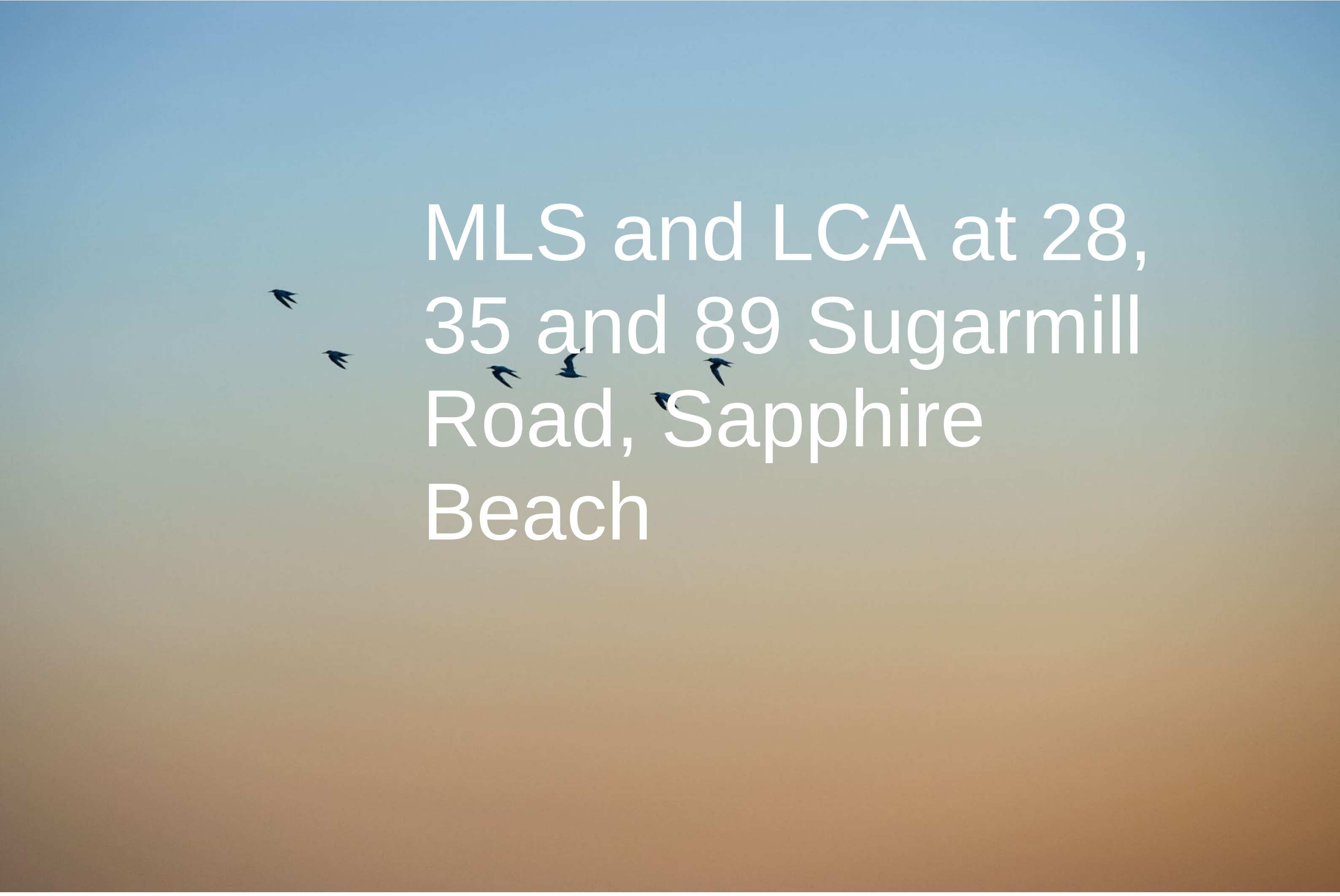

MLS and LCA at 28, 35 and 89 Sugarmill Road, Sapphire Beach

3 November 2021

For: Mr Keiran Grimley, Dr Chandran Arianayagam and Dr Ian Martyn:

Authored by: Strider Duerinckx

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1 Introduction

Earth Water Consulting Pty Limited (EWC) were engaged by Grahame Fry on behalf of parties Mr Keiran Grimley, Dr Chandran Arianayagam and Dr Ian Martyn to undertake a Minimum Lot Size (MLS) and Land Capability Assessment (LCA) for the proposed subdivision of 28, 35 and 89 Sugarmill Road, Sapphire Beach, as shown on Figure 1.

The purpose of the MLS and LCA is to show that wastewater from an On-site Sewage Management System (OSMS) can be sustainably applied on the proposed lots.

2 Proposed Development

Based on plans of the proposed subdivision layout by Mid North Coast Surveys, it is understood that it is proposed to subdivide the subject properties as follows in **Table 1** and shown in Figure 2.

Table 1: Property Details

Existing Property	Lot & DP	Existing Size (m^2)	Proposed No. of Lots	Proposed Lot Sizes (m^2)
No. 28	L12, DP243972	20,336	2	6,636-13,700
No. 35	L91, DP786155	23,660	2	11,500-12,100
No. 89	L17, DP249273	20,325	2	11,290-8,977

3 Scope of Work

The MLS and LCA were undertaken by Strider Duerinckx of EWC. The study methodology included:

- A desktop review of Site conditions including geology, hydrogeology, soils, and landscape features;
- A site inspection to map site and soil constraints plus an audit of the existing dwelling OSMS in relation to the proposed subdivision boundary;
- Drilling of four boreholes to assess soil conditions across the Site;
- Assessment of a range of site constraints including landform, slope, aspect, drainage, flooding and proximity to sensitive environments;
- A minimum lot size analysis involving the review of a number of nearby lot sizes, developed, constrained and available land area footprints;
- Analysis of two selected soil samples for a range of chemical properties including pH, EC, dispersibility, PSorp, CEC and ESP;
- Estimation of likely wastewater loads (quantity and quality) from future dwellings on the proposed lot, and undertake confirmation water and nutrient balance modelling to size suitable land application areas;

- Determining an appropriate level of wastewater treatment and the preferred method of land application of effluent to overcome the constraints on the proposed lots.

4 Site Details and Existing OSMS

The properties are zoned RU2 (rural landscape). The proposed disturbance zones for dwellings and wastewater are located in the existing cleared areas.

4.1.1 No. 28 Sugarmill Road

Twenty Eight Sugarmill Road is located on the northern downslope side of the road. The property is dominated by cleared land with a gentle north-facing slope in the upper southern portion, and a forested section in the lower northern third.

A mapped intermittent drainage is located in the forested northwestern corner of the property, and a dam is present in the western portion of the cleared land.

The existing dwelling, gazebo, swimming pool and shed are located in the southeastern portion.

The existing OSMS consists of an older concrete septic tank ~ 2.4kL and a single absorption trench located to the north of the dwelling. The absorption trench will be located within required buffers to the proposed lot boundary and will need to be upgraded.

Photograph 1 – Looking west from the dwelling on Lot 120 across the boundary line towards the proposed Lot 121. The dam on the right of the image will require filling and decommission.

Photograph 2 – Looking south across the southern portion of proposed Lot 121 with the building envelope towards the road frontage.

Photograph 3 – The existing Septic tank on Lot 120.

4.1.2 No. 35 Sugarmill Road

Thirty Five Sugarmill Road is located on the southern uphill side of the road.

The groundsurface slopes gently to the north down from a low ridgeline spur in the upper southern portion of the property, and an intermittent drainage alignment drains along the western boundary to the north. There are cleared sections of land in the northeastern and southwestern portions of the property, and stands of large Blackbutt and Angophora eucalypt trees in the north western portion of the property.

An existing dwelling is present in the elevated southeastern portion, with a carport and swimming pool adjacent, and a tennis court towards the southwestern corner boundary.

The existing OSMS consists of a relatively new (4 to 5 years old) 3kl concrete septic tank and absorption trenches with three inspection ports and a distribution box, located on the eastern side of the dwelling and swimming pool (Figure 3). The existing trench is located at an appropriate distance of the proposed Lot 910/911 boundary to provide sufficient buffers.

Photograph 4 – Looking southwest across Proposed Lot 911 towards the proposed building envelope on the RH side of the photograph. The recommended EMA is located in the background over the existing tennis court.

Photograph 5 – Looking west across the central section of the proposed Lot 911.

4.1.3 No. 89 Sugarmill Road

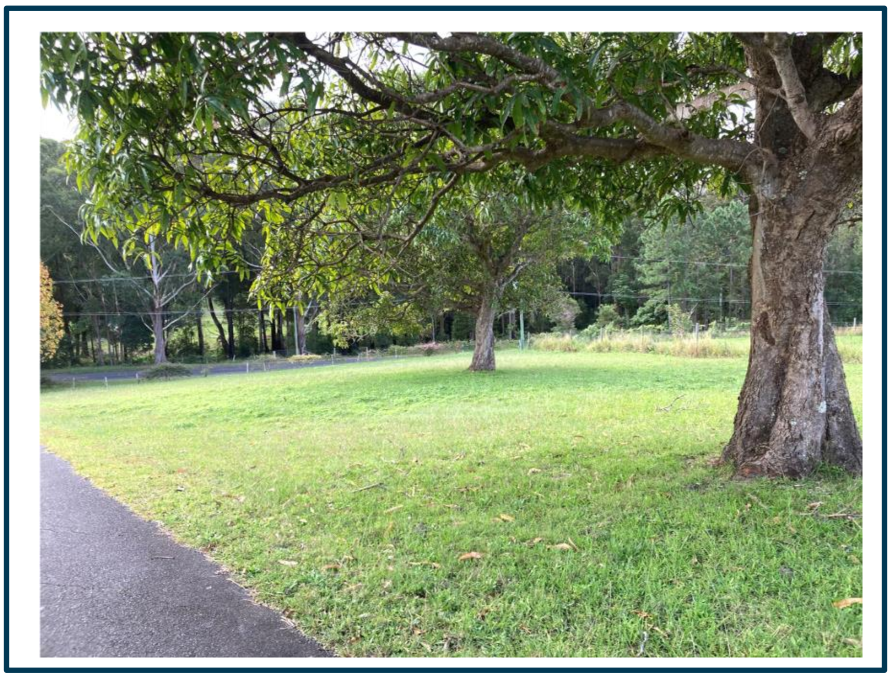
Eighty Nine Sugarmill Road is located on the southern uphill side of the road.

