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Integrated Water Cycle Management Plan
Proposed RISE Development (MP08-0234)
Bilambil Heights, West Tweed
New South Wales

Prepared for:
Terranora Group Management
C/- Steve MacRae Development Services

April, 2009

Document control

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Title:	**Integrated Water Cycle Management Plan, Proposed RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales**	
Project Manager:	Allan Genn	
Author:	Alison Fullagar	
Client:	Terranora Group Management	
Client Contact:	C/- Steve MacRae, Steve MacRae Development Services	
Client Reference:		
Synopsis:	This report examines options available and recommends a suite of management systems to implement an Integrated Water Cycle Management strategy for this project.	

Revision History

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Summary

The New South Wales Minister for Planning agreed on September 30, 2008 to consider the site as a potential State Significant site (reference No. MP 08-0234) and has authorised the submission of a Concept Plan. Subsequently the NSW Department of Planning issued a list (dated February 6, 2009) of the Director General's Environmental Assessment Requirements (DGEAR's) for the proposed development.

This report, titled '*Integrated Water Cycle Management Plan, Proposed Development, RISE, Bilambil Heights*' (March 2009), provides detailed responses to the specific DGEAR's concerning stormwater and water cycle management.

This report examines options for implementing an Integrated Water Cycle Management (IWCM) strategy for the proposed RISE project, Bilambil Heights, New South Wales. A number of IWCM scenarios have been sized and their performance assessed using Aquacycle and spreadsheet computer models.

This report recommends implementing the following systems.

- Demand management – use of water efficient appliances.
- Rainwater (roof runoff) collection and re-use (household or community scale).
- Stormwater collection and reuse.
- Treatment of stormwater runoff.

Implementing these systems would achieve the following.

- Total anticipated water consumption would be reduced by approximately 26.9% through the use of WELS rated water-efficient fittings and appliances throughout the development.
- Approximately 75.2% of water required on the site would be obtained from sources other than the reticulated mains water supply.
- Approximately 41.7% of collectable roof water would be captured and reused.
- Stormwater runoff quality would be improved to minimise adverse impacts on the downstream receiving waters.
- Stormwater runoff peak flows would be no greater than at present.
- Groundwater resources would be protected and enhanced.

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Glossary

Australian Height Datum (AHD)	National reference for relative height measurement in Australia.
Average Recurrence Interval (ARI)	The average or expected length of time between exceedances of a given variable, such as rainfall.
Bund	An embankment constructed around an area to prevent the inflow or outflow of liquids. Also called Bunding.
Catchment	The area above a given point which contributes to the runoff.
Clay	Very fine-grained sediment or soil (often defined as having a particle size less than 0.002 mm, or 2 microns, in diameter).
Ephemeral	A stream that flows briefly only in direct response to precipitation in the immediate locality and the channel of which is at all times above the watertable.
Erosion	The process by which material (such as rock or soil) is worn away or removed (as by wind or water).
Groundwater	The water contained in interconnected pores located below the watertable in an unconfined aquifer or located in a confined aquifer.
Intermittent	A stream in which the flow is seasonal, usually in response to rainfall in the immediate area (see ephemeral).
Loam	Medium-textured soil composed of approximately 10% to 25% clay, 25% to 50% silt and less than 50% sand.
pH	The degree of acidity or alkalinity measured on a scale of 1 to 14 with 7 as neutral. From 0 to 7 is acidic; from 7 to 14 is alkaline.
Sand	Sediment composed of particles within the size range 63 microns to 2 millimetres.
Scouring	The action of removing sediment from stream banks, particle by particle. This is a more destructive process than collapse when viewed over time due to incremental effects.
Sediment	Unconsolidated, fine-grained material (typically derived from the weathering of rocks), that is transported by water and settles on the floor of seas, rivers streams and other bodies of water.
Silt	Sediment having particles finer than sand and coarser than clay (i.e. 2 to 63 microns).
Sub-catchment	A smaller area within a catchment drained by one or more tributaries of the main water body.
Suspended Solids (SS)	The concentration of filterable particles in water (retained on a 0.45mm filter) and reported by volume (mg/L).
Total Nitrogen (TN)	Total nitrogen is the sum of the nitrogen present in all nitrogen-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Total Phosphorus (TP)	Total phosphorus is the sum of the phosphorus present in all phosphorus-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Turbidity	A measure of the cloudiness of water which is determined by the amount of light scattered by suspended particles.

1) Introduction

1.1 General

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by Terranora Group Management to undertake an assessment of water cycle management options in support of the proposed development of a master planned community – the RISE project at Bilambil Heights, West Tweed, New South Wales.

The RISE project is the subject of a major project application (reference: MP08-0234). This reference number, together with the term 'site', is used throughout this report to refer to the RISE major project application area (approximately 110ha).

On September 30, 2008, the Minister for Planning agreed to consider the site as potentially State Significant (reference No. MP08_0234) and has authorised the submission of a Concept Plan. Subsequently the NSW Department of Planning issued a list (dated February 6, 2009) of the Director General's Environmental Assessment Requirements (DGEAR's) for the proposed development.

This report, titled *Integrated Water Cycle Management Plan, Proposed RISE Development, (MP08-0234), Bilambil Heights, West Tweed, New South Wales* (April 2009) provides detailed responses to the specific DGEAR's concerning stormwater and water cycle management.

The relevant items from the DGEAR's are listed below (in *italic* text) followed by our response to each item (in plain text).

> ***2. Biodiversity and Threatened Species***
> *(6) Assess any potential impact on surrounding waterways in terms of water quality and aquatic ecosystems. This should include but not be limited to:*
> *(a) Onsite pollution such as accidental spills and sewer overflows;*

All waste water will be collected by an underground sewer system and conveyed to Council's treatment plant for treatment and disposal. The potential for sewer overflows is considered to be limited to the failure of pumping stations. Sewer pumping stations would have an inbuilt alarm system and emergency storage capacity. In the event of a failure, it would be Council's responsibility to react to the alarm and arrange for pumps and tankers to remove sewage from the site and prevent spills or overflows.

As the site is not on a major through road, all imported chemicals or other materials would be for use on the site. The potential for major chemical spills is considered minimal. However in the unlikely event of a spill, the spilled material would in most cases eventually flow into the stormwater drainage system.

In most catchments a constructed wetland would serve as the point of containment, treatment and removal. In the event of a spill, stormwater harvesting from the particular catchment would cease, and the water supply demand would be met by the town water supply system.

Vegetated buffer zones will be provided surrounding any waterways adjacent to or traversing the site (refer to the separate report on agricultural buffers, titled *'Agricultural Buffer Zone Assessment, Proposed RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales'*, prepared by Gilbert & Sutherland, dated April 2009).

> *(b) Stormwater Management and treatment*

Stormwater quality treatment will be provided for the site in accordance with Tweed Shire Council's 'deemed to comply' stormwater treatment requirements. By meeting TSC guidelines, stormwater runoff leaving the site will be of an acceptable quality to discharge into the surrounding waterways and therefore should not cause any detriment to the water quality or aquatic ecosystems present.

> ***5. Utilities and Infrastructure***
> *(2) Preparation of a Concept Stormwater Management Plan that outlines general measures for stormwater and effluent management in relation to climate, topography, soil types and local geology and identify potential risk issues. Measures to be*

incorporated on site, include (but not limited to) on site stormwater detention, water sensitive urban design measures, the impact on the quality of surface water and groundwater.

This report constitutes the conceptual stormwater management plan for the site. Further details are provided in Section 4.

(3) Identify the proposed sources of water supply for the development including any reliance on groundwater or local catchments including addressing water sustainability and efficiency principles.

The development proposal aims to minimise the reliance of the site on the potable mains supply and maximise the use of alternate water sources (rainwater and stormwater) where the supply quality is suitable for the end use.

