Consulting Surveyors
Surveying~Planning~Engineering~Project Management
ph (02) 43521419 f (02) 43512437
Po Box 198 Wyong NSW 2259, DX 7314 Wyong

From: Stewart, Adam [mailto:ACStewart@wyong.nsw.gov.au]
Sent: Monday, 18 July 2011 12:16 PM
To: Matt Smith
Subject: Watermain extension - Lot 23 DP1159704 - Berkeley Road, Fountaindale

Matt,

I refer to your letter dated 6 July 2011 and drawing (ref: 16984, sheet 1, and dated 4/7/2011) detailing the proposed watermain extension in Berkeley Road. The concept has been reviewed and is considered generally satisfactory with some amendments, which are; the deletion of the watermain on the north side of Berkeley Road (and road crossing), and the provision of a loop at the western extent of the proposed watermain. The final arrangement of the loop and provision of water fittings can be discussed with the preparation of the detailed design. The environmental impact of providing the watermain must be discussed in the supporting documentation submitted with the rezoning application.

Water supply contributions are applicable for connection into the Berkeley Vale water supply area, and currently levied at a rate of $1619.85 per lot. As you are aware, this rate is indexed annually on the 1st July.

Please do not hesitate to contact me if you require any further clarification

Kind regards,

Adam Stewart
Senior Development Engineer
Development Engineering
Wyong Shire Council
P.O. Box 20 , WYONG NSW 2259
Tel: 02 4350 5514 Fax: 02 4351 2098
E-mail: Adam.Stewart@wyong.nsw.gov.au WWW: http://www.wyong.nsw.gov.au/

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Senior Staff
Matthew R. Smith
Registered Surveyor
B.Surv. (Hons).

REF:mrs:jr/16984wsc.lt3
6 July 2011

Wyong Shire Council
PO Box 20
WYONG NSW 2259

Attention: Water and Sewage

Re: Lot 23 DP 1159704
Berkeley Road, Fountaindale

Dear Sir/Madam

Our client currently has a rezoning request lodged with Council (RZ/15/2009) for the abovementioned property.

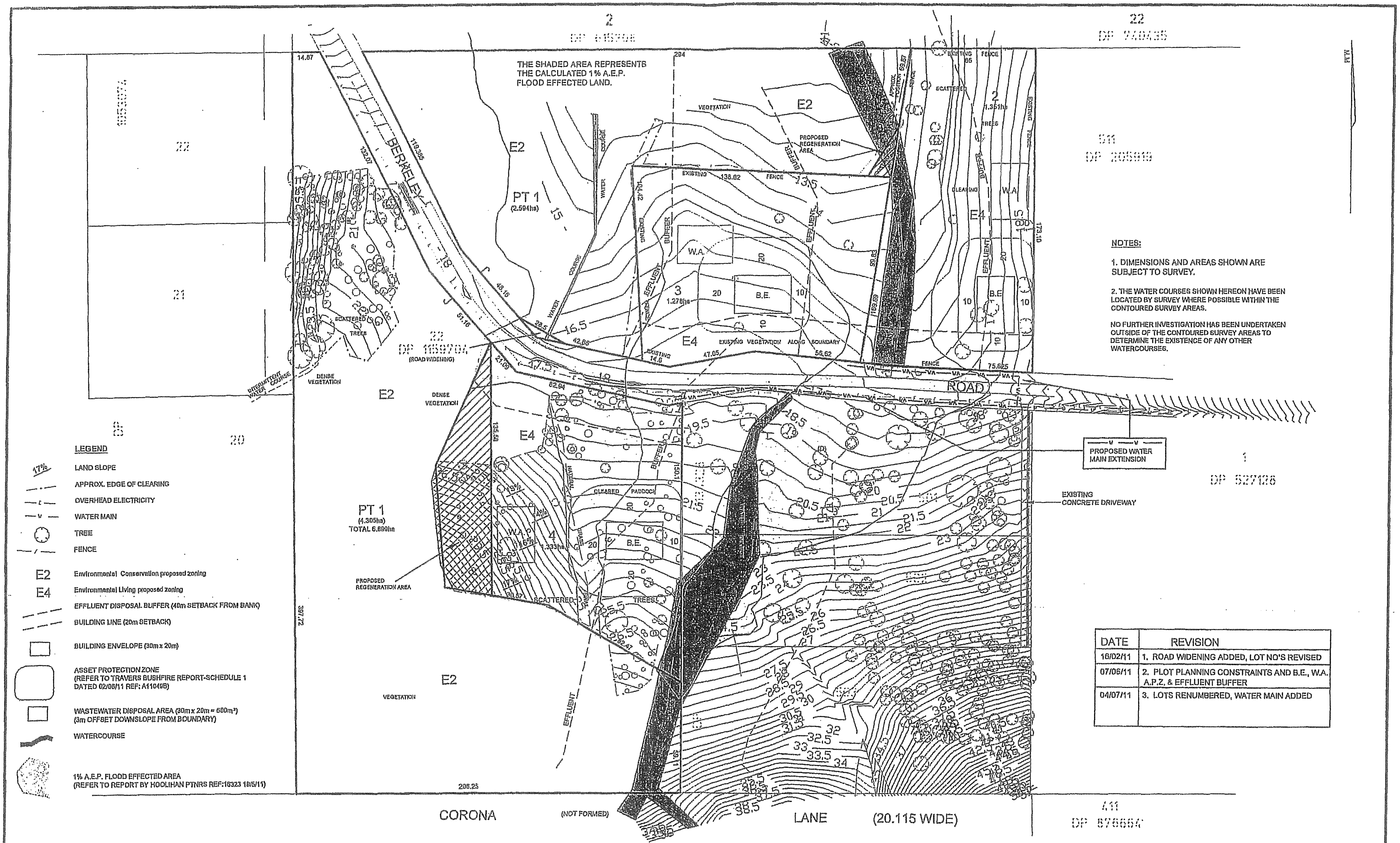
In Council's correspondence dated 27.10.2010 various additional information was requested including further advice regarding water connection.

The existing water main currently terminates at the north eastern corner of Lot 501 DP 1134328 and during the recent upgrade of Berkeley Road a conduit and poly pipe was placed across the road to the northern side.

Could you please advise if it would be possible to extend the existing water main as shown on the attached plan to service the proposed lots.

Yours faithfully
EVERITT & EVERITT Consulting Surveyors

....
Matthew R Smith
B.Surv.(Hons.).
Surveyor Registered under the Surveying and Spatial Information Act 2002.



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PROJECT

HAPIDO PTY LTD
TSM PTY LTD
LOT 23 DP 1159704
BERKELEY RD FOUNTAINDALE

SHEET 1

PLAN OF PROPOSED SUBDIVISION

CAD File: 16984SUBREV2

SCALE: 1:2000 (A3)
DATUM: AHD
REFERENCE: 16984
DRAWN: DB
CHECKED: BE
DATE: 27/06/08