Onsite Wastewater Management Report

for

proposed subdivision at

Hawthorne Rd, Bargo

Prepared by:

Mark Passfield and Adam Bishop

14 May 2004

Document Certification

I hereby declare that I have prepared this Onsite Wastewater Management Report following the standards and guidelines set out in the following documents, where applicable:

(i) Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households (Department of Local Government, 1998);

(ii) AS/NZS 1547: *On-site Domestic Wastewater Management* (Standards Australia / Standards New Zealand, 2000); and

(iii) Draft Local Approvals Policy for New Installations of On-Site Management Systems for Residential Dwellings (Wollondilly Shire Council, November 1998)

To my knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an honest appraisal of the sites opportunities and constraints, subject to the limited scope and resources available for this project.

Mark Passfield
Geotechnical Engineer
Morse McVey & Associates Pty Ltd
14 May 2004

Picton Office:
PO Box 138, Picton, NSW 2571
ph: (02) 4677 1668 • email: abishop@morsemcvey.com.au

Nowra Office:
PO Box 3092, North Nowra, NSW 2541
ph: (02) 4423 2822 • email: nowra@morsemcvey.com.au

Contents

Executive Summary

Morse McVey & Associates have been engaged to assess site suitability for onsite wastewater management, based on a proposed rezoning and subdivision of lands at the southern end of Hawthorne Rd, Bargo (figure 1, the "site"). The subdivision involves ¼ acre lots for land fronting Avon Dam Road with minimum 1 acre lots for remaining lands. The ¼ acre lots will be serviced by pumpout, while the larger lots require an onsite wastewater management system.

Based on a detailed site and soil assessment, we recommend that the site has good opportunity for sustainable onsite wastewater management and in this regard the subdivision is supported. This report makes recommendations for wastewater management on each allotment that meet all the understood requirements of Council and other regulatory bodies. The assessment is based on one acceptable option for wastewater management, i.e. an aerated wastewater treatment system (AWTS) with irrigation. If future owners wish to use an alternative system, additional design work is required and Morse McVey & Associates will be pleased to help. This additional work would be the subject of a separate consultancy.

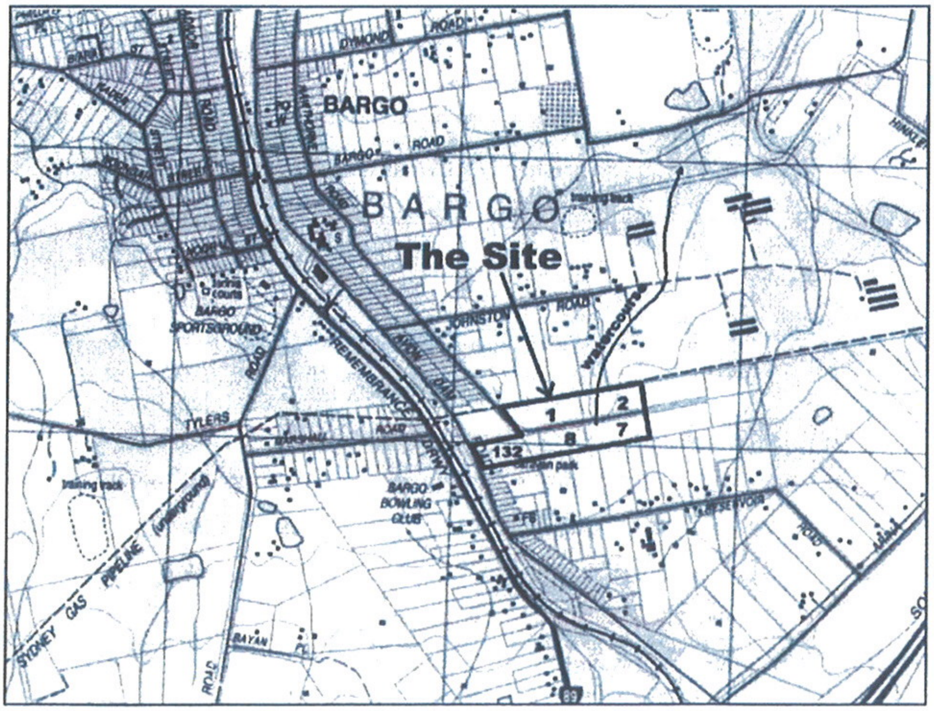


Figure 1 Locality Plan

1 Site Evaluators

Company: Morse McVey and Associates Pty Ltd
Job Ref: 036039
Name: Mark Passfield and Adam Bishop
Address: PO Box 138 Picton, NSW 2571 (1st Floor NAB Building, Cnr Menangle & Argyle Streets, Picton)
Phone: (02) 4677-1668 Fax: (02) 4677-1709
Date of assessment: 7 May 2004
Signature:

2 Site Identification

Address: Lots 1, 2, 7, 8, and 132 Hawthorne Rd, Bargo

Council area: Wollondilly Shire Council

Developer: Mr Micheal Avinou

Contact Phone: 0407 224 563

Contact Postal Address: Lot 1B Hawthorne Rd, Bargo

Proposed Development: Subdivision into ¼ acre and 1 acre lots (figures 2 to 6)

Intended Water Supply: Reticulated (town) water supply available

Assessment Criteria:

- *Draft Local Approvals Policy for New Installations of Onsite Management Systems for Residential Dwellings* (Wollondilly Shire Council, 1998)
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households* (Department of Local Government, 1998)
- AS/NZS 1547:2000 *On-site Domestic Wastewater Management* (Standards Australia / Standards New Zealand, 2000)

