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REPORT ON ASSESSMENT FOR THE SITING OF A PROPOSED EFFLUENT MANAGEMENT SYSTEM AT No. 3 BOUNDARY STREET, WARRIEWOOD

PREPARED FOR: MR. S. AVERY

SUBMITTED TO: PITTWATER COUNCIL

REF. No. 030807

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CONTENTS

1. INTRODUCTION

This report outlines the results of an investigation and assessment undertaken in relation to the siting of a proposed effluent management system at No. 3 Boundary Street, Warriewood. The investigation was performed at the request of Mr. S. Avery, and the report will be submitted to Pittwater Council as part of the Septic Tank Application and Construction certificate as a whole.

The property has an area of 8245m^2 that is situated off Boundary Street at a distance of 350m south of the intersection with Mona Vale Road. The proposed development comprises the construction of a two-storey dwelling in the northeastern part of the property and the siting of an associated effluent management system (Figure 1). Note that the dwelling will be contained within the confines of a designated building envelope at 14m x 15m (i.e. 210m^2) that maintains set-back distances of 7.5m from the northern boundary and 20m from the eastern boundary.

Whilst the property has a relatively large area, all development and the land application of wastewater will be contained in an area that has been cleared and utilised by a previous owner. This will minimise the potential for any further environmental impacts because only minimal vegetation removal will be required to facilitate the proposed development and effluent management scheme. Due to the physical and environmental constraints on the property as a whole, a 'best-fit' solution will be applied to on-site effluent management, and where possible, appropriate guidelines and standards will be adhered to.

2. PROPOSED EFFLUENT MANAGEMENT SYSTEM AND WASTEWATER VOLUME

The proposed effluent management scheme for the dwelling comprises use of an aerated/aerobic wastewater treatment system **(AWTS)** with a surface irrigation arrangement for land application. This type of system comprises single or dual pre-cast processing tanks from which treated effluent is dispersed from various discharge points over a prescribed surface area. The main environmental concern with the AWTS is considered to be the levels of nitrates, phosphates and chlorine generated, particularly if prescribed treatment levels are not achieved. Nevertheless, an AWTS provides what is deemed as 'secondary' treated effluent that can be applied onto the land surface.

Reference to the Guidelines in Department of Local Government et. al. (1998) shows the expected quality of wastewater after treatment in an AWTS, which is given in Table 1. Design figures may not be indicative of long-term operational characteristics, and an AWTS must be well maintained and operated to achieve this quality on a continuous basis. Note that it is understood that Re-Accredited systems, as should be used on the site, provide a better final wastewater quality with nitrogen **(N)** and phosphorus **(P)** concentrations typically not exceeding 15mg/litre and 10 - 12mg/litre respectively.

TABLE 1: EXPECTED QUALITY OF WASTEWATER AFTER TREATMENT IN AN AERATED/AEROBIC WASTEWATER TREATMENT SYSTEM*

PARAMETER	**CONCENTRATION**	**FAILURE INDICATOR**
BIOCHEMICAL OXYGEN DEMAND	<20mg/L	>50mg/L
SUSPENDED SOLIDS	<30mg/L	>50mg/L
TOTAL NITROGEN	25 – 50mg/L	not applicable
TOTAL PHOSPHORUS	10 – 15mg/L	not applicable
FAECAL COLIFORMS NON-DISINFECTED EFFLUENT	up to 10^4 cfu/100mL	not applicable
FAECAL COLIFORMS DISINFECTED EFFLUENT	<30cfu/100mL	>100cfu/100mL
DISSOLVED OXYGEN	>2mg/L	<2mg/L

* Prior to Re-Accreditation.

Note that at the time of compiling this report, the actual type (or brand) of AWTS is not known. Further to Table 1 and the paragraph preceding, it is probable that actual treatment levels achieved may vary between different system types, in that certain systems can provide a better final effluent quality (particularly for N and P) that is consistent with 'advanced secondary' wastewater.

Nevertheless, it is expected that any AWTS would provide an effluent quality at least consistent with the requirements of Re-Accredited systems and secondary treated wastewater.

Aerated/aerobic systems rely on biological activity for proper system operation. Changes to the effluent loadings, in the form of either a significant increase or decrease, may result in poor system performance. It is suggested that an AWTS must be operated continuously and the power must not be turned off, as intermittent use may require servicing of the system at each start up.