The groundsurface drops down from a ridgeline spur on the southern boundary, with a generally northwest facing downward slope towards the northern boundary of the property. An intermittent drainage enters the property on the western boundary and drains north into a farm dam, and then subsequently exits the property on the northern boundary (Figure 3).

An existing dwelling is present in the elevated southern portion of the property, with a sealed driveway leading from the road edge.

The existing OSMS consists of an older concrete septic tank ~2.4kL in size, and single absorption trench of unknown size and dimensions, located on the northwestern corner of the dwelling (Figure 3). The system, while old, appeared to be operating adequately at the time of inspection. The absorption trench will be located within required buffers to the proposed lot boundary and will need to be upgraded.

Photograph 6 – Looking south towards Lot 171 building envelope in the southern portion of that Lot.



Photograph 7 – Looking north across proposed Lot 171, with access for proposed Lot 170 from the road edge on the right side of the image, and the proposed EMA for Lot 171 on the grassed area downslope of the mango trees.

Photograph 8 –The mapped intermittent drainage on proposed Lot 171. The existing dam is in the trees on the left of the image.

4.2 Site Constraints

Table 2 summarises the Site constraints for the primary and reserve EMAs for each of the proposed lots. These are discussed in terms of the degree of limitation they present (i.e. minor, moderate or major limitation) for on-site effluent application. Reference is made to the rating scale described in Table 4 of DLG (1998). Site features are presented in Figure 3.

Lot 121 is at No.28, Lot 171 is at No.35, and 911 is at No.89 Sugarmill Road.

Table 2: Site Constraints

Constraint	Degree of Limitation		
	Minor	Moderate	Major
Landform: Lot 121 – Linear convergent mid slope Lot 170 – Waxing divergent mid slope Lot 911 – Waxing planar mid slope	171, 911	121	
Exposure: Lots 120, 121, 910, 911 - Good exposure. Minimal trees near the proposed EMAs. **Lots** 170, 171, some shading to the east.	121, 911	171	

Constraint	Degree of Limitation		
	Minor	Moderate	Major
Slope: Lots 121, 171 - Gentle slopes of 0-10% to the west and north. Lot 911 – Moderate slopes of 10-12% to the north.	121	171, 911	
Rocks and Rock Outcrops: No rock outcrops were observed on the Site.	All lots		
Erosion Potential: Active erosion risk is lower on the gentle slopes and higher on steeper. Erodible subsoils are present.	121	171, 911	
Climate: The Site experiences a sub-tropical-temperate climate, typical of north-eastern NSW.	All lots		
Vegetation: All lots – relatively cleared with forest margins	All lots		
Fill: No filling on the proposed EMAs	All lots		
Surface Waters: An intermittent drainage line passes through Lots 171 and 911, however these drainage lines are outside the buffer restriction for the EMA on this Lot. All Lots- >40m	All Lots		
Groundwater: (NSW Office of Water: Groundwater Bore Search) A number of licensed bores are located along Sugarmill Road.			All lots

Constraint	Degree of Limitation		
	Minor	Moderate	Major
 There are no registered bores on the subject properties. The closest bores are located about 70m to the north, northeast and east of the properties. GW300482 was drilled to 90m, but no useful aquifer details are provided. GW307371 was drilled to 38m depth with a hard and cracked black and brown shale aquifers encountered at between 18 and 22m and between 31 sand 36m depth. Groundwater vulnerability? Clay subsoil, distance and deep groundwater depth indicate that the risk to groundwater would be minimal.			
Stormwater run-on and upslope seepage: Lot 171– mid to lower slope position with runon risk. Lots 121,911 – mid slope position.	121, 911	171	
Flood Potential: The proposed EMAs are not impacted by 1:100 year flood extents on the CHCC flood mapping.	All lots		

4.3 Soil Survey and Description

4.3.1 Regional Soils

We reviewed the Soil Landscapes of the Coffs Harbour 1:100,000 Sheet (Milford, 1999) which indicates that the properties are generally underlain by the Megan Soil Landscape (Table 3).

Table 3: Soil Landscape

Proposed Lots	Soil Landscape	Type	Typical Profile	Limitations
All Lots	Megan	Erosional	moderately deep to deep (>100 cm), well drained structured Red Earths, Brown Earths, Yellow Earths, Brown, Yellow or Red Podzolic Soils and Krasnozems.	strongly acid, aluminium toxicity potential and low subsoil fertility, stoney (localised) steep slopes (localised), high water erosion hazard (localised).

Soils were assessed by drilling four (4) boreholes (Figure 3) to 1.2m depth or refusal. In general, these soils comprised:

- Approximately 100-200mm of clay loam topsoil, dark brown to black, some pale brown mottling, with moderate to strong structure; overlying
- Approximately 200-450mm of clay loam subsoil, brown with pale red or orange mottling;
- Approximately 300 - 600mm of light clay, pale red or orange brown, with slight red, grey and white mottling; overlying
- At least 200mm of light to medium clay, either pale red orange or white grey with orange or white mottling.

There was variability in the soil profile with position on the landscape but all consisted of the clay loam over light clay profile typical of the Megan Soil Landscape.

Competent bedrock was not encountered in the boreholes. The borehole logs are provided in Appendix A.

Photograph 9 – BH1 soil profile.

4.4 Soil Chemistry

Table 4 summarises the key soil physical and chemical assessments. Reference is made to the rating scale described in Table 6 of DLG (1998). Two samples were selected for laboratory analysis (BH1 0.5-0.7). The laboratory report is included in Appendix B.

Table 4: Soil Assessment

Parameter	Constraint		
	Minor	Moderate	Major
Depth to bedrock or hardpan (m): Boreholes were terminated at 1.2m depth in soil. It is believed that competent bedrock will be located at >1.5m based on soil landscape and position.	All lots		
Depth to high soil watertable: The depth of the vadose zone (i.e. non-saturated soil material above watertable) was greater than 1.2m at the time of the investigation. The depth to the permanent groundwater aquifer is expected to be more than 7m depth based on local groundwater bores.	All lots		
Coarse Fragments (%): The subsoils contained <20% coarse fragments.	All lots		
Hydraulic loading rate: Soil structure: Strong Soil texture: Light clays Permeability category: Category 5a Hydraulic loading recommended: 8mm/day for primary, and 12mm/day secondary treated effluent into an absorption bed field and 3mm/day for SSI. Reasons for the hydraulic loading recommendation: Strongly structured clay subsoils.		All lots	
pH: 3.99 pH Units from. Acidic coastal soils.			All lots
Electrical Conductivity (dS/m): 0.235dS/m. Not saline.	All lots		
Dispersiveness:		All lots	

Parameter	Constraint		
	Minor	Moderate	Major
Class 3/6 (Slake 2). The instability of these aggregates is expected to increase slightly with the application of effluent.			
Sodicity (ESP): ESP of 1.1%. The ESP infers a minimal potential for structural degradation.	All lots		
Cation Exchange Capacity: CEC was measured at 20.4 cmol/kg, which indicates that the soils have a high ability to accept and release excess nutrients from effluent.	All lots		
Phosphorus Adsorption: Psorp of 18,590kg/ha were reported in the subsoils.	All lots		

5 Minimum Lot Size (MLS) Analysis

A minimum lot size analysis and modelling were completed to determine the maximum lot density suitable for subdivision on the Site.

5.1 Methodology

When considering the suitability for a lot to sustainably manage wastewater on-site, we typically refer to ‘available effluent management area’. This broadly refers to available areas (i.e. not built out or used for a conflicting purpose) where OSMS will not be unduly constrained by site and soil characteristics. Available area on a developed lot is determined by the following factors:

- total building area (including dwellings, sheds, pools etc.) which includes a defined building envelope but may extend beyond with additional improvements to a property, such as driveways and paths (impervious areas), and gardens/vegetated areas unsuitable for effluent reuse;
- dams, intermittent and permanent watercourses running through lots;
- maintenance of appropriate buffer distances from property boundaries, buildings, driveways and paths, dams and watercourses;
- flood prone land;
- excessive slope;
- excessively shallow soils;
- heavy (clay) soils with low permeability;

- excessively poor drainage, shallow groundwater and/or stormwater run-on; and
- excessive shading by vegetation.

The residual areas (areas not otherwise occupied by improvements, buffers, restrictions or conservation vegetation) were then calculated for the selected lots (Figure 8), and the available area compared to the wastewater envelope required.

5.2 MLS Buffer Distances

Buffer distances from EMAs are typically enforced to minimise risk to public health, maintain public amenity and protect sensitive environments. Generally, adopted environmental buffers for secondary treated effluent land applied into absorption trenches/ beds based on DLG (1998) are:

- 250m from domestic groundwater bores;
- 100m from permanent watercourses;
- 40m from intermittent watercourses and dams;
- 6m from downslope property boundaries and 3m from upslope property boundaries; and
- 6m from downslope buildings and 3m from upslope buildings.

In addition, developed areas such as inground water tanks and swimming pools were also buffered.

Primary treatment was selected as default due to proposed lots in the current investigation area being ~10,000m^2.

5.3 MLS Comparative Lots Assessed

Six nearby representative lots were selected that have already been subdivided (Table 5) (Figure 4). The lots ranged in size from 2,887-4,212m^2 area. The next available lot sizes greater than this on Wakelands and Gaudrons Road were 20,000m^2, and given the 6636-13,700m^2 proposed for the properties the larger lot size was not considered appropriate to compare to. As such the smaller lots assessed provide a worst case scenario of OSMS restrictions.