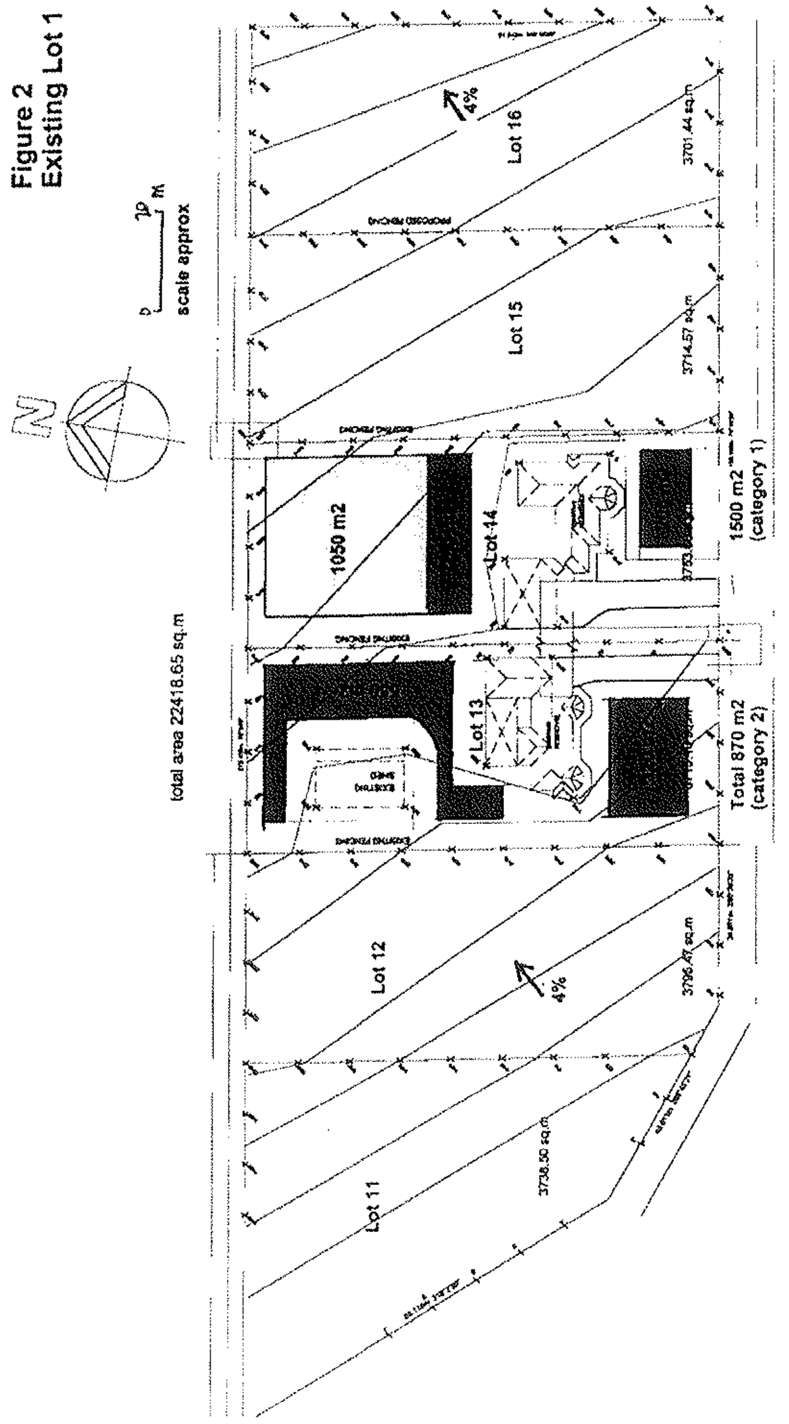


Figure 2 - Existing Lot 1

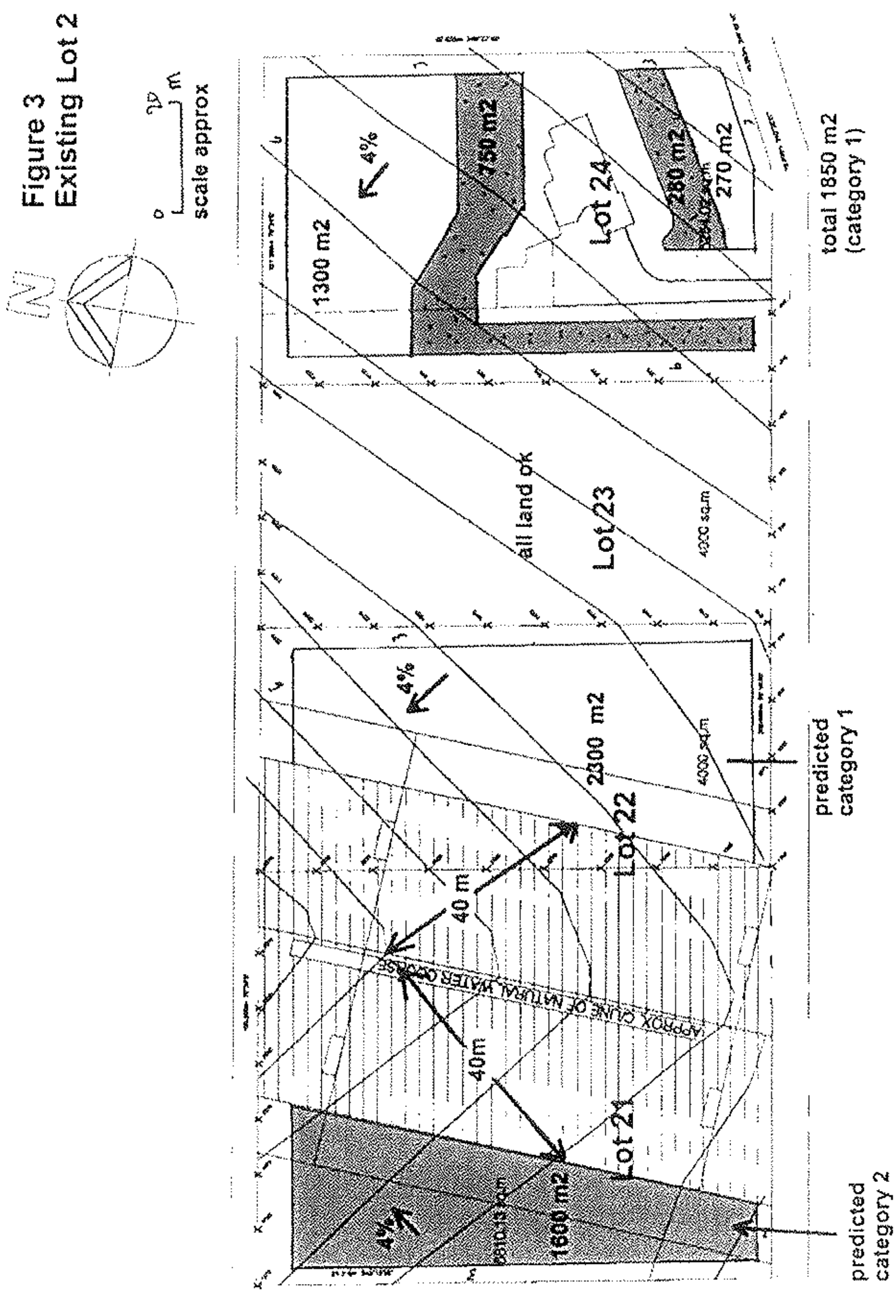


Figure 3 - Existing Lot 2

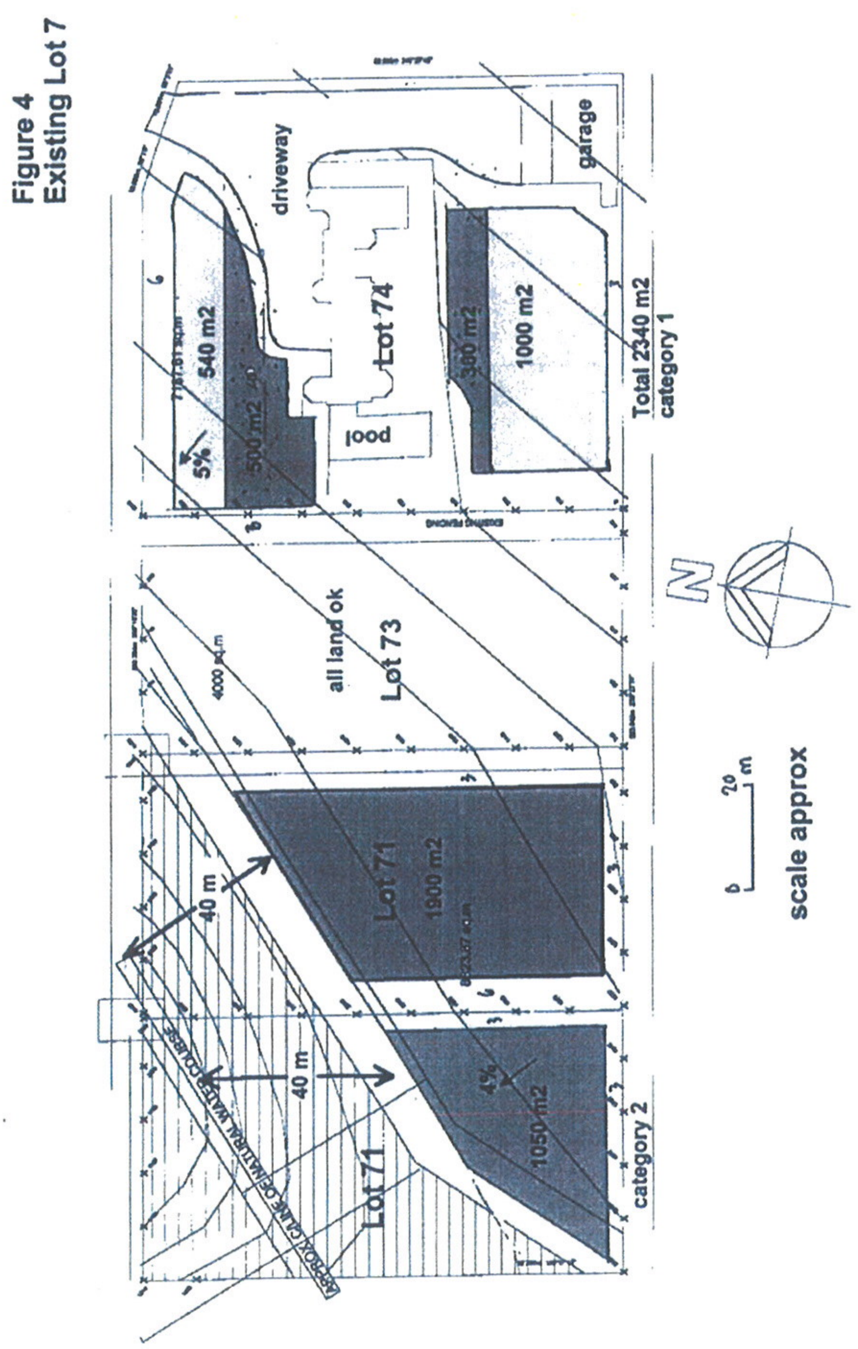


Figure 4 - Existing Lot 7

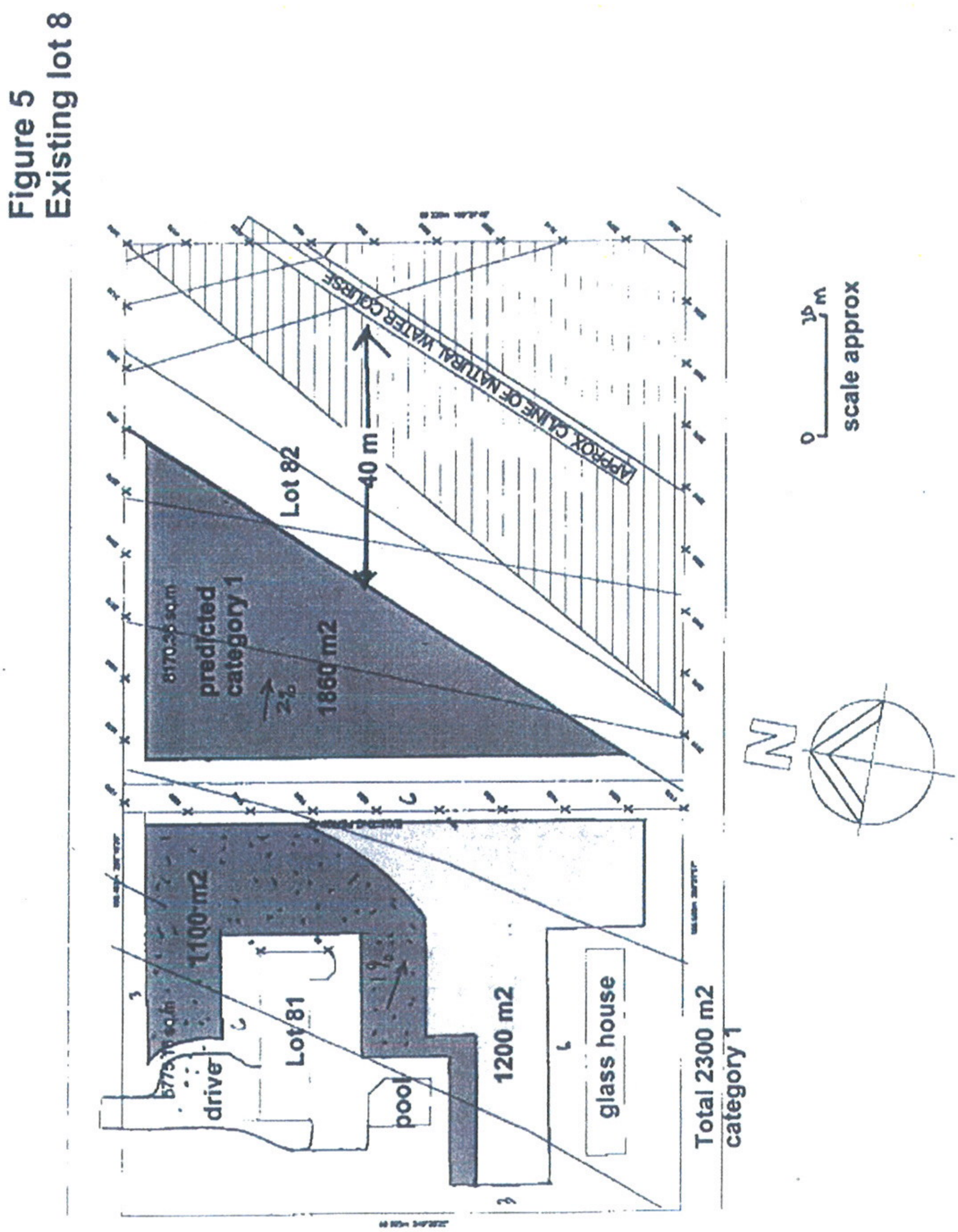


Figure 5 Existing Lot 8

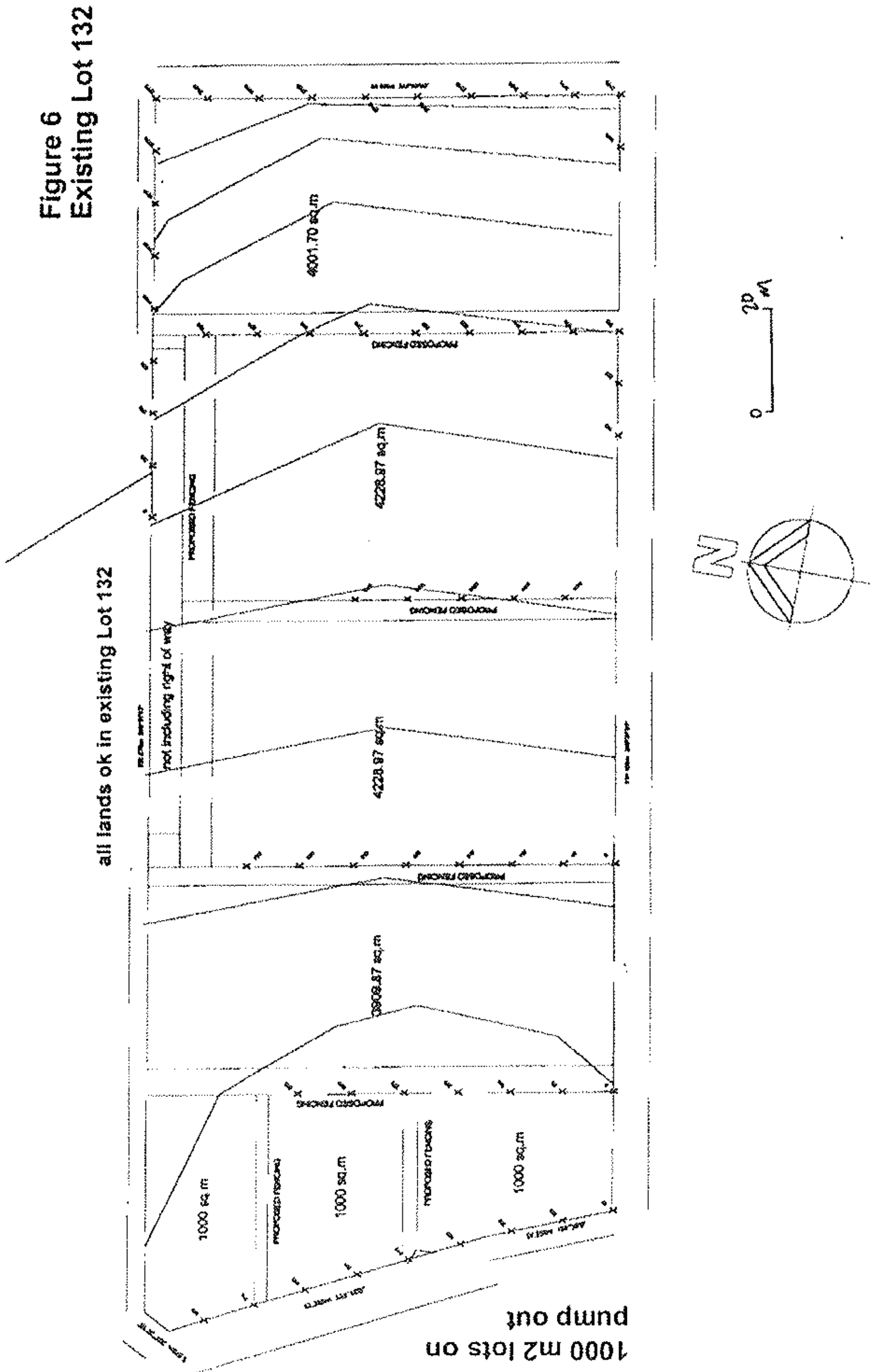


Figure 6 Existing Lot 132

3 Site Assessment

3.1 Introduction

The site and soil assessment sections contain the results of a detailed site investigation by Adam Bishop on 27 February 2003 and 28 March 2003. The assessment has been undertaken following Tables 4 and 6 in the *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households* (Department of Local Government, 1998), which describes a rating system for onsite effluent management facilities (Appendix A). Our investigation focuses only on the larger (1 acre minimum) lots, a site investigation being unnecessary for the smaller lots where pumpout is proposed.

A range of possible site constraints are considered including, but not limited to:-

- proximity to permanent and intermittent watercourses;
- landform, site gradient and drainage characteristics;
- aspect and exposure;
- extent of surface rock outcrop;
- existing native vegetation; and
- climate of the area

The following sections provide a brief commentary on the levels of constraint for onsite effluent disposal across the site. Comments relate to the site generally, but in some cases comments are made about specific lots.

3.2 Climate

Climatic data is taken from the closest available rainfall and evaporation gauging stations. The Bargo area possesses a cool temperate climate with annual median rainfall of 897.2 mm [Station number 68166 - Buxton Rainfall Station (1967-Present; 34° 14'42" S, 150° 31'14" E; Elev. 420 m)], 96 wet days per year, median annual pan evaporation of 1557 mm (Picton Composite Data), temperatures below 15°C in winter.