It would be prudent, as with on-site or reticulated sewer, to implement a water usage minimisation scheme in the dwelling. An AWTS provides for re-use of all domestic wastewater, however reducing the loads to be treated and applied to the land will significantly decrease the potential for adverse environmental impacts. Consideration should be given to the installation of AAA-rated water limiting devices on showers and taps, and the use of 3/6 litre or 5.5/11 litre dual-flush toilets.

It is also suggested to utilise 'environmentally friendly' cleaning, washing and detergent products in a dwelling to reduce the levels of phosphorus, as well as sodium, discharged into the treatment system and soils. Furthermore, reducing the amounts of such products used would also be beneficial to the environment. Reference to the Figure in Appendix 1 shows the sodium adsorption ratios for a variety of laundry detergents (Patterson, R.A. 1994). In order to reduce the amount of sodium discharged into the soils, it is recommended that laundry detergents with sodium adsorption ratios of 20 or less should be used (the lower the better). Cross-matching low sodium products with 'low' phosphorus ones would also be beneficial.

It is understood that the proposed dwelling comprises four bedrooms, lacks a reticulated water supply and will be initially occupied by one person. Table 4.3 A1 of AS/NZ Standard 1547 (2000) shows that a four bedroom dwelling has a population equivalent of 6 - 7 persons.

Reference to Appendix 4.2 D of AS/NZ Standard 1547 (2000) shows that wastewater flow design allowances are now based on a per person volume rather than a per bedroom volume. From the Appendix, a design volume of 140 litres per person per day can be applied to the site because there is a non-reticulated water supply. Based on this data, the design effluent volume generated by a maximum of seven people in the dwelling would be 980 litres per day.

3. SITE DESCRIPTION

The property, which is accessed via Boundary Street, is situated at a distance of about 2km west of the centre of Mona Vale township. Entry to the site is gained via an existing gateway at the eastern boundary, and there is a gravel driveway extending from the gate to proposed dwelling. As shown in Figure 1, the two-storey dwelling will be contained within the confines of a designated building envelope at 14m x 15m in the northeastern part of the property.

The proposed effluent re-use area, incorporating the irrigation lines after treatment in an AWTS, is situated at a distance of 18.5m west of the dwelling where there is a land fall of approximately 1 in 5 – 7 in a south to southwesterly direction. This area has previously been cleared of the majority of native vegetation and will be incorporated with proposed landscaping measures and an 'inner protection zone' for bushfire control purposes.

Landscaping with respect to the re-use area will involve construction of a small retaining wall adjacent to the southern and western sides, filling with sandy soil to provide a near-level surface, addition of topsoil and then turfing. The effluent irrigation area maintains set-back distances of 6.5 – 12m from the nearest northern property boundary and is immediately south of an existing gravel track. Adjacent to the southern and western sides of the re-use area, there is relatively undisturbed native vegetation comprising a variety of trees, shrubs, groundcovers and grasses.

The proposed dwelling is situated at an elevation of approximately 50m AHD. The nearest intermittent watercourse within the drainage path from the effluent re-use area is situated at a distance of 40m to the southwest. From this point the intermittent watercourse (i.e. Narrabeen Creek) trends in a south to southeasterly direction for a distance of about 3.5km before entering Mullet Creek and attaining a perennial flow approximately 750m from the northern end of Narrabeen Lakes. The intermittent watercourse also passes through the Warriewood sewerage treatment plant at a distance of approximately 2km southeast of the subject site.

Climatic conditions at the site are generally temperate throughout the year. The average annual rainfall in nearby Pittwater is approximately 1225mm, whilst the annual evaporation is 1790mm (exceeds rainfall in all months except May and June).

4. FIELDWORK METHODS

The initial phase of the fieldwork comprised a site inspection and ground survey aimed at delineating the preferred position of the effluent re-use area with respect to the location of the proposed dwelling and the geomorphological characteristics of the land.

Further to the ground survey, three 100mm diameter hand-auger holes were bored to a maximum depth of 0.9m across the effluent re-use area. The auger holes were used to determine the physical characteristics of the subsurface strata.

To assess soil permeability, results of the auger holes are related to the textural/structural classification in Table 4.1.1 of AS/NZ Standard 1547 (2000) which enables determination of the soil category and corresponding indicative permeability value. The indicative permeability value can be converted to a design irrigation rate **(DIR)** from Table 4.2 A4 of AS/NZ Standard 1547 (2000).