Table 5: Comparative Lots Assessed

Address	Lot Area (m^2)	Zoning
39-41 Gaudrons Road	4,005	RU2
45 Gaudrons Road	4,001	RU2
75 Gaudrons Road	4,212	RU2
7 Wakelands Road	2,887	RU2
341 Solitary Islands Way	3,282	RU2
347 Solitary Islands Way	3,008	RU2

The properties typically included a dwelling, garage/shed, landscaped trees, shrubs and gardens, driveways, water tanks, and recreational space. This development style will be similar to that proposed for the Site and therefore minimum lot size and development potential should be consistent.

5.4 MLS Assessed Available EMA

Table 6 and **Error! Reference source not found.** shows the assessment of available effluent management areas for each of the assessed lots. As is evident, the variability of lot sizes, on-lot improvements and restrictions of developed lots makes selection of a "typical" lot difficult, however comparison of the site constraints indicates that minimum lot size is the most significant issue to address.

Table 6: Minimum Lot Size Assessment Results

Id	Lot Area (m^2)	Developed Area (m^2)[1]	Total Restricted Area (m^2)[2]	Available Eff. Application Area (m^2)	Percent of Lot Available for Eff. Disp. (%)	>1010m^2 Area Available for Secondary Treatment?
39-41	4,005	1,293	2,142	1,873	47	Yes
45	4,001	1,166	2,154	1,843	46	Yes
75	4,212	1,564	2,377	1,827	43	Yes
7	2,887	704	2,639	587	20	No
341	3,282	970	2,213	1,069	33	No
347	3,008	748	1,871	1,137	38	No

1. House, driveway, shed etc
2. Includes developed area, protected vegetation and buffers to waterways and boundaries

5.5 Discussion

A comparison of nearby properties suggests that:

- The assessed properties are between 3,000-4,000m2 in footprint, less than the minimum 6,636m^2 proposed;
- Except for the smallest lot, No.7, of ~2,800m^2, each have about 1,200-1,800m^2 of available unconstrained area for effluent application. The smaller lot has only 587m^2 footprint;
- Typically available area for effluent application represents about 30-50% of the total lot area, the smaller the lot, the same development footprint requirements impact on land area available for effluent application; and
- Allowing for additional developed footprint such as sheds and swimming pools that may not be present currently, and constraints such as buffers to gullies and protected forest vegetation, the minimum 1,010m^2 footprint typically required for a primary treatment and land application

OSMS would still be able to be met. As such given the low slopes and limited site and soil constraints, a minimum 6,000m^2 lot sizing would be considered acceptable.

6 Recommended OSMS Combination

Due to the cost of reticulated sewerage provision by Council, it is expected that the properties will not be sewered in the foreseeable future.

Based on the site and soil constraints and subdivision boundaries, the minimum treatment and land application combination selected for 28, 35 and 89 Sugarmill Road, Sapphire Beach are:

- Treatment to a primary standard and subsurface application into an appropriately sized absorption bed field.

During future development application for a particular dwelling on lots of 8,000m^2 or more, with judicious placement of the dwelling and improvements, and limiting wastewater generation volumes, alternative OSMS combinations may be considered acceptable including treatment to a secondary standard and land application by subsurface irrigation, or wet or dry compost systems.

7 Effluent Management Areas

7.1 Design Hydraulic Load

For hydraulic loading purposes a proposed dwelling of five bedrooms on tank water was assumed for the proposed lots. AS/NZS1547:2012 recommends that a wastewater generation load of 120L per person per day for households supplied by tank water be used as a basis for wastewater system design. The hydraulic load for the existing and proposed dwellings is based on 1.5 persons per bedroom. The design hydraulic loading for a four bedroom dwelling under full occupancy is presented in Table 7.

Table 7: Proposed Design Hydraulic Load

No. of Bedrooms	Design Wastewater Load (L/day)
4	720

7.2 Sizing of Effluent Management Areas

Water balance modelling was undertaken to determine sustainable effluent application rates, and from this estimate the necessary size of the EMA required for effluent to be applied from a primary treatment system trench or beds. The procedures used in the water balance generally follow the *AS/NZS 1547:2012* standard and DLG (1998) Guideline. The water balance used is a monthly nominated area model. These calculations determined minimum EMAs for given effluent loads for each month of the year. The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation + Storage

The input data and results for the primary treated trench/ bed water balance are presented in Table 8, and calculation sheets in Appendix C.

A conservative nutrient balance was also undertaken, which calculates the minimum buffer around a trench or bed to enable nutrients to be assimilated by the soils and vegetation. The nutrient balance used here is based on the simplistic DLG (1998) methodology, but improves this by more accurately accounting for natural nutrient cycles and processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as ammonification (the conversion of organic nitrogen to ammonia) and a certain amount will be lost by denitrification, microbial digestion and volatilisation. A summary of the nutrient balance is provided in Table 8.

Table 8: Inputs and Results of Primary Treatment Modelling

Data Parameter	Units	Value	Comments
Hydraulic load	L/day	720	6 persons occupancy.
Precipitation	mm/month	Coffs Harbour	BoM, Median monthly.
Pan Evaporation	mm/month	Coffs Harbour MO	BoM, mean monthly.
Retained rainfall	unitless	0.85	Proportion of rainfall that remains onsite and infiltrates the soil, allowing for 15% runoff.
Crop Factor	unitless	0.6-0.8	Expected annual range for vegetation based on monthly values.
Design Loading Rate (DLR) - Primary	mm/day	8	Maximum rate for design purposes, based on strongly structured clay subsoils.
Effluent total nitrogen concentration	mg/L	60	Target effluent quality for secondary treatment systems.
Effluent total phosphorus concentration	mg/L	15	Target effluent quality for primary treatment systems.
Soil phosphorus sorption capacity	kg/ha	18,590	Value based on soil testing.

Data Parameter	Units	Value	Comments
Nitrogen uptake rate by plants	kg/Ha/yr	250	Conservative estimated value.
Phosphorus uptake rate by plants	kg/Ha/yr	25	Conservative estimated value.
Design life of system (for nutrient management)	years	50	Reasonable minimum service life for system.
Minimum primary treatment trench/ bed basal area for hydraulic load (m^2)			105m^2 (258m^2 absorption trench field footprint)
Minimum area for total phosphorus load (m^2)			180m^2
Minimum area for total nitrogen load (m^2)			505m^2

Based on modelling an EMA and reserve EMA of 505m^2 each have been nominated for a future four bedroom dwelling, totalling 1010m^2. The proposed locations of the EMAs are shown on Figure 5, including reserve EMAs of 505m^2 for existing dwellings.

The actual size and configuration of the EMAs will be dependent on a wastewater management plan at the time of dwelling development planning and application to install or upgrade an OSMS.

8 Upgrades to Existing OSMS

Upgrades to the existing OSMS are required on 28 and 89 Sugarmill Road to enable the proposed subdivision.

For 28 Sugarmill Road, the absorption trench is located within the 12m setback to the proposed boundary. A replacement primary treatment EMA of 505m^2 has been allocated on the Lot 120 plus a reserve EMA.

For 89 Sugarmill Road, the absorption trench is also located within the 12m setback to the proposed boundary. A replacement secondary treatment EMA of 252m^2 has been allocated on the Lot 170 plus a reserve EMA. Secondary treatment is required to meet reduced buffers to the boundaries and intermittent waterways from that lot.

9 Buffers

Buffer distances or setbacks from EMAs are required to minimise risk to public health, maintain public amenity and protect sensitive environments. The buffers from DLG (1998) are presented in **Table 9** below.

Table 9: Available Buffers

Site Feature	DLG (1998) Buffer	Achievable?
Intermittent watercourses, drainage channels and dams	40m	**Yes**
Permanent waterways	100m	**Yes**
Domestic groundwater bore	250m	**No, 70m.**
Property boundary	Primary - 6m downslope / sideslope of, and 12m sideslope or upslope of	**Yes**
Driveway and building	6m downslope of / 3m upslope of	**Yes**

Although all the recommended EMAs fall within the 250m buffer to a domestic groundwater bore required by DLG (1998), this guideline did not provide any scientific justification for that buffer and the document is dated about 22 years ago. Appendix R of AS/NZS1547:2012, a more recent document and a national standard provides the ability to risk assess buffers based on site and soil constraints. The maximum risk assessed buffer in AS/NZS1547:2012 to bores or wells is 50m for high risk scenarios such as primary treated wastewater, shallow high resource groundwater, aquifers in highly porous soils or rock, and surface or above ground effluent land application. The recommended minimum OSMS combination poses a lower risk than this worst case, and the local groundwater aquifer is relatively deep at >40m depth beneath a substantial clay soil layer. As such a lesser risk assessed buffer would be expected.

In any case, all recommended EMAs would be located >50m from the nearest bores.

10 Conclusions & Recommendations

Having undertaken a minimum lot size and land capability assessment for the proposed subdivision of 28, 35 and 89 Sugarmill Road, Sapphire Beach, EWC consider that there is the opportunity for the sustainable application of wastewater following subdivision of the existing properties into smaller lots (**Table 10**).

Table 10: Summary of Development Recommendations

Property	Minimum Lot Size (m^2)	Minimum OSMS Combination
28 Sugarmill	6,000	Primary treatment and subsurface land application over 505m^2.
35 Sugarmill	6,000	
89 Sugarmill	6,000	

For any future system we recommend that:

- A dwelling specific OSMS should be designed by an experienced professional, taking into account the assumptions and recommendations contained in this report; and
- An OSMS should be installed by a suitably qualified plumber, ensuring that effluent is distributed evenly across the entire area serviced.

11 References

Coffs Harbour City Council (2015) *On-site Sewage Management Strategy 2015*, Coffs Harbour.