It is proposed that the water supply for all non-potable uses within the development will be sourced primarily from rainwater, which will be collected from all roof areas within the development, treated in an on-site treatment plant and pumped to a central storage reservoir for re-distribution across the site.

Stormwater runoff collected in the wetland areas in catchments 8, 9, 10, 12 and 13 will be harvested and treated as a supplement to the rainwater supply.

Water balance modelling, as described in Section 3 of this report, indicates that the proposed rainwater/stormwater collection and distribution system would be able to satisfy 95.8% of the non-potable water demand across the site. In the modelling carried out to date, the remaining 4.2% would be sourced from a potable mains supply top-up.

(4) Identify any risks of groundwater depletion or water table rise.

It is anticipated that there would be some localised, transient groundwater mounding in the vicinity of each of the constructed wetlands, due to the depth of storage required for stormwater harvesting. It is estimated that the localised increase in groundwater level would fluctuate with climatic conditions and be limited to an area of approximately 15m outside the boundary of each wetland (to be confirmed by modelling at Development Application to TSC stage if required).

The potential for groundwater mounding around the constructed wetlands would be unlikely to have any broader impact on the groundwater table within the region.

Extraction of groundwater is not proposed.

The risk of groundwater depletion or water table rise is therefore considered minimal. This would be demonstrated by an onsite investigation and computer modelling during the detailed design phase for Development Applications to TSC.

10. Flooding.
Assessment of any flood risk for the site should be conducted in accordance with the NSW Government's Flood Prone Land Policy as set out in the Floodplain Development Manual, 2005.

Noted. See Section 1.3 for details.

12. Site Preparation Works
(3) Provide preliminary Erosion and Sediment control Plan.

Noted. An Erosion and Sediment Control Plan has been prepared by Gilbert & Sutherland. Refer to the *'Erosion and Sediment Control Plan, Proposed RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales'* dated April 2009.

(4) Provide a contaminated land report that identifies and assesses any land contamination.

Noted. A separate report titled *'Contamination Assessment Summary, RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales'* (April 2009) has been prepared by Gilbert & Sutherland to address contaminated land issues for the subject site.

15. Agriculture
(1) Consider the potential impacts of the proposal on existing agriculture in the area.

Noted. Refer to the separate report on agricultural buffers titled *'Agricultural Buffer Zone Assessment, Proposed RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales'*, prepared by Gilbert & Sutherland, dated March 2009.

> *(2) Monitoring of the quality and volumes of any discharged water to ensure no reduction in quality and quantity to downstream agricultural users of the water.*

The proposed stormwater quality treatment system meets Tweed Shire Council's strict guidelines for stormwater quality treatment. As such, water discharged from the site should be of a satisfactory standard for downstream water users.

> *(3) Demonstrate consistency with requirements of the Northern Rivers Catchment Action Plan.*

The Northern Rivers Catchment Action Plan's Management Target W2 refers to Urban Water Cycle Management within the region, focusing on *'maximising the benefits and minimising negative impacts associated with the management of urban water supply, waste water and stormwater.'*

This report provides a conceptual integrated water cycle management strategy for the proposed RISE development, addressing water supply, rainwater collection and re-use and stormwater treatment and harvesting.

1.2 Site description

The RISE site is located in New South Wales just south of the border of NSW and Queensland, approximately 10km south-west of Tweed Heads in the township of Bilambil.

The site comprises; Lots 32 & 33 on DP1085109, Lot 31 on DP850230, Lot2 on DP867486 and Lot 4 on DP822786 under the ownership of Terranora Group Management Pty. Ltd.; Lot 1 on DP1033810, Lot 1 on DP1033811 and Lot 1 on DP595529 owned by Tweed Shire Council; and Crown Road separating Lot 2 on DP867486, Lot 33 on DP1085109 and Lot 2 on DP555026. The location of the site is shown on Drawing No. GJ0495.1.1.

With a total land area of approximately 184ha, the subject site contains an area of some 110ha of development footprint (the area described by MP08-0234) and is characterised by undulating land ranging from 2m to 216m Australian Height Datum (AHD).

The majority of the site has been cleared of native vegetation for past agricultural activities. An existing golf course occupies the south-eastern portion of the development footprint, as shown on the aerial photograph in Drawing No. GJ0495.1.2.

A number of small dams currently exist on the site and these will be preserved as wetland areas in the proposed development.

1.3 Flood impacts

1.3.1 General

A review of Tweed Shire Council's flood data indicates that the northern portion of the site adjacent to Cobaki Creek may be subject to flooding during a regional 100 years Average Recurrence Interval (ARI) event. The project has been designed to accommodate this constraint.

Adequate on-site detention will be provided to ensure that there are no increases in flows in Cobaki Creek and at the other points of discharge for all storm events up to and including the 100 years ARI event. The proposal would therefore have no impact on the existing creek or the existing adjoining development.

Further detail of flood mitigation and management measures would be provided in support of a later application to TSC for Development Approval.

1.3.2 Playing fields flooding.

Apart from the Sports Park area to the north of Cobaki Road, the site is elevated and well above local and regional flood levels. Emergency access to or from the site would be available via Marana Street.

Tweed Shire Council has provided details of potential 100 years Average Recurrence Interval (ARI) flood heights in the vicinity of

the proposed Sports Park in Precinct U from its regional 36 hour storm flood modelling results. Copies of the details provided by Council are attached as Appendix 1. These results indicate that the flood level would be approximately RL3.5m AHD. The minimum acceptable level on the Sports Park area (as defined in TSC's 'Subdivision Manual' DCP16, Table 4.33c) is no lower than 1.0m below the 100 years ARI flood level. The minimum acceptable level would therefore be approximately RL 2.5m AHD. Given that the existing surface level appears to be between RL 2.0 and 3.0m AHD, the earthworks required to achieve the desired finished level would be minimal. This complies with Council's policy that no more than 300mm of filling should be placed in areas where the depth velocity product is greater than 0.3m^2/sec.

As requested by Council Officers, a 50m buffer zone for the Sports Park has been provided adjacent to Cobaki Creek.

The style of Sports Park to be provided has been discussed with officers from TSC. Based on these discussions, it is proposed that flood compatible facilities would be constructed. Such facilities would include;

- a bicycle BMX track
- a skateboard park
- tennis courts
- basket ball courts and
- netball courts

together with appropriate club house facilities and car parking areas. Club house facilities would be constructed in an appropriate location (out of the main flow path) with a floor level at least 300mm above the 100 year ARI flood level.

Because there are some irregularities in Council's flood model and its output, and the digital terrain model grid is too coarse for detailed design or assessment of the proposed development's impacts, it is proposed that detailed flood modelling would be undertaken during the detailed design process at the Development Application stage for the Sports Park. Such modelling would examine the likely flood heights due to local storms having a range of durations in the Cobaki Creek catchment. The impact on these heights of elevated tail water levels resulting from regional floods would also be examined.

However, based on the information available at present, it is expected that the requirement that the proposed development should have no adverse impacts on flood levels or velocities upstream or downstream of the site can be achieved. The layout of the proposed Sports Park would be adjusted if necessary on the basis of these future results.

In summary, the provision of the Sports Park and facilities that accord with Tweed Shire Council's intentions appears achievable but will need to be checked against detailed modelling at the later Development Application stage.