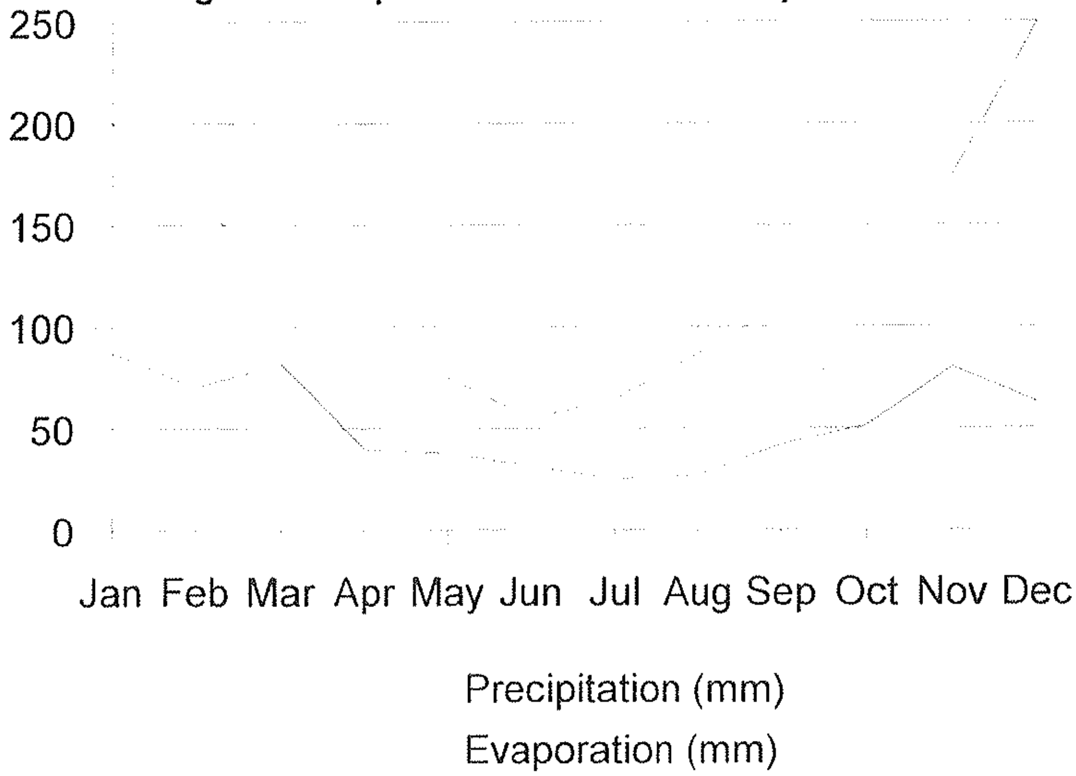
The climate of the area provides a minor limitation to onsite effluent management. Monthly pan evaporation exceeds rainfall throughout the year and this will allow good potential for evapotranspiration of treated effluent.

Table 1 summarises median monthly rainfall, average pan evaporation and number of wet days for Buxton. Figure 7 shows monthly evaporation and precipitation graphically.

Table 1 Climatic Summary for Buxton

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)	87.3	70.3	81.6	39.9	37.9	31.7	25	27	42.2	51.6	80.2	63	897.2
Evaporation (mm)	200	160	130	100	75	55	65	87	110	150	175	250	1557
Rain Days (number)	11	9	9	4	8	5.5	5.5	7	7	7.5	10	9	96

Figure 7: Graph of rainfall and Pan Evaporation - Buxton



3.3 Proximity to Surface Waters
The site contains an intermittent watercourse that crosses Lot 8, then Lot 7 and then extends roughly in a north/northeast direction through Lot 2, and then offsite. We recommend a 40 m buffer between the watercourse and any effluent management areas, to meet Council requirements; moderate limitation.

3.4 Flood Potential
We are not aware of any flood study having been undertaken on the property. Land within and immediately surrounding the watercourse is subject to flooding. This area should be avoided for building and effluent management purposes. We estimate that a 40 m buffer from the watercourse should be adequate to ensure all effluent management areas and electrical components are above the 100 year ARI flood level, though flood modelling would be necessary to confirm this; minor limitation.

3.5 Run-on and Seepage
In areas outside the main watercourse run-on and up-slope seepage is minor, due to small upslope catchments, low slopes and good vegetative cover; minor limitation.

3.6 Site Drainage
Moderate to high infiltration with minor to moderate downslope runoff, moisture tolerant vegetation such as tea-trees occur in the drainage line, but not elsewhere; minor limitation.

3.7 Groundwater
We observed no signs of groundwater seepage across the site. The site's soils show no signs of a seasonal high watertable above 700 mm depth - soils tend to be whole coloured with little or no mottling. Generally, the risk of shallow groundwater pollution is considered low.

The 1:250,000 map of groundwater vulnerability for the Hawkesbury - Nepean Catchment (DLWC, 1997) was consulted. Groundwater beneath the site is mapped as having a *Low* vulnerability.

Registered bore information was sourced from the NSW Department of Land and Water Conservation (DLWC) database and eleven registered bores are within 2 km of the centre of this site. The closest bore (No. GW102418) is approximately 600 m from the site, on the western side of Remembrance Driveway. The bore description indicates the underlying geology comprises shale and sandstone. Two water bearing zones exist, the shallowest starting at 29 m depth. The risk of groundwater pollution resulting from this development is considered very low.

According to DLG (1998) a 250 metre buffer setback is required between all effluent management areas and bores that are used for domestic groundwater supply; minor limitation.

3.8 Exposure
Areas to be used for effluent management generally have an exposed northerly aspect with full sun and wind exposure, minor shading; minor limitation.

3.9 Slope
Slopes across the site range between about two and five percent; minor to moderate limitation. Based on slope alone, land is suitable for spray irrigation; minor limitation.

3.10 Landform
Crest and simple sideslopes occur over most of the site, with an open drainage line flowing through Lots 8, 7 and 2; minor to moderate limitation.

3.11 Erosion Potential
No significant signs of existing sheet erosion on this mostly gently sloping, well vegetated site. However, gully erosion is occurring along poorly constructed road table drains. Erosion potential within future effluent management areas is expected to be low provided they remain well vegetated; minor limitation.

3.12 Fill
No signs of fill present; minor limitation.

3.13 Surface Rock
Any areas of exposed rock must be avoided for effluent disposal due to the high risk of runoff from these areas. Less than 5% surface rock present as exposed sandstone floaters, especially in the eastern part of the site; minor limitation.