Department of Local Government et al. (1998). *Environment & Health Protection Guidelines: On-site Sewage Management for Single Households*.

Milford, H. B., (1999) *Soil Landscapes of the Coffs Harbour 1:100 000 Sheet*, Department of Land and Water Conservation Soil Landscape Series.

Standards Australia / Standards New Zealand (2012*). AS/NZS 1547:2012 On-site Domestic-wastewater Management*.

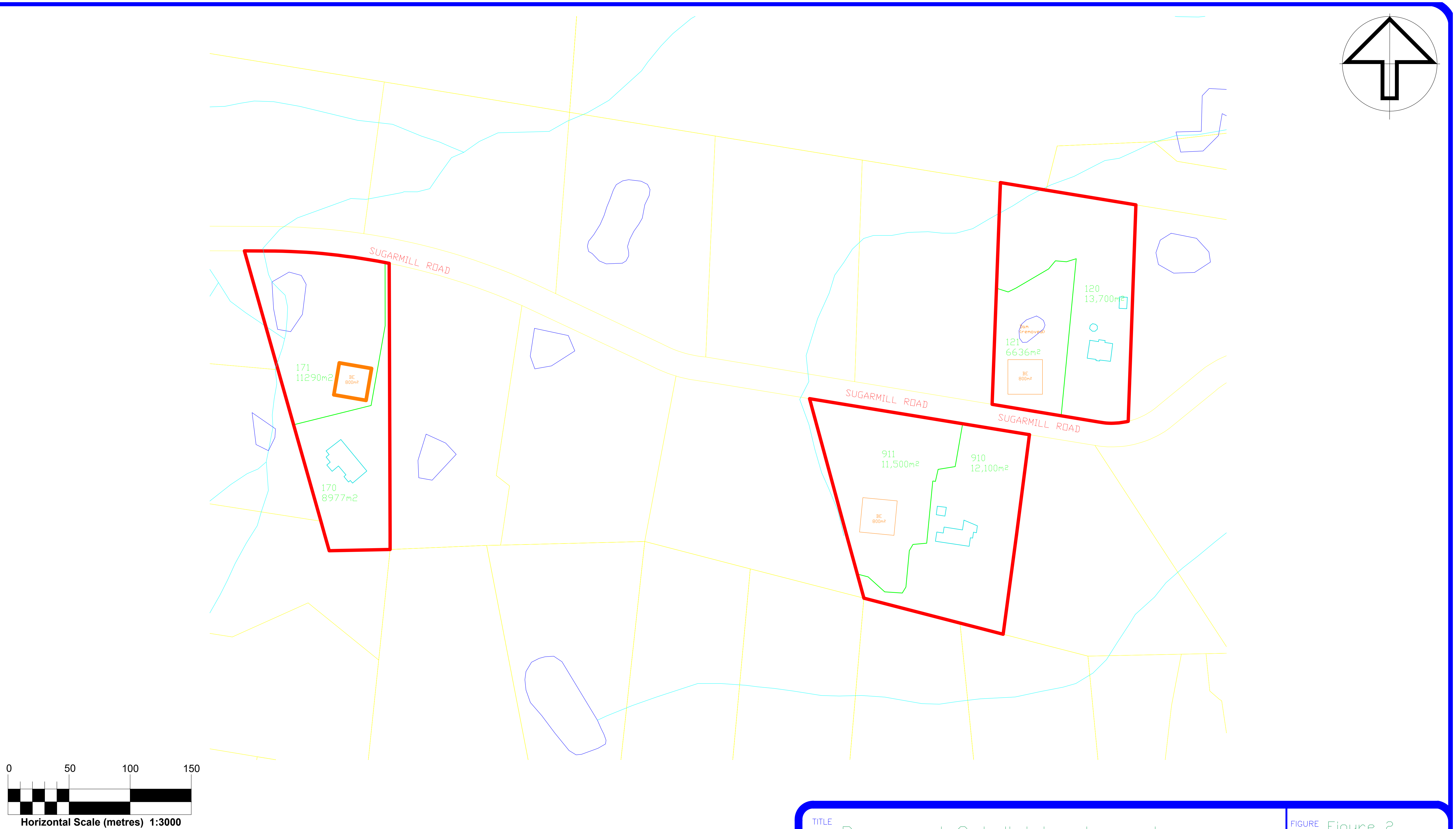
FIGURES

EARTH WATER CONSULTING

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams

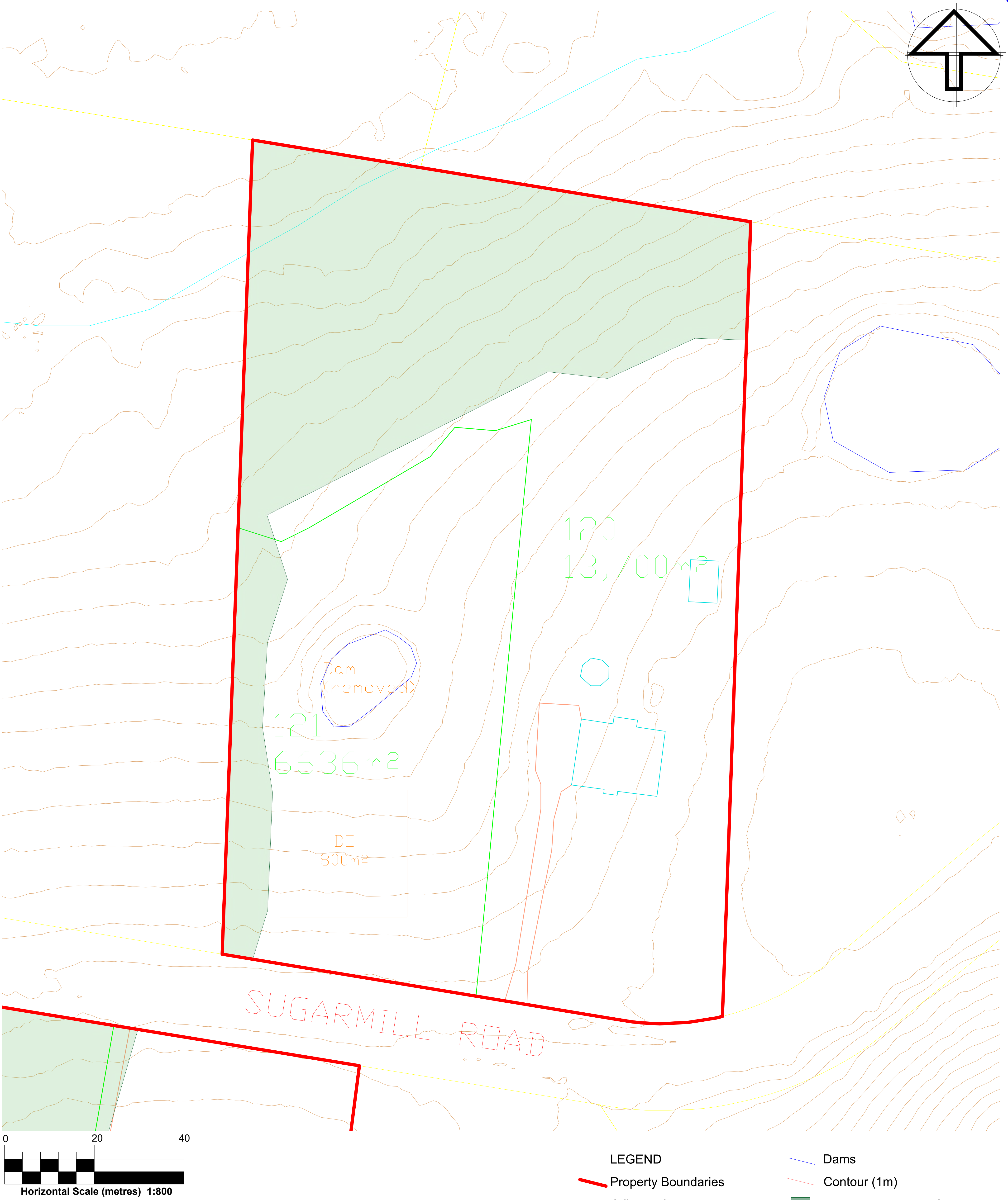
TITLE Site Location			PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach		CLIENT Grimley, Martyn & Arianayagam
FIGURE Figure 1					
SHEET 1 OF 1	ISSUE B	AUTHOR SD	DATE 2/11/21	SCALE 1:4000	PROJECT 2021-165



LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Proposed Subdivision Bdy
- Proposed Building Envelope

TITLE: Proposed Subdivision Layout				FIGURE: Figure 2
				SHEET: 1 OF 4 — ISSUE: A
PROJECT: LCA for 28, 35 and 89 Sugarmill Road, Sapphire Beach				CLIENT: Grimley, Arianayagam & Martyn
AUTHOR: SD	DATE: 2/11/21	SCALE: 1:3,000		PROJECT: 2021-165