5. GROUND SURVEY

The location of the proposed effluent re-use area in the cleared land at a distance of 18.5m west of the dwelling has been carefully delineated on the site with Mr. Avery and is shown in Figure 1. Whilst the property has a relatively large area, results from the ground survey indicate that the site is affected by the following constraints to the land application of secondary treated wastewater:

- the intermittent watercourse in the eastern part of the site.
- the native vegetation away from the clearing adjacent to the southern and western sides of the re-use area.
- the steeper land associated with the position of the native vegetation and intermittent watercourse.
- the limited occurrence of sandstone floaters in and adjacent to the re-use area.

Further to the constraints above, the aim of the effluent management scheme is to provide the maximum usable area for irrigation purposes in the cleared land to the west of the dwelling at an appropriate distance from the intermittent watercourse.

In light of the position of the intermittent watercourse, a set-back distance of 40m for effluent re-use is provided in accordance with Table 5 of the guidelines in Department of Local Government et. al. (1998). Provision of this buffer also increases the distance from the edge of the native vegetation to about 10m.

As detailed in Section 3, the effluent re-use area will be incorporated with proposed landscaping measures and an inner protection zone for bushfire control purposes. Landscaping with respect to the re-use area will involve construction of a small retaining wall adjacent to the southern and western sides to a maximum height of about 1.5m. Sandy soil filling will be placed in the land upslope of the retaining wall – depth of fill will decrease in a northerly direction and meet the natural ground surface adjacent to the southern side of the gravel track. Note that the existing vehicular track on the western side of the dwelling will no longer be used once construction is completed (possibly 'rehabilitated'). Topsoil and turf will then be provided over the finished retained and filled surface.

The additional volume of permeable soil to be provided in the effluent re-use area will overcome any limitations relating to the occurrence of sandstone floaters and also significantly assist with the absorption and assimilation of treated wastewater.

As a function of the constraints to effluent management detailed above, there is a usable area of 430m^2 available for irrigation purposes in the land to the west of the dwelling. It is proposed to utilise all of this usable area for effluent re-use.

6. SUBSURFACE PROFILE

Reference to the Sydney 1:100 000 scale Soil Landscape Sheet indicates that the proposed effluent re-use area and adjacent parts are underlain by the colluvial 'Watagan' Landscape Group which occurs on rolling to very steep hills on fine-grained Narrabeen Group sediments (mainly interbedded laminite and shale with quartz to lithic quartz sandstone).

The soils of the Watagan group comprise shallow to deep (30 – 200cm), Lithosols/Siliceous Sands and Yellow Podzolic Soils on sandstones; moderately deep (100 – 200cm) Brown Podzolic Soils,

Red Podzolic Soils and Gleyed Podzolic Soils on shales (Chapman and Murphy, 1989). Findings from the auger holes are considered to best equate with Yellow Podzolic Soils over sandstone as described above.

General limitations of the Watagan group include mass movement hazard, steep slopes, severe soil erosion hazard, very strong acidity, low fertility, high aluminium toxicity and occasional rock outcrop (Chapman and Murphy, 1989).

The subsurface profile observed as a whole is considered to have a 'duplex' structure as there is a moderately well-defined textural and permeability contrast between the A and B soil horizons. With reference to Table 4.1 D4 of AS/NZ Standard 1547 (2000), the A1 and A2 soil horizons have a single grained structure whilst the B horizon soil has a moderate to strong structure.

The soils are described in accordance with the classification schemes in Australian Soil and Land Survey: Field Handbook (1990) and AS/NZ Standard 1547, 2000 (Appendix 1). Note that there are limited surface sandstone floaters in the effluent re-use area that will either be removed or covered with additional sandy soil as part of formation of the proposed retaining wall. The typical subsurface profile observed in the auger holes is summarised below.

(i) LOAMY SAND (TOPSOIL) – A1 Horizon

- occurs from the surface to an average depth of 0.25m.
- comprises grey to dark-brown, fine to medium grained loamy sand with few quartz gravels and ironstone fragments (i.e. 2 – 10% coarse fragments from Table 4.1 D2 of AS/NZ Standard 1547, 2000).
- soil category 1 from Table 4.1.1 of AS/NZ Standard 1547 (2000).

(ii) CLAYEY SAND – A2 Horizon

- occurs from an average depth of 0.25 - 0.5m.
- comprises grey and dark-brown, fine to medium grained clayey sand with few quartz gravels and ironstone fragments (i.e. 2 – 10% coarse fragments).
- soil category 1.