3.14 Vegetation
The site contains mostly improved pasture, turf grasses and exotic garden plants, with minor existing native vegetation, particularly along the watercourse. Any areas of existing native vegetation should be avoided for effluent irrigation because nutrient rich wastewater does not suit these species. Do not irrigate within the dripline of existing native trees; minor limitation.

3.15 Buffer Distances
DLG (1998) recommends the following buffer distances from effluent management areas:

(i)	Permanent watercourses (m)	>100 m
(ii)	Intermittent watercourses and dams (m)	>40 m
(iii)	Open drainage depressions	>20 m
(iv)	Domestic groundwater bores (m)	>250 m
(v)	Boundary of premises (m)	>3-6 * m
(vi)	Swimming pool (m)	>6 m

(vii)	Buildings (m)	(Spray)	>15 m
		(Subsurface or drip/trickle)	>3-6 * m

* the larger figure is used when the irrigation area is upslope of the feature, the lower figure when downslope.

4 Soil Assessment

4.1 Physical Description

A general soil survey was undertaken at the time of the site visit, the results of which are described below. The soil assessment was undertaken generally following Table 6 in Department of Local Government (1998), which describes a rating system for onsite effluent management facilities (see Appendix A).

Six test pits were excavated by backhoe across the proposed development. This was suitable to assess soil variability. Test pit profile descriptions are provided in Appendix C. Generally, well structured loam topsoils overly clay subsoils. Soils are well suited to effluent irrigation.

4.1.1 Geology and Soil Landscape

The Wollongong-Port Hacking 1:100,000 Soil Landscape Map (DLWC, 1990) indicates the entire site is on a single soil landscape - Lucas Heights. Our investigations suggest that two soil landscapes occur - the Lucas Heights Soil Landscape occupies the eastern part of the site and Blacktown Soil Landscape occurs in the western part. The boundary was not accurately mapped and is not important for this assessment, though it probably runs roughly north-south on the western side of the watercourse. For the purposes of onsite wastewater management, soils on the two landscapes have similar absorptive and treatment properties.

4.1.2 Soil Depth

Depth to bedrock is greater than 1.0 m in all test pits investigated; minor limitation.

4.1.3 Depth to High Seasonal Watertable

The depth to seasonal high watertable is greater than 700 mm - indicated by mottling of the deeper subsoils in some profiles. Standing water was observed in one borehole only (TP6, in the watercourse) - this is probably due to the high rainfall that had occurred in the week prior to our soil survey; minor to moderate limitation.

4.1.4 Soil Permeability

Soil permeability was not directly measured but can be inferred from the soil texture, structure and depth, with reference to AS/NZS1547 (2000). The well structured loam topsoils have an indicative permeability (K_{sat}) of 1.5 to 3.0 metres per day. This equates to a maximum design irrigation rate (DIR), for wastewater, of 28 mm per week. This figure is used in water balance calculations to determine the required size of the irrigation area; minor limitation.

4.2 Laboratory Testing

The results of laboratory soil testing are contained in Appendix D. Samples from Test Pits 1, 3 and 5 were analysed. Analyses of pH, EC and Emerson Aggregate Class were undertaken in-house while analyses of exchangeable cations and phosphorus sorption capacity were performed by the DLWC's Scone Research Centre soil testing laboratory. The following sections provide a brief discussion of the results.

4.2.1 pH

Soil pH is a measure of the acidity or alkalinity of a soil. It relates to the concentration of the hydrogen ions (H^+) in the soil solution measured on a negative logarithmic scale of 1 to 14. The concentrations of hydrogen ions are equal to the hydroxyl ions (OH^-) at pH 7, greater below pH 7 (acid) and fewer above (alkaline).

In the urban environment, the importance of pH is usually confined to its effect on the availability of elements in the soil and, therefore, possible deficiencies and/or toxicities. Whether these elements are available to plants depends on their solubilities, being available only when in soluble forms. Note that the "essential" plant nutrients are in their most soluble forms around pH 6 to 7.

Soil pH of 1:5 soil/water suspensions was measured using a hand held pH meter. Soil pH across the site ranges from slightly to very strongly acid. The measured pH ranged between 5.0 to 6.2. Soil conditions do not appear to be restricting plant growth and no remediation is considered necessary; minor to moderate limitation.

4.2.2 Electrical Conductivity

The electrical conductivity (EC) of 1:5 soil/water suspensions are used to detect the presence of soluble salts and, from this, suggest the general salinity level. The main soluble salts likely to be present are sodium, calcium and magnesium, which might be chlorides, sulfates or carbonates. The standard unit of electrical conductivity in soil is deciseimens per metre (dS/m).

Where the levels of soluble salts rise in soil, they can reduce the vigour or kill existing vegetation increasing the erosion hazards and, in extreme cases, promote the destruction of building works and roads. While the salinity levels at a particular site might initially be acceptable in or near the root zone, certain land uses can cause the watertable to rise from deeper levels at the site or on other lands nearby causing increased salinity. Irrigation of wastewater is a potential trigger for rising watertables which can be avoided with good management.

Electrical conductivity of the saturated extract (ECe) was calculated by first measuring the electrical conductivity of a 1:5 soil in water suspension and using an appropriate multiplier factor to convert EC (1:5) to ECe. Calculated ECe values range between 0 and 0.2 decisiemens per metre. Soils are non-saline; minor limitation.

4.2.3 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 Emerson Aggregate Test was performed on topsoils and subsoils. Soil samples recorded Emerson Aggregate Classes of either 8 (no slaking and no dispersion) or 3(1) (no slaking but minor dispersion after remoulding sample); minor limitation.

4.2.4 Cation Exchange Capacity

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, 1992).
Cation exchange capacity for topsoils ranged between 7.1 and 12.7 cmol (+) / kg , while for subsoils it ranges between 15.8 and 18.5 (Appendix D). These CEC values are reasonable and will not present a constraint to onsite effluent management; minor limitation.

4.2.5 Exchangeable Sodium Percentage

The exchangeable sodium percentage (ESP) is calculated as [% Na / CEC] x 100. It is an indicator of sodicity - the tendency for soil dispersion and structural decline. Hazelton & Murphy (1992) 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

All soils have ESP values less than 3.0 and are non-sodic; minor limitation.

4.2.6 Phosphorus Sorption Capacity

Phosphorus is an important plant nutrient and its availability to plants depends heavily on soil pH, soil texture, organic matter content and clay mineralogy. Phosphorus is also an important environmental pollutant, particularly in our waterways where it is responsible for promoting weed growth and algal blooms.