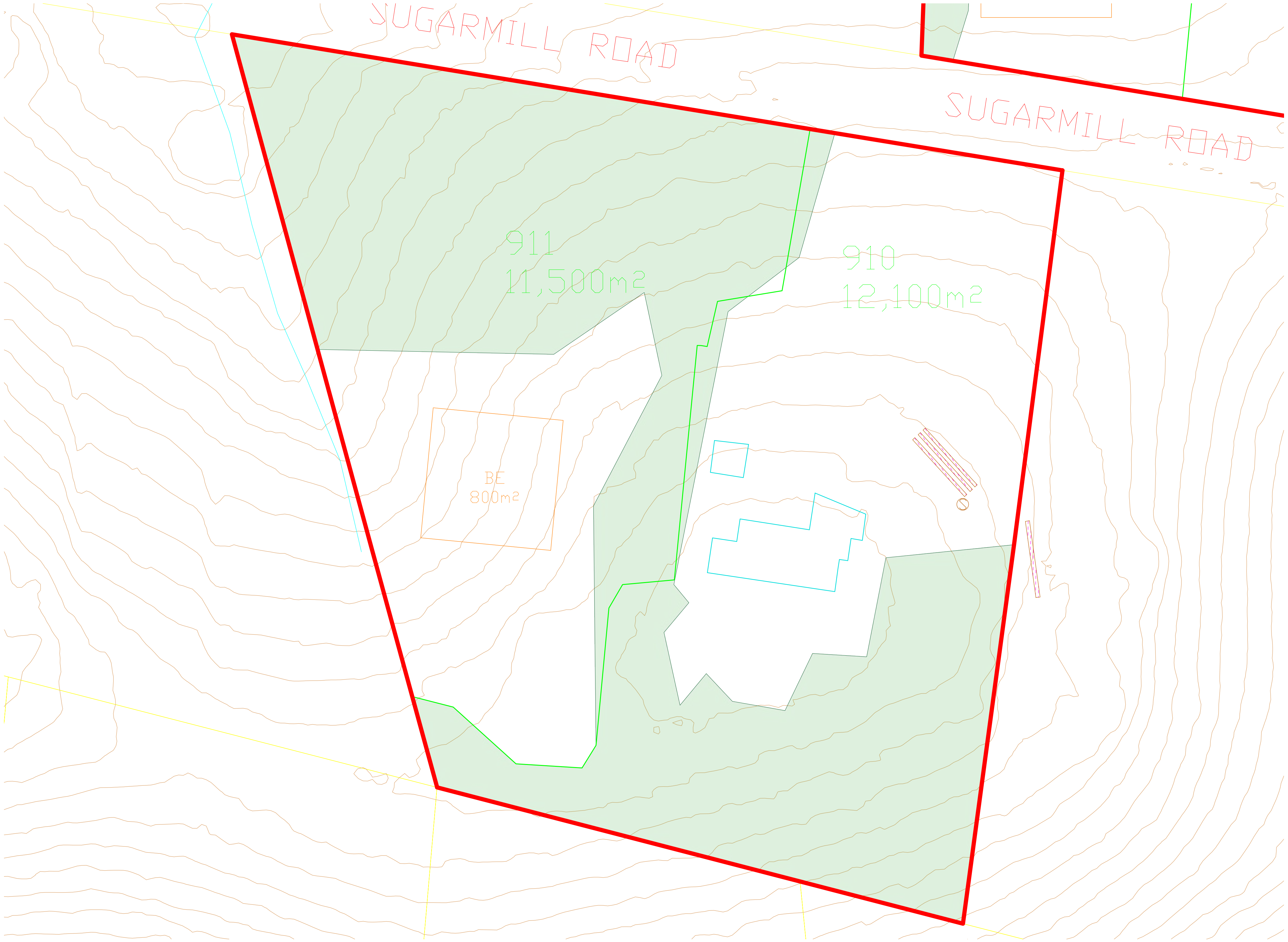


LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope

TITLE: 28 Sugarmill Road Proposed Subdivision Layout		FIGURE: Figure 2	
		SHEET: 4 OF4	ISSUE: A
PROJECT: LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach		CLIENT: Grimley, Arianayagam & Martyn	
AUTHOR: SD	DATE: 28/10/21	SCALE: 1:800	PROJECT: 2021-165

EARTH WATER CONSULTING



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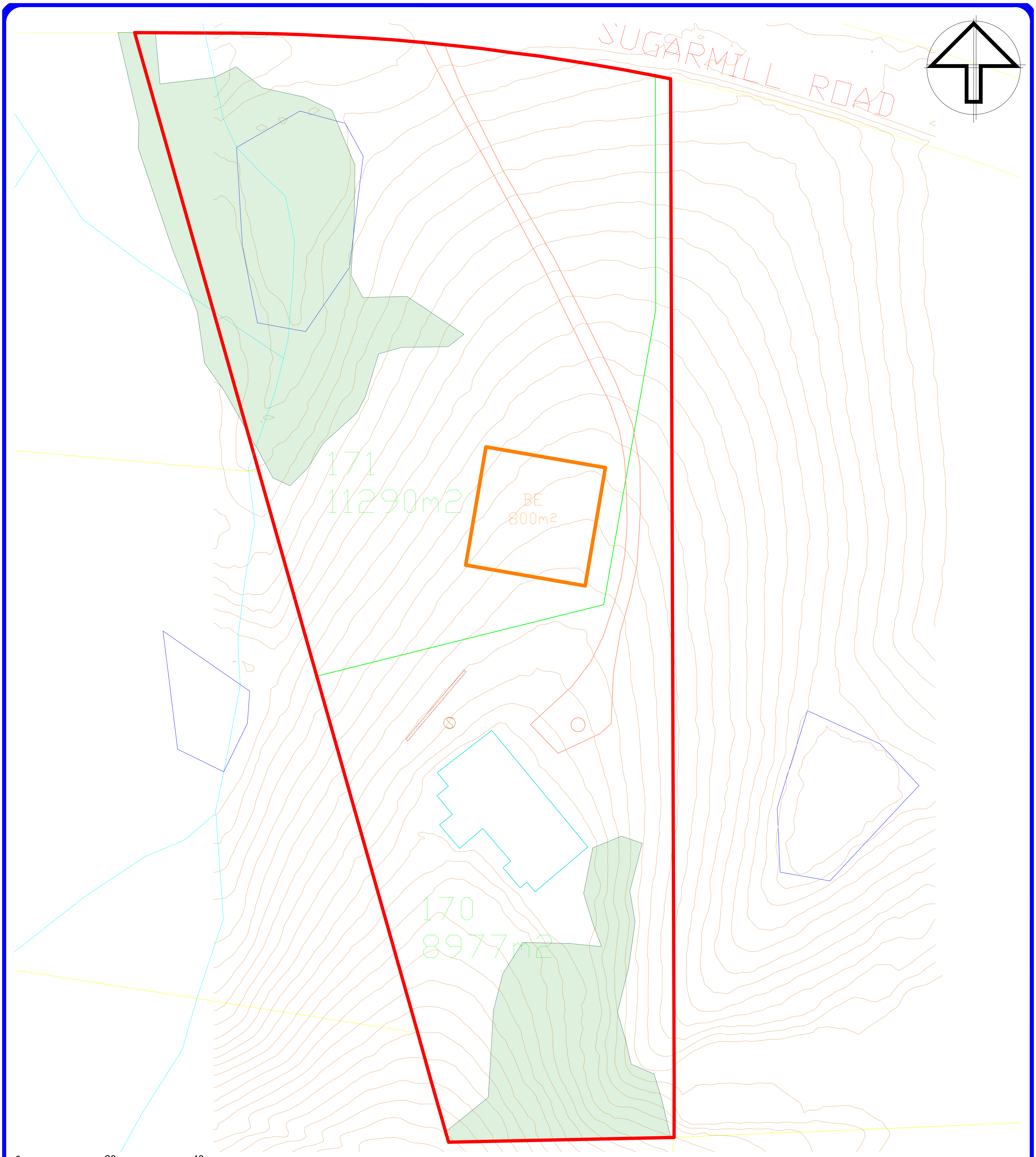
Horizontal Scale (metres) 1:1000

EARTH WATER CONSULTING

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope

TITLE	35 Sugarmill Road Proposed Subdivision Layout
FIGURE	Figure 2
SHEET	3 OF 4
ISSUE	A
PROJECT	LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach
CLIENT	Grimley, Arianayagam & Martyn
AUTHOR	SD
DATE	2/11/21
SCALE	1:1,000
PROJECT	2021-165



0 20 40

Horizontal Scale (metres) 1:800

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope

EARTH WATER CONSULTING

TITLE: 89 Sugarmill Road Proposed Subdivision Layout	FIGURE: Figure 2
	SHEET: 4 OF 4 — ISSUE: A
PROJECT: LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach	CLIENT: Grimley, Arianayagam & Martyn
AUTHOR: SD	DATE: 28/10/21
SCALE: 1:800	PROJECT: 2021-165

0 10 20 30

Horizontal Scale (metres) 1:600

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Existing OSMS Tank
- Existing OSMS Bed
- Approx Borehole Location

EARTH WATER CONSULTING

TITLE: 28 Sugarmill Road Existing Site Layout		FIGURE: Figure 3	
		SHEET: 1 OF 3	ISSUE: A
PROJECT: LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach		CLIENT: Grimley, Arianayagam & Martyn	
AUTHOR: SD	DATE: 28/10/21	SCALE: 1:600	PROJECT: 2021-165

0 25 50

Horizontal Scale (metres) 1:1000

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Existing OSMS Tank
- Existing OSMS Bed
- Approx Borehole Location

