Larry Cook Consulting Pty Ltd
(ABN 27 159 132 055)

PO Box 8146 TUMBI UMBI NSW 2261
Office: 02 4340 0193 Mobile: 0428 884645 Email: larrycookconsulting@gmail.com

CONCEPT WASTEWATER MANAGEMENT PLAN FOR PROPOSED SUBDIVISION

Lot 100 in DP1064980
792 Seaham Road Seaham

for

B. Statham

Distribution

B. Statham (1) **Rep.No. 18047-A**

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1. INTRODUCTION AND BACKGROUND

As requested by *B. Statham* (the owner), *Larry Cook Consulting* has conducted a wastewater treatment and disposal investigation on 17 proposed new allotments created by the proposed subdivision of Lot 100 in DP1064980 Seaham Road Seaham, lower Hunter Valley (the Site). The location of the Site is shown in a lot plan presented in **Figure 1** and on an aerial photo in **Figure 2**. A plan of the proposed subdivision showing the 18 new lots is presented in **Figure 3**. A contour plan is presented in **Figure 4**.

The site is not connected to the municipal sewerage system and as such, Port Stephens Council (Council) requires the preparation of a Wastewater Management Plan (WMP for the new On-Site Sewerage Management systems (OSSMs).

A WMP in this part of the local government area (LGA) must be prepared in accordance with Council's Development Assessment Framework (DAF) which was developed in 2011. The DAF adopts a risk based approach for the design of safe and sustainable On-Site Sewerage Management systems in the LGA and as such, sets out minimum requirements for the assessment, design and construction of these systems. A review of the DAF and advice recently obtained from Council reveals that the Site is a High Hazard Allotment in terms of application of treated wastewater. This WMP addresses the assessment requirements, particularly the minimum standards listed in Table 6.1 for High Hazard Allotments and Section 6 in the DAF.

This WMP provides a strategy for the design of a new On-Site Sewerage Management system (OSSM) for each proposed new allotment. The OSSM system is designed to:

1. Dispose of treated effluent on-site using an approved and effective methodology in accordance with the Environmental Health Protection Guidelines (DLG 1998) and AS/NZS 1547:2012 (SAI & NZS 2012).
2. Meet the environmental and health *Performance Objectives* documented in the Environmental Health Protection Guidelines (DLG 1998) which ensure that on-site sewage management for single households is appropriate and will not affect public health or the environment.

These objectives are detailed in Section 7.1.

2. INVESTIGATOR

Larry Cook, an environmental scientist and geoscientist undertook the effluent disposal management investigation. Larry Cook is qualified to carry out such investigations.

3. EXISTING DEVELOPMENT

The Site is a largely cleared and partly developed parcel of land. A *Google Earth* image over the Site showing existing conditions is presented in **Figures 1 and 3**. Existing infrastructure includes a single storey dwelling, garage, pool and shed in the northern corner of the Site. Two small farm dams are located on the Site; one in the north-western part and the other in the north-eastern part (**Figure 3**).

It is understood that wastewater generated from the existing dwelling is treated to primary standard in a Council-approved septic tank with disposal via an absorption trench system. The exact location and specifications of the disposal area are unknown but the site inspection did not reveal any wet areas.

4. PROPOSED DEVELOPMENT

The owner proposes to subdivide Lot 100 into 18 variably-sized new allotments. The proposed new lots and their layout are shown in **Figure 3**. The lots and respective areas are listed in **Table 1**.

Table 1
Register of New Lots

New Lot	Area (ha)	New Lot	Area (ha)
1	2.65	10	2.00
2	2.00	11	2.61
3	2.00	12	2.60
4	2.00	13	2.00
5	2.30	14	2.00
6	2.37	15	2.00
7	2.04	16	2.15
8	2.00	17	2.17
9	2.00	18	4.11

It is noted that the new allotments are all greater than 4,000 m^2 in size which is a trigger for certain additional investigations and assessments in the DAF.

It is also noted that new proposed Lot 18 hosts the existing dwelling which, according to the owner, will remain and the OSSM retained subject to Council approval. Access to the new allotments will be off Sophia Jane Drive at the southern end of the subdivision. Sophia Jane Drive is off Seaham Road.

For the purposes of calculating the design hydraulic load for each new allotment, an equivalent five bedroom dwelling is adopted which may include four bedrooms and an office/study the latter of which must be included as a potential bedroom particularly if it is similar in size (and layout) to the bedrooms, can fit a bed and has a built-in wardrobe.

The municipal sewerage system is not presently connected to the Site and, as such, Port Stephens Council (Council) requires the development of an On-Site Seweage Management (OSSM) system for any proposed development on each new allotment.

5. SITE INFORMATION

Lot 100 (the Site) is a multi-sided parcel of vacant rural land oriented broadly north-south and approximately 44 ha in area. The Site is in the Parish of Seaham, County of Durham and in the Port Stephens Council local government area (LGA). The western boundary of the Site fronts Seaham Road (**Figure 2**).

The Site is surrounded by partly developed rural and rural-residential land. There is mains power and town water available to the land but no municipal sewerage system.

6. SITE ASSESSMENT

The Site is located on the eastern-facing flank of a north-south oriented relatively low-lying ridge system. The flank slopes down to the east into an extensive wide flood plain associated with the former and present Williams River located approximately 3.2 km east of the Site. The Site is undulating and straddles a local topographic high with gentle to moderate slopes to the north, east and south.

The elevation of the subdivision varies between approximately 10 and 15 m Australian Height Datum (AHD). The eastern and south-eastern parts and north-western corner of the Site are bordered by wetlands. No defined drainages are observed on the Site.

A ground contour plan is presented in **Figure 4**. The Site straddles a north-northeasterly trending ridge (topographic high) at elevation 15 m AHD. The land is observed to slope to the west from this topographic high at an average slope of 1 in 8 (12 %), to the south at an average slope of 1 in 8 (12 %) and to the east towards the Williams River flood plain at an average slope of 1 in 8 (12 %).

The subdivision is interpreted to be underlain by overlying Permian Sedimentary rocks belonging to the Branxton Formation of the Maitland Group consisting mainly of a sequence of interbedded flat-lying sandstone, siltstone and conglomerate. Based on the soil investigations carried out as part of this study over the subdivision, the

types of sedimentary rocks in this area and soil development are observed to be similar.

The Site is largely cleared with isolated pockets of open tall eucalypts observed during the field investigations.

7. ON-SITE WASTEWATER MANAGEMENT PLAN

7.1 CLIMATE

Sun and wind exposure over the Site is observed to be excellent. No temperature, evaporation and rainfall data are available for the Site. Based on temperature data from the official BOM station at Williamtown RAAF (Station No. 061078), mean daily maximum temperatures for the land are expected to be always greater than 15^{o}C (**Table 1**). Williamtown RAAF station was used because it is by far the closest official weather station with official pan evaporation data. Rainfall statistics for Williamtown RAAF are also provided in **Table 2**.

The water balance calculations utilised in the hydraulic balance (**Appendices A and B**) are based on the temperature, rainfall and mean monthly pan evaporation data acquired from Williamtown RAAF and is believed to be the best meteorological values available for the subject land.

Table 2
Summary Climate Statistics – Williamtown RAAF (Station 061078)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	28.0	27.5	26.2	23.6	20.3	17.6	17.0	18.6	21.3	23.6	25.4	27.3	23.0	61	1942 2011
Mean minimum temperature (°C)	18.0	18.1	16.3	13.2	10.1	7.9	6.4	6.8	9.1	12.0	14.3	16.5	12.4	61	1942 2011
Rainfall															
Mean rainfall (mm)	96.8	120.5	120.1	105.8	115.1	122.3	72.3	75.8	60.1	74.5	81.6	79.5	1123.6	64	1942 2011
Decile 5 (median) rainfall (mm)	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82.0	61.8	1083.0	59	1942 2011
Mean number of days of rain ≥ 1 mm	11.9	11.9	12.9	11.5	12.7	12.5	10.2	10.2	9.6	11.7	11.8	11.0	137.9	59	1942 2011
Evaporation															
Mean Evaporation (mm)	213.9	173.6	151.9	114	83.7	72	80.6	111.6	141	170.5	189	223.2	1725	37	1974 2011

7.2 SOIL INVESTIGATIONS AND ASSESSMENT

The reader is referred to the *Soil Landscapes of the Newcastle 1:100,000 Sheet* Report (Matthei, 1995). The soils beneath the Site are grouped with the Bolwarra soil landscape which is developed on rolling hills overlying Permian Sedimentary rocks belonging to the Branxton Formation of the Maitland Group in this area.

Detailed soil investigations including representative multi-depth soil sampling and testing was carried out over the whole subdivision. The objectives are to:

- assess the type and depth of soils, and chemistry across the whole sub-division;
- determine any significant variation of these parameters across the subdivision, if it indeed exists; and
- assess for any potential for cumulative impacts on the environment from the creation of the sub-division.

That is, describe and classify the soil over the Site and subdivision, determine the range of the depths of the soil profile developed atop the Carboniferous sedimentary and volcanic rock sequence and establish any potential variations of these parameters across the sub-division. A total of 25 soil holes were drilled over the subdivision. The locations of the soil test sites are shown in **Figure 5**. Soil bore logs are provided in **Appendix C**.

In summary, the soil investigations on the Site revealed a relatively thin 0.1 to 0.2 m-thick layer of organic-rich silty sandy loam topsoil overlying silty sandy clay loam which grades down into residual light to medium clay. Groundwater was not encountered in the investigations.

The soils were classified according to the textural classification in AS/NZS 1547:2012. The textural classification of the Silty Sandy LOAM encountered down to approximately 0.20 m beneath the majority of the Site allows a determination of its expected permeability in accordance with Table 5.1 of AS/NZS 1547:2012 (SAI & NZS, 2012). The indicative permeability value (K_{sat}) for a weakly structured loam is predicted to be between approximately 0.5 and 1.5 m/d with an expected Design Loading Rate (DLR) of approximately 30 mm/day (Table L1 in Appendix L, AS/NZS 1547:2012) and a Design Irrigation Rate (DIR) of approximately 4 mm/day (approximately 28 mm/week) (Table M1 in Appendix M).

Although the disposal of treated wastewater would be within the silty sandy LOAM described above, the silty sandy loam is underlain by a colluvial-residual Clay LOAM grading down into a light to medium CLAY which must be taken into consideration in designing the on-site disposal of wastewater.

Table R1 in AS/NZS 1547:2012 recommends a vertical separation distance of between 0.60 and 1.5 m between the effluent application depth and any groundwater

or restrictive soil conditions. This is referred to as the limiting layer. The results of the site investigations indicate that the light to medium clay is the limiting layer which is intersected at approximately 0.20 to 0.30 m beneath the majority of the Site. Therefore the DIR or DLR should be based on the most limiting soil horizon occurring within the 0.60 m separation distance from the zone of effluent application.

In this regard, taking into consideration the limiting light to medium clay horizon at approximately 0.20 to 0.30 m depth, the indicative saturated hydraulic conductivity value of weakly structured Clay LOAM or a strongly structured light/medium CLAY is predicted to be between approximately 0.06 and 0.12 m/d with an expected DIR of approximately 21 mm/week (7 mm/day) and a DLR of approximately 12 mm/day. In this regard, a DLR of 12 mm/day and a DIR of 21 mm/week are considered appropriate for any calculations of the size of a Land Application Area (LAA) for each new allotment.

Soil samples were collected from the silty sandy loam topsoil in each test hole and underlying clay in a representative number of holes. Samples were submitted to a NATA accredited laboratory for the following tests listed in **Table 3**

Table 3 **Soil Test Parameters**
• pH • Electrical Conductivity (EC) • Exchangeable Sodium Capacity (ESP) • Cation Exchange Capacity (CEC) • Phosphorus Sorption (P Sorp) • Modified Emerson Class (EAT)

A copy of the analytical certificate for soil testing over the whole subdivision is provided in **Appendix D**. Soil test results are summarised in **Table 4**.

The results of the soil testing indicate the following:

- The soils are strongly acidic with **pH values** between 4.3 and 5.1. The recorded pH values are typical of soils in the district and wider region. They should not pose any constraints for the on-site disposal of treated wastewater. Anecdotal evidence from investigations in these soil types in the region suggests that turf and plant growth does not appear to be affected in any way. If required, the soil pH can be raised by the addition of lime.
- The soils are non-saline with **Electrical Conductivity (EC)** measurements recorded between 0.08 and 0.51 dS/cm.
- The **Cation Exchange Capacity (CEC)** results indicate a very low to low risk of adversely impacting on the structural stability and nutrient availability for plants and a medium risk for the underlying clay loam and clay soil. The 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 such media as fertilisers (Hazelton & Murphy, 2007).

- The **Exchangeable Sodium Percentage (ESP)** results reveal that all soils samples tested on the Site are non-sodic. The ESP is an important indicator of sodicity, which affects soil structural stability and susceptibility to dispersion.
- The **Phosphorus Sorption (P-sorption)** results reveal a medium high to very high limitation which, from numerous soil investigations in the district and wider region, is not uncommon. 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 wastewater disposal area.
- The **Emerson Aggregate Test (EAT)** is a measure of soil dispersibility and susceptibility to erosion and structural degradation. The soil testing revealed a low risk of dispersion for all soil samples tested.

In summary, the comprehensive soil testing program indicates that the soils on the Site are suitable for the application of treated wastewater subject to sufficient available land on each new allotment.

Table 4
Summary Soil Test Results and Ratings

Sample ID	Soil Category	Depth (m)	pH (pH units)[1]	Rating	EC (dS/m)[2]	Rating	CEC ($cmol^+/kg$)[3]	Rating	ESP (%)[4]	Rating	PSorp (mg/kg)[5]	Rating	EAT[6]	Rating
SBH 1	L	0.30	4.8	SA	0.30	NS	4.3	VL	0.5	NS	320	MH	8	L
SBH 2	L	0.20	4.8	SA	0.16	NS	2.9	VL	0.3	NS	260	MH	6	L
SBH 2	ClayL-C	0.80	4.7	SA	0.18	NS	10.2	L	0.2	NS	630	VH	8	L
SBH 3	L	0.15	4.4	SA	0.17	NS	4.2	VL	0.5	NS	340	MH	7	L
SBH 4	L	0.20	4.7	SA	0.15	NS	3.8	VL	0.5	NS	290	MH	7	L
SBH 4	ClayL-C	0.60	4.4	SA	0.23	NS	12.6	M	2.1	NS	670	VH	8	L
SBH 5	L	0.30	4.7	SA	0.18	NS	6.8	L	0.7	NS	450	H	8	L
SBH 6	L	0.10	4.7	SA	0.23	NS	3.3	VL	0.3	NS	320	MH	6	L
SBH 6	ClayL-C	0.50	4.3	SA	0.42	NS	13.1	M	4.5	NS	680	H	8	L
SBH 7	L	0.10	4.5	SA	0.28	NS	4.2	VL	0.2	NS	340	MH	6	L
SBH 8	L	0.10	4.4	SA	0.27	NS	4.7	VL	0.4	NS	400	H	6	L
SBH 8	ClayL-C	0.50	4.3	SA	0.23	NS	12.0	L	1.8	NS	660	H	8	L
SBH 9	L	0.15	4.5	SA	0.30	NS	5.4	VL	0.4	NS	440	H	6	L
SBH 10	L	0.10	4.6	SA	0.24	NS	5.2	VL	0.6	NS	420	H	6	L
SBH 10	ClayL-C	0.50	4.3	SA	0.23	NS	11.3	L	0.5	NS	690	H	8	L
SBH 11	L	0.20	4.6	SA	0.19	NS	3.9	VL	0.5	NS	300	MH	6	L
SBH 12	ClayL-C	0.20	4.6	SA	0.15	NS	3.9	VL	0.8	NS	310	MH	8	L