1.4 Proposed development

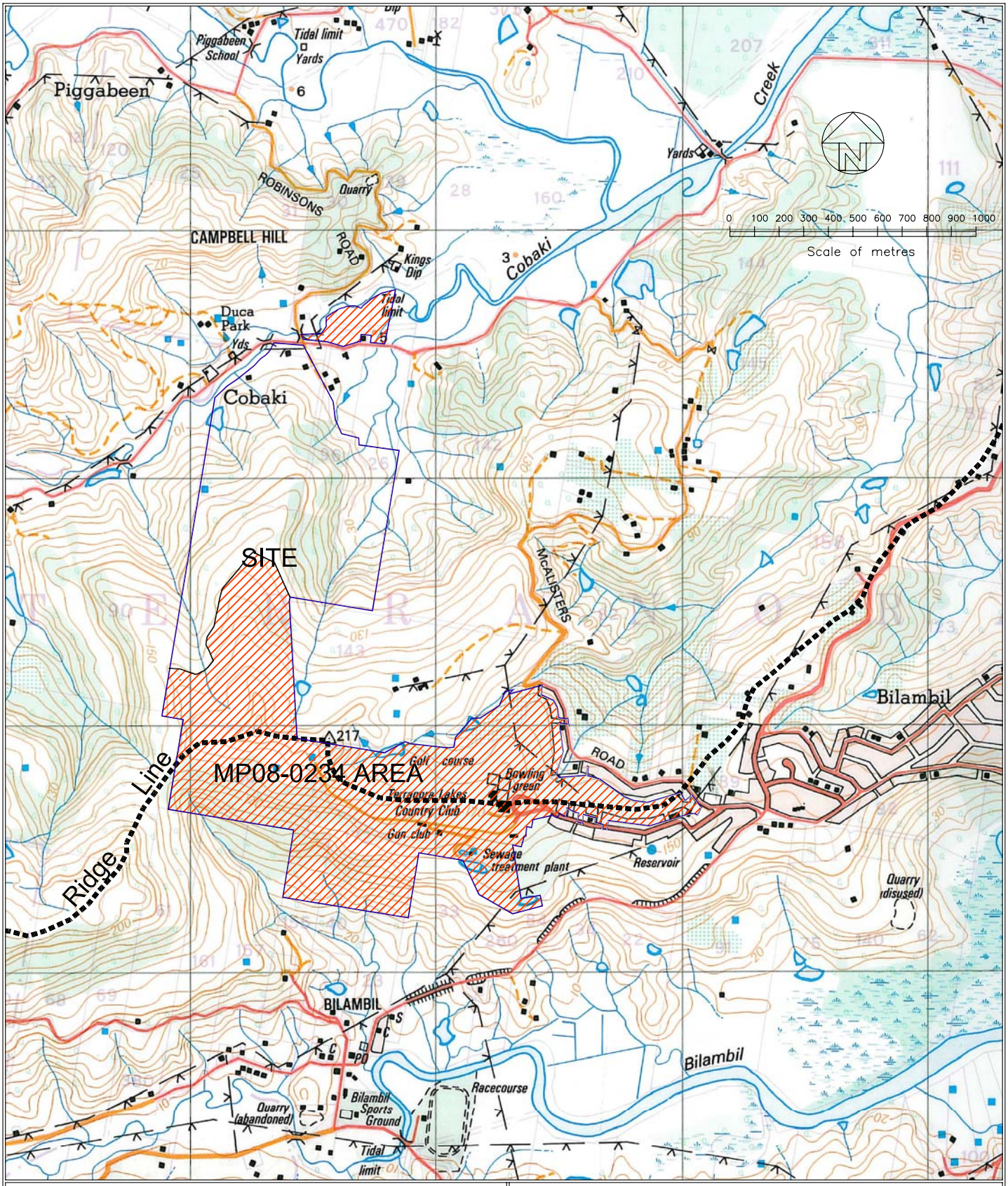
The proposed development, as shown in Drawing No. GJ0495.1.1, for the MP08-0234 application can be described as a large mixed-use precinct, comprising:

- 181 residential lots
- 70 hillside pole homes
- 160 resort apartments
- 36 penthouses
- 367 apartments
- 176 villas and townhouses
- 16 art shop houses
- 100 retirement cottages
- 486 retirement apartments
- 12 retirement villas
- 200 nursing beds
- health spa
- private school
- 4,647m² retail space
- 5,300m² commercial space
- extensive open space and recreational areas.

It is proposed that the development will be established using a Community Title Scheme (CTS) structure which will entail the creation of the Rise Community Body Corporate.

1.5 Project history

Gilbert & Sutherland have been an integral part of the project design team since its inception. This has allowed Gilbert & Sutherland to integrate the IWCM system into the design as the project has evolved.



GILBERT+SUTHERLAND
agriculture · water · environment

Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

SITE LOCATION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
		DATE 8/04/09	CHECKED	GJ0495.1.1

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Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

PROJECT
TERRANORA GROUP MANAGEMENT
RISE - MP08-0234
BILAMBIL HEIGHTS
EXISTING DEVELOPMENT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 27/03/09	CHECKED

DRAWING No. GJ0495.1.2

2) Integrated Water Cycle Management

2.1 IWCM Concept

Integrated Water Cycle Management (IWCM) can be described as a way of managing water in which all components of the water system (water supply, stormwater and wastewater) are integrated to optimise the use of the resource.

Sound IWCM means the community's water needs are met, whilst minimising environmental impacts and maximising the efficient use of this finite resource.

IWCM can involve the integration of a large number of concepts for re-use, reduction and recycling. These options may include (but are not limited to):

- demand management – use of water efficient appliances
- rainwater (roof runoff) collection and re-use (household or community scale)
- stormwater collection and reuse
- aquifer storage and recovery
- effluent recycling (sewer mining).

The optimum IWCM solution for any community will typically involve a combination of these options, based on existing infrastructure, local climate and site-based constraints. Economic and social factors may also contribute to the selection of appropriate IWCM options.

2.2 IWCM at RISE

A preliminary assessment of potential IWCM options for the RISE community was undertaken to identify individual components appropriate to the site. From these, an indicative IWCM strategy was developed for analysis and modelling. The selected IWCM strategy is described below.

Roof runoff will be collected from all buildings within the development and stored in community rainwater tanks located in each precinct. Rainwater from all precincts will be pumped to and treated at a central treatment plant, then held in a storage reservoir for distribution throughout the site.

Stormwater runoff collected in the wetlands within catchments 8, 9, 10, 12 and 13 will be used to supplement the rainwater supply. A maximum 500mm storage depth has been allowed for within each of the wetlands, and daily evaporation from the water surface within each wetland has been included in the water balance. Collected stormwater will also pass through the treatment plant prior to being held in the reservoir for distribution.

The secondary water supply (rainwater and treated stormwater) will be used by residents for toilet flushing, laundry and domestic outdoor uses and will also be made available for irrigation of public and private open space areas.

A reticulated (town water) supply will be provided to households and businesses for kitchen, laundry and bathroom uses.

In addition to meeting the requirements of BASIX, it is intended that all buildings within the development will be fitted with WELS Scheme rated water-efficient devices (including taps, showerheads, toilets, dishwashers and washing machines) to further reduce the demand on both the reticulated and secondary water supplies.

Stormwater quality treatment will be provided for the remainder of rainfall runoff (not captured and stored in the community rainwater tanks) by means of constructed wetlands within each catchment in accordance with Tweed Shire Council's 'deemed to comply' requirements. Existing dams on the site will be incorporated into these wetland areas, providing detention and treatment of runoff prior to it leaving the site.

Sizing of the water supply and storage devices has been carried out in accordance with the requirements of Council's 'Development Design Specification D11 Water Supply' Version 1.2, June 2004 and Water Services Association of Australia 'Water Supply Code of Australia' Version 2.3. Their performance has been assessed by means of water balance modelling which is described in Section 3 of this report. Stormwater quality treatment is discussed in Section 4.

2.2.1 Stormwater treatment and reuse

A water treatment plant would be installed on-site in a central location to treat collected stormwater to a standard acceptable to the NSW Department of Health prior to its reuse in homes for toilet flushing and laundry cold water. The capacity and type of treatment plant to be used would be the subject of further studies and assessment. Such details would be submitted to TSC as part of an application for a Development Approval. It is envisaged that the issues to be considered at the time of the plant selection and design would include:

- the water quality objectives to be achieved for the intended uses of the water (fit for purpose)
- the disinfection requirements applicable
- the treatment process to be used
- management and storage of any chemicals used in the process
- removal and disposal off-site of waste products and residues
- provision of a standby power source
- design and construction requirements of the plant housing structure to minimise visual impacts and noise.