When assessing a site's suitability for wastewater application it is important to assess the soils' ability to fix (sorb) phosphorus, this being a significant mechanism for controlling phosphorus that is applied in wastewater. Phosphorus sorption tends to increase with increasing clay content, iron and aluminium concentration, and organic matter.

Phosphorus sorption capacity (PSC) and phosphorus sorption index (PRI) was measured and analysed with the assistance of DLWCs Scone Research Service Centre.

The PSC for topsoils ranged between 552 and 791mg/kg. These soils are considered to have a high to very high sorption rating (Hazelton & Murphy, 1992). Subsoils in all cases have higher PSC values than their respective topsoils, ranging between 603 and 860 mg/kg. These values are considered very high (Hazelton & Murphy, 1992).

The soils appear to have a good capacity to sorb phosphorus and phosphorus is highly unlikely to leach from the soil profile and cause environmental concerns offsite. The average PSC for the subsoils is 770 mg/kg. This equates to approximately 12,320 kg/ha, assuming an effective soil depth of 1.0 m and bulk density of 1.6. In the nutrient balance model this value is halved [1] to allow for the fact that field P-sorption is usually less than the theoretical maximum.

1 The laboratory figure is theoretical and actual field sorption is generally less than this (reported as between 25% and 50 % of the theoretical value in DLG (1998). Because the soils are well structured, allowing a high surface area for effluent contact, 50% is used.

5 Summary of Site Constraints and Opportunities

5.1 Climate

The climate of the area provides a minor limitation to onsite wastewater treatment and disposal, as evaporation is greater than precipitation for all months of the year. A hydraulically balanced irrigation area will effectively manage wastewater with only a low risk of runoff.

5.2 Soil Characteristics

Soils across the site are well suited to effluent irrigation and provide excellent opportunity for further treatment of wastewater. The loam topsoils have a strong infiltration potential and provide good opportunity for absorption of wastewater. The clay subsoils are relatively well drained, being well structured and mostly whole coloured. A design irrigation rate of 28 mm/week is used in water balance calculations. Soil chemical testing showed most constraints are present at a minor level only and no soil remediation will be required.

5.3 Landform and Slope

Most of the site contains gently sloping, simple sideslopes. These areas are well suited to effluent irrigation with only a low risk of runoff. A watercourse traverses the site and land within 40 m of this will be avoided (see below).

5.4 Proximity to Watercourses

The site contains an intermittent watercourse that crosses Lot 8, then Lot 7 and then extends roughly in a north/northeast direction through Lot 2, and then offsite. We propose a 40 m buffer (exclusion zone) between the watercourse and any effluent management areas, to meet Council requirements.

5.5 Land Availability

Most of the land across the site is suitable for effluent management. However, land within 40 m of the watercourse must be excluded. After consideration of required buffer distances all lots, including those constrained by the watercourse and those with existing developments, have enough room to sustainabley dispose of the predicted wastewater generated by a five-bedroom home (1015 litres per day, see section 6.2 below).

However not all lots have, or are likely to have, more than 1500 m^2 of land available – the figure required to comply with a "category one" assessment according to Wollondilly Shire Council's Onsite Wastewater Approvals Policy. In these cases (proposed Lots 13 (existing dwelling), 21 and 71) effluent disposal must be by subsurface irrigation (refer to figure 2 to 6). We expect that site-specific onsite wastewater management studies will be required to accompany development applications for each new lot. This will identify the final amount of land available for effluent management on each lot.

6 Effluent Generation

6.1 General Characteristics

Domestic wastewater is derived from four main sources within households:

- kitchen
- bathroom (basin, bath and shower)
- laundry
- toilet

Toilet waste is known as black water and contributes on average between about 15 and 35 percent of the domestic wastewater flow. Its contribution is generally lower where 6/3 litre dual flush toilets are installed and this is generally a requirement for new installations in NSW. All other wastewater is known as greywater and contributes on average between 65 and 85 percent of the domestic wastewater flow.

Table 2 below presents typical pollutant concentrations in domestic wastewater, including the relative contribution of greywater and blackwater to those loads.

Table 2 Characteristics of Typical Untreated Domestic Wastewater (taken from DLG, 1998)

Parameter	Loading	Greywater %	Blackwater %
flow - non reticulated water supply	100-140 L/person/day	65	35
flow - reticulated water supply	150-300 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

6.2 Effluent Volume

The design daily effluent load is influenced by the number of occupants in the household, the number and type of wastewater generating facilities installed, the type of supply (i.e. town or tank water) and the water conservation practices employed by occupants. Several methods exist for estimating wastewater flows and the estimates provided in AS/NZS 1547:2000 are used here [2]. The adopted design, per person effluent load is 145 L/person/day.

Table 3 Design Effluent Load

No. of Bedrooms	Probable Maximum Number of Residents	Design Daily Flow
3	5	725
4	6	870
5	7	1015
6	8	1160

For the purposes of design, a five bedroom house [3], generating 1015 litres per day, is adopted here.

2 Flow estimates assume standard water reduction fixtures are installed, including dual flush 11/5.5 litre water closets, shower-flow restrictors, aerator faucets (taps) and water conserving automatic washing machines

3 A study or studio that has a door is considered to be a bedroom.

7 Recommendations

7.1 Effluent Treatment System Selection

This report is not intended to provide a detailed description of all possible methods for effluent treatment and subsequent land application. However, based on our site and soil investigation, primary treatment using a septic tank with subsequent land application to absorption trenches or evapotranspiration beds is not ideal because of the clay subsoils and relatively high development density. [4] In addition, primary treatment alone does not remove significant quantities of nutrients or pathogens and consequently the potential for groundwater or surface water contamination is relatively high.

It is recommended that wastewater comprising combined black and greywater streams should be treated to a secondary standard prior to land application by surface or subsurface irrigation. Secondary treatment involves aerobic, biological processes to stabilise, degrade and remove organic matter and some nutrients. The AS/NZS 1547 (2000) *On-site domestic-wastewater management* performance standard for secondary treatment is based on a quality equal to or better than 20g/m^3 BOD_5 and 30g/m^3 Suspended Solids. Secondary treated wastewater that will be managed by surface irrigation requires disinfection to less than 30 cfu/100 mL, this normally being achieved by either chlorination, U.V. or other suitable method.

Secondary treatment is provided by a number of different effluent treatment systems, including:

(i) aerated wastewater treatment system (AWTS)
(ii) aerobic sand filter (ASF)
(iii) modified earth evapotranspiration system (MEES)
(iv) subsurface flow reed-bed.