SBH 13	L	0.20	4.7	SA	0.24	NS	6.3	L	0.2	NS	430	H	7	L
SBH 13	ClayL-C	0.50	4.5	SA	0.22	NS	11.1	L	2.7	NS	700	H	7	L
SBH 14	L	0.30	4.7	SA	0.23	NS	4.4	VL	0.5	NS	350	MH	6	L
SBH 15	L	0.15	4.5	SA	0.20	NS	6.5	L	0.3	NS	460	H	6	L
SBH 16	L	0.20	4.5	SA	0.27	NS	5.0	VL	0.3	NS	400	H	6	L
SBH 16	ClayL-C	0.50	4.3	SA	0.51	NS	12.8	M	4.5	NS	720	H	8	L
SBH 17	L	0.20	4.3	SA	0.43	NS	5.5	VL	0.4	NS	430	H	6	L
SBH 17	ClayL-C	0.60	4.1	SA	0.46	NS	11.3	L	1.0	NS	670	H	7	L
SBH 18	L	0.15	4.2	SA	0.45	NS	5.0	VL	0.6	NS	380	MH	8	L
SBH 19	L	0.20	4.3	SA	0.42	NS	3.8	VL	1.2	NS	320	MH	8	L
SBH 20	L	0.30	4.5	SA	0.37	NS	4.2	VL	0.9	NS	330	MH	6	L
SBH 21	L	0.30	5.1	SA	0.08	NS	3.9	VL	0.3	NS	310	MH	7	L
SBH 22	L	0.20	4.4	SA	0.12	NS	3.3	VL	0.3	NS	300	MH	7	L
SBH 23	L	0.20	4.7	SA	0.21	NS	3.4	VL	0.6	NS	350	MH	6	L
SBH 23	ClayL-C	0.70	4.0	SA	0.22	NS	14.5	M	0.7	NS	740	H	8	L
SBH 24	L	0.30	4.5	SA	0.28	NS	3.1	VL	0.3	NS	290	MH	6	L

Soil Categories: L: loam, CL: clayey loam, ClayL: clay loam, C: Clay	
1. pH: Measure of acidity. SA: strongly acidic, MA: moderately acid, SA: slightly acid, N: neutral	(Hazelton & Murphy, 2007)
2. EC: Measure of salinity. NS: non-saline, SS: slightly saline, MS: moderately saline, HS: highly saline, ES: extremely saline	(Hazelton & Murphy, 2007)
3. CEC: Capacity of the soil to hold and exchange cations. VL: very low, L: low, M: medium, H: high, VH: very high	(Hazelton & Murphy, 2007)
4. ESP: Indicator of sodicity regarding soil structural stability and susceptibility to dispersion. NS: non-sodic, S: sodic, SS: strongly sodic, VSS: very strongly sodic	(Hazelton & Murphy, 2007)
5. PSorp: Capacity of a soil to bind any phosphorus. VL: very low, L: low, M: medium, H: high, MH: medium high, VH: very high	(Hazelton & Murphy, 2007)
6. EAT: Potential of susceptibility for dispersion. H: high, M: moderate, L: low	

7.3 HYDRAULIC LOAD

It is understood that the reticulated town water supply will be available to any new development on the 18 new allotments. The number of total equivalent bedrooms adopted in this concept WMP is five which allows for dedicated five bedrooms or a configuration comprising four bedrooms and a study. The design of the hydraulic load adopts standard water reduction fixtures as defined in AS/NZS 1547:2012. Based on this scenario, the design maximum wastewater production is approximately 150 L/person/day (Table H1 in Appendix H in AS/NZS 1547:2012). The adopted wastewater allowance is consistent with Section 6.2 and Table 6.2 of the DAF which prescribes a wastewater allowance of 150 L/person/day for a residential development on reticulated (town) water supply.

Consistent with AS/NZS 1547:2012 and Council's DAF, the calculation of the hydraulic load adopts a design total of eight persons for the equivalent five bedrooms (Council directed 1.6 persons per bedroom). Therefore the Design Hydraulic Load for the calculations for an equivalent **five bedrooms** is 1,200 L/day.

Design Hydraulic Load (5 bedrooms): 1,200 L/day

In comparison, the Design Hydraulic Load for an equivalent **four bedrooms** is 960 L/day.

Design Hydraulic Load (4 bedrooms): 960 L/day

7.4 SYSTEM SELECTION

In terms of the application of treated wastewater on the proposed allotments in the Site, the potential global limitations for the Site have been reviewed, assessed and the results summarised in **Table 5**. Positive site attributes include excellent sun and wind exposure over each allotment, relatively gentle sloping ground, locally moderate draining loamy sand soils and healthy grass cover.

Table 5 Assessment of Limitations for On-site Disposal of Treated Wastewater Lot 100 DP1064980 792 Seaham Road, Seaham				
Feature	Site	Capable level (Low Limitation)	Marginal Level (Mod. Limitation)	Unsuitable Level (High Limitation)
Proximity to any drainages	> 40 m to any surface water bodies	X		
Depth to bedrock (m)	> 1.00 m	X		
Depth to Water Table (m)	> 1.00 m	X		
Soil Permeability	Loam topsoil to 0.3 m (0.5-1.5 m/day) Clay loam/light-med clay to 1.1 m (0.06-0.12 m/day)	X	X	
Soil Drainage	Moderate		X	
Coarse Fragments (%)	< 20 % (none recorded in soil investigations)	X		
Bulk Density (g/cm^3)	~1.5		X	
pH (pH units)	4.3 – 5.1		X	
Electrical Conductivity (dS/m)	0.08 – 0.51	X		
Sun/wind Exposure	Excellent	X		
Flood Potential	Nil on upper parts of allotments	X		
Slope (%)	< approx. 5 - 12%		X	
Landform	Undulating		X	
Run-on seepage	Low	X		
Erosion Potential	Low	X		
Site Drainage	Moderate		X	
Site Fill	nil	X		
Practical Available Land Area (m^2)	> 1,000 m^2 per allotment	X		

7.5 WASTEWATER TREATMENT SYSTEM

Although, according to Council's DAF and AS/NZS 1547:2012, primary treatment of wastewater generated from any development on the 18 allotments is not precluded, the high hazard classification of the Site and surrounding sensitive environment, wastewater generated from any proposed developments should be treated to secondary standard using a Department of Health approved *Aerated Water Treatment System* (AWTS) or similar system. A NSW Health-approved AWTS is

considered suitable for developments on the Site and is therefore recommended for installation.

In summary, the AWTS is a small-scale sewage treatment system that is suitable for single households. The system consists of one or two tanks of 3,000 L minimum capacity containing a series of chambers. Through a series of treatment and disinfection processes, the wastewater is transformed into non-potable water that can be applied to lawns and gardens or disposed in several approved ways. The treatment process incorporates clarification, aeration, biological treatment and disinfection (chlorination and/or UV treatment). The discharge water is treated to a secondary standard. Typical final wastewater nutrient levels for an AWTS are 20 to 50 mg/L Total N and 8 to 18 mg/L Total P.

The location of the treatment system on each new allotment can be chosen by the installer or licensed plumber to suit any proposed building and plumbing arrangements.

The installation of any AWTS will not be in a flood hazard area, specifically the 1 % AEP flood level and, as such, special conditions on its installation (placement of electrics and lid sealing) will not be required.

7.6 WASTEWATER DISPOSAL

A review of site limitations, results of the soil investigations and review of topography, locations of any vegetation communities has resulted in the delineation of areas on each new allotment considered suitable for the disposal of minimum secondary treated wastewater. The nominated areas are effectively wastewater disposal envelopes that incorporate the building envelopes.

The areas considered suitable for the disposal of treated wastewater on each new allotment are shown in **Figure 6**. The position of the Land Application Area (LAA) for each new allotment takes into account the guideline buffer setback distances from the property boundaries, any surface water bodies, mapped areas of potential/actual acid sulphate soils, vegetation, access driveways, the 1 % AEP flood extent and predicted distance for viral die-off.

The nominated areas have excellent sun and wind exposure and satisfactory soil development. Disposal methods considered suitable for the new allotments include sub-surface drip irrigation, surface spray irrigation, Wisconsin sand mound, amended soil mound, ETA beds and conventional absorption beds.

Section 6.4.2 of Council's DAF provides four key principles for the effective design of an on-site land application system based on significant Australian and overseas research into the factors that influence the performance of the systems. These are reproduced from the DAF as follows:

- ***Intermittent dosing / resting*** *allows time for aerobic breakdown of the biomat or biofilms that form on soil surfaces. It also encourages breakdown of nutrients and other pollutants. During wet, cool conditions it minimises opportunities for saturated soil conditions.*
- ***Division of land application areas into sub-zones*** *goes hand in hand with intermittent dosing and provides additional redundancy into a design in the event of minor component failure.*
- ***Provision of more than 600mm of unsaturated soil*** *between the point of application and limiting layers (e.g. bedrock or weathered rock) or groundwater has been shown in a range of soils to deliver a high level of effluent polishing and disinfection. In some cases this may require the use of raised irrigation beds.*
- ***Even effluent distribution*** *using pressure dosing (e.g. pressure compensating drip irrigation or LPED) maximises the active surface area of a land application system and minimises the potential for localised failure due to variable levels.*

In accordance with best industry practice and preferred method of disposal in Council's DAF, **pressure compensated sub-surface drip irrigation is the preferred method of disposal**.

7.7 SUB-SURFACE DRIP IRRIGATION

7.7.1 Calculations

Design parameters and calculations for the design five bedrooms are provided in **Appendix A**. Design parameters and calculations for the design four bedroom scenario are provided in **Appendix B**. The calculations of the disposal area proposed for the Site are summarised in **Table 6**. The calculations are based on an equivalent four and five bedroom scenario for a new dwelling on each new allotment.

Therefore, the proposed total primary application area required to accept the design hydraulic loads of 960 and 1,200 L/day with full wet weather storage, a satisfactory 50 year phosphorus adsorption life and the uptake of the total nitrogen is approximately 700 to 850 m^2 respectively.

Table 6 Summary Disposal Area Calculations		
	Equivalent 4 bedrooms (6.4 persons)	**Equivalent 5 bedrooms (8 persons)**
Hydraulic Load (L/day)	**960**	**1,200**
Area (m^2)		
Minimum Area Method	248	310
Nominated Area Method with full wet weather storage	700	850
100 % Nitrogen Uptake	282	353
50-year Phosphorus Life	306	382
Proposed Application Area (Most Limiting)	**700 m^2**	**850 m^2**
Adopted Application Area	**700 m^2**	**850 m^2**
Parameters and Assumptions:		
1. Total N	20 mg/L	
2. Total P	8 mg/L	
3. Indicative Permeability:	0.5 and 1.5 m/d overlying 0.06-0.12	
4. Design Irrigation Rate (DIR):	m/day	
5. Effective Absorption Depth:	21 mm/wk	
6. Soil Phosphorus Sorption Capacity:	0.70 m	
7. Soil Treatment:	4,725 kg/ha Nil	

7.7.2 Nutrient Calculations

The nutrient calculations and results are provided in the third spread sheet in **Appendices A and B**. The calculations are comprehensive and take into all relevant parameters and values based on the current literature. The basic formula used to calculate the area requirements based on nitrogen and phosphorus loadings are taken from the Environmental Health Protection Guidelines (DLG 1998) and are provided below in support of the model calculations in **Appendices A and B**.

The critical Total Nitrogen loading rate used in the example on Page 153 in the Environment and Health Protection Guidelines (DLG, 1998) is a 'nominal' loading rate of 25 mg/m^2/day. The calculations in this WMP adopt a rate of 68 mg/m^2/day which is consistent with the calculations used by other workers. According to our literature research, this is considered to be a conservative level and is used in the calculations below. The source publication is a landmark paper on nitrogen in wastewater written by Bob Patterson of *Lanfax Laboratories* in Armidale (Patterson, 2003). The relevant section relating to critical nitrogen uptake is reproduced below.

"The Environment and Health Protection Guidelines (DLG, 1998) suggest a nominal nitrogen loading of 25 mg/m2/day (91 kg/ha/year) be applied to land application systems. When this loading rate is compared with typical plant and microbial uptake

rates, it is difficult to understand the scientific basis for the guideline value. While the value is called 'nominal' the author has had some authorities impose this as the maximum loading rate. The value is simply the mean of the range of TN for uptake values of perennial pasture referred to by EPA (1995) as 65-130 kg/ha.yr, which references a NSW Agriculture 1991 Feedlot Manual.

The revised Feedlot Manual (NSW Agriculture, 1997) indicates that for an irrigated perennial ryegrass pasture, growing actively March to December, the expected nitrogen uptake rate is 420 kg/ha.yr. Kikuyu is expected to remove 520 kg/ha.yr. Removal of the aerial portion of the grasses is required to remove the nitrogen from the application area. It would follow, although not discussed in the guidelines, that a further quantity of nitrogen would be stored in the root system as organic nitrogen, in the microbial biomass and leaching of nitrogen would be restricted to only a portion of the nitrate-N..."

The critical phosphorus loading rate used in the example on Pages 153 and 154 in the Environment and Health Protection Guidelines (DLG, 1998) is a 'nominal' loading rate of 3 mg/m^2/day However, a review of the literature on wastewater chemistry suggests that a more realistic critical loading rate is possibly closer to 7 mg/m^2/day. The source publication is a landmark paper on phosphorus in wastewater written by Robert Patterson of *Lanfax Laboratories* in Armidale (Patterson, 2001). The relevant section relating to phosphorus uptake in soils is reproduced below.

"...In all the (analytical) methods, P sorption only accounts for the addition of labile inorganic P being added and measured at specified pH for a particular period. The tests do not account for the pH of the effluent added or the other elemental constituents of the effluent, in particular the proportion of monovalent and divalent cations.
The addition of organic P components will have no immediate impact on determination of P sorption, yet substantial masses of organic P can be stored in the soil without loss by leaching...."

"The purpose of determining P sorption is to predict the capacity of the soil to bind, and reduce the potential for effluent-applied inorganic P leaching from the soil and entering surface or groundwater. The results of this testing program do not support the general discount factor of 70% from measured P sorption to that actually adsorbed. Since part of the P in effluent is in organic form, a soil's capacity to adsorb P is greater than determined for inorganic P sorption...."

The critical phosphorus loading rate adopted in this WMP is 7 mg/m^2/day. The formulae documented in the Environment and Health Protection Guidelines follows in their relevant sections with calculations for the Site.

The following calculations are provided for the four-bedroom (960 L/day) hydraulic load scenario. The calculations for the five-bedroom (1,200 L/day) scenario are summarised in **Table 6**.

Determination of Minimum Area Based on Nitrogen Loading

$$A = \frac{C \times Q}{L_n}$$

$$A = 20 \times 960 / 68$$
$$= 282.4\ m^2$$

where A = land Area (m^2)
C = concentration of Total Nitrogen (TN) (17 mg/L) less 20% for lost to soil processes
Q = treated wastewater flow rate (L/day)
L_n = critical TN loading rate ($mg/m^2/day$) (Whitehead & Associates)

Determination of Area Based on Phosphorus Loading

The determination of the minimum area is based on a phosphorus loading of 10 mg/L. Based on the parameters gleaned from research by Patterson (2001) and used by a leading consultancy in the industry, a phosphorus soil sorption without leaching factor of 0.7, a critical phosphorus uptake rate of 7 $mg/m^2/day$ and a recommended phosphorus sorption ability of 50 years is as follows;.

$$A = P_{\text{generated}} / (P_{\text{adsorbed}} + P_{\text{uptake}})$$

$$A = 140.2/ (0.331 + 0.128)$$
$$= 305.6\ m^2$$

$$P_{\text{generated over 50 years}} = TP \times Q \times \text{days} \times \text{years}$$
$$= 8 \times 960 \times 365 \times 50$$
$$= 140.2\ (2.80\ kg/year)$$

where $P_{\text{generated}}$ = amount of phosphorus generated (kg)
TP = Total Phosphorus concentration in treated wastewater (mg/L)
Q = treated wastewater flow rate (L/day)

$$P_{adsorbed} = P\ Sorp \times 0.7$$
$$= 4{,}725 \times 0.7$$
$$= 0.331\ kg/m^2$$

where $P_{adsorbed}$ = amount of phosphorus that can be adsorbed without leaching
P Sorp = phosphorus sorption capacity (kg/ha)

$$P_{uptake\ over\ 50\ years} = CPLR \times days \times years$$
$$= 7 \times 365\ days \times 50\ years$$
$$= 0.128\ kg/m^2$$

where P uptake = amount of phosphorus vegetation uptake
CPLR = critical P loading rate ($mg/m^2/day$)

The results are summarised in **Table 7**.