It is intended that ownership, operation and maintenance of the plant will come under the control of the Community Title Scheme (CTS) body corporate.

3) Water balance modelling

3.1 Conceptual rainwater tank design

Community rainwater storage tanks will be installed to capture the roof runoff from all buildings within the development.

The location of the site makes it well-suited to the collection of rainfall. Orographic rainfall occurs when moisture-laden air is forced to rise when land barriers such as mountain ranges lie in the path of extensive moving air masses. The ideal conditions for this are when winds off a warm ocean meet a relatively continuous mountain range close to the coast, at right angles.[1]

The topography surrounding the proposed RISE development indicates that the site is likely to be subject to orographic rainfall, in addition to convective and frontal rainfall (which are less terrain specific). It is therefore expected that the local rainfall at the RISE site will be greater than that received in neighbouring low-lying coastal areas, providing potential for the collection of a larger volume of roof water than in some surrounding areas.

Considerable research has been carried out by P. J. Coombes and others into the cost effectiveness of tanks, possible tank configurations and potential water uses together with the impacts of various combinations of these on water supply and stormwater drainage infrastructure. Water Smart Practice Note 4, produced by the Lower Hunter and Central Coast Regional Environmental Management Strategy, provides a brief summary of this research. A copy of this document is included as Appendix 2.

It is intended that a dual supply system will be installed and that the secondary supply (treated rainwater and stormwater) will be used for flushing toilets, laundry and outdoor uses. These uses ensure that water would be drawn from the tanks on a daily basis, which in turn ensures that the tanks more frequently have some capacity to store rainfall runoff.

As all water collected in the tanks will pass through the on-site treatment plant prior to distribution throughout the development, a first flush diversion device or filtration unit is not considered necessary. Although the secondary supply is not intended to be used for potable purposes, the treatment plant should be designed to treat water to safe standard for primary contact and potentially for use as a potable supply in the future.

Water would be delivered back to the properties by a number of methods. For example electric pumps activated by line pressure drop could be used. For this development, it is envisaged that water would be pumped from the low level storage tanks, through the treatment plant and to a header tank, to be located on the top of the ridge in Precinct L from which it would gravitate to the individual properties. A booster pump would also be installed to supply those lots at a higher elevation than the reservoir. A standby power source would be provided to ensure continuous supply in the event of an interruption to the mains power supply. This is the preferred option as it would ensure that water would be available for toilet flushing during power failures.

It is recommended that the header tank have a minimum capacity of approximately one day's supply to allow for continuity of supply in the event of temporary failure/shutdown of the treatment plant.

Although this report only addresses the MP08-0234 section of the RISE development, the header tank has been sized to cater for the proposed future stages of the development as well.

It has been estimated by VKL Consulting engineers that the maximum daily demand for recycled water for the entire development would be approximately 2,944kL/day, hence it is recommended the header tank cater for 3ML of treated water, and the treatment plant have the capacity to treat 3ML/day.

[1] Bureau of Meteorology, 2007, Canberra ACT, viewed July 5, 2007, <http://www.bom.gov.au/info/ftweather/page_9.shtml>.

The header tank may be constructed in two stages to suit the staged development of the entire Rise development.

The roofwater tanks have been sized on a precinct by precinct basis, with separate tanks being provided for each major land use within the larger precincts. The natural topography requires some of the community tanks to be further divided to ensure gravity feeding from roof runoff. This in turn minimises energy consumption due to pumping requirements.

The development precincts are shown on Drawing No. GJ0495.1.3, with the areas contributing to each of the community tanks shown on Drawing No. GJ0495.1.4.

The rainwater storage tanks would be installed during the construction phase of the development in accordance with Council's policies and WSAA and the NSW Plumbing Code requirements.

Sections 3.2 and 3.3 of this report describe the sizing of community rainwater tanks for the development. The performance of these water tanks and potential reduction in reticulated water supply to the site (relative to a non-IWCM development scenario) are discussed in sections 3.4 to 3.6.

3.2 Roof areas

Roof areas for major buildings were estimated from their respective footprints indicated on the base plan for the site (Drawing No. GJ0495.1.3). For smaller residential buildings average individual roof areas were estimated as follows:

- houses (Residential A) = 250m^2
- hillside pole homes = 212m^2
- townhouses = 165m^2
- boulevard villas = 300m^2
- 2 storey and retirement villas = 165m^2
- retirement apartments = 55m^2
- retirement cottages = 160m^2.

3.3 Storage sizes

Estimates of rainwater storage tank sizes were made based on the following criteria:

- 5kL of storage is to be provided for each residential dwelling with its own roof area (including Residential A lots, pole homes, villas and townhouses)
- 3kL of storage is to be provided for each residential apartment
- 5L of storage is to be provided for every square metre of roof area for all other buildings in the development.

3.4 Water usage

This section details the estimated total water usage within the development excluding the irrigation of large public open space areas, which is discussed in Section 3.5. It takes into account the likely usage rates when the water demand reduction measures have been installed.

It should be noted that the stormwater harvesting system would not meet the peak demand design requirements, however it would make a significant contribution to the Integrated Water Cycle management system and enable considerable reductions in the demand for potable water from Council's mains.

Because the recycled water system would not be able to achieve 100% supply reliability, the reticulated potable water supply system would have to be designed to meet the entire demand rate for those times of prolonged drought when recycled water would not be available.

3.4.1 Indoor water use

Rates of indoor water usage were estimated based on the typical domestic-wastewater flow design allowances given in Appendix 4.2D of AS/NZS 1547:2000 and reprinted in Appendix 3 of this document.

Indoor water usage for the General Case (conventional water usage with no re-use or recycling measures in place), was estimated using the typical wastewater flow allowance for a reticulated community.[2] These calculations provided a basis for comparing the water savings resulting from the Integrated Water Cycle Management (IWCM) Case.

Indoor water usage for the IWCM Case was estimated using the average of the reticulated community and on-site tank supply flow allowances. The use of an average of the two water sources is based in the assumption that the rainwater will

[2] AS/NZS 1547:2000 Appendix 4.2D.

be complemented by a reticulated supply for some domestic uses and for extended periods of low rainfall.

The wastewater flow allowances used in the model are presented in Table 3.4.1.1.

Table 3.4.1.1 Wastewater flow allowances (based on AS/NZS 1547:2000)

Category	General (L/pp/day)	IWCM (L/pp/day)
Households	145	95
Staff (all occupations)	40	35
Hotel guests/ resident staff	180	160
Tavern – bar trade (bar customers)	25	22.5
Tavern – restaurant (diners)	30	25
Child care centre (children)	40	35
Training (students)	40	35
Community halls/clubs (patrons)	15	12.5
Shops/ Supermarket (customers)	15	12.5
Art house facilities (customers)	15	12.5
Swimming pool (patrons)	30	25
Tennis court (patrons)	15	12.5
Health spa (customers)	65	57.5

For residential uses an average population (in equivalent persons, EP) for each dwelling type was assumed in order to calculate the overall domestic usage within each precinct. These populations are shown in Table 3.4.1.2.

Table 3.4.1.2 Assumed populations per dwelling by type

Dwelling type	Average persons per dwelling
Dwelling houses / duplexes	
Res A	2.6
Hillside housing	2.6
Rural Residential Lots	2.6
Medium density dwellings	
3 storey boulevard villas	2.3
3 storey townhouses	2.3
2 storey townhouses	2.3
2 storey villas	2.3
Penthouses	1.95
Sub-penthouses	1.95
Apartments	1.95
Retirement dwellings / aged care	
Retirement villas	1.3
Retirement cottages	1.3
Retirement apartments	1.3
Nursing beds	0.85

Based on these assumptions, a total residential population of approximately 3,200EP would be catered for within the development.