(iii) SANDY CLAY – B Horizon

- occurs from an average depth of 0.5 – 0.8m.
- comprises firm, brown to orange-brown and light-grey sandy clay with few quartz gravels and ironstone fragments (i.e. 2 – 10% coarse fragments).
- soil category 4.

(iv) WEATHERED SANDSTONE – C Horizon

- occurs from an average of 0.8m, and was observed to a maximum depth of 0.9m.
- comprises low strength (i.e. sandy and slightly clayey), brown to orange-brown and light-grey, fine to medium grained sandstone.

No free groundwater was observed in any of the auger holes to 0.9m. The minimum expected to a consistent groundwater table below the site, and in the area generally, would be in the vicinity of at least 20 - 30m.

7. DESIGN IRRIGATION RATE AND AREA REQUIREMENTS

As detailed in Section 5 and shown in Figure 1, there is a usable area of 430m^2 to the west of the proposed dwelling that is available for effluent re-use via surface irrigation. This area will be levelled by filling and retained on the southern and western sides. The filling material should be of a typical 'crushed sandstone' variety having a loamy sand to clayey sand texture – any 'more clayey' soils should not be used.

Whilst a substantial volume of sandy soil filling will be provided in the re-use area, that is up to about 1.5m in depth on the outer sides, design calculations below are based on the properties of the most-limiting B horizon sandy clay soil as encountered in the auger holes.

Findings regarding the sandy clay from the auger holes in Section 6 and reference to Table 4.1.1 of AS/NZ Standard 1547 (2000) correspond with soil category 4 for clay loams and an indicative permeability value of 0.5 – 1.5m/day for the moderately to highly structured material. This equates with an 'imperfectly drained' indicative drainage class. Reference to Table 4.2A4 in AS 1547

(2000) shows that for soil category 4, the corresponding DIR value is 25mm/week. This equates with a DIR value of 3.5mm per day, or an equivalent application rate of 3.5 litres/m^2/day.

Based on the design effluent volume of 980 litres per day for a maximum of seven people in the dwelling, the irrigation area requirement would be:

- 980 litres/day divided by 3.5 litres/m^2/day = 280m^2.

The above result indicates that, based on the hydraulic properties, an area of only 280m^2 would be required for irrigation purposes. However, it is proposed to utilise the total area of 430m^2 that is available for effluent re-use to the west of the dwelling in the area to be retained and landscaped (Figure 1). Therefore,

PROPOSED EFFLUENT RE-USE AREA = 430m^2 for maximum volume of 980L/day.

7.1 Preparation of the Effluent Re-Use Area

Note that it is important to ensure that the surface irrigation system utilised effectively covers the total available area of 430m^2 so the hydraulic and nutrient loads can be adequately catered for by the soils and vegetation cover.

To raise the pH of the typically strongly acidic soils, it is suggested to apply lime across the re-use area and incorporate into the top 100mm of soil. Lime should be applied at a rate of approximately 0.5 - 0.6kg per square metre in and adjacent to the irrigation area. It is understood that lime can be purchased from plant nurseries, Stock and Station/Rural supply stores and it is suggested to reapply the additive and carefully incorporate into the soils as required every two to three years for example. It would be prudent to contact the Department of Land and Water Conservation (soils Division) and NSW Agriculture to assess any advice they can provide regarding soil additives, application methods and rates. Note that it would be worthwhile adding lime in the existing soils prior to filling, then also after this has occurred.

Note how recent NSW Agriculture studies indicate that to assist with the spreading of soil additives such as lime across areas of pasture and increase its positive attributes, it is suggested to introduce the 'Long Worm' (deep burrowing), 'Turgid Worm' (topsoil burrowing) and 'Trap Worm' (middle layers) in the effluent re-use area proper. This will assist to ensure that lime does not remain on the

surface, as typically occurs when spread, but will be transferred to the subsoil and effectively act to raise pH.

As discussed on site with Mr. Avery, after retaining and filling the re-use area and adjacent margins will be turfed. Prior to turfing, a layer of topdressing to about 50mm in thickness will be provided over the surface of this area. Regarding the type of turf, it would be prudent to provide a grass mix with a blend of fescue, kentucky blue and perennial ryegrass (or similar) in order to provide a vigorous, year-round growth period. Alternately, these grasses could be intersown (by seed) with another type of turf. Provision of topdressing and turf will significantly enhance the benefits of evapotranspiration and concurrently reduce the absorption loads of the subsurface strata.