Table 7
Summary Results of Nutrient Calculations

Parameter	Calculation
Estimated Total Nitrogen Concentration (AWTS)	20 mg/L
Estimated Total Phosphorus Concentration (AWTS)	8 mg/L
Estimated bulk soil density	1500 kg/m^3
Phosphorus sorption depth (from field soil testing)	0.70 m
Phosphorus sorption capacity (laboratory testing)	450 mg P/kg (4,725 kg/ha)
Design wastewater load (4-5 bedrooms town water)	960–1,200 L/day (150 L/person/day)
Design application area	700 - 850 m^2
Total nitrogen not assimilated	0 kg/year
Total phosphorus not assimilated	1.79 – 2.60 kg/year
Site phosphorus longevity	Greater than 50 years

7.7.3 Design Sub-Surface Drip Irrigation

The important design elements of the sub-surface irrigation system are summarised as follows:

- The recommended type of irrigation is pressurised sub-surface drip irrigation which, if designed and installed correctly, ensures even, widespread and efficient application of treated wastewater under controlled application rates within the root-zone of plants and grasses.
- The treated wastewater should be applied evenly across the designated disposal area.
- There are several suitable and available proprietary, pressure-compensating drip irrigation systems which are designed for irrigation of wastewater which contain elevated levels of nutrient and biological loads, BOD and suspended solids. Industry examples include:

    - *UniBioline* - Netafim Australia
    - *Safe-T-Flow* - BUI Ebb & Flow Technologies, Australia
    - *Wasteflow* - Triangle Filtration & Irrigation, Australia
    - *KISS Ground Irrigation system*
    - *Triangle Irrigation system*

    These proprietary irrigation systems incorporate root intrusion protection and are designed to significantly reduce the risk of any blockages.
- The irrigation lines should be installed at a depth of between approximately 100 and 150 mm below ground surface, parallel to the ground slope and parallel to each other. The recommended separation distance between lateral pipes in the irrigation panels is less than approximately 1.0 m which will minimise 'striping'.
- Manufacturers recommend the installation of:
    - In-line 120-micron disc filter in order to minimise the amount of solids entering the pipelines and emitters
    - Air release valves (vacuum breaker 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

It is recommended that these elements are inspected for integrity and operational status and cleaned as necessary during quarterly contractual inspections and maintenance. Repairs or replacement should be carried out as required.

A design for irrigation is provided in **Figure 7** and an industry example of a sub-surface irrigation layout with principle components is presented in **Figure 8**.

7.8 RESERVE APPLICATION AREA

In accordance with Section 6.4.4 of Council's DAF policy, Land application Areas (LAAs) dosed with secondary treated effluent do not require provision of a reserve (backup) LAA if:

- individual land holdings are greater than 4,000 m^2;
- there is demonstrated ability to satisfy guideline buffer setback distances; and
- the disposal of treated wastewater is via irrigation or mounds.

The sizes of the proposed allotments in the Site all exceed 4,000 m^2 and there is considered to be no impediment to satisfy the guidelines buffer setback distances. In addition, the preferred and recommended method of disposal of treated wastewater is sub-surface drip irrigation. In this regard, delineation of areas on each allotment for reserve disposal is not required.

7.9 FLOOD HAZARD

The Site is flood affected. The minimum elevation on the Site for the disposal of treated wastewater is understood to be 4.2 m Australian Height Datum (AHD) is annotated in **Figures 3 and 4.** This affects new allotments 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12 and 18. The flood planning level is designated as 6.1 m AHD. However, this WMP has identified sufficient available area on each new allotment for the location of a Land Application Area and satisfactory disposal of treated wastewater above the 1 % AEP level.

7.10 ACID SULPHATE SOIL HAZARD

Acid sulphate soils (ASS) have been identified on the Site from a review by others of the Acid Sulphate Soil Rick maps published by the NSW Department of Environment and heritage. ASS identified on the Site is annotated in **Figure 9** and consists of the following:

- Class 2 ASS - mapped on new allotments 4, 5, 6 and 18.
- Class 3 ASS - mapped on new allotments 10, 11 and 12.
- Class 4 ASS - mapped on new allotments 1, 3, 4, 6 and 18.

In accordance with Section 6.3.10 of the DAF, the potential presence of acid sulphate soils on low-lying coastal and estuarine areas such as the setting for the Site should be evaluated. As the DAF notes, the disturbance of potential acid sulphate soils should be avoided as part of any on-site sewage management system design.

However, this WMP has identified sufficient available area on each new allotment for the location of a Land Application Area and satisfactory disposal of treated wastewater in areas not identified as an ASS hazard.

7.11 CUMULATIVE IMPACT ASSESSMENT

A Cumulative Impact Assessment (CIA) may be required for unsewered High Hazard allotments that result in an increase in building entitlements, such as a subdivision development. However, Section 2.3.4 of Council's DAF waives the need for a CIA where:

- individual land holdings are greater than 4,000 m^2; and
- the proposed Land Application Areas (LAAs) ensure LAAs will comply with the guideline buffer setback distances listed in Table 6-10 of the DAF.

The sizes of the proposed allotments in the Site all exceed 4,000 m^2 and there is considered to be no impediment to satisfy the guidelines buffer setback distances. In this regard, a CIA is not required.

Although a CIA is not required for the proposed subdivision, a Pathogen Transport Model was run to estimate the distance that viral pathogens may migrate downslope from a Land Application Area on the allotments given the consistent landform, soils and hydrogeological characteristics of the Site. The model predicts the fate of pathogens in the environment and provides a measure of the performance of the proposed wastewater treatment process and wastewater disposal systems at the site. The resulting setback distances for viral die-off assesses the potential for possible adverse impacts on the environment, in particular impacts on any receiving waters

The foundations of the Pathogen Transport Model were developed by Beavers and Gardner (1993) and described (and refined) by Cromer et. al. (2001). The Pathogen Transport Model applies mainly to wastewater migrating down a hydraulic gradient from a Land Application Area (LAA) in saturated soils. Pathogens can also migrate downslope in overland flow that has intersected the LAA. However, the proposed LAAs are sub-surface irrigation fields where the risk of effluent resurfacing and flowing offsite is negligible.

Cromer (2001) identified four key assumptions used in the modelling assuming secondary treatment of wastewater is used:

- Die-off times for bacteria exceed the die-off times for viruses. That is, bacteria are assumed to die-off within a shorter distance than viruses;
- Viral reduction has been set at a three times the order of magnitude for secondary treated wastewater from the proposed aerated wastewater treatment systems. Disinfection in the proposed treatment systems provides high level of conservatism in the calculations.

- The adopted average soil groundwater temperature is 15°C which is considered plausible for the regional location of the Site. Cromer notes that cooler temperatures allow viruses to reside longer in the soil resulting in potentially greater travel distances. Climate data indicates that the average mean air temperature exceeds 15°C. The implication is that the average groundwater temperatures likely exceed 15°C which provides a further level of conservatism in the modelling.
- A conservative soil porosity of 30% is adopted for silty sandy loam to sandy clay loam topsoils in which wastewater will be disposed.

The first step to predict the horizontal distance travelled in groundwater to achieve total viral die-off is to use Figure 1 in Cromer (2001) to determine days travel time using groundwater temperature and a selected order of magnitude reduction.

The second step is the calculation of the predicted maximum travel distance using Equation 4 in Cromer *et al.* (2001):

$$Dg = (t\text{-}dv.P/K)/(P/K.I)$$

Where:

Dg:	Distance travelled in groundwater
T:	Time in days
dv:	Depth to Water Table (Vertical drainage before entering groundwater)
P:	Effective porosity of soil)as a fraction)
K:	Saturated hydraulic conductivity
I:	Groundwater gradient (as a fraction)

The assumptions used for the above parameters in the Pathogen Transport Model for the Site and predicted maximum distance of viral transport (die-off distance) are provided in **Table 8**.

Table 8: Pathogen Transport Model Assumptions and Results		
Parameter	**Nominated Value**	**Comments/Assumptions**
Soil Porosity (decimal)	0.3 (30%)	Based on typical porosity of silty sandy loam to sandy clay loam soil
Hydraulic Conductivity Ksat (m/day)	1.5	Average for silty sandy loam to sandy clay loam topsoils
Depth to Groundwater (m)	4	Conservatively low to take into consideration possible seasonal perched watertable in clay subsoils (permanent groundwater >11 m)
Groundwater Gradient (%)	20	Conservatively high given maximum ground slopes on Site ~12%. Some allotments less than 12%.
Groundwater Temperature (^{o}C)	15	Conservatively less than mean air temperatures
Adopted Log Reduction of Pathogens	3	Conservatively high given that wastewater is disinfected (chorine)
Required Setback Distance (m)	20.2	Horizontal distance travelled in groundwater to achieve a log 3 reduction in viral numbers

The results of the Pathogen Transport Model predict a Log 3 reduction (total die-off) of pathogens within approximately 20.2 m of the downside perimeter of the Land Application Area (LAA). This distance is taken into account in locating the LAA on each of the new allotments with the exception of New Lot 18 which hosts the existing dwelling.

The existing LAA located close to the existing dwelling in New Allotment 18 is presently receiving primary treated wastewater from a gravity-driven septic tank. Cromer (2001) suggests a five times the order of magnitude for primary treated wastewater. The results of the model for the existing absorption trench system adopting the same parameters and assumptions predicts a Log 5 reduction (total die-off) of pathogens within approximately 35.2 m of the trench system.

7.12 DIVERSION DRAIN

A diversion drain or suitable device must be constructed immediately upslope of the Land Application Areas on sloping allotments to intercept and divert any overland flow or shallow water migrating downslope from upslope areas. A design cross

section through an example of a diversion drain with general specifications is provided in **Figure 10**.

7.13 BUFFER DISTANCES

The position of the proposed Land Application Area (LAA) on each new allotment satisfies the following guideline buffer distances listed in **Table 9** and documented in Table 5 of the Environmental Health Protection Guidelines (DLG 1998). There are farm dams on proposed new allotments 11 and 18 but no defined drainages or water wells (bores).

Table 9
Buffer Distances

From Intermittent Drainages	40 m
From Permanent Drainages	100 m
From Dams	40 m
From Domestic water well (Bore)	250 m
Upgradient of Property Boundary	6 m
Downgradient of Property Boundary	3 m
Upgradient of swimming pools, driveways and buildings	6 m
Downgradient of swimming pools, driveways and buildings	3 m

8. CONCLUSIONS AND RECOMMENDATIONS

- The wastewater management plan is developed to meet the environmental and health *Performance Objectives* documented in the Environmental Health Protection Guidelines (DLG 1998), in particular the avoidance of any impacts on public health or the environment. The design disposal of secondary treated effluent on-site proposes an approved and effective methodology in accordance with the Environmental Health Protection Guidelines (DLG 1998) and AS/NZS 1547:2012 (SAI & NZS 2012).
- The geology, soil characteristics and attributes, landform, available land for on-site application and local climate allow treated wastewater to be disposed on-site via sub-surface drip irrigation.
- A Department of Health approved AWTS (or suitable treatment system) and disposal via sub-surface drip irrigation in an appropriately constructed irrigation system is considered suitable for each of the new allotments.
- The recommended area for the sub-surface irrigation system is approximately 700 to 850 m^2. This calculated disposal area is predicated on a hydraulic load of 960 to 1,200 L/day respectively.
- The Land Application Areas for each allotment are above the 1% AEP flood level and sufficiently upslope of any potential and actual Acid Sulphate Soil hazards.

- The results of the Pathogen Transport Model for new allotments 1 through 17 predict total die-off of pathogens within approximately 20.2 m of the downside perimeter of the Land Application Area (LAA). The results of the model for the existing absorption trench system in new allotment 18 predicts a total die-off of pathogens within approximately 35.2 m of the trench system.
- Pressure compensated drips and root invasion protection should be used in the sub-surface drip irrigation system. Lilac coloured *UniBioline, Wasteflow, Triangle*, *Safe-T-Flow* or *KISS* dripper line should be used.
- Nomination of a reserve land application area is not required.
- The proposed location of Land Application Areas are shown in **Figure 6**. The design specifications of the sub-surface irrigation system are shown in **Figure 8**. An industry example of a typical sub-surface drip irrigation layout is provided in **Figure 9**. Construction of any irrigation system should be in general accordance with the principles documented in Section 7.7.3.
- An approved AWTS will require quarterly (3-monthly) contractual inspections which include the examination of the operation of the aerator, pump, disinfection system and alarm system. This is an ongoing cost.
- The construction of the irrigation (disposal) system and associated plumbing and hydraulic connections should be undertaken by a licensed plumber/drainer or suitably licensed practitioner with experience in installing wastewater treatment and on-site disposal systems in accordance with AS/NZS 1547:2012 and any relevant codes of practices.
- The optimal route for the plumbing between the AWTS or similar treatment system and the disposal system can be selected by the licensed plumber or installer to suit the development.
- As required, select an AWTS (or suitable treatment system) and complete an *Application to Install Sewage Management System including Greywater Treatment System and Greywater Diversion System* Sec 68, Chapter 7 LGA 1993. A Council fee applies.

9. REFERENCES

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For and on behalf of
Larry Cook Consulting

Larry Cook
Environmental consultant and Hydrogeologist

APPENDIX A

CALCULATIONS
SUB-SURFACE IRRIGATION

Four bedrooms

Environment and Health Protection Guidelines
Minimum Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	960
Design Percolation Rate	R	mm/wk	21

Lot 100 DP1064980 792 Seaham Road, Seaham

Parameters	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
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Evaporation	E		mm/month	213.9	173.6	151.9	114	83.7	72	80.6	111.6	141	170.5	189	223.2	1725
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Outputs																
Evapotranspiration	ET	E*C	mm/month	149.73	121.52	106.33	57	41.85	28.8	32.24	55.8	70.5	85.25	132.3	156.24	1037.56
Percolation	B	(R/7)*D	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	242.7	205.5	199.3	147.0	134.9	118.8	125.2	148.8	160.5	178.3	222.3	249.2	2132.6
Inputs																
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Retained Precipitation		P*0.75	mm/month	57.9	71.7	83.0	64.0	77.1	76.8	54.6	45.2	37.3	42.2	61.5	46.4	717.45
Possible Effluent Irrigation	W	(ET+B)-P	mm/month	184.8	133.8	116.4	83.0	57.8	42.0	70.6	103.7	123.2	136.1	160.8	202.9	1415.1
Actual Effluent Irrigation	I	H/12	mm/month	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	1415.1
Inputs		P+I	mm/month	175.8	189.6	200.9	181.9	195.0	194.7	172.5	163.1	155.2	160.1	179.4	164.3	2132.6
Storage	S	(P+I)-(ET+B)	mm/month	-66.9	-15.9	1.5	34.9	60.2	75.9	47.3	14.3	-5.3	-18.2	-42.9	-85.0	
Cumulative Storage	M	-	mm	-66.9	-15.9	1.5	36.4	96.6	172.5	219.8	234.1	228.8	210.6	167.8	82.8	
Irrigation Area	L	365*Q/H	m^2	247.6												
Storage	V	Largest M	mm	234.1												
		(V*L)/1000	m^3	58.0												

Environment and Health Protection Guidelines

Nominated Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	960
Design Percolation Rate	R	mm/wk	21
Land Area	L	m^2	700