3.4.2 Outdoor water use

Ex-house or outdoor water usage rates have been estimated at 30% of total water usage for both domestic dwellings and other built facilities.

3.4.3 Water sources

Although planning for the RISE community has aimed to maximise the use of the secondary (non-potable) water supply, a portion of the overall water use must be of drinking water quality and hence sourced from the reticulated supply.

For domestic/residential supply, it has been assumed that 100L/person/day of household water use (indoor and outdoor) may potentially be sourced from the secondary supply, with the remainder coming from the reticulated mains supply.

For retail, commercial or industrial supply, a conservative estimate of 30% of overall usage may potentially be sourced from the rainwater tank.

This allows for an estimate of the overall water savings due to the implementation of IWCM as well as an estimate of the reduction in reticulated water supply to the development.

3.5 Open space irrigation

In addition to general outdoor water use attributed to each dwelling or other built facility, watering of parks and open spaces would also take place throughout the development.

The areas of open space to be irrigated are discussed in Section 3.5.1. The modelled assumption was that irrigation of these areas would only be used to offset evapotranspiration. It has been assumed that daily top-up watering would be used

to supplement rainfall only on days when the daily rainfall is less than the evapotranspiration rate.

Further to this, for the IWCM Case, any irrigation water is intended only to be sourced from secondary supply (rainwater and treated stormwater). This assumes that in the case of extended dry periods when the rainwater tanks become empty, restrictions may be imposed on outdoor uses by the proposed Rise Body Corporate to maintain a reliable supply of the treated water for toilet flushing and laundry use.

3.5.1 Watered areas

In a previous report[3] regarding the subject site, irrigation areas most likely to create slope stability problems (in perceived order of priority) were characterised as follows:

- Steep slopes (nominally greater than 30% grade) over which effluent irrigation occurs.
- Gentle slopes (nominally less than 15% grade), subject to full area irrigation with adjacent steep slopes.
- Intermediate slopes (nominally between 15% and 30% grade) over which effluent irrigation occurs.
- Gentle slopes, subject to full area irrigation, with adjacent intermediate slopes; or gentle slopes, subject to partial area irrigation, with adjacent steep slopes.
- Gentle slopes subject to partial area irrigation, with adjacent intermediate slopes.

As the majority of the site is characterised by such steep slopes, it has been assumed that the primary area to be watered would be the Sports Park area in Precinct U on the northern-most fringe of the development. The area of this precinct (4.5ha) has therefore been adopted as the watered area for the tank balance modelling.

3.6 Climatic data

The performance of the tanks has been assessed using a model which calculates the amount of rainfall captured from the roof area, the amount of runoff and the amount of water to be drawn from the mains supply.

Average values were calculated using 30 years of daily time-step rainfall data for the period from 1961 to 1990. This information was obtained from the Bureau of Meteorology for its site at Tweed Heads, which is considered appropriate for this study in terms of proximity and relief.

An analysis of this 30 year dataset yielded an average annual rainfall of 1762mm.

An analysis of the daily time-step rainfall data set for Tweed Heads spanning the period from 1890 to 1994 provided the following annual rainfall data:

• Driest Year	693mm
• 10th percentile year	1,199mm
• Median year	1,672mm
• Average year	1,699mm
• 90th percentile year	2,236mm
• Wettest year	3,194mm

It should be noted that in the above analysis the results are statistical annual totals and may not necessarily refer to an actual historical year.

The 30 year model period is considered to be representative of current climatic conditions as the average annual rainfall for the period is 1,762mm, which compares with the long term average of 1,699mm.

The continuous model for the rainwater tank balance run from 1961 to 1990 would therefore be expected to yield conservative results. This is because the average rainfall of the dataset is higher than the long term average. Average monthly potential evapotranspiration values were sourced from Tweed Shire Council's Stormwater Quality Design Specification (D7) and used to calculate the average daily evapotranspiration rate, presented in Table 3.7.1, for input into the model.

[3] Woodward-Clyde, 1997, *Terranora resort project – assessment of geotechnical stability subject to effluent loading*.

Table 3.7.1 Evapotranspiration data

Month	Average Daily Evapotranspiration (mm)
January	5.32
February	4.82
March	4.35
April	3.33
May	2.26
June	2.00
July	1.94
August	2.42
September	3.50
October	4.35
November	5.00
December	5.32

3.7 Secondary supply performance

The performance of each rainwater tank has not been assessed individually. This is because water from all community tanks will be connected to the storage reservoir and be made available for use throughout the entire development.

The overall performance of the secondary water supply has been assessed in terms of reductions in:

- indoor/domestic water use
- outdoor water use
- reticulated water use
- total water use
- roof rainfall to runoff.

Table 3.7.1 shows the recommended capacity of each community rainwater tank within the development. Average tank depths of 2.5m have been assumed to give an indication of the land area each tank will occupy.

Table 3.7.1 Rainwater tank capacity

Tank	Precincts	Capacity (kL)
1	B2 (102 apartments)	306
2	B1, B2 (78 apartments) & B3	339
3	D2	200
4	D1	400
5	F	180
6	A4 to A10	682
7	A1, A12, A13 & A14	36
8	A2, A3 & A11	125
9	E1 & E3	150
10	E2	225
11	G1, G2, G3 & G4	716
12	H1 (20 lots)	100
13	H1 (14 lots) & L15	155
14	H2	10
15	J	180
16	L1 to L9	337
17	L10, L11 & L12	570
18	L13	150
19	L14	75
20	M1, M2 & M3	776
21	N1, N2 & N4	355
22	O1	135
23	N3, N5, N6, & N7	262
Storage Reservoir - Secondary Supply		3,000
TOTAL TANK VOLUME (kL)		**9,464**

Precincts C and K have been excluded as they represent land to be dedicated to Council for Reservoirs.

The locations of the community tanks and secondary supply storage reservoir are shown on Drawing No. GJ0495.1.5.

A summary of the estimated performance of the secondary water supply, based on the 30 year model period, is presented in Table 3.7.2.

Table 3.7.2 Secondary supply performance

Criteria	Annual average (ML)	(%)
Total Usage	172.2	
Rainwater (treated)	138.2	80.3%
Stormwater (treated)	26.2	15.2%
Imported (mains)	7.9	4.6%
Collectable rainwater	331.4	
Rainwater used	138.2	41.7
Rainwater to runoff	193.1	58.3

3.8 Summary of water usage

The performance of the secondary water supply for the development has been described in Section 3.7 above.
Table 3.8.1 summarises the estimated overall water balance for the precinct.

Table 3.8.1 Overall water balance for the subject development.

Criteria	Annual average (ML)	(%)
Usage		
Indoor	149.1	59.8%
Outdoor	58.9	23.6%
Irrigation	41.3	16.6%
Total	249.4	
Supply		
Reticulated mains	85.0	34.1%
Rainwater	138.2	55.4%
Stormwater	26.2	10.5%
Total	249.4	

Table 3.8.2 provides a summary of the reductions achieved by the IWCM Case when compared to the General Case described in Section 3.4.

The results presented in this section apply to only the MP08-0234 sectionof the RISE development, however the infrastructure has been sized for the entire proposed development. Estimated supply reliability for the entire development is presented in Appendix 4.