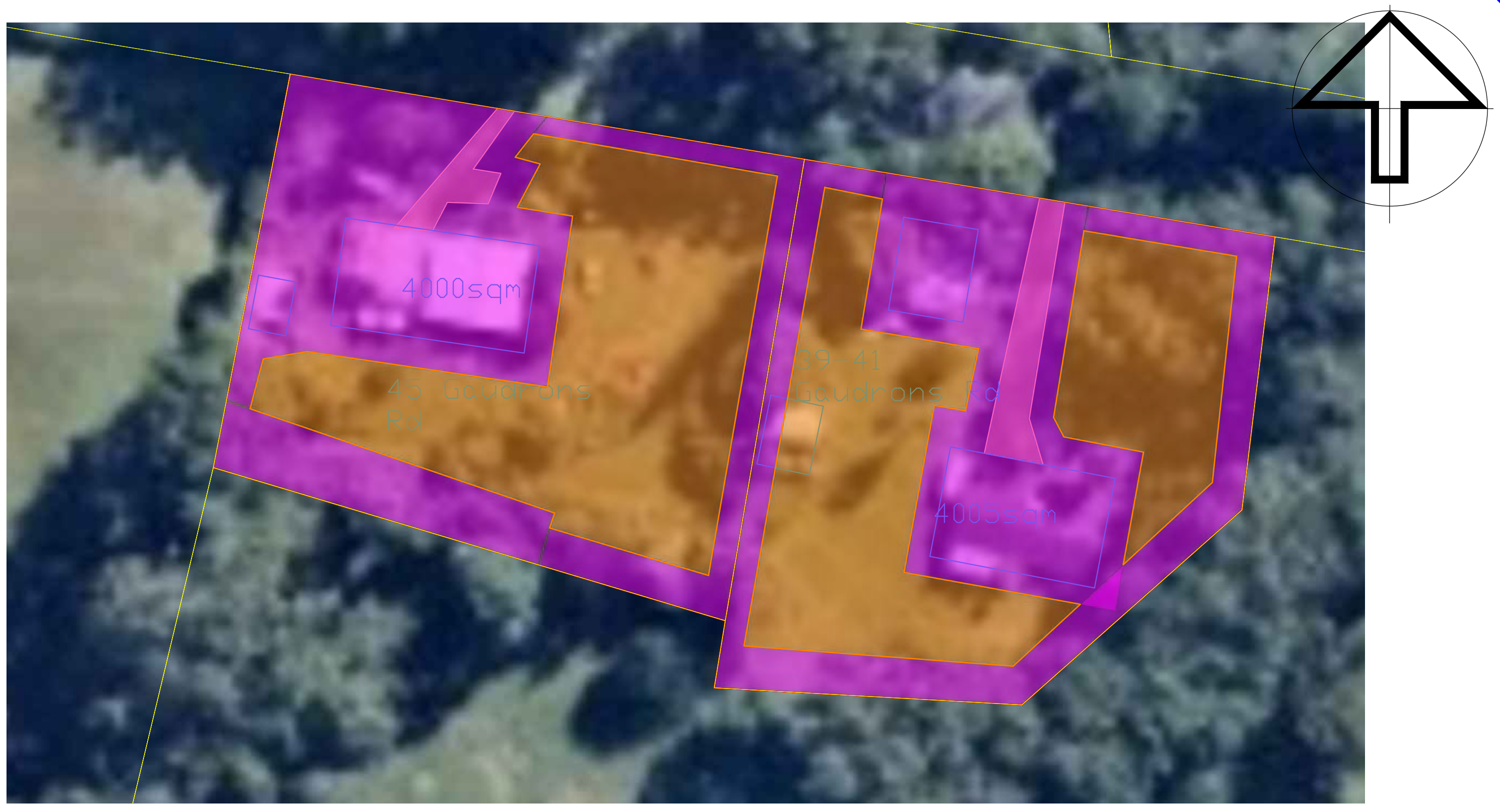
EARTH WATER CONSULTING

TITLE: 35 Sugarmill Road, Existing Site Layout	FIGURE: Figure 3
	SHEET: 2 OF 3 — ISSUE: B
PROJECT: LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach	CLIENT: Grimley, Martyn and Arianayagam
AUTHOR: SD — DATE: 17/09/21 — SCALE: 1:1000	PROJECT: 2021-165

TITLE 89 Sugarmill Road Existing Site Layout			FIGURE Figure 3
			SHEET 3 OF 3 ISSUE A
PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach			CLIENT Grimley, Arianayagam & Martyn
AUTHOR SD	DATE 7/9/21	SCALE 1:800	PROJECT 2021-165

EARTH WATER CONSULTING

7 Wakeland, 341 and 347 Solitary Is. Way



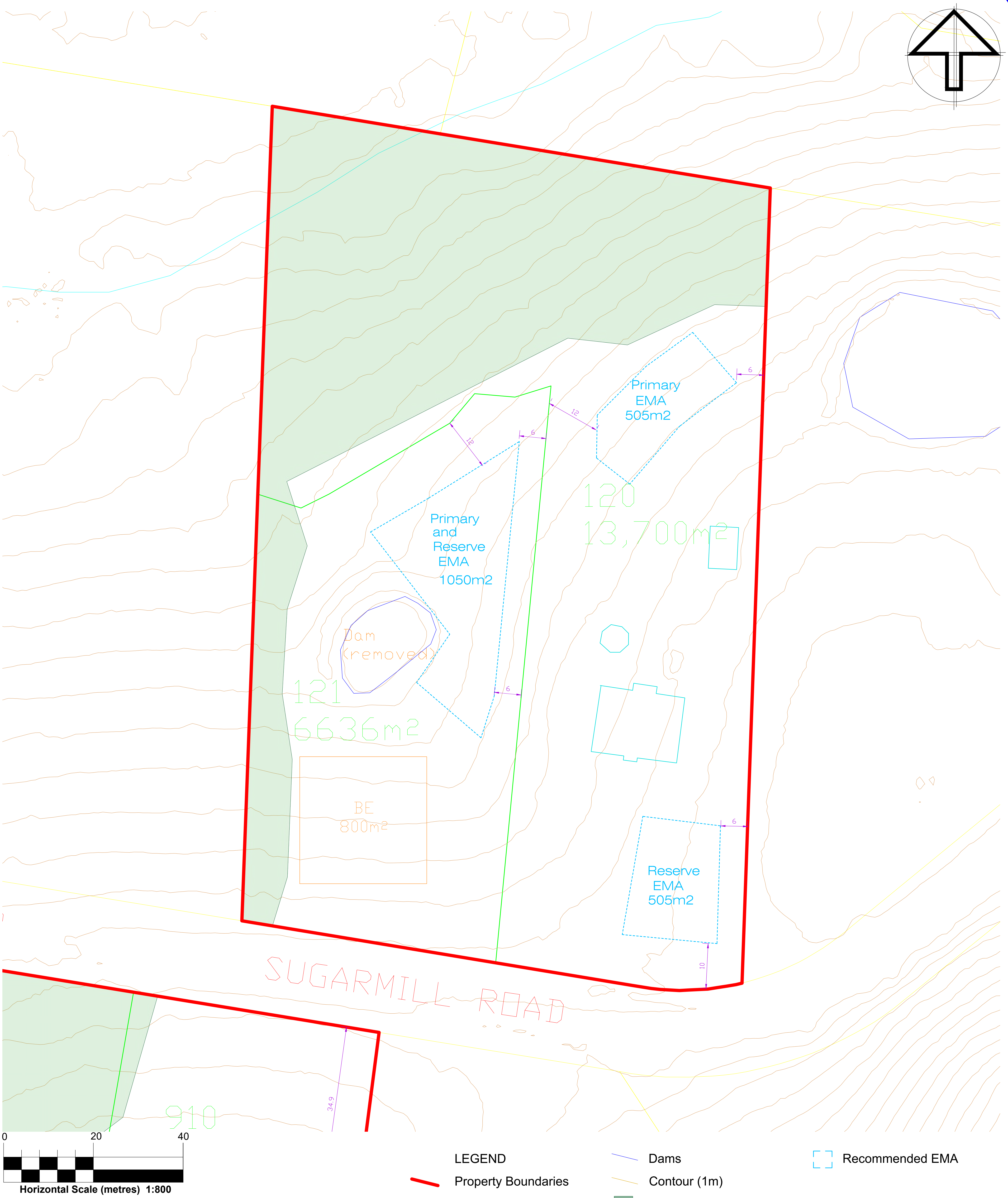
39-41 & 45 Gaudrons Road

75 Gaudrons Road

LEGEND
- Property Boundary
- Adjacent Lot
- Drainage Alignment
- EMA Restricted Area
- EMA Available Area

TITLE Comparative Lot Size Constraints			FIGURE Figure 4
			SHEET 1 OF 1 / ISSUE A
PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach			CLIENT Grimley, Arianayagam & Martyn
AUTHOR SD	DATE 28/10/21	SCALE 1:1,000	PROJECT 2021-165