Lot 100 DP1064980 792 Seaham Road, Seaham

Parameters	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
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Evaporation	E		mm/month	213.9	173.6	151.9	114	83.7	72	80.6	111.6	141	170.5	189	223	1725
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Inputs																
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Retained Precipitation		P*0.75	mm/month	57.9	71.7	83.0	64.0	77.1	76.8	54.6	45.2	37.3	42.2	61.5	46.4	717.45
Possible Effluent Irrigation	W	(Q*D)/L	mm/month	42.5	38.4	42.5	41.1	42.5	41.1	42.5	42.5	41.1	42.5	41.1	42.5	500.6
Inputs		P+W	mm/month	100.4	110.1	125.5	105.1	119.6	117.9	97.1	87.7	78.4	84.7	102.6	88.9	1218.0
Outputs																
Evapotranspiration	ET	E*C	mm/month	149.73	121.52	106.33	57	41.85	28.8	32.24	55.8	70.5	85.25	132.3	156.2	1037.56
Percolation	B	(R/7)*D	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	242.7	205.5	199.3	147.0	134.9	118.8	125.2	148.8	160.5	178.3	222.3	249.2	2132.6
Storage	S	(P+W)-(ET+B)	mm/month	-142.3	-95.4	-73.9	-41.9	-15.2	-0.9	-28.1	-61.1	-82.1	-93.6	-119.7	-160.4	
Cumulative Storage	M	-	mm	-142.3	-95.4	-73.9	-41.9	-15.2	-0.9	-28.1	-61.1	-82.1	-93.6	-119.7	-160.4	
		2nd year		-142.3	-95.4	-73.9	-41.9	-15.2	-0.9	-28.1	-61.1	-82.1	-93.6	-119.7	-160.4	
Storage	V	Largest M	mm	-0.9												
		(V*L)/1000	m^3	-0.6												

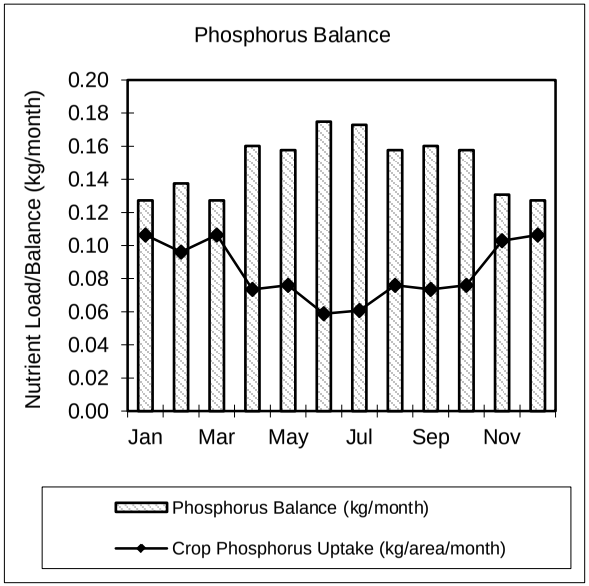
Monthly Nutrient Balance Calculation

Nutrient & Soil Paramaters	
Estimated Total - N concentration (mg/L)	**20**
Effluent Total P Concentration (mg/L)	**8**
Effluent Ammonia - N concentration (mg/L) (55% total N)	11
Effluent Organic - N concentration (mg/L) (15% total N)	3
Effluent Oxidised - N concentration (mg/L) (30% total N)	6
Organic N conversion to ammonia (%)	90
Ammonia loss through volatilisation(%)	25
Oxidised N loss through denitrification (%)	10
Critical Total Nitrogen Loading Rate (mg/m^2/day)	68
Critical Phosphorus Loading Rate (mg/m^2/day)	7
Estimated Soil Bulk Density (kg/m^3)	1500
Assumed Phosphorus Sorption Depth (m)	0.70
Lab-determined P-Sorp capacity (mg P/kg soil)	450

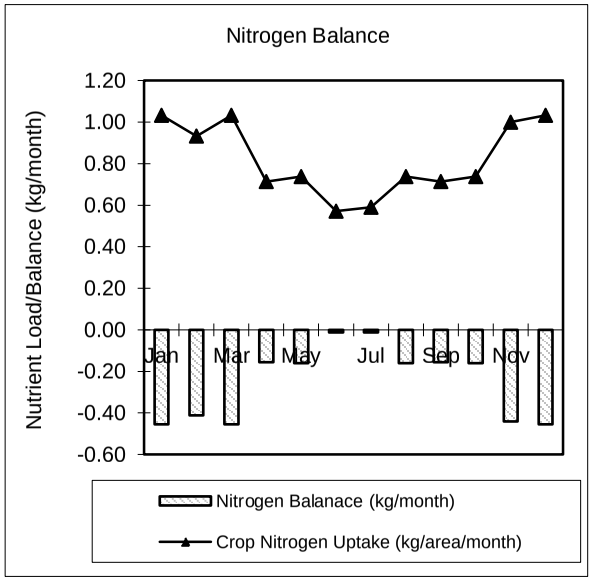
Hydraulic Load and Disposal Area Parameters	
Design wastewater load (L/day)	960
Design Application Area (m^2)	700

Computed Parameters	
Ammonia N Load (kg/year)	4.80
Organic N load (kg/year)	0.11
Oxidised N load (kg/year)	1.89
Effective total N load (kg/year)	6.80
Phosphorus load (kg/year)	2.80
Soil phosphorus sorption capacity (kg/ha)	4725

Results Summary	
Total nitrogen not assimilated (kg/year)	0.00
Percent of nitrogen not assimilated (%)	0
Total phosphorus not assimilated (kg/year)	1.79
Site phosphorus longevity (years)	185



Month	Days in Month	Growth Rate Factor (0-1)	Nitrogen Load (kg/month)	Crop Nitrogen Uptake (kg/area/month)	Nitrogen Balanace (kg/month)	Positive Nitrogen Balance (kg/month)	Phosphorus Load (kg/month)	Crop Phosphorus Uptake (kg/area/month)	Phosphorus Balance (kg/month)	Positive Phosphorus Balance (kg/month)
Jan	31	0.7	0.58	1.03	-0.46	0.46	0.23	0.11	0.13	0.13
Feb	28	0.7	0.52	0.93	-0.41	0.41	0.23	0.10	0.14	0.14
Mar	31	0.7	0.58	1.03	-0.46	0.46	0.23	0.11	0.13	0.13
Apr	30	0.5	0.56	0.71	-0.16	0.16	0.23	0.07	0.16	0.16
May	31	0.5	0.58	0.74	-0.16	0.16	0.23	0.08	0.16	0.16
Jun	30	0.4	0.56	0.57	-0.01	0.01	0.23	0.06	0.17	0.17
Jul	31	0.4	0.58	0.59	-0.01	0.01	0.23	0.06	0.17	0.17
Aug	31	0.5	0.58	0.74	-0.16	0.16	0.23	0.08	0.16	0.16
Sep	30	0.5	0.56	0.71	-0.16	0.16	0.23	0.07	0.16	0.16
Oct	31	0.5	0.58	0.74	-0.16	0.16	0.23	0.08	0.16	0.16
Nov	30	0.7	0.56	1.00	-0.44	0.44	0.23	0.10	0.13	0.13
Dec	31	0.7	0.58	1.03	-0.46	0.46	0.23	0.11	0.13	0.13
Total	365	6.8	6.80	9.83	-3.04	3.04	2.80	1.01	1.79	1.79



APPENDIX B

CALCULATIONS
SUB-SURFACE IRRIGATION

Five bedrooms

Environment and Health Protection Guidelines
Minimum Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	1,200
Design Percolation Rate	R	mm/wk	21

Lot 100 DP1064980 792 Seaham Road, Seaham

Parameters	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
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Evaporation	E		mm/month	213.9	173.6	151.9	114	83.7	72	80.6	111.6	141	170.5	189	223.2	1725
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Outputs																
Evapotranspiration	ET	E*C	mm/month	149.73	121.52	106.33	57	41.85	28.8	32.24	55.8	70.5	85.25	132.3	156.24	1037.56
Percolation	B	(R/7)*D	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	242.7	205.5	199.3	147.0	134.9	118.8	125.2	148.8	160.5	178.3	222.3	249.2	2132.6
Inputs																
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Retained Precipitation		P*0.75	mm/month	57.9	71.7	83.0	64.0	77.1	76.8	54.6	45.2	37.3	42.2	61.5	46.4	717.45
Possible Effluent Irrigation	W	(ET+B)-P	mm/month	184.8	133.8	116.4	83.0	57.8	42.0	70.6	103.7	123.2	136.1	160.8	202.9	1415.1
Actual Effluent Irrigation	I	H/12	mm/month	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	117.9	1415.1
Inputs		P+I	mm/month	175.8	189.6	200.9	181.9	195.0	194.7	172.5	163.1	155.2	160.1	179.4	164.3	2132.6
Storage	S	(P+I)-(ET+B)	mm/month	-66.9	-15.9	1.5	34.9	60.2	75.9	47.3	14.3	-5.3	-18.2	-42.9	-85.0	
Cumulative Storage	M	-	mm	-66.9	-15.9	1.5	36.4	96.6	172.5	219.8	234.1	228.8	210.6	167.8	82.8	
Irrigation Area	L	365*Q/H	m^2	309.5												
Storage	V	Largest M	mm	234.1												
		(V*L)/1000	m^3	72.5												

Environment and Health Protection Guidelines

Nominated Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	1,200
Design Percolation Rate	R	mm/wk	21
Land Area	L	m^2	850

Lot 100 DP1064980 792 Seaham Road, Seaham

Parameters	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
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Evaporation	E		mm/month	213.9	173.6	151.9	114	83.7	72	80.6	111.6	141	170.5	189	223	1725
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Inputs																
Precipitation	P		mm/month	77.2	95.6	110.6	85.3	102.8	102.4	72.8	60.2	49.7	56.2	82	61.8	1083
Retained Precipitation		P*0.75	mm/month	57.9	71.7	83.0	64.0	77.1	76.8	54.6	45.2	37.3	42.2	61.5	46.4	717.45
Possible Effluent Irrigation	W	(Q*D)/L	mm/month	43.8	39.5	43.8	42.4	43.8	42.4	43.8	43.8	42.4	43.8	42.4	43.8	515.3
Inputs		P+W	mm/month	101.7	111.2	126.7	106.3	120.9	119.2	98.4	88.9	79.6	85.9	103.9	90.1	1232.7
Outputs																
Evapotranspiration	ET	E*C	mm/month	149.73	121.52	106.33	57	41.85	28.8	32.24	55.8	70.5	85.25	132.3	156.2	1037.56
Percolation	B	(R/7)*D	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	242.7	205.5	199.3	147.0	134.9	118.8	125.2	148.8	160.5	178.3	222.3	249.2	2132.6
Storage	S	(P+W)-(ET+B)	mm/month	-141.1	-94.3	-72.6	-40.7	-14.0	0.4	-26.9	-59.9	-80.9	-92.3	-118.4	-159.1	
Cumulative Storage	M	-	mm	-141.1	-94.3	-72.6	-40.7	-14.0	0.4	-26.5	-59.9	-80.9	-92.3	-118.4	-159.1	
		2nd year		-141.1	-94.3	-72.6	-40.7	-14.0	0.4	-26.5	-59.9	-80.9	-92.3	-118.4	-159.1	
Storage	V	Largest M	mm	0.4												
		(V*L)/1000	m^3	0.3												

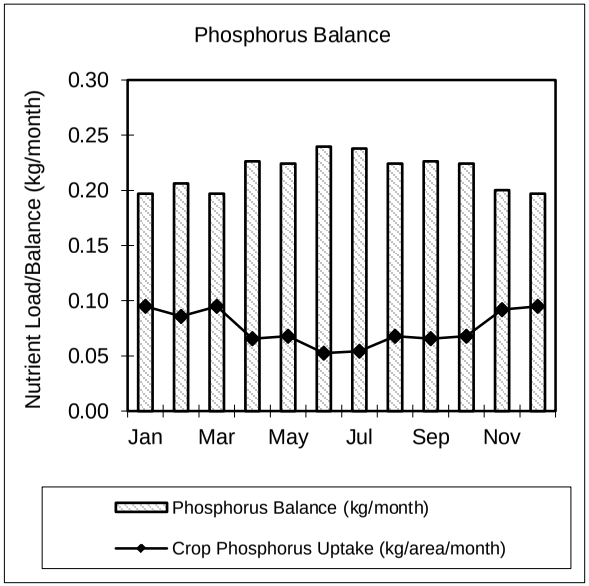
Monthly Nutrient Balance Calculation

Nutrient & Soil Paramaters	
Estimated Total - N concentration (mg/L)	**20**
Effluent Total P Concentration (mg/L)	**8**
Effluent Ammonia - N concentration (mg/L) (55% total N)	11
Effluent Organic - N concentration (mg/L) (15% total N)	3
Effluent Oxidised - N concentration (mg/L) (30% total N)	6
Organic N conversion to ammonia (%)	90
Ammonia loss through volatilisation(%)	25
Oxidised N loss through denitrification (%)	10
Critical Total Nitrogen Loading Rate (mg/m^2/day)	68
Critical Phosphorus Loading Rate (mg/m^2/day)	7
Estimated Soil Bulk Density (kg/m^3)	1500
Assumed Phosphorus Sorption Depth (m)	0.70
Lab-determined P-Sorp capacity (mg P/kg soil)	450

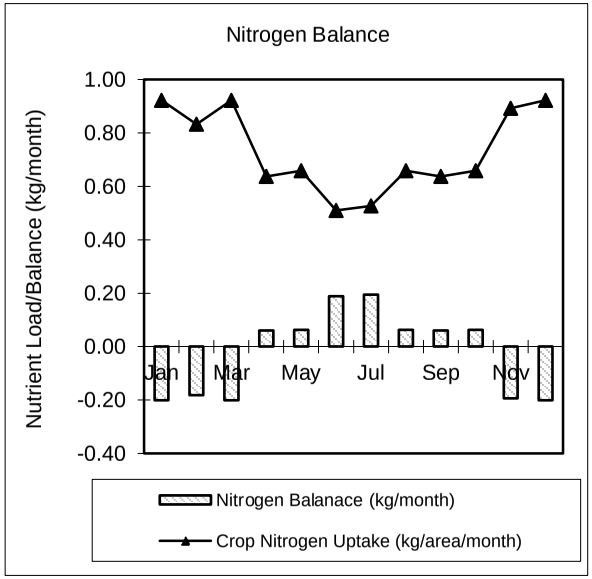
Hydraulic Load and Disposal Area Parameters	
Design wastewater load (L/day)	1,200
Design Application Area (m^2)	625

Computed Parameters	
Ammonia N Load (kg/year)	6.00
Organic N load (kg/year)	0.13
Oxidised N load (kg/year)	2.37
Effective total N load (kg/year)	8.50
Phosphorus load (kg/year)	3.50
Soil phosphorus sorption capacity (kg/ha)	4725

Results Summary	
Total nitrogen not assimilated (kg/year)	0.00
Percent of nitrogen not assimilated (%)	0
Total phosphorus not assimilated (kg/year)	2.60
Site phosphorus longevity (years)	114



Month	Days in Month	Growth Rate Factor (0-1)	Nitrogen Load (kg/month)	Crop Nitrogen Uptake (kg/area/month)	Nitrogen Balanace (kg/month)	Positive Nitrogen Balance (kg/month)	Phosphorus Load (kg/month)	Crop Phosphorus Uptake (kg/area/month)	Phosphorus Balance (kg/month)	Positive Phosphorus Balance (kg/month)
Jan	31	0.7	0.72	0.92	-0.20	0.20	0.29	0.09	0.20	0.20
Feb	28	0.7	0.65	0.83	-0.18	0.18	0.29	0.09	0.21	0.21
Mar	31	0.7	0.72	0.92	-0.20	0.20	0.29	0.09	0.20	0.20
Apr	30	0.5	0.70	0.64	0.06	0.06	0.29	0.07	0.23	0.23
May	31	0.5	0.72	0.66	0.06	0.06	0.29	0.07	0.22	0.22
Jun	30	0.4	0.70	0.51	0.19	0.19	0.29	0.05	0.24	0.24
Jul	31	0.4	0.72	0.53	0.19	0.19	0.29	0.05	0.24	0.24
Aug	31	0.5	0.72	0.66	0.06	0.06	0.29	0.07	0.22	0.22
Sep	30	0.5	0.70	0.64	0.06	0.06	0.29	0.07	0.23	0.23
Oct	31	0.5	0.72	0.66	0.06	0.06	0.29	0.07	0.22	0.22
Nov	30	0.7	0.70	0.89	-0.19	0.19	0.29	0.09	0.20	0.20
Dec	31	0.7	0.72	0.92	-0.20	0.20	0.29	0.09	0.20	0.20
Total	365	6.8	8.50	8.78	-0.28	1.67	3.50	0.90	2.60	2.60