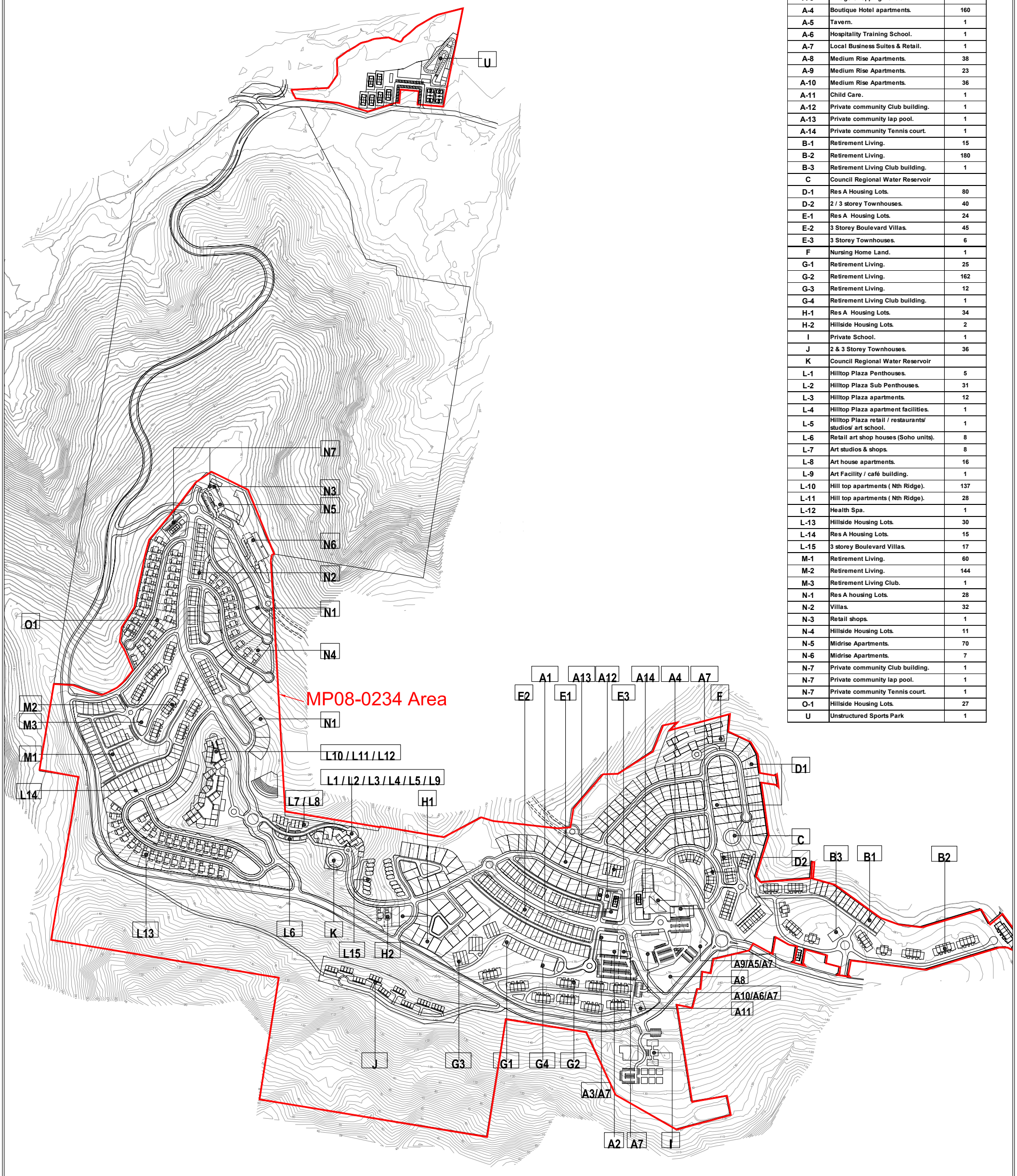
3.9 Community Title Scheme (CTS)

It is intended that RISE is created using a Community Title Scheme (CTS). All residences, buildings, parks, open space and the IWCM system will come under the control of the CTS body corporate.

As such the body corporate will be able to monitor, manage and control the total private water supply system in perpetuity.

Table 3.8.2 General Case versus IWCM

Criteria	General Case (ML/year)	IWCM Case (ML/year)	Reduction (%)
Usage			
Indoor	212.8	149.1	29.9%
Outdoor	85.5	58.9	31.1%
Irrigation	45.1	41.3	8.3%
Total	343.4	249.4	27.4%
Water from reticulated supply	343.4	85.0	75.2%



Precinct.	Product.	Number.
A-1	Community Hall.	1
A-2	Village supermarket.	1
A-3	Village Shopping Centre.	1
A-4	Boutique Hotel apartments.	160
A-5	Tavern.	1
A-6	Hospitality Training School.	1
A-7	Local Business Suites & Retail.	1
A-8	Medium Rise Apartments.	38
A-9	Medium Rise Apartments.	23
A-10	Medium Rise Apartments.	36
A-11	Child Care.	1
A-12	Private community Club building.	1
A-13	Private community lap pool.	1
A-14	Private community Tennis court.	1
B-1	Retirement Living.	15
B-2	Retirement Living.	180
B-3	Retirement Living Club building.	1
C	Council Regional Water Reservoir	
D-1	Res A Housing Lots.	80
D-2	2 / 3 storey Townhouses.	40
E-1	Res A Housing Lots.	24
E-2	3 Storey Boulevard Villas.	45
E-3	3 Storey Townhouses.	6
F	Nursing Home Land.	1
G-1	Retirement Living.	25
G-2	Retirement Living.	162
G-3	Retirement Living.	12
G-4	Retirement Living Club building.	1
H-1	Res A Housing Lots.	34
H-2	Hillside Housing Lots.	2
I	Private School.	1
J	2 & 3 Storey Townhouses.	36
K	Council Regional Water Reservoir	
L-1	Hilltop Plaza Penthouses.	5
L-2	Hilltop Plaza Sub Penthouses.	31
L-3	Hilltop Plaza apartments.	12
L-4	Hilltop Plaza apartment facilities.	1
L-5	Hilltop Plaza retail / restaurants/ studios/ art school.	1
L-6	Retail art shop houses (Soho units).	8
L-7	Art studios & shops.	8
L-8	Art house apartments.	16
L-9	Art Facility / café building.	1
L-10	Hill top apartments (Nth Ridge).	137
L-11	Hill top apartments (Nth Ridge).	28
L-12	Health Spa.	1
L-13	Hillside Housing Lots.	30
L-14	Res A Housing Lots.	15
L-15	3 storey Boulevard Villas.	17
M-1	Retirement Living.	60
M-2	Retirement Living.	144
M-3	Retirement Living Club.	1
N-1	Res A housing Lots.	28
N-2	Villas.	32
N-3	Retail shops.	1
N-4	Hillside Housing Lots.	11
N-5	Midrise Apartments.	70
N-6	Midrise Apartments.	7
N-7	Private community Club building.	1
N-7	Private community lap pool.	1
N-7	Private community Tennis court.	1
O-1	Hillside Housing Lots.	27
U	Unstructured Sports Park	1