EARTH WATER CONSULTING

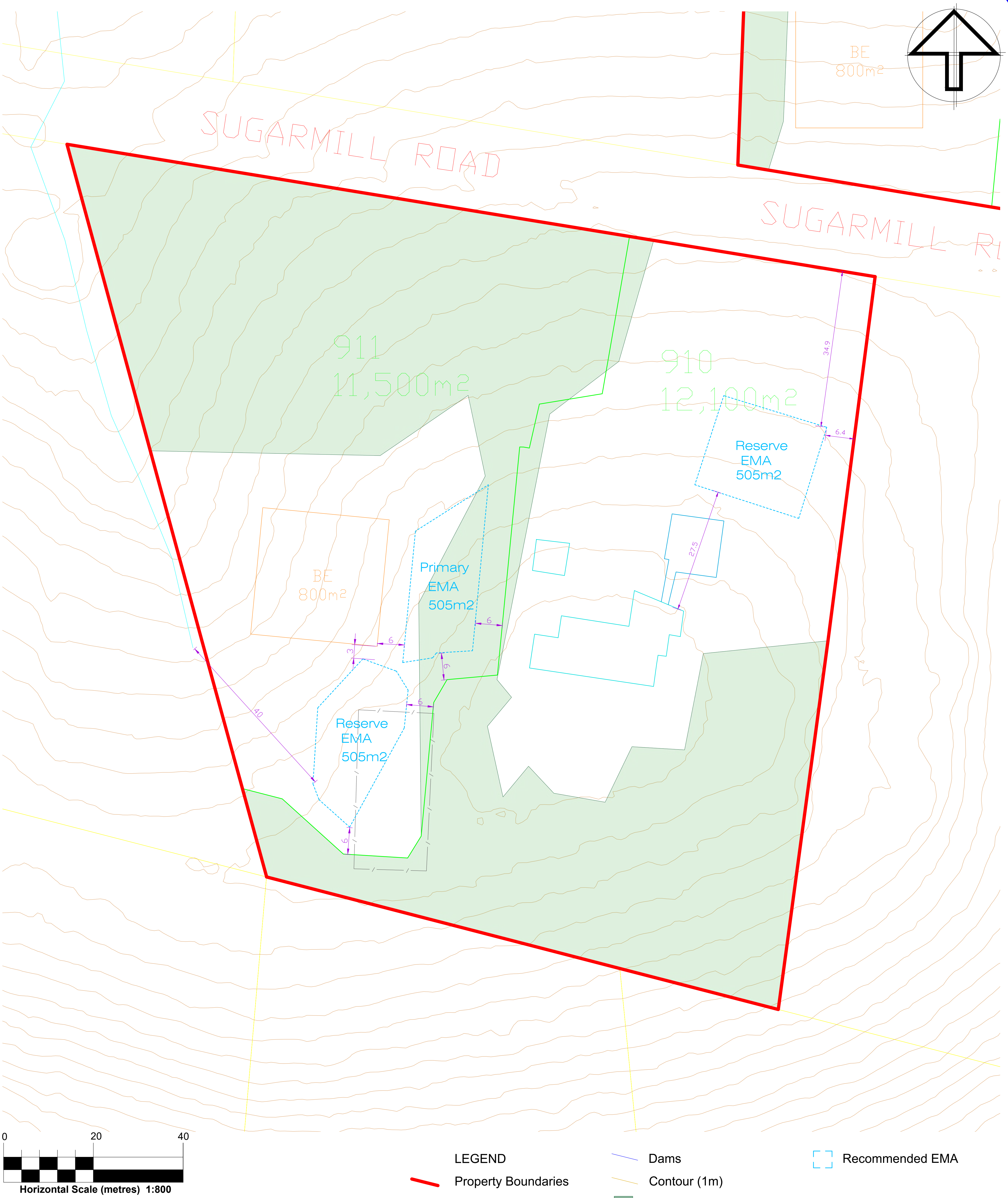


LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope
- Recommended EMA

EARTH WATER CONSULTING

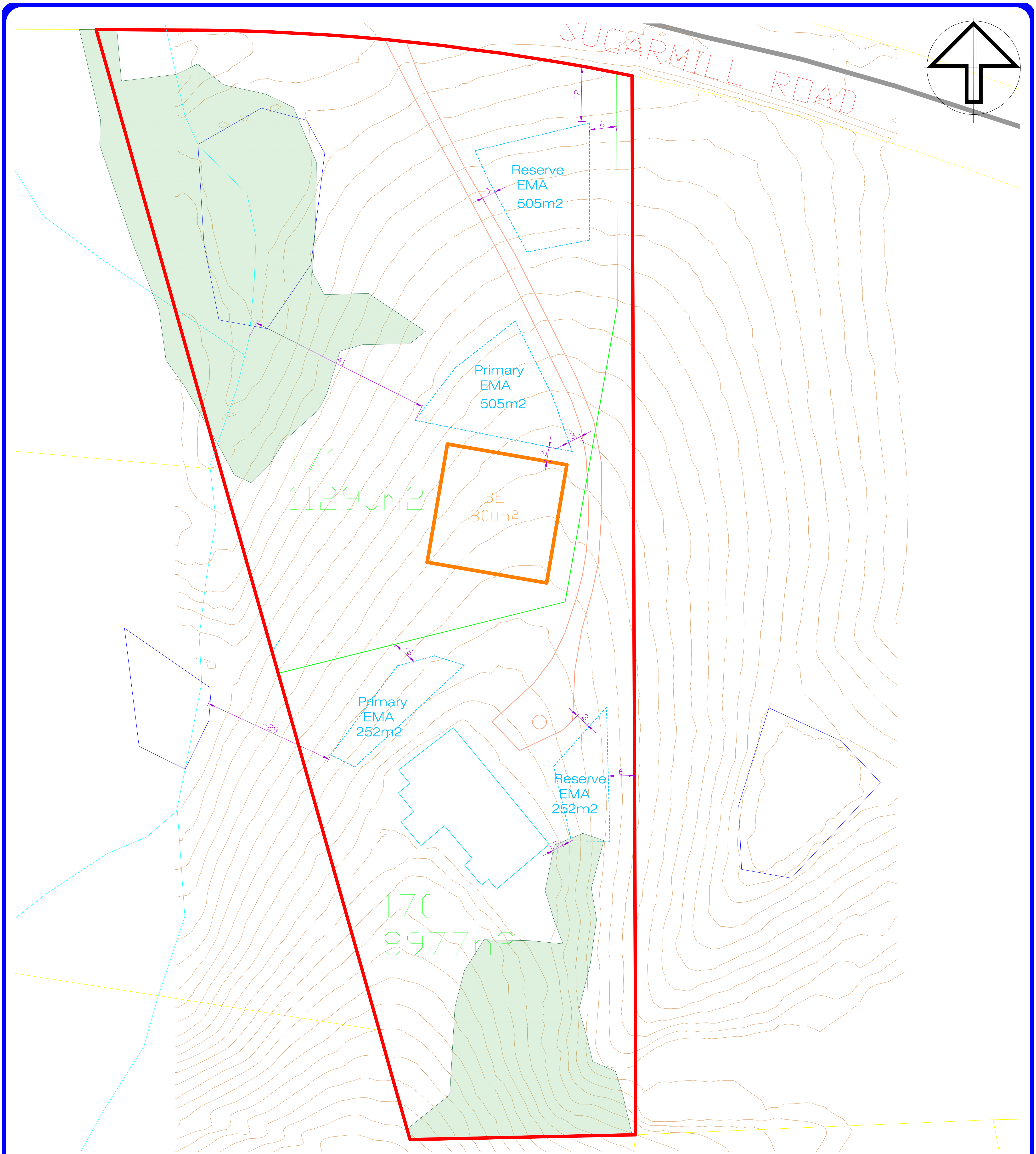
TITLE 28 Sugarmill Recommended Effluent Management Areas			FIGURE Figure 5 SHEET 1 OF 3 ISSUE A
PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach			CLIENT Grimley, Arianayagam & Martyn
AUTHOR SD	DATE 28/10/21	SCALE 1:800	PROJECT 2021-165



LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope
- Recommended EMA

TITLE 35 Sugarmill Recommended Effluent Management Areas		FIGURE Figure 5	
		SHEET 2 OF3	ISSUE A
PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach		CLIENT Grimley, Arianayagam & Martyn	
AUTHOR SD	DATE 28/10/21	SCALE 1:800	PROJECT 2021-165



0 20 40

Horizontal Scale (metres) 1:800

LEGEND

- Property Boundaries
- Adjacent Lots
- Intermittent waterways
- Dams
- Contour (1m)
- Existing Vegetation Outline
- Proposed Building Envelope
- Recommended EMA

TITLE 89 Sugarmills Road Recommended Effluent Management Areas		FIGURE Figure 5	
		SHEET 3 OF3	ISSUE A
PROJECT LCA for 28, 35 & 89 Sugarmill Road, Sapphire Beach		CLIENT Grimley, Arianayagam & Martyn	
AUTHOR SD	DATE 28/10/21	SCALE 1:1000	PROJECT 2021-165

EARTH WATER CONSULTING

APPENDIX A

Soil Borelog

		Borehole No:	**BH1**
		Logged by:	NS
		Drilling date:	25/05/2021
Project ref:	2021-165	Drilling method:	Power auger
Client:		Borehole location:	Figure 2
Address:	28 Sugarmill Rd Sapphire Beach	Borehole coords:	

PROFILE DESCRIPTION

Depth (m)	Sampling depth/name	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1			A1	Clay Loam	Moderate	Black/Dark Brown	Nil	Nil	SM	Topsoil
0.2			A2	Clay Loam	Strong	Pale Brown	Pale Orange	Nil	SM	Transferral
0.3										
0.4										
0.5			B2	Light Clay	Strong	Pale Red	Pale Brown	Nil	SM	Residual
0.6	S									
0.7										
0.8				Light Clay	Strong	Pale Red Orange	White	Nil	SM	Residual
0.9										
1.0										
1.1										
1.2										
1.3					Borehole terminated at 1.2m					
1.4										
1.5										

Moisture condition

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

Soil Borelog

Borehole No:	**BH2**
Logged by:	NS
Drilling date:	25/05/2021
Drilling method:	Power auger
Borehole location:	Figure 2
Borehole coords:	513864, 6656545

Project ref:	2021-165
Client:	
Address:	28 Sugarmill Rd Sapphire Beach

PROFILE DESCRIPTION

Depth (m)	Sampling depth/name	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1			A1	Clay Loam	Moderate	Black/Dark Brown	Nil	Nil	SM	Topsoil
0.2			A2	Clay Loam	Strong	Dark Brown	Pale Orange	Nil	SM	Transferral
0.3										
0.4										
0.5	S		B2	Light Clay	Strong	Pale Red	Pale Orange, White, Grey	Nil	SM	Residual
0.6										
0.7										
0.8				Light Clay	Strong	Pale Red Orange	White	Nil	SM	Residual
0.9										
1.0	S									
1.1										
1.2										
1.3						Borehole terminated at 1.2m				
1.4										
1.5										

Moisture condition

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

Soil Borelog

Borehole No:	**BH3**
Logged by:	NS
Drilling date:	25/05/2021
Project ref:	2021-165
Client:	
Address:	35 Sugarmill Rd Sapphire Beach
Drilling method:	Power Auger
Borehole location:	Figure 2
Borehole coords:	513723, 6656354

PROFILE DESCRIPTION

Depth (m)	Sampling depth/name	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1			A1	Clay Loam	Strong	Dark Brown	Pale Brown	Nil	SM	Topsoil Charcoal
0.2			B1	Clay Loam	Strong	Pale Brown	Pale Red Orange	< 5%	SM	Transferral
0.3										
0.4										
0.5										
0.6	S									
0.7			B2	Light Clay	Strong	Pale Orange Brown	Pale Red	Nil	SM	Residual
0.8										
0.9										
1.0										
1.1			B3	Light Clay	Strong	Orange/Pale Red	White/Pale	Nil		Residual
1.2										
1.3					Borehole terminated at 1.2m					
1.4										
1.5										