APPENDIX C

SOIL BORE LOGS

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 1
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379372 Northing: 6381345
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL	B	T	0.0				**0.00m - 0.40m Dark Brown Silty Sandy Loam.** Common organics. Dry and loose.	D	L	TOPSOIL	0.0
							0.40m - 1.40m Silty Clay Loam to Light Clay. Yellow - brown to khaki motted orange-red streaky. Medium dense and dry.				
			0.5				>0.70m Brick red/brown and slight grit. Stiff and plastic.	D	MD/ D	COLLUVIAL\RESIDUAL	0.5
	B	T									
			1.0				**1.40m - Silty Residual 'C' horizon.** Pale brown to yellow. Crumbly weathered. Dry and dense.				1.0
							SBH 1 terminated at 1.40 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency
- **VS** Very Soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very Stiff
- **H** Hard

Density Index
- **VL** Very Loose
- **L** Loose
- **MD** Medium Dense
- **D** Dense
- **VD** Very Dense

Samples
- **B** Bulk Sample
- **D** Disturbed Sample
- **U50** Undisturbed Sample (50mm diam.)
- **N** S.P.T. Value

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **Wp** Plastic Limit
- **Wl** Liquid Limit

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 2
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379306 Northing: 6381287
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL	B	T	0.0				**0.00m - 0.25m Silty Sandy Loam.** Dark brown to grey brown with grit. Rocks to 12mm, including quartz.	D	L	TOPSOIL	0.0
							0.25m - 0.60m Sandy loam. Some silt. Grey brown. Moist and loose. Quartz sand and sub angular rocks to 15mm grading to off white course quartz sand and rocks at depth.	M	L	COLLUVIAL	
			0.5								0.5
	B	T							MD	COLLUVIAL/RESIDUAL	
							0.60m - 1.40m Clay Loam to Light / Medium Clay. Yellow-brown to khaki mottled orange - red. Medium dense to dry, plastic, in part gritty.	D			
			1.0								1.0
							1.40m - 1.80m Sandy Clay. Blue grey. Weathered sedimentary rock.	D			
			1.5				**SBH 2 terminated at 1.80 m depth.**		MD	RESIDUAL	1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency

VS	Very Soft
S	Soft
F	Firm
St	Stiff
VSt	Very Stiff
H	Hard

Density Index

VL	Very Loose
L	Loose
MD	Medium Dense
D	Dense
VD	Very Dense

Samples

B	Bulk Sample
D	Disturbed Sample
U50	Undisturbed Sample (50mm diam.)
N	S.P.T. Value

Moisture

D	Dry
M	Moist
W	Wet
Wp	Plastic Limit
Wl	Liquid Limit

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 3
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379472
	792 Seaham Road	Northing:	6381318
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.15m Silty Sandy Loam**. Dark brown to	D	L	TOPSOIL	
I							grey brown,				
L	B	T					**0.15m - 0.20m Sandy Loam.** Grey to pale brown.		L	COLLUVIAL	
							Common rounded laterite fragments to 35mm atop	D		COLLUVIAL/RESIDUAL	
			0.5				the clay, 'old' surface on clay and ironstone.				0.5
	B	T					**0.20m - 0.70m Clay Loam to Light Medium Clay.**	D	MD		
							Yellow - brown to khaki motted orange tending to			RESIDUAL	
							red - brown. Gritty at 0.60m				
			1.0				**0.70 - 1.00** Grey to pale brown - beige. Sandy	D	MD		1.0
							weathered rock.				
							SBH 3 terminated at 1.0 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 4
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379532 Northing: 6381388
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Brown to dark	D	L	TOPSOIL	
I							brown. Dry and loose. Organisc. Minor rounded			COLLUVIAL	
L	B	T					fragments of weathered siltstone.		L		
							0.10m - 0.30m Silty Sandy Loam. Mid brown to	M		COLLUVIAL/RESIDUAL	
			0.5				yellow grey brown. Moist, loose, common organics.				0.5
							Gritty (fragments up to 2mm). Rounded rocks to				
	B	T					40mm		MD		
							0.30m - 0.80m Clay Loam. Yellow brown, khaki	D			
							clay loam to light/medium clay mottled - orange-red.			RESIDUAL	
			1.0				grading to red-brown gritty silty sandy clay at depth.				1.0
							Grit to 3mm.				
							0.80m - 1.50m Weathered Sandstone/ Siltstone.	D	MD		
							Grey to off white (pale brown). Strongly weathered.				
			1.5				**SBH 4 terminated at 1.5 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 5
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid) Easting:	0379530
		Northing:	6381465
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Mid brown to	D	L	TOPSOIL	
I							brown. Loose and dry, Common organics.			COLLUVIAL	
L	B	T					**0.10m - 0.60m Silty Sandy Loam.** Brown to grey	D	L		
							brown. Dry and loose. Common organics. Gritty				
			0.5				inpart (fragments to 2mm). Noticeably silty and				0.5
							moist (rain).				
	B	T					**0.60m - 0.90m Silty Clay Loam to light /Medium**	D	MD	COLLUVIAL/RESIDUAL	
							Clay. Red brown silty. Sub angular rock fragments				
							to 3mm.				
			1.0				**0.90m - 1.00m Weathered Siltstone.** Grey to	D	MD	RESIDUAL	1.0
							beige to pale brown strongly weathered siltstone /				
							fine sandstone.				
							SBH 5 terminated at 1.0 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 6
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379461
	792 Seaham Road	Northing:	6381427
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.08m Silty Sandy Loam**. Brown. Dry and loose. Common organics.	D	L	TOPSOIL	
I									L	~~COLLUVIAL~~	
L	B	T					**0.08m - 0.14m Silty Sandy Loam.** Grey brown to pale brown. Dry and loose. Common organics and rounded cobbles to 60mm atop clay.	D		COLLUVIAL/RESIDUAL	
			0.5						MD		0.5
	B	T					**0.14m - 0.80m Clay Loam to Light/Medium clay.** Red brown. Gritty, motted yellow khaki.	D			
			1.0				**0.80 - 1.0 Strongly Weathered Siltstone.** Grey to beige to pale brown.	D	MD	RESIDUAL	1.0
							SBH 6 terminated at 1.0 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 7
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379426
	792 Seaham Road	Northing:	6381505
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Brown Dry and loose. Common organics, gritty.	D	L	COLLUVIAL/TOPSOIL	
I									L	COLLUVIAL	
L	B	T					**0.10m - 0.15m Silty Sandy Loam.** Grey to pale brown. Rounded rock fragments to 5mm.	D		COLLUVIAL/RESIDUAL	
			0.5				**0.15m - 0.60m Silty Clay Loam to Light/Medium Clay**. Red brown Gritty. Mottled khaki-yellow.	D	MD		0.5
	B	T								RESIDUAL	
							0.60 m- 1.10m Clay. Grey to pale brown, mottled yellow-orange grading down into weathered RX at 1.10m - 1.60m	D	MD		
			1.0				**1.10m - 1.60m Weathered Siltstone.**				1.0
								D	MD	RESIDUAL	
							SBH 7 terminated at 1.60 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 8
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379474 Northing: 6381598
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL	B	T	0.0				**0.00m - 0.10m Silty Sandy Loam.** Brown to grey brown. Common organics. Dry and loose. Pebbles, rocks and rounded quartz present.	D	L	COLLUVIAL/TOPSOIL	0.0
										COLLUVIAL	
							0.10m - 0.70m Clay. Red-brown with yellow-khaki mottles, gritty.	D	L		
			0.5								0.5
	B	T					**0.70m - 1.00m Light to Medium Clay.** Grey to mottled yellow-khaki. Gritty.	D			
							1.00m - 2.00m Weathered Siltstone. Grey to pale brown. Rocks present.	D	MD	COLLUVIAL/RESIDUAL	
			1.0				**2.00m - 2.50m Weathered Sitstone.** Grey to pale brown.Harder but still weathered.		MD	RESIDUAL	1.0
								D			
			1.5				**SBH 8 terminated at 2.50 m depth.**				1.5
									MD		
			2.0								2.0
										RESIDUAL	
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 9
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379543
	792 Seaham Road	Northing:	6381580
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam**. Brown topsoil. Loose and dry organics. Pebbles to 30mm.	D	L	COLLUVIAL/TOPSOIL	
I										COLLUVIAL	
L	B	T							L	COLLUVIAL/RESIDUAL	
							0.10m - 0.17m Silty Sandy Loam. Grey to grey pale brown Dry and loose, common organics. Gritty with pebbles.	D		
			0.5						MD		0.5
	B	T					**0.17m - 0.60m Clay Loam to Light/Medium Clay.** Khaki to yellow-brown motted orange. Clay gritty to 8mm. Rare pebbles to 30mm.	D		RESIDUAL	
									MD		
			1.0				**0.60m - 0.90m Clay.** Red-brown with gritty khaki-yellow mottles.	D		RESIDUAL	1.0
									MD		
							0.90m - 1.10m Weathered Siltstone. Grey to pale brown weathered siltstone.	D			
			1.5				**SBH 9 terminated at 1.10 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 10
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379577
	792 Seaham Road	Northing:	6381643
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0.0				**0.00m - 0.10m Silty Sandy Loam.** Dark brown to brown topsoil. Dry and loose. Common organics. Gritty.	D	L	COLLUVIAL/TOPSOIL	0.0
										COLLUVIAL/RESIDUAL	
									MD		
							0.10m - 0.70m Silty Clay Loam to Light/Medium Clay. Brown to red-brown mottlled yellow-orange. Gritty. Rare rounded pebbles to 30mm (possible laterite) within the upper parts of the profile. Grades down into grey khaki clay with yellow-orange mottles. Gritty.	D			
			0.5								0.5
	B	T									
										RESIDUAL	
			1.0						MD		1.0
							0.70 - 1.0 Weathered Siltstone. Grey to pale brown to mauve.	D			
			1.5				**SBH 10 terminated at 1.0 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 11
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379640 Northing: 6381601
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0				**0.00m - 0.08m Silty Sandy Loam.** Brown. Dry and loose. Common organics. Fragments of sub-angular siltstone to 20mm.	D	L	TOPSOIL COLLUVIAL	0
							0.08m - 0.26m Silty Sandy Loam. Grey to pale brown . Loose and dry to moist. Common organics. Gritty.	D	L	COLLUVIAL/RESIDUAL	
			0.5						MD		0.5
	B	T					**0.26m - 0.60m Clay Loam to Light/Medium Clay.** Red-brown motted khaki-yellow grey.	D	MD	COLLUVIAL/RESIDUAL	
							0.60m - 0.80m Clay Loam to Light/Medium Clay. Grey to pale brown motted khaki-yellow.	D	MD	RESIDUAL	
			1.0				**0.80 - 1.00 Siltstone.** Weathered, pale brown to beige.	D	MD		1.0
			1.5				**SBH 11 terminated at 1.00 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency
- **VS** Very Soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very Stiff
- **H** Hard

Density Index
- **VL** Very Loose
- **L** Loose
- **MD** Medium Dense
- **D** Dense
- **VD** Very Dense

Samples
- **B** Bulk Sample
- **D** Disturbed Sample
- **U50** Undisturbed Sample (50mm diam.)
- **N** S.P.T. Value

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **Wp** Plastic Limit
- **Wl** Liquid Limit

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Job No:	18047
Hole No:	SBH 12
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379777
	792 Seaham Road	Northing:	6381527
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Brown topsoil.	D	L	COLLUVIAL/TOPSOIL	
I							Dry and loose. Common organics. Fragments of			COLLUVIAL	
L	B	T					weathered oxidised siltstone.		L		
							0.10m - 0.24m Silty Sandy Loam. Grey to pale	D		COLLUVIAL/RESIDUAL	
			0.5				brown . Loose and dry to moist. Common organics.				0.5
							Gritty.		MD		
	B	T					**0.24m - 0.70m Silt Clay Loam to light/medium**				
							Clay. Yellow brown to khaki-grey motted. Gritty. *	D		RESIDUAL	
							Note no red clay		MD		
			1.0				**0.70m - 0.80m Siltstone.** Weathered cream to pale	D			1.0
							brown-mauve.				
							SBH 12 terminated at 0.8 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