GILBERT+SUTHERLAND
agriculture · water · environment

Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

PROJECT

TERRANORA GROUP MANAGEMENT

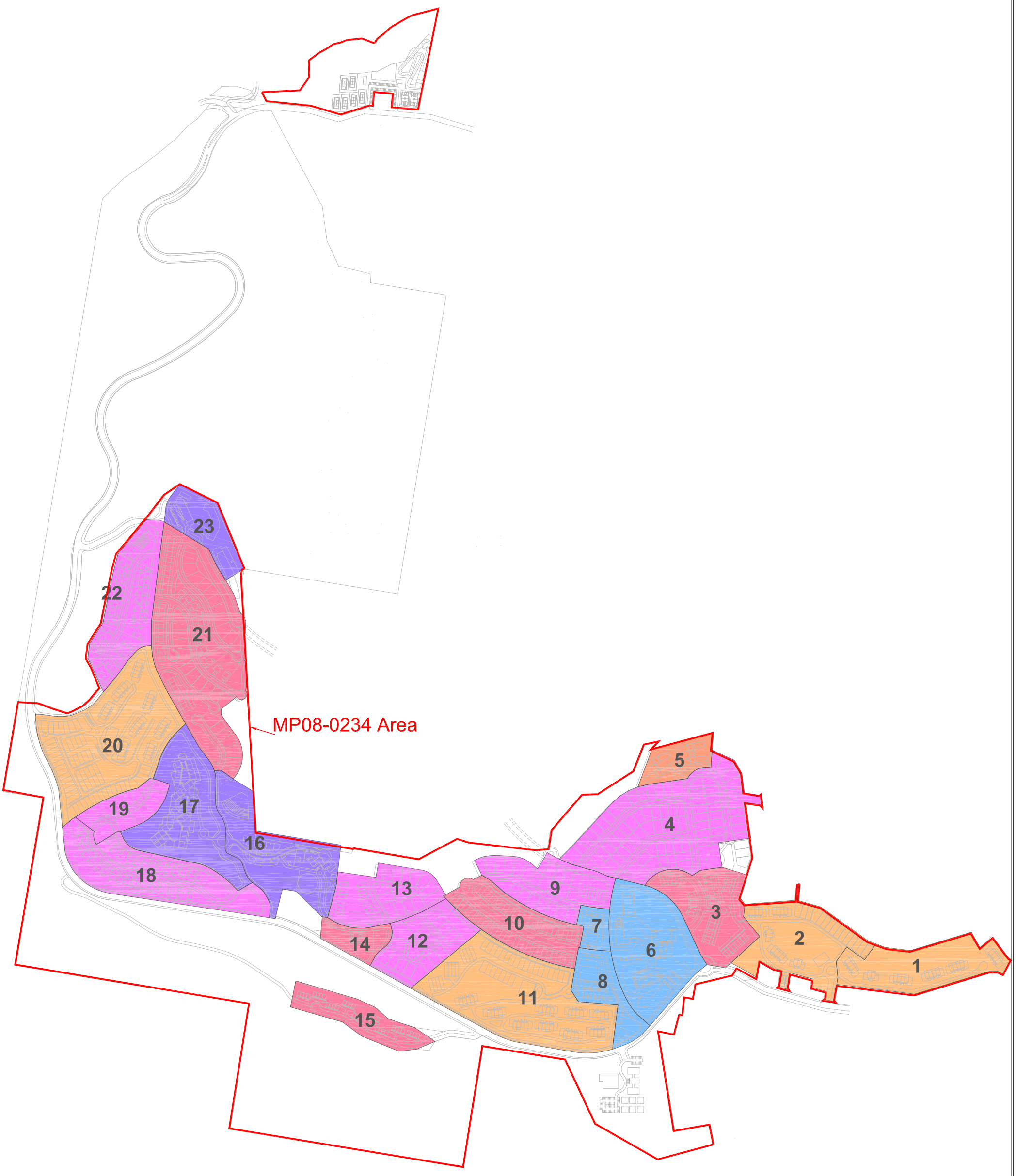
RISE - MP08-0234

BILAMBIL HEIGHTS

PROPOSED DEVELOPMENT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 27/03/09	CHECKED

DRAWING No. GJ0495.1.3



Notes
1. Catchment numbering sequence is not indicative of stage or precinct construction sequence.
2. Catchment boundaries are subject to approvals and detailed design.

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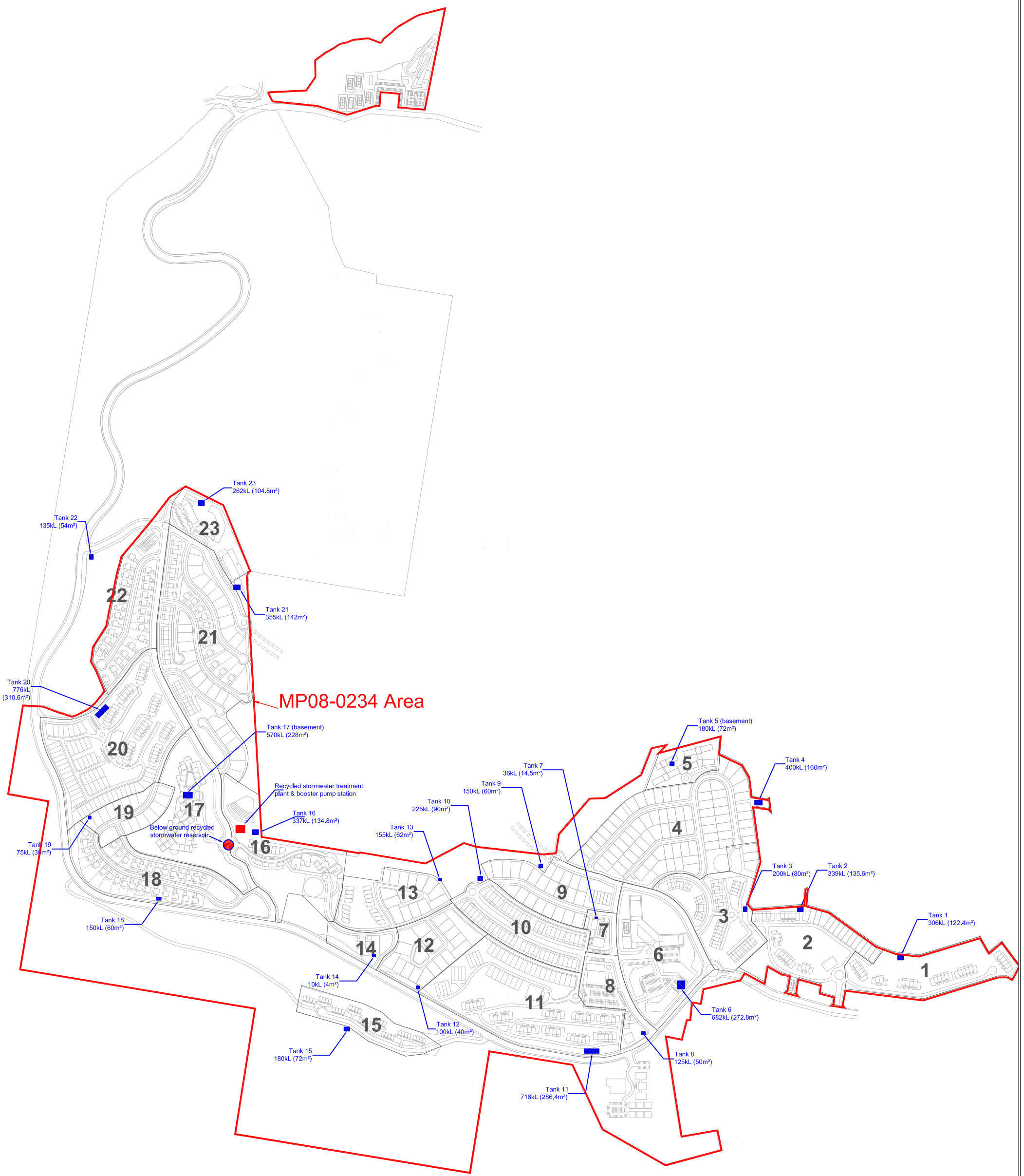
Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT
TERRANORA GROUP MANAGEMENT
RISE - MP08-0234
BILAMBIL HEIGHTS
RAINWATER TANK CATCHMENTS

SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
DATE 06/04/09	CHECKED	GJ0495.1.4



Notes
1. Catchment numbering sequence is not indicative of stage or precinct construction sequence.
2. Catchment boundaries and tank volumes are subject to approvals and detailed design.
3. Tank locations are indicative only.

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Eastside
5/232 Robina Town Centre Drive, Robina, Qld. 4226
Phone 55789944 Mobile 0418 760919 Fax 55789945

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

COMMUNITY RAINWATER TANK DETAILS

SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
DATE 04/04/09	CHECKED	GJ0495.1.5

4) Stormwater quality treatment

4.1 Proposed development

The physical characteristics of the site have been described in Section 1 of this report.