Moisture condition

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

Soil Borelog

Borehole No:	**BH4**
Logged by:	NS
Drilling date:	25/05/2021
Drilling method:	Power Auger
Borehole location:	Figure 2
Borehole coords:	513269, 6656501

Project ref:	2021-165
Client:	
Address:	89 Sugarmill Road Sapphire Beach

PROFILE DESCRIPTION

Depth (m)	Sampling depth/name	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1			A1	Clay Loam	Strong	Dark Brown	Black	Nil	D to SM	Topsoil
0.2										
0.3			B1	Clay Loam	Strong	Pale Brown	Orange, Red, Dark Brown	< 5%	SM	Residual
0.4										
0.5			B2	Light Clay	Strong	Pale Brown Grey	Pale Orange	Nil	SM	Residual
0.6										
0.7	S									
0.8										
0.9										
1.0										
1.1			B3	Medium Clay	Strong	White/Pale Grey				Residual
1.2										XW Bedrock
1.3					Borehole terminated at 1.2m					
1.4										
1.5										

Moisture condition

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

APPENDIX B

WASTEWATER DISPOSAL SOIL ASSESSMENT

1 sample supplied by Earth Water Consulting Pty Ltd on 27/5/2021 - Lab Job No. K7414
Analysis requested by Strider Duerinckx. - **Your Project: BH1 0.5-0.7**
PO Box 50 BELLINGEN NSW 2454

	SAMPLE 1 **BH1**
Job No.	*K7414/1*
Description	Clay
Moisture Content (% moisture)	24
Emerson Aggregate Stability Test (SAR 5 Solution) note 12	EAT Class 3/6, Slake 2 [see note 12]
Soil pH (1:5 $CaCl_2$)	3.99
Soil Conductivity (1:5 water dS/m)	0.027
Soil Conductivity (as EC_e dS/m) [note 10]	0.235
Native NaOH Phosphorus (mg/kg P)	6.56
Residual phosphorus remaining in solution from the initial phosphate phosphorus	
Initial Phosphorus concentration (ppm P)	**30**
72 hour - 3 Day (ppm P)	4.07
120 hour - 5 Day (ppm P)	3.99
168 hour - 7 Day (ppm P)	3.76
Equilibrium Phosphorus (ppm P)	3.61
EXCHANGEABLE CATIONS	
Calcium (cmol+/kg)	0.54
Magnesium (cmol+/kg)	2.09
Potassium (cmol+/kg)	0.10
Sodium (cmol+/kg)	0.21
Aluminium (cmol+/kg)	1.11
Hydrogen (cmol+/kg)	16.34
ECEC (effective cation exchange capacity)(cmol+/kg)	20.4
Exchangeable Calcium %	2.6
Exchangeable Magnesium %	10.2
Exchangeable Potassium %	0.5
Exchangeable Sodium % (ESP)	1.1
Exchangeable Aluminium %	5.4
Exchangeable Hydrogen %	80.1
Calcium/ Magnesium Ratio	0.26

Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al

2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).

3. ppm = mg/kg dried soil

4. Insitu P determined using 0.1M NaOH and shaking for 24 hrs before determining phosphate

5. Soils were crushed using a ceramic grinding head and mill; five 1g subsamples of each soil were used to which 40ml of 0.1M NaCl with Xppm phosphorus was added to each. The samples were shaken on an orbital shaker

6. Exchangeable sodium percentage (ESP) is calculated as sodium (cmol+/kg) divided by ECEC

7. All results as dry weight DW - soils were dried at 6OC for 48hrs prior to crushing and analysis.

8. Phosphorus Capacity method from Ryden and Pratt, 1980.

9. Aluminium detection limit is 0.05 cmol+/kg; Hydrogen detection limit is 0.1 cmol+/kg. However for calculation purposes a value of 0 is used.

10. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm; EC_e conversions: sand loam 14, loam 9.5; clay loam 8.6; heavy clay 5.8

11. 1 cmol+/kg = 1 meq/100g

12. Emerson Aggregate Stability Test (EAST) for Wastewater applications (see Sheet 3 - Patterson, 2015). MEAT Class 1: Slaking, complete dispersion; Class 2: Slaking, some dispersion; Class 3-6: Slaking 1 slight to 3 complete, No dispersion; Class 7: No slaking, yes swelling; Class 8: No slaking, no swelling.

13. Analysis conducted between sample arrival date and reporting date.

14. .. Denotes not requested.

15. This report is not to be reproduced except in full.

16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960
Accredited for compliance with ISO/IEC 17025 - Testing

Checked:............

PHOSPHORUS SORPTION TRIAL

1 sample supplied by Earth Water Consulting Pty Ltd on 27/5/2021 - Lab Job No. K7414
Analysis requested by Strider Duerinckx. - Your Project: BH1 0.5-0.7

Calculations for Equilibrium Absorption Maximum for Soil provided

I.D.	JOB NO.	Equilibrium P mg P/L (in solution)	Added P mg P/L	P Sorb at Equil. mg P/kg	Native P mg P/kg	Equilibrium P Sorption Level µg P/g soil	Divide Ø (from Table)	Equilibrium Absorption Maximum (B) µg P/g soil
BH1	**K7414/1**	3.6	30	1056	7	1062	0.62	**1,710**

Calculations for phosphorus sorption capacity

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (=X)	minus the native P (=Y)	**kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
BH1	*K7414/1*	1710	(=B x theta)	(=X -native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)

EXAMPLE 1 - Calculations for phosphorus sorption capacity using a wastewater phosphorus of 15mg/L P

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (ie. 0.84)	minus the native P (=Y)	**kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
BH1	*K7414/1*	1710	1437	1430	**2,789**	**18,590**

Checked:............

APPENDIX C

Nominated Area Water Balance & Storage Calculations

Site Address: **Sugarmill Road, Sapphire Beach**

Proj Ref: 2021-165

Notes:

Flow Allowance		120	l/p/d
No. of bedrooms		4	bdr
Occupancy		1.5	p/room
Design Wastewater Flow	Q	720	L/day
Daily DLR		8.0	mm/day
Crop Factor	C	0.6-0.8	unitless
Retained Rainfall Coefficient	RRc	0.85	untiless
Void Space Ratio	V	0.3	unitless
Nominated Land Application Area	N	105	sqm
Trench/Bed wetted thickness	Ww	0.1	m
Rainfall Data	Coffs Harbour Rainfall Data (monthly median)		
Evaporation Data	Coffs Harbour MO- Average		

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Median Rainfall	R	\	mm/month	151.2	179	205.1	135.9	117.4	90	54.3	40.7	35.4	74.7	130.4	114.1	1612.2
Average Evaporation	E	\	mm/month	192.2	156.8	148.8	117	86.8	69	77.5	105.4	135	161.2	171	192.2	**0**
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.70	0.70	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	154	125	119	82	61	41	47	63	95	113	137	154	**1189.94**
Percolation	B	DLRxD	mm/month	248.0	224	248.0	240.0	248.0	240.0	248.0	248.0	240.0	248.0	240.0	248.0	**2920.0**
Outputs		ET+B	mm/month	401.8	349.44	367.0	321.9	308.8	281.4	294.5	311.2	334.5	360.8	376.8	401.8	**4109.9**
INPUTS																
Retained Rainfall	RR	R*RRc	mm/month	128.52	152.15	174.335	115.515	99.79	76.5	46.155	34.595	30.09	63.495	110.84	96.985	**1128.97**
Effluent Irrigation	W	(QxD)/L	mm/month	212.6	192.0	212.6	205.7	212.6	205.7	212.6	212.6	205.7	212.6	205.7	212.6	**2502.9**
Inputs		RR+W	mm/month	341.1	344.2	386.9	321.2	312.4	282.2	258.7	247.2	235.8	276.1	316.6	309.6	**3631.8**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month		0.0	0.0	66.2	64.0	76.0	78.7	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-202.2	-17.6	66.2	-2.2	12.0	2.7	-119.2	-213.6	-329.0	-282.6	-200.8	-307.3	**-271.8**
Cumulative Storage	M		mm	0.0	0.0	66.2	64.0	76.0	78.7	0.0	0.0	0.0	0.0	0.0	0.0	**284.9**
Maximum Bed Storage Depth for Area	BS		mm	**78.70**	Is the calculated storage acceptable?			Yes, storage is conservative								

Nominated trench width	0.9	
Total length based on nominated width	116.7	
No. of beds	8	
Individual bed lengths	14.6	
Individual Bed footprints	13.1	
Spacing between beds	1.5	
Total bed area	258	
Nutrient uptake zone	403	2m buffer nutrient uptake allowance

Nutrient Balance

Proj Ref: 2021-165

Site Address: Sugarmill Road, Sapphire Beach

Notes:

INPUT DATA

Hydraulic Load		720	L/Day	
Effluent N Concentration		60	mg/L	
% Lost to Soil Processes		0.2	Decimal	
Total N Loss to Soil		8640	mg/day	
Effluent P Concentration		15	mg/L	
Design Life of System		50	yrs	
Crop N Uptake	250	kg/ha/yr =	68	$mg/m^2/day$
Crop P Uptake	25	kg/ha/yr =	7	$mg/m^2/day$
P-sorption analytical result in soil		18590	kg/ha	
% of Predicted P-sorp		0.75	Decimal	

Nitrogen Balance

Nitrogen uptake ability in vegetation	68	$mg/m^2/day$
Nitrgen loading in wastewater	34560	mg/day
Area required for nitrogen	**505**	m^2

Phosphorus Balance

P adsorbed	1.39425	kg/m^2
P uptake	0.125	kg/m^2
P generated	273.75	kg
Area required for Phosphorus	**180**	m^2