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Job No:	18047
Hole No:	SBH 13
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379660
	792 Seaham Road	Northing:	6381530
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T					**0.00m - 0.10m Silty Sandy Loam.** Brown. Gritty. Graduational. Common organics. Dry and loose.	D	L	COLLUVIAL/TOPSOIL	
									L	COLLUVIAL	
							0.10m - 0.30m Silty Sandy Loam. Grey to gradational brown to pale brown. Common organics. Dry and loose.	D		COLLUVIAL/RESIDUAL	
			0.5						SD		0.5
	B	T					**0.30m - 0.80m Silty Clay Loam to Ligt/Medium Clay.** Red brown gritty mottled khaki-grey grades quickly down into grey-pale brown mottled yellow-khaki silty clay loam to light/medium clay. Gritty.	D		RESIDUAL	
			1.0						SD		1.0
							0.80m - 1.00m Weathered Siltstone. Pale brown to mauve and cream .	D			
			1.5				**SBH 13 terminated at 1.0m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 14
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379652
	792 Seaham Road	Northing:	6381678
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0.0				**0.00m - 0.10m Silty Sandy Loam.** Brown. Common organics. Dry and Loose. Gritty.	D	L	TOPSOIL	
										COLLUVIAL	
							0.10m - 0.45m Silty Sandy Loam. Grey to pale brown. Gritty. Organics common. Moist and loose. Tends to be more silty.	M	L		
			0.5								0.5
	B	T					**0.45m - 1.40m Silty Clay Loam to Light/Medium Clay.** Khaki-yellow-brown to red-brown patchy. Gritty. Fragments to 5mm. Rounded Pebbles to 15mm.	D	MD	COLLUVIAL/RESIDUAL	
			1.0				**1.40m - 1.60m Weathered Siltstone.** Light brown to red-brown weathered siltstone.	D			1.0
							SBH 14 terminated at 1.60 m depth.		MD		
			1.5							RESIDUAL	1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 15
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379608 Northing: 6381737
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
NIL	B	T	0.0				**0.00m - 0.07m Silty Sandy Loam.** Brown, topsoil. Common organics. Dry and loose. Gritty.	D	L	COLLUVIAL/TOPSOIL	0.0
										COLLUVIAL	
									L	COLLUVIAL/RESIDUAL	
							0.07m - 0.20m Silty Sandy Loam. Grey brown to pale brown Gritty, rounded pebbles to 5mm. Silty to clayey. Gravel on top of clay (pebble/boulder to 10cm)	D			
			0.5								0.5
	B	T							MD		
							0.20m - 0.80m Silty Clay Loam to Light/Medium Clay. Red-brown. Gritty mottled khaki grey. Grading to lighter coloured.	D		RESIDUAL	
			1.0						MD		1.0
							0.80m - 1.0m Weathered Siltstone. Off white, silty sandy rocks. .	D			
							SBH 15 terminated at 1.0 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 16
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379520
	792 Seaham Road	Northing:	6381782
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T					**0.00m - 0.05m Silty Sandy Loam.** Brown. Dry and Loose. Common organics. Gritty. Sub angular siltstone fragments up to 15mm.	D	L	COLLUVIAL/TOPSOIL	
									L	COLLUVIAL	
							0.05m - 0.30m Silty Sandy Loam. Grey to pale brown-khaki clay clods (red-brown). Common organics. Gritty. Fragments of siltstone to 20mm	D		COLLUVIAL/RESIDUAL	
			0.5								0.5
	B	T							MD		
							0.30m - 0.80m Silty Loam to Light/Medium Clay. Red-brown mottled grey-khaki. Gritty. Dry and medium dense.	D			
									MD	RESIDUAL	
			1.0							RESIDUAL	1.0
							0.80m - 0.90m Clay Loam. Pale brown. Gritty. Minor yellow mottles.	D	MD		
							0.90m - 1.10m Weathered Siltstone. Beige-pale brown	D			
			1.5								1.5
							SBH 16 terminated at 1.10 m depth.				
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 17
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379617
	792 Seaham Road	Northing:	6381914
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T					**0.00m - 0.05m Silty Sandy Loam.** Brown. Dry and loose. Common organics. Gritty. Common rounded pebbles to 10mm. Boulders rounded upto 50mm	D	L	COLLUVIAL/TOPSOIL COLLUVIAL	
			0.5				**0.05m - 0.34m Silty Sandy Loam.** Brown to grey brown. Gritty. Rounded pebbles to 5mm. Dry/loose. Slighty clayey towards base. Common organics.	D	L MD	COLLUVIAL/RESIDUAL	0.5
	B	T					**0.34m - 0.80m Silty Clay Loam to Light/ medium Clay.** Yellow-red-brown motted orange-khaki-grey. Gritty.	D		RESIDUAL	
			1.0				**0.80m - 1.20m Clay Loam.** Grades down into dominantly grey-khaki with red-orange brown mottles and patches. Gritty.	D	MD		1.0
							1.20 - 1.60 Siltstone. Weathered grey-pale brown.	D	MD	RESIDUAL	
			1.5				**SBH 17 terminated at 1.60 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 18
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980 792 Seaham Road Seaham	Coordinates (MGA Grid)	Easting: 0379610 Northing: 6381844
		Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.07m Silty Sandy Loam.** Brown topsoil.	D	L	COLLUVIAL/TOPSOIL	
I							Gritty. Dry/loose. Organics.			COLLUVIAL	
L	B	T					**0.07m - 0.20m Silty Sandy Loam.** Brown to grey	D	L	COLLUVIAL/RESIDUAL	
							brown. Mottled yellow in parts. Dry and loose.				
			0.5				Common Organics.		MD		0.5
							0.20m - 0.70m Clay Loam to Light/Medium Clay.	D			
	B	T					Red brown-orange. Gritty. Mottled yellow-orange.				
							Dry and medium dense to plastic.			RESIDUAL	
							0.70m - 1.50m Silty Clayey Loam to Light Clay.	D	D		
			1.0				Grey-khaki Gritty with pebbles to 5mm. Dry and				1.0
							dense.				
							1.50m - 1.80m Weathered Siltstone. Beige to pale				
							brown with rounded pebbles to 25m (in rock-				
							conglomerites).	D			
			1.5								1.5
							SBH 18 terminated at 1.80 m depth.		D	RESIDUAL	
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 19
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379520
	792 Seaham Road	Northing:	6381887
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Brown. Common organics. Gritty. Dry and Loose.	D	L	COLLUVIAL/TOPSOIL	
I										COLLUVIAL	
L	B	T					**0.10m - 0.28m Silty Sandy Loam.** Grey-brown Common organics. Gritty. Pebbles (rounded) to 30mm. Gritty and fragments of siltstone to 80mm	D	L		
			0.5							COLLUVIAL	0.5
							0.28m - 0.60m Silty Clay Loam to Light Clay. Yellow-brown mottled orange-red gritty. Dry, medium dense to dense.	D	MD/D		
	B	T							D	COLLUVIAL/RESIDUAL	
							0.60m - 0.90m Silty Clay Loam to Light/ Medium Clay. Khaki yellow to grey mottled yellow-orange. Gritty. Pebbles to 20mm (rounded).	D			
			1.0							RESIDUAL	1.0
									D		
							0.90m - 1.0m Siltstone. Pale brown to yellow brown. Contains pebbles - possible conglomerate.	D			
			1.5								1.5
							SBH 19 terminated at 1.00 m depth.				
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 20
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379444
	792 Seaham Road	Northing:	6381776
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.10m Silty Sandy Loam.** Brown Dry and loose, abundant organics, gritty.	D	L	COLLUVIAL/TOPSOIL	
I										COLLUVIAL	
L	B	T					**0.10m - 0.60m Silty Sandy Loam.** Brown to grey brown Dry and loose. Common organics. Boulders to 100mm. Gritty. Fragments of sub angular oxidised siltsone (rare) to 25mm.	D	L		
			0.5								0.5
	B	T					**0.60m - 0.90m Silty Clay Loam to Light/ Medium Clay.** Red-orange brown.Gritty. Dry, medium dense to dense, plastic. Mottled grey-khaki.	D	SD	COLLUVIAL/RESIDUAL	
			1.0							RESIDUAL	1.0
							0.90m - 1.40m Clay Loam to Light Clay. Off white to grey, mottled red- orange. Gritty.	D	SD		
							1.40m - 1.70m Weathered Siltstone. Grey-off white.	D			
			1.5						SD	RESIDUAL	1.5
							SBH 20 terminated at 1.70 m depth.				
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 21
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379381
	792 Seaham Road	Northing:	6381619
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0.5				**0.00m - 0.13m Silty Sandy Loam.** Brown. Dry and Loose. Abundant organics, grity.	D	L	COLLUVIAL/TOPSOIL	
							0.13m - 0.60m Silty Sandy Loam. Grey to grey brown Dry to moist. Common organics. Common rounded pebbles and boulders to 80mm. Abundant gravel/pebbles/boulders.	D/M	L	COLLUVIAL	0.5
	B	T	1.0				**0.60m - 1.10m Silty Clay Loam to Light/ Medium Clay.** Red-brown-orange. Gritty, plastic, dry and dense/medium dense. Some pebbles (green) rounded to 15mm.	D	MD	COLLUVIAL/RESIDUAL	1.0
			1.5				**1.10m - 1.40m Silty Clay Loam to Light/ Medium Clay.** Yellow-orange mottled grey-black, gritty, abundant pebbles to 20mm.	D	MD	COLLUVIAL/RESIDUAL	
							1.40m - 1.50m Weathered Siltstone. Off white to grey-khaki with pebbles, Possible conglomerate.	D	MD	RESIDUAL	1.5
			2.0				**SBH 21 terminated at 1.50 m depth.**				2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 22
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379452
	792 Seaham Road	Northing:	6381693
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0.0				**0.00m - 0.10m Silty Sandy Loam.** Brown. Dry and loose. Abundant organics. Gritty.	D	L	COLLUVIAL/TOPSOIL	0.0
										COLLUVIAL	
							0.10m - 0.30m Silty Sandy Loam. Grey to grey-brown. Dry and loose. Gritty. Some fragments of siltstone, exotics to 50mm. Rounded pebbles and boulders to 150mm.	D	L		
			0.5							COLLUVIAL/RESIDUAL	0.5
	B	T					**0.30m - 0.80m Silty Clay Loam to Light/ Medium Clay.** Red brown. Gritty. Mottled khaki-grey.	D	SD		
										COLLUVIAL/RESIDUAL	
			1.0				**0.80m - 1.30m Clay Loam to Light/ Medium Clay.** Dark grey-khaki. Gritty with red-orange-brown mottles.	D	SD		1.0
							1.30m - 1.60m Weathered siltstone. Yellow brown to pale brown.	D	SD	RESIDUAL	
			1.5								1.5
							SBH 22 terminated at 1.60 m depth.				
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 23
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid)	Easting: 0379333
	792 Seaham Road		Northing: 6381485
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.08m Silty Sandy Loam.** Brown Dry and loose, abundant organics. Gritty.	D	L	COLLUVIAL/TOPSOIL	
I										COLLUVIAL	
L	B	T					**0.08m - 0.20m Silty Sandy Loam.** Grey brown common organics, abundant gravel and pebbles/boulders to 50mm. Gritty.	D	L	COLLUVIAL/RESIDUAL	
			0.5								0.5
	B	T					**0.20m - 0.90m Silty Clay Loam to Light/ Medium Clay.** Orange-red-brown gritty. Mottled khaki-grey.	D	SD		
			1.0				**0.90m - 1.50m Clay Loam to Light/ Medium Clay.** Dark grey-khaki with mottled yellow-orange-red patches. Gritty.	D	SD	COLLUVIAL/RESIDUAL	1.0
							1.50m - 1.80m Weathered Siltstone. Pale brown to off white.	D			
			1.5				**SBH 23 terminated at 1.80 m depth.**		SD	RESIDUAL	1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 24
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379223
	792 Seaham Road	Northing:	6381349
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T	0.5				**0.00m - 0.45m Silty Sandy Loam.** Brown grey. Gritty. Common Organics. Dry and loose. Moist. NO gravel or pebbles.	D	L	COLLUVIAL/TOPSOIL	
							0.45m - 0.50m Silt Clay Loam to Light/ Medium Clay. Yellow-brown mottled red-orange-khaki. Dry but dense/medium dense.	D	MD/D	COLLUVIAL	0.5
							SBH 24 terminated at 0.50 m depth.				
			1.0								1.0
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Larry Cook Consulting Pty Ltd

Job No:	18047
Hole No:	SBH 25
Sheet 1	of 1

LOG OF TEST HOLE

Client:	B. Statham	Test Bore Location: Ref. Figure 1	
Project:	Wastewater Management Investigations	Test Method: Drilling Rig	
Project Location:	Lot100 DP1064980	Coordinates (MGA Grid) Easting:	0379469
	792 Seaham Road	Northing:	6381283
	Seaham	Logged by: LLC	Date: Feb 2012

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N							**0.00m - 0.15m Silty Sandy Loam**. Dark brown to	D	L	TOPSOIL	
I							grey brown,				
L	B	T					**0.15m - 0.20m Sandy Loam.** Grey to pale brown.		L	COLLUVIAL	
							Common rounded laterite fragments to 35mm atop	D		COLLUVIAL/RESIDUAL	
			0.5				the clay, 'old' surface on clay and ironstone.				0.5
									MD		
	B	T					**0.20m - 0.70m Clay Loam to Light Medium Clay.**	D			
							Yellow - brown to khaki motted orange tending to			RESIDUAL	
							red - brown. Gritty at 0.60m				
			1.0				**0.70 - 1.00** Grey to pale brown - beige. Sandy	D	MD		1.0
							weathered rock.				
							SBH 25 terminated at 1.0 m depth.				
			1.5								1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample (50mm diam.)	**W**	Wet
St	Stiff	**D**	Dense			**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

APPENDIX D

LABORATORY CERTIFICATE

SYDNEY ANALYTICAL LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

LARRY COOK

PO BOX 8146
TUMBI UMBI 2261

ATTN: LARRY COOK

JOB NO:	SAL23973F
CLIENT ORDER:	SEAHAM
DATE RECEIVED:	17/02/12
DATE COMPLETED:	08/03/12
TYPE OF SAMPLES:	SOILS
NO OF SAMPLES:	33

.....
Issued on 15/03/12
Lance Smith
(Chief Chemist)

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL23973F
CLIENT ORDER: SEAHAM

	SAMPLES	pH 1:5	COND. dS/m	CEC cmol+/kg	ESP %	*P.SORP mg/kg	*EMERS. Class
1	SBH1/0.30	4.8	0.30	4.3	0.5	320	8
2	SBH2/0.20	4.8	0.16	2.9	0.3	260	6
3	SBH2/0.80	4.7	0.18	10.2	0.2	630	8
4	SBH3/0.15	4.4	0.17	4.2	0.5	340	7
5	SBH4/0.20	4.7	0.15	3.8	0.5	290	7
6	SBH4/0.60	4.4	0.23	12.6	2.1	670	8
7	SBH5/0.30	4.7	0.18	6.8	0.7	450	8
8	SBH6/0.10	4.7	0.23	3.3	0.3	320	6
9	SBH6/0.50	4.3	0.42	13.1	4.5	680	8
10	SBH7/0.10	4.5	0.28	4.2	0.2	340	6
11	SBH8/0.10	4.4	0.27	4.7	0.4	400	6
12	SBH8/0.50	4.3	0.23	12.0	1.8	660	8
13	SBH9/0.15	4.5	0.30	5.4	0.4	440	6
14	SBH10/0.10	4.6	0.24	5.2	0.6	420	6
15	SBH10/0.50	4.3	0.23	11.3	0.5	690	8
16	SBH11/0.20	4.6	0.19	3.9	0.5	300	6
17	SBH12/0.20	4.6	0.15	3.9	0.8	310	8
18	SBH13/0.20	4.7	0.24	6.3	0.2	430	7
19	SBH13/0.50	4.5	0.22	11.1	2.7	700	7
20	SBH14/0.30	4.7	0.23	4.4	0.5	350	6
21	SBH15/0.15	4.5	0.20	6.5	0.3	460	6
22	SBH16/0.20	4.5	0.27	5.0	0.3	400	6
23	SBH16/0.50	4.3	0.51	12.8	4.5	720	8
24	SBH17/0.20	4.3	0.43	5.5	0.4	430	6
25	SBH17/0.60	4.1	0.46	11.3	1.0	670	7
26	SBH18/0.15	4.2	0.45	5.0	0.6	380	8
27	SBH19/0.20	4.3	0.42	3.8	1.2	320	8
28	SBH20/0.30	4.5	0.37	4.2	0.9	330	6
29	SBH21/0.30	5.1	0.080	3.9	0.3	310	7
30	SBH22/0.20	4.4	0.12	3.3	0.3	300	7
31	SBH23/0.20	4.7	0.21	3.4	0.6	350	6
32	SBH23/0.70	4.0	0.22	14.5	0.7	740	8
33	SBH24/0.30	4.5	0.28	3.1	0.3	290	6
DUPLICATES:							
20	SBH14/0.30	4.8	0.22	4.6	0.6	340	6
MDL		0.1	0.001	0.1	0.1	1	
Method Code		C1	WA2	S7	C35	S9	C43
Preparation		P5	P5	P5	P5	P5	P1

RESULTS ON DRY BASIS

SYDNEY ANALYTICAL LABORATORIES

LABORATORY DUPLICATE REPORT

JOB NO: SAL23973F
CLIENT ORDER: SEAHAM

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
SBH14/0.30	pH		0.1	4.7	4.8	2
SBH14/0.30	Conductivity	dS/m	0.001	0.23	0.22	4
SBH14/0.30	CEC	cmol+/kg	0.1	4.4	4.6	4
SBH14/0.30	ESP	%	0.1	0.5	0.6	17
SBH14/0.30	*P Sorption	mg/kg	1	350	340	3
SBH14/0.30	*Emerson Class	Class		6	6	0

Acceptance criteria:

RPD <50% for low level (<20xMDL)
RPD <30% for medium level (20-100xMDL)
RPD <15% for high level (>100xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL23973F
CLIENT ORDER: SEAHAM

METHODS OF PREPARATION AND ANALYSIS

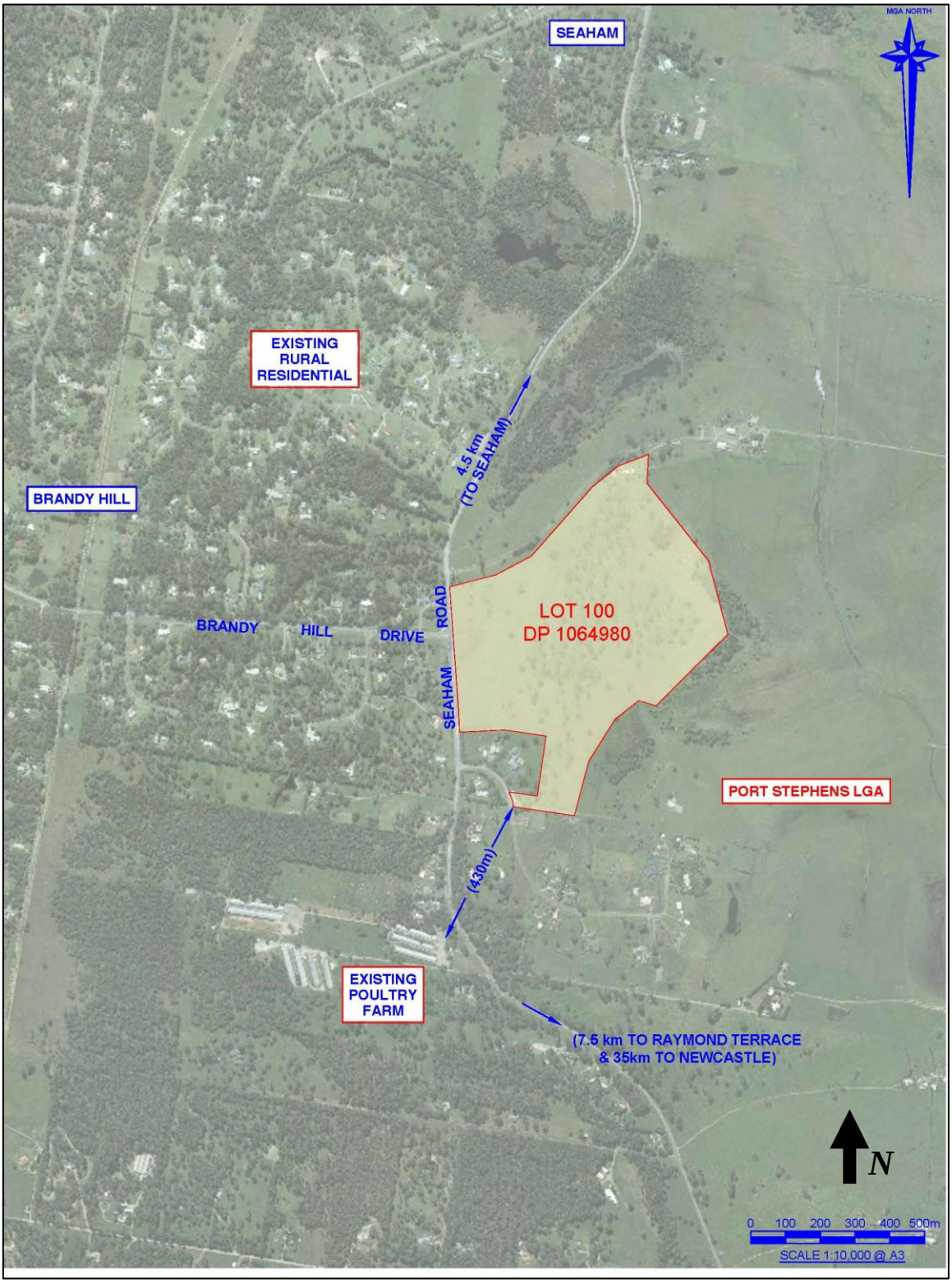
The tests contained in this report have been carried out on the samples as received by the laboratory.