Note that grass in and adjacent to the re-use area should be mown regularly to promote vigorous growth and cuttings harvested and removed to prevent the recycling of nutrients back to the soils.

In the event of weed proliferation due to the discharge of treated effluent, it is suggested that adequate eradication measures are implemented to prevent their possible spread beyond the margins of the re-use area. Ensure also that construction activities do not adversely impact on the area delineated for effluent re-use, such as the compaction/stripping of topsoil, unnecessary vehicular movements and the placement of materials for example.

8. INSTALLATION, OPERATION AND MAINTENANCE

For the effluent management system to work well, both the supplier and the owner must be committed to its management. The AWTS should be installed by a certified supplier and serviced on a quarterly basis. A properly operated and maintained system should meet the expected parameters for the wastewater in Table 1, Section 2.

Newly installed systems often require a lead-in time before satisfactory performance is achieved. This time can often be reduced by promoting establishment of the bacteria in the treatment system. The effectiveness of the system will, in part, depend on how it is used and maintained. A guide to good maintenance procedures, from Department of Local Government (1998), is listed below:

DO

- have the system inspected and serviced four times per year by an approved contractor.
- have the system service include assessment of sludge and scum levels in all tanks, and performance of the irrigation area.
- have the tank(s) desludged at least every three years.
- have the disinfection chamber inspected and tested quarterly to ensure correct disinfection levels.
- have the grease trap (if installed) cleaned out at least every two months.
- keep a record of pumping, inspections, and other maintenance.
- learn the location and layout of the treatment system and land application area.
- use biodegradable liquid detergents such as concentrates with low sodium and phosphorus levels (see Appendix 1).
- conserve water.

DON'T

- put bleaches, disinfectants, whiteners, nappy soakers and spot removers in large quantities into the AWTS via sinks, toilets or washing machines.
- allow any foreign material such as nappies, sanitary napkins, condoms and other hygiene products to enter the system.
- use more than the recommended amounts of detergents.
- put fats and oils down the drain and keep food waste out of the system - this is considered to be particularly important because food scraps can result in a higher than acceptable BOD_5 level and excess oils/fats can overload or hinder the performance of any type of effluent treatment system. Use of a sink strainer in the kitchen would be prudent and removing excess food waste/oils from plates with a paper towel before washing would reduce the input of fats and organic material into the AWTS.
- switch off the power to the system, even if the dwelling is unoccupied.

9. CONCLUSIONS AND RECOMMENDATIONS

(i) An investigation and assessment has been undertaken in relation to the siting of a proposed effluent management system at No. 3 Boundary Street, Warriewood. The property has an area of 8245m^2 that is situated off Boundary Street at a distance of 350m south of the intersection with Mona Vale Road.

(ii) The proposed development comprises the construction of a two-storey, four bedroom dwelling in the northeastern part of the property and the siting of an associated effluent management system. The dwelling will be contained within the confines of a designated building envelope at 14m x 15m (i.e. 210m^2) that maintains set-back distances of 7.5m from the northern boundary and 20m from the eastern boundary.

(iii) The proposed effluent management scheme for the dwelling, that has a maximum design wastewater output volume of 980 litres/day, comprises use of an AWTS with a surface irrigation arrangement for land application. The proposed re-use area, where the irrigation lines will be established, comprises 430m^2 and is situated at a distance of 18.5m west of the dwelling. Preparation and soil treatment measures detailed in the report should be implemented in the re-use area.

(iv) Provided the guidelines detailed in the report are followed, it is considered that the proposed effluent management scheme for the dwelling will not result in significant adverse environmental impacts in the cleared land, native vegetation, watercourses, waterbodies or groundwaters.