For the purpose of this report it is assumed that an AWTS is used (i.e. a secondary treatment system with disinfection). However, should future owners wish to use a different type of system, a site specific wastewater assessment should be undertaken.

7.2 Expected Effluent Quality

The performance of most conventional wastewater treatment systems is dependant on many factors associated with system design, plus the quality of influent to the system. A reasonable guide to the target quality for secondary treated effluent is shown in Table 4. Some systems will achieve substantially better results than this.

4 Septic systems are often acceptable on large rural properties, subject to site suitability, but are not normally acceptable in the urban environment due to the higher public health and environmental risks they present.

Table 4 Secondary Treated Effluent Quality
(taken from DLG, 1998)

Parameter	Value
Biochemical Oxygen Demand (BOD_5)	< 20 mg/L
Suspended solids	< 30 mg/L
Total Nitrogen	25 - 50 mg/L
Total Phosphorus	10 - 15 mg/L
Faecal Coliforms (disinfected)	< 30 cfu/100 mL
Dissolved Oxygen	> 2 mg/L

Effluent with a quality as described in table 4 is suitable for disposal by surface irrigation.

7.3 Land Application System Selection

Treated effluent must be applied to the land in a manner that meets various environmental and public health performance objectives. A range of suitable land application methods are available. Soil and site conditions suggest that an irrigation scheme will be a cost effective and an environmentally sound method for the disposal of all treated wastewater. However, it is important to ensure even and widespread application of effluent to prevent waterlogging and nutrient overloading in small areas. The irrigation system design must also ensure that the risk of effluent runoff to receiving waters is negligible.

Wollondilly Shire Council's Onsite Wastewater Approvals Policy requires that more than or equal to 1500 m^2 of land must be available for irrigation to permit surface spray irrigation. Such lands are classified as category 1 (refer to section 5.5 and figures 2 to 6). Where this is not the case subsurface irrigation must be adopted. In many cases this will not be known until site specific onsite wastewater management reports are lodged with each new development application. The different types of irrigation systems are discussed in Appendix E.

7.4 Sizing of Irrigation Areas

To determine the necessary size of effluent management areas and wet weather storage requirements on future allotments, water and nutrient balance modelling is used as described in the DLG (1998) guidelines. The results of this modelling are contained in Appendix B.

7.4.1 Water Balance

The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation

Median rainfall and evaporation data is used. Rainfall data for the site is taken from Buxton rainfall station and evapotranspiration figures are taken from composite data for Picton. A design irrigation rate (DIR) of 28 mm/week is adopted, based on observed soil characteristics and the values contained within AS/NZS 1547:2000 table 4.2A4.

Using the **minimum area method** water balance and wet weather storage calculations described in DLG (1998), 184 square metres of irrigation area and 29.1 cubic metres of storage is required (Table A1). To identify the maximum area / zero storage option, the **nominated area** method was used. This method found the need for 250 square metres of land for zero storage, under the proposed hydraulic loading (Table A2).

7.4.2 Nutrient Balance

Nutrient concentrations will vary depending on the chosen treatment system. For the purpose of this report we have adopted concentrations of 12 mg/L and 20 mg/L for phosphorous and nitrogen respectively [5]. The critical loading rate for nitrogen is assumed as 25 mg/m^2/day [6]. A conservative, field soil phosphorus sorption capacity of 6,160 kg/Ha is adopted.

Nitrogen was found to be the limiting nutrient, as its area requirement of 812 square metres is greater than the area required for phosphorus assimilation, which is 331 square metres (Table A4).

7.5 Wet Weather Storage

The optimum irrigation area is 820 square metres and this is more than three times the area required by the hydraulic balance. Therefore, we do not consider that additional wet weather storage is required. In addition the proposed areas can be considered to incorporate any requirement for a reserve area (which is nominally based on an additional area equivalent to the hydraulic requirement).

7.6 Configuration of Irrigation Areas

The optimum irrigation area is selected by taking the larger of the hydraulic loading and nutrient balance calculations. In this case, the nitrogen balance is the limiting factor and the required irrigation area is approximately **820 square metres**, based on a five bedroom dwelling.

Where constraints apply (e.g where the land is affected by the watercourse or where there are existing dwellings) available irrigation areas are identified in figures 2 to 6. The figures show those lands that are suitable for irrigation and those that must be avoided. Effluent irrigation must not be undertaken outside the areas identified as suitable.

5 based on test results provided by numerous recently accredited AWTS manufacturers

6 The default values taken from DLG (1998) guidelines.

The total irrigation area should be split into a number of roughly equally sized zones. At a minimum two separate zones should be installed - i.e. two separate irrigation areas each approximately 410 square metres. A combination of manual and/or automatic switching valves will be used to help switch the wastewater flow between the different irrigation zones. The benefit of split fields is that one can rest while the other is active. This can be highly beneficial in the long term performance of the land application area.

An irrigation expert familiar with irrigation equipment, and design of irrigation systems, must be consulted to design and install the irrigation system. The irrigation plan must ensure that all irrigation areas are serviced evenly to prevent the risk of effluent runoff and soil degradation. We recommend that a detailed irrigation layout plan be provided to Council with future development applications, prior to installing the system. The irrigation system can be checked against this plan prior to commissioning and final sign-off.

Important Note - If the owner is having difficulty allocating a suitably sized irrigation area on their property, some alternatives exist that might be suitable on this site. These include:

(i) use of a treatment system that provides a higher level of nutrient removal, thus requiring a smaller irrigation area;
(ii) use of a mounded earth system or sand mound for effluent disposal; and
(iii) use of evapotranspiration beds.

Any deviation from this report will require an additional investigation by Morse McVey & Associates, or another environmental consultant familiar with site and soil investigations and design of onsite wastewater management systems. This should be undertaken once the final position of future buildings, driveways and other infrastructure is determined.

7.7 Buffer Distances

Apart from the previously mentioned buffer that must be maintained between all effluent management areas and the watercourse, specific buffers apply to land application areas as follows:

The buffer distances to be applied for **spray irrigation** are:

- 6 metres if area up-gradient and 3 metres if area down-gradient of driveways and property boundaries
- 15 metres to dwellings
- 3 metres to paths and walkways
- 6 metres to swimming pools

The buffer distances to be applied for **subsurface irrigation and surface drip/trickle irrigation** are 6 m if area up-gradient and 3 m if area down-gradient of swimming pools, property boundaries, driveways and buildings.