P5	Sample dried, split and crushed to -150um
P1	Analysis performed on sample as received
C1	pH - AS1289.4.3.1
WA2	Conductivity - 1:5 soil/water extract Determined by APHA 2510B
S7	Cation Exchange Capacity & Exchangeable/Soluble Cations Determined by Silver Thiourea Method CEC-1
C35	Exchangeable Sodium Percentage - Silver Thiourea Extract Determined by APHA 3500B
*S9	Phosphorus Sorption - Dept of Agriculture Standard Method Determined by APHA 4500F
*C43	Modified Emerson Crumb Test: Based on AS1547-1990 Appendix F

*The laboratory's NATA accreditation does not cover performance of this test

FIGURES

Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Phone 02 4340 0193**	**Wastewater Management Plan**	Scale: As shown
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Lot Plan	**FIGURE 1**



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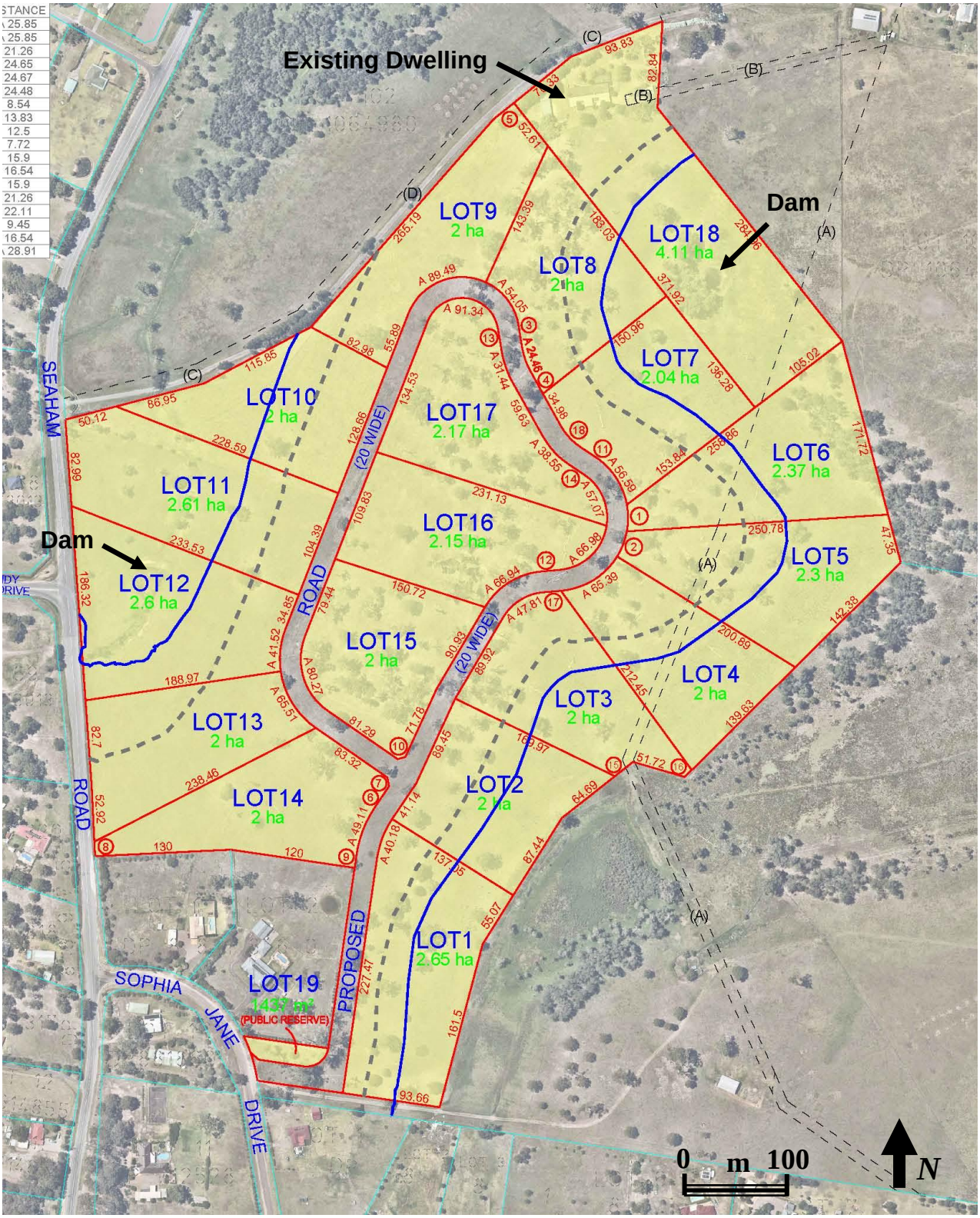
Tumbi Umbi NSW 2261
Phone 02 4340 0193

Wastewater Management Plan

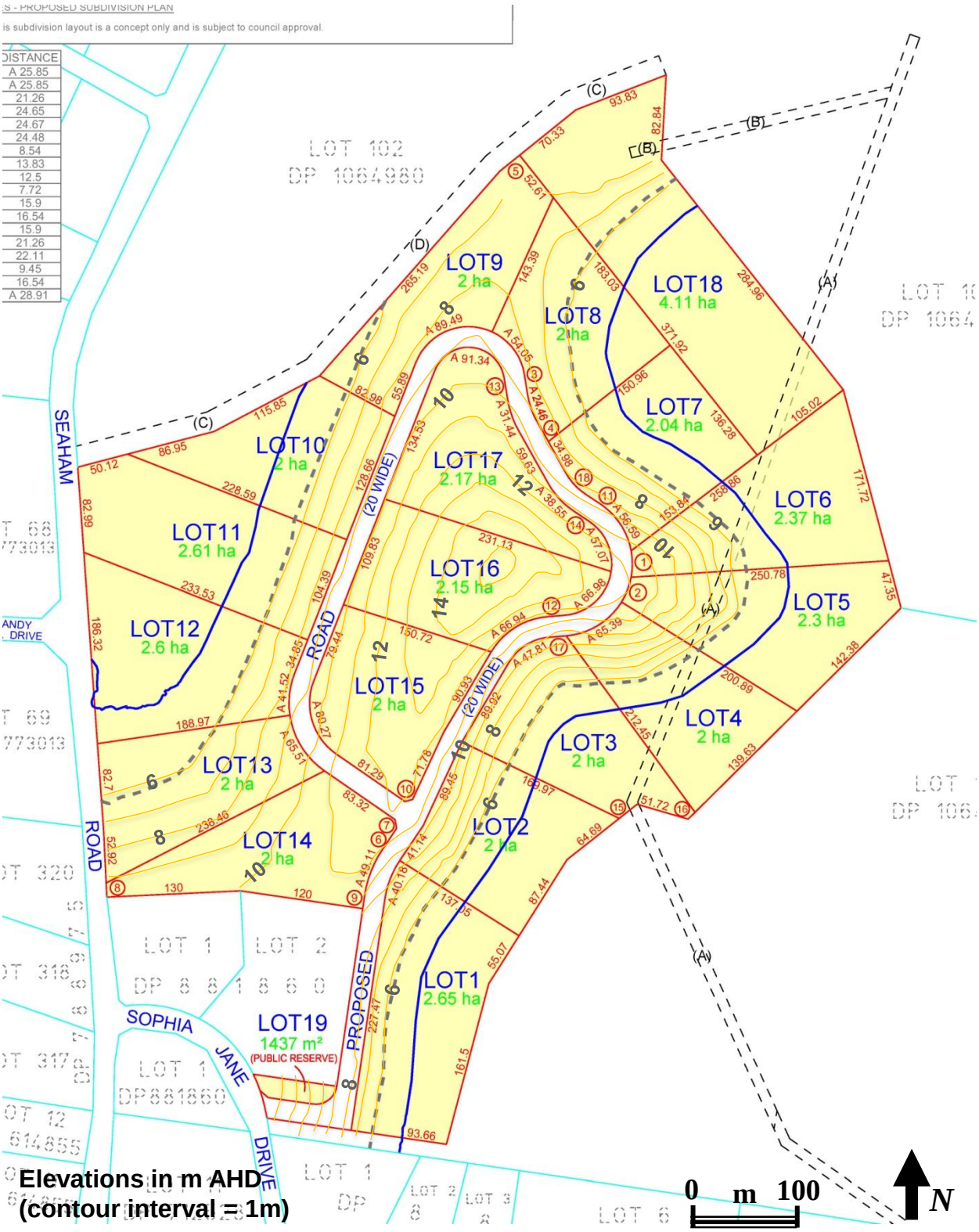
Scale: As shown

Lot 100 in DP1064980
792 Seaham Road Seaham
Location of Site

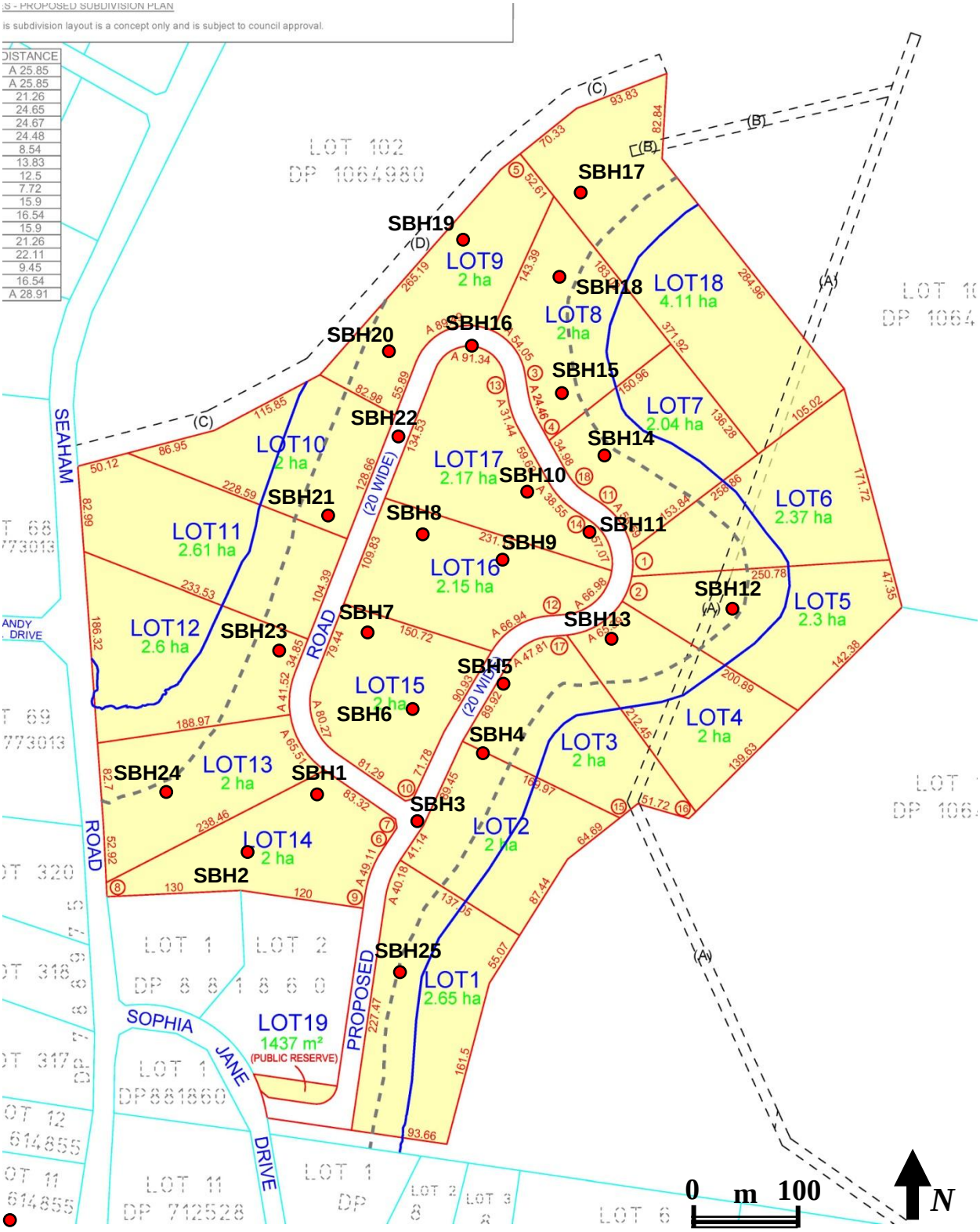
FIGURE 2



Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Phone 02 4340 0193**	**Wastewater Management Plan**	Scale: As shown
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Site Plan Showing Proposed Subdivision Layout	**FIGURE 3**



Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Phone 02 4340 0193**	**Wastewater Management Plan**	Scale: As shown
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Contour Plan	**FIGURE 4**