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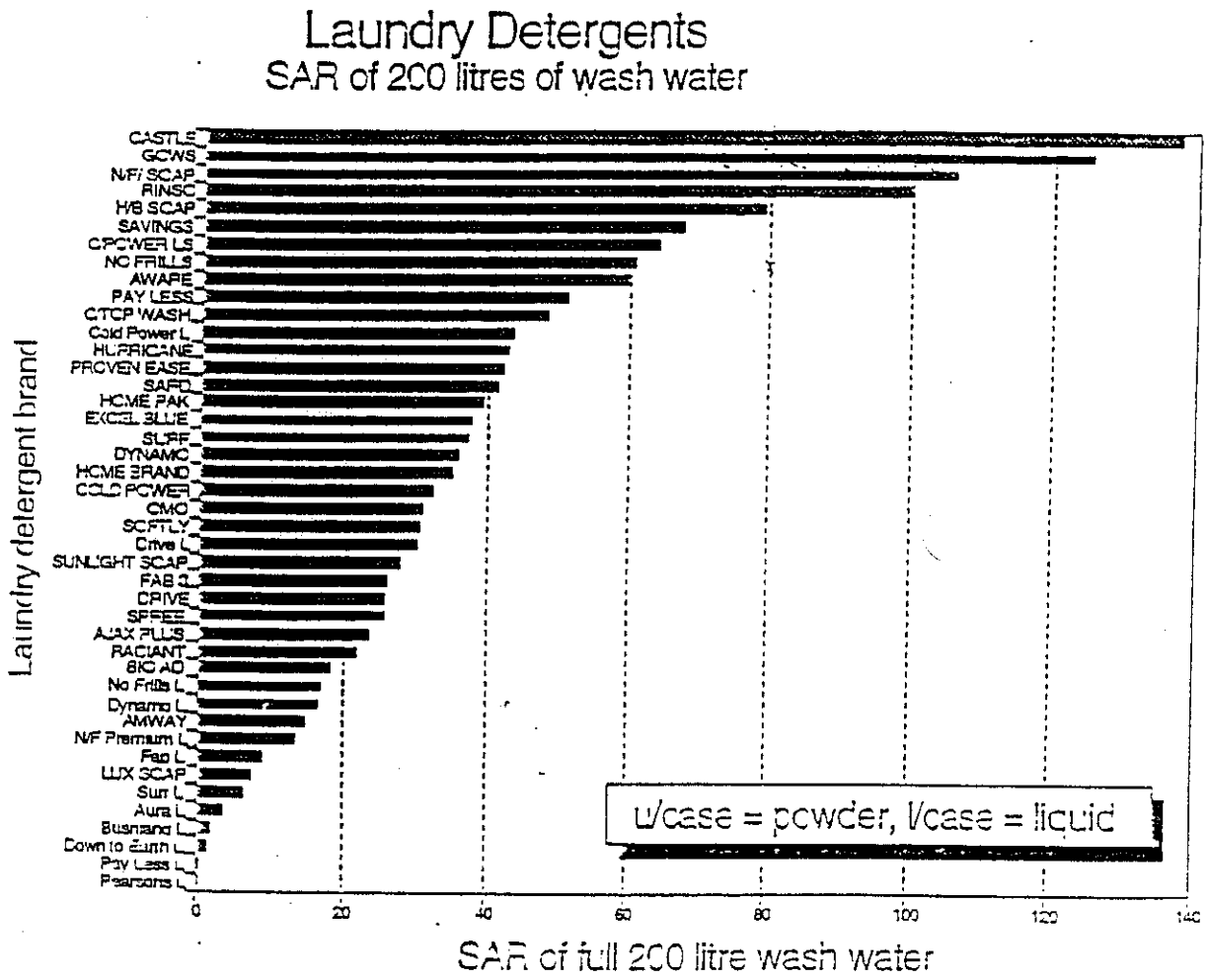
APPENDIX 1

SODIUM ADSORPTION RATIO VALUES FOR A VARIETY OF LAUNDRY DETERGENTS AND SOIL CLASSIFICATIONS



Sodium Adsoption Ratio Laundry Detergents

FROM: Patterson, R.A. (1994). On-site Treatment and Disposal of Septic Tank Effluent. University of New England, pHd Thesis (unpublished).

SOIL CLASSIFICATION

From: Australian Soil and Land Survey: Field Handbook 1990

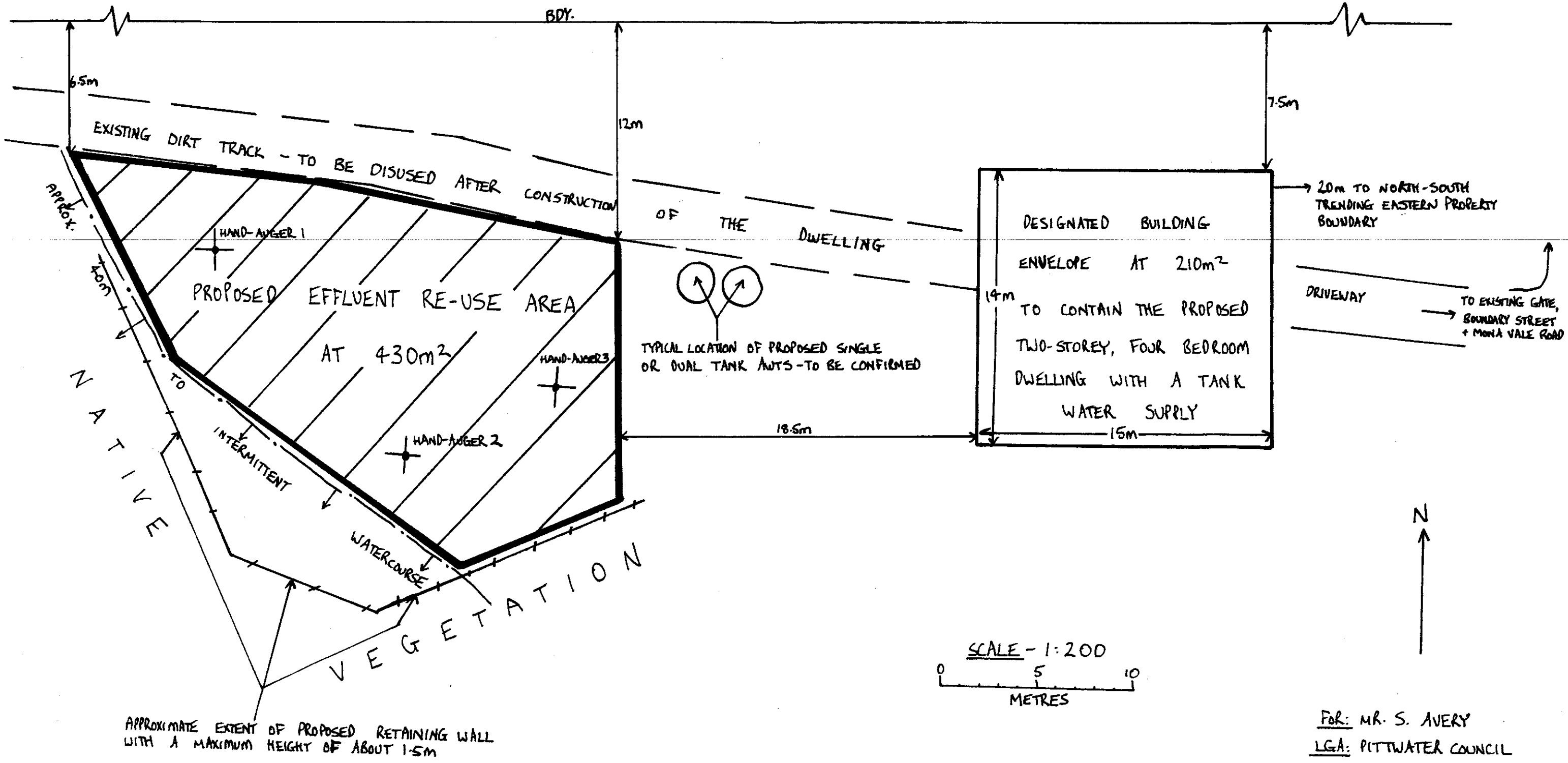
Field Texture Grade		*Behaviour of moist bolus*	*Approximate clay content (%)*
S	*Sand*	coherence nil to very slight; cannot be moulded; sand grains of medium size; single sand grains adhere to fingers.	commonly less than 5%
LS	*Loamy sand*	slight coherence; sand grains of medium size; can be sheared between thumbs and forefinger to give minimal ribbon of about 5mm.	about 5%
CS	*Clayey sand*	slight coherence; sand grains of medium size; sticky when wet; many sand grains stick to fingers; will form minimal ribbon of 5-15mm; discolours fingers with clay stain.	5%-10%
SL	*Sandy loam*	bolus coherent but very sandy to touch; will form ribbon of 15-25mm; dominant sand grains are of medium size and are readily visible.	10%-20%
L	*Loam*	bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter is present; will form ribbon of about 25mm.	about 25%
ZL	*Silty Loam*	coherent bolus; very smooth to often silky when manipulated; will form ribbon of about 25mm.	about 25% and with silt 25% or more
SCL	*Sandy clay loam*	strongly coherent bolus; sandy to touch; medium size sand grains visible in finer matrix; will form ribbon of 25-40mm.	20%-30%
CL	*Clay loam*	coherent plastic bolus; smooth to manipulate; will form ribbon of 40-50mm.	30%-35%
CLS	*Clay loam, sandy*	coherent plastic bolus; medium size sand grains visible in finer matrix; will form ribbon of 40-50mm.	30%-35%
ZCL	*Silty clay loam*	coherent plastic bolus; plastic and often silky to the touch; will form ribbon of 40-50mm.	30%-35% and with silt 25% or more
LC	*Light clay*	plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50-75mm.	35-40%
LMC	*Light medium clay*	plastic bolus; smooth to touch; slight to moderate resistance to ribboning shear; will form ribbon of about 75mm.	40%-45%
MC	*Medium clay*	smooth plastic bolus; handles like plasticine and can be modelled into rods without fracture; has moderate resistance to ribboning shear; will form ribbon of 75mm or more.	45%-55%
MHC	*Medium heavy clay*	smooth plastic bolus; handles like plasticine; can be modelled into rods without fracture; has moderate to firm resistance to ribboning shear; will form ribbon of 75mm or more.	50% or more
HC	*Heavy clay*	smooth plastic bolus; handles like stiff plasticine; can be modelled into rods without fracture; has firm resistance to ribboning shear; will form ribbon of 75mm or more.	50% or more