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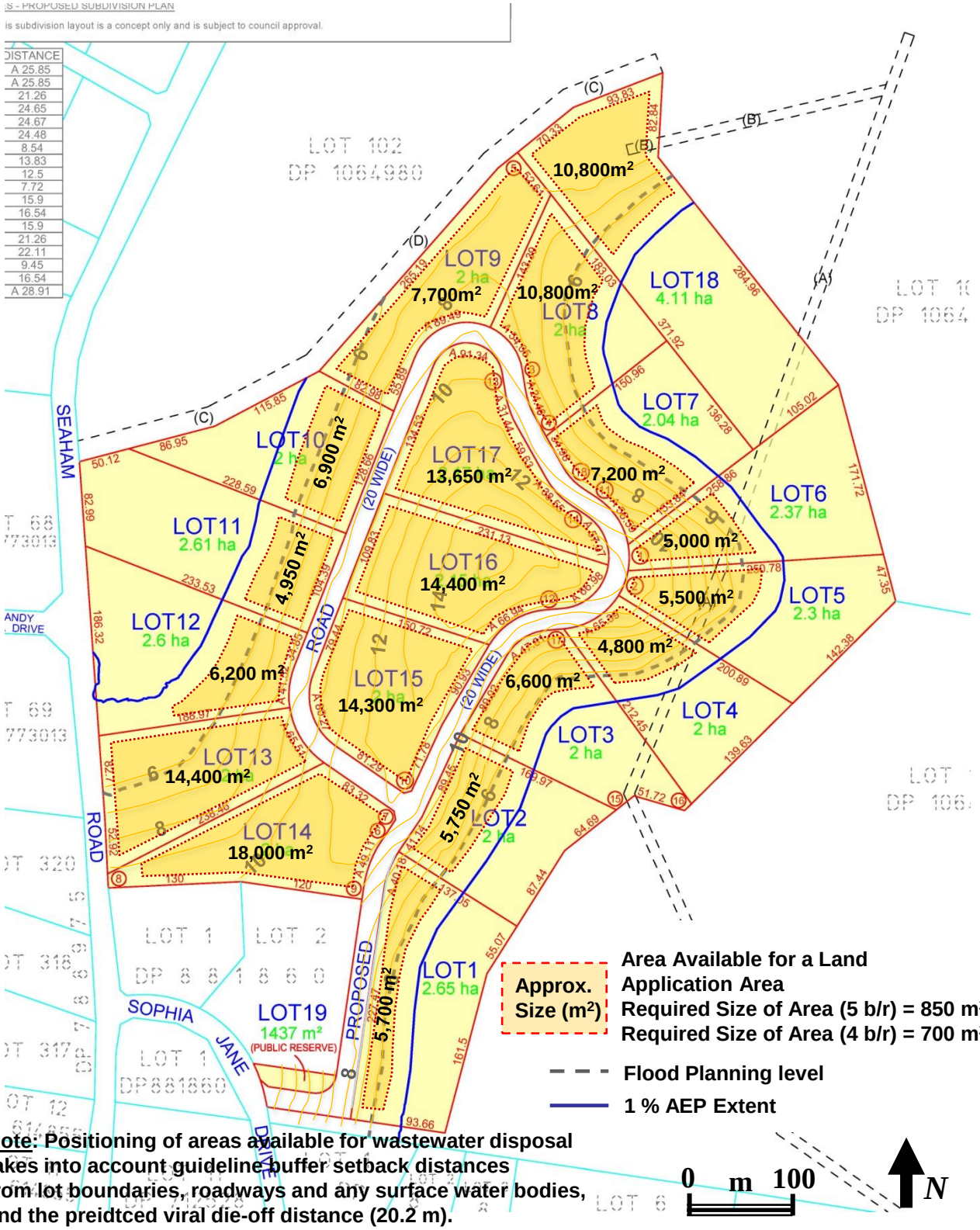
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Locations of Soil Test Holes	**FIGURE 5**



Note: Positioning of areas available for wastewater disposal takes into account guideline buffer setback distances from lot boundaries, roadways and any surface water bodies, and the preidtced viral die-off distance (20.2 m).

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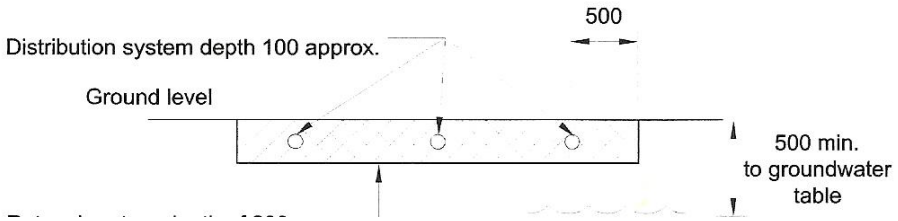
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Areas Suitable for Wastewater Application	**FIGURE 6**

Not to Scale

Recommended Dripper Line Separation = approx. 0.6 – 1.0m
Recommended Emitter separation = 0.4 m
Proposed Application Area = 700 – 850 m^2

Sub-Surface Drip Irrigation Concept Plan



LOAMS/GRAVEL SOILS

Sub-Surface Drip Irrigation Bed Cross Section

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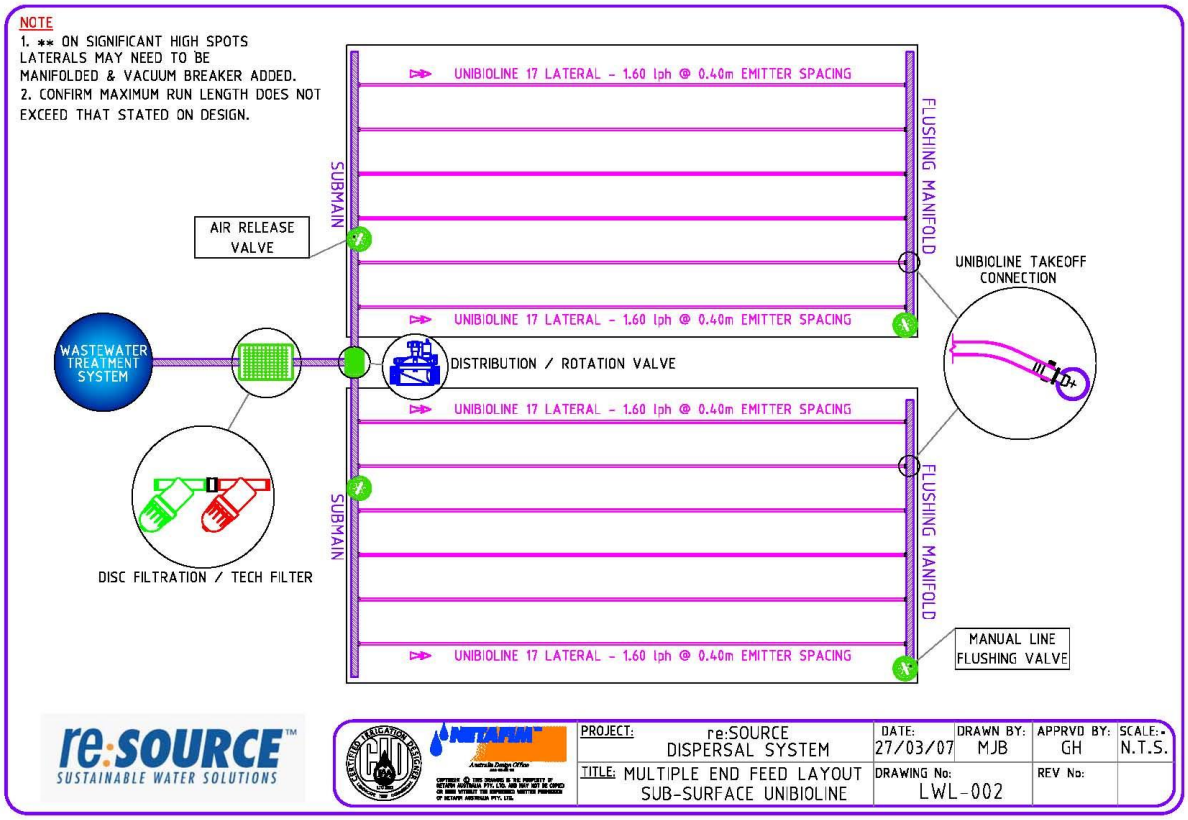
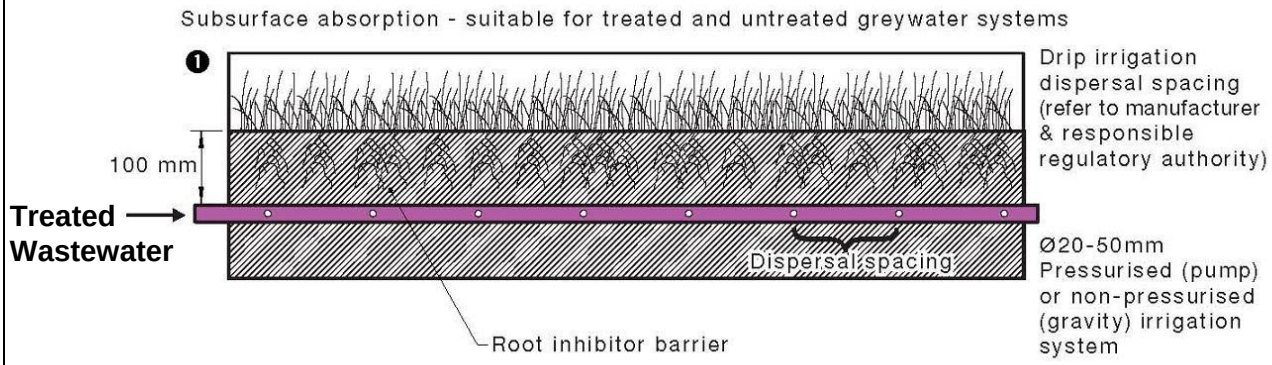
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Design Sub-Surface Irrigation	**FIGURE 7**



Industry Example Sub-Surface Drip Irrigation System



Typical Cross Section

Modified after *Urban Greywater Design and Installation Handbook* (National Water Commission, 2008)

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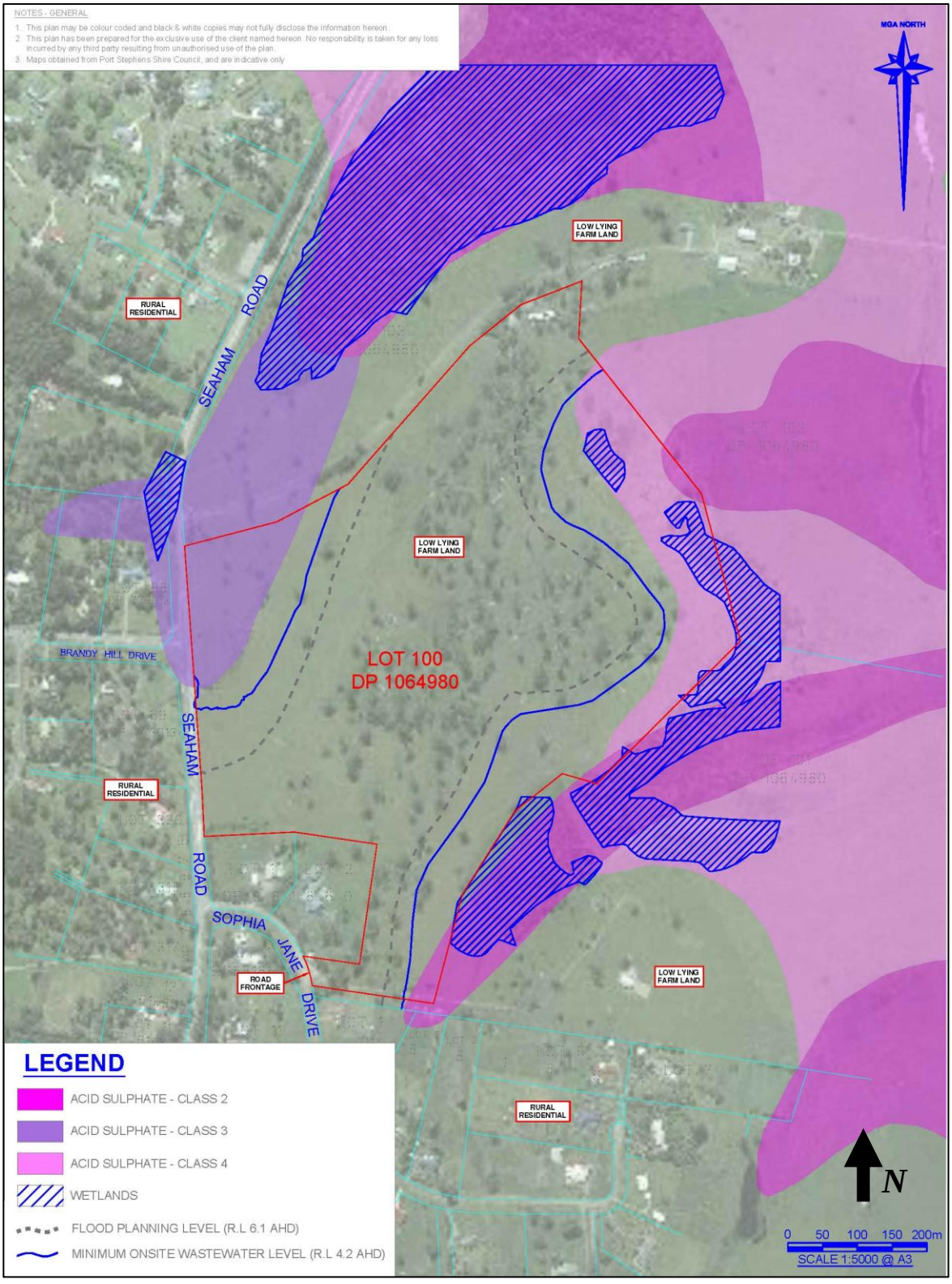
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Industry Example Sub-Surface Drip Irrigation System	**FIGURE 8**



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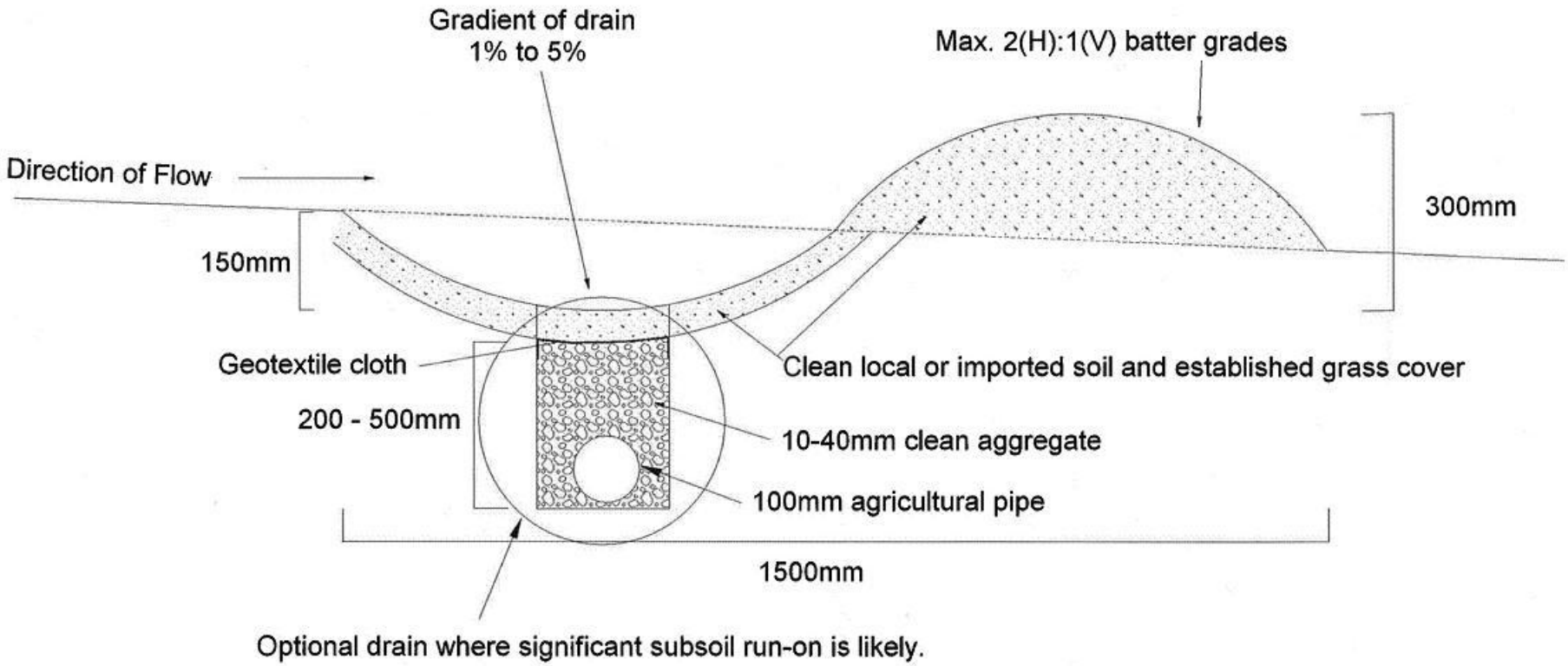
	Lot 100 in DP1064980 **792 Seaham Road Seaham** Acid Sulphate Mapping	**FIGURE 9**



Current Recommended Practice Design after SCA (2012)
Designing and Installing On-Site Wastewater Systems

Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Ph 02 4340 0193**	**Wastewater Management Plan** **Lot 100 in DP1064980** **792 Seaham Road Seaham** Diversion Drain Design	**N**	Scale: As shown **FIGURE 10**