ASSESSMENT OF SOIL TEXTURE

From AS/NZS 1547:2000 – On site domestic wastewater management - Table 4.1D1

Classification	Properties	Typical clay content % (see note)
Sand	Very little to no coherence; cannot be moulded; single grains stick to fingers.	less than 5
Loamy sand	Slight coherence; forms a fragile cast that just bears handling; gives a very short (5mm) ribbon that breaks easily; discolours the fingers.	5-10
Sandy loam	Forms a cast but will not roll into a coherent ball; individual sand grains can be seen and felt; gives a ribbon of 5-25mm long.	10-20
Fine Sandy loam	As for sandy loams, except that the individual sand grains are not visible, although they can be heard and felt; gives a ribbon 15-25mm long.	10-20
Loam	As for sandy loams but cast feels spongy, with no obvious sandiness, or silkiness; may feel greasy if much organic matter is present; forms a thick ribbon about 25mm long.	10-25
Silty Loam	As for loams but not spongy; very smooth and silky; will form a very thin ribbon 25mm long and dries out rapidly.	10-25
Sandy clay loam	Can be rolled into a ball in which sand grains can be felt; forms a ribbon 25-40mm long.	20-30
Fine sandy clay loam	As for sandy loam, except that individual sand grains are not visible although they can be heard and felt; forms a ribbon 25-40mm long	20-30
Clay loam	Can be rolled into a ball with a rather spongy feel; slightly plastic; smooth to manipulate; will form a ribbon 40-50mm long.	25-35
Silty clay loam	As for clay loams but not spongy; very smooth and silky; will form ribbon about 40-50mm long; dries out rapidly.	25-35
Sandy clay	Forms a plastic ball in which sand grains can be seen, felt or heard; forms a ribbon 50-75mm.	35-45
Light clay	Smooth plastic ball that can be rolled into a rod; slight resistance to shearing between thumb and forefinger; forms a ribbon of 50-75mm long.	35-40
Silty clay	As for light clay but very smooth and silky; will form a ribbon about 50-75mm long but very fragmentary; dries out rapidly.	40-50
Medium clay	Smooth plastic ball; handles like plasticine and can be moulded into rods without fracture; some resistance to ribboning, forms a ribbon of 75mm or more long.	40-55
Heavy clay	Smooth plastic ball that handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning; forms a ribbon of 75mm or more in length.	50 or more
NOTE: The typical clay content figures are included for information only.		

FIGURE 1: PLAN SHOWING THE LOCATION OF THE PROPOSED DWELLING AND EFFLUENT RE-USE AREA AT No 3 BOUNDARY STREET, WARRIEWOOD



FOR: MR. S. AVERY
LGA: PITTWATER COUNCIL
DRAWN: G. AUSTIN, January 2004
REPORT REF. NO. 030807

BLUE MOUNTAINS GEOLOGICAL AND ENVIRONMENTAL SERVICES