The proposed development comprises the construction and/or installation of the following components:

- site earthworks and house pad benching
- roads
- water reticulation mains (dual reticulation system)
- underground electricity distribution cables
- telecommunication cables
- other ancillary services
- residential and commercial buildings
- landscaping.

It is anticipated that the site will be developed in stages, with the construction works for each phase comprising:

- complete earthworks and benching
- topsoil and grass areas that will not be built on within one month
- stabilise all cut-and-fill batters
- construction of roads, drainage and other services
- progressively complete landscaping as buildings are completed.

When the development has been completed, the majority of the site will be covered by some form of improvement protecting the soils from erosion, hence minimising the transport of suspended solids from the site. These improvements will include structures, paved areas and extensive landscaping.

4.2 Receiving environment

The site straddles a ridge that acts as the divide between the Cobaki Creek and Bilambil Creek catchments. The portion of the site that lies to the north of the ridge falls in a northerly direction towards Cobaki Creek, which discharges into the Cobaki Broadwater. The southern portion of the site falls towards Bilambil Creek which discharges into the Terranora Broadwater. The Cobaki Broadwater and the Terranora Broadwater are connected and both discharge into the Tweed River at Tweed Heads via the Terranora Inlet.

Runoff from approximately 70% (132ha) of the site flows into Cobaki Creek near or above the limit of the tidal influence. Runoff from the balance of the site flows into Bilambil Creek in the upper reaches of the tidal zone.

For the purposes of this report the receiving waters are Cobaki Creek and Bilambil Creek. The environmental values for these waters have been described in Council's undated *Tweed Urban Stormwater Quality Management Plan* as;

- aquatic ecosystem protection
- direct potable water
- primary body contact recreation (swimming & action sports)
- secondary body contact recreation (boating)
- agricultural irrigation water supply
- livestock drinking water
- homestead water supply (non potable).

Care should therefore be taken to ensure that the proposed development does not have an adverse impact on the receiving waters or their environmental values.

4.3 Stormwater quality treatment

Stormwater quality treatment for the development will be provided in accordance with the 'deemed to comply' requirements for subdivisions as outlined in Tweed Shire Council's *Development Design Specification, D7 – Stormwater Quality*.

For large catchments (>5ha) constructed wetlands, sized according to the guidelines, have been provided. Runoff from smaller catchments would be directed through a gross pollutant trap (GPT) prior to discharge. Litter baskets would be provided in the gully pits on major roads to provide at source treatment of road runoff.

In addition to satisfying the minimum deemed to comply requirements, additional water quality treatment will be provided through the use of grassed swales and vegetated buffer zones, where the slope is less than 5%.

Descriptions of how each of the proposed treatment measures will function are

provided in Section 4.4, with details on the sizing of the constructed wetlands being provided in Section 4.5.

4.4 Stormwater treatment devices

This section provides a description of each type of stormwater treatment device to be incorporated into the development.

4.4.1 Constructed wetlands

Constructed wetlands store runoff and gradually release it between storm events. They generally incorporate a controlled discharge at the outlet. It is envisaged that the existing dams would be modified to operate as constructed wetlands.

New wetlands would also be constructed to serve catchments where there are no existing dams.

The constructed wetland would include both open water and macrophyte zones.

The open water zones generally provide water quality improvement by allowing suspended sediment within the water to settle, thus reducing turbidity.

Nutrients and heavy metals, which bind to the sediment particles, may also be removed in this process. These zones also provide flow attenuation and energy dissipation in order to protect downstream areas from scouring.

Generally, the depth of the open water zone should be no greater than 1.5m in order to maximise sediment accumulation and reduce maintenance frequency whilst limiting stratification and emergent plant growth.

Batter slopes of the open water zone should be shallow enough to allow maintenance machinery sufficient reach to remove sediment when required, but steep enough to reduce land consumption. A typical range would be 1V:6H to 1V:8H depending on site constraints.

The macrophyte zone of a wetland would generally consist of emergent water plants in shallow water. These areas are capable of removing organic material, suspended solids, nitrogen, phosphorus, heavy metals and pathogens.

The depth of the macrophyte zone would not exceed 0.6m during normal operating conditions and would generally range from 0.1m to the specified maximum depth. The batters of the macrophyte zones would have gentle slopes ranging from 1V:6H to 1V:8H.

4.4.2 Gross pollutant traps (GPT)

A GPT will be installed in the drainage system for each small catchment prior to discharge into the surrounding environment. Care should be taken to ensure that the GPT is located such that access for inspection and maintenance is readily available.

The GPT may be a proprietary make or purposefully designed and built in accordance with Council's development guidelines to suit the particular conditions. Each GPT will be sized based on the Q3month design flow, with a high-flow bypass being provided for less frequent events.

It should be noted that it has been assumed that the GPT would be required to treat runoff from the developed portions of the catchment only and that relatively 'clean' runoff from undisturbed areas would bypass the GPT.

4.4.3 Litter baskets

Also known as gully pit inserts, these devices are a form of Gross Pollutant Trap. A litter basket is an at source collection unit, which can be fitted to an existing or new stormwater gully pit.

Essentially these comprise a fabric filter bag fitted to a plastic or metal frame mounted inside the gully pit. They can be designed to be removed by hand or by a truck fitted with a small hoist. Alternatively they can be cleaned with a vacuum truck.

The size of the openings in the filter bag can be adjusted (by selection of appropriate filter material) to suit the particular location and anticipated pollutants. These units have high flow bypass mechanisms to enable the gully pits to continue operating in the event of higher flows than the filter bag's capacity or when the filter bag is full of captured material. This device should not increase ponding at the gully pits.

It is envisaged that the main road, other connecting roads between precincts and major carparks for retail, commercial or community facilities would be constructed with concrete kerb and channel. In this highly trafficked area, litter, hydrocarbons and sediment are potential problems.

It has been assumed that litter baskets would be installed in all gully pits in these areas.

4.4.4 Vegetated buffers and swales

Also known as buffer zones and grassed areas, vegetated buffers are used to treat shallow overland flow.

Swales are shallow grass-lined channels. Swales are sometimes used as an alternative to kerb and channel. These devices operate in a similar manner, removing pollutants by binding them to soil particles, settling, filtration and infiltration. They also act to reduce and attenuate storm runoff.

The vegetated buffers and swales would be provided by the existing vegetation where possible. Where necessary, the vegetation may be improved by additional plantings or rehabilitation.

Drainage outlets to the vegetated buffers and swales would be designed to minimise scour (by the use of energy dissipaters if required) and to distribute flows across a broad area to achieve shallow sheet flow conditions.

4.5 Constructed wetland sizing

The catchment boundaries within the development are shown in Drawing No. GJ0495.1.6.

Wetlands have been sized according to Council's *Development Design Specification D7, Stormwater Quality*, dated June 2004, with a base area of 500m² of wetland per hectare of urban/developed area. Of this area, 250m²/ha must be a deep water zone and the other 250m²/ha is prescribed as a macrophyte zone.

Urban and open space areas within each catchment are provided in Table 4.5.1 and are shown on Drawing No GJ0495.1.7.

Table 4.5.1 Catchment areas

Catchment	Open space (ha)	Urban area (ha)	Total area (ha)
1	0.000	0.668	0.668
2	0.000	0.366	0.366
3	0.000	2.739	2.739
4	0.000	0.487	0.487
5	0.000	4.316	4.316
6	0.079	4.812	4.891
7	1.103	3.740	4.843
8	1.588	7.976	9.564
9	6.802	12.805	19.607
10	1.966	2.544	4.510
11	2.790	1.246	4.036
12	2.966	5.803	8.769
13	2.755	8.038	10.793
14	28.449	9.591	38.040
15	16.024	5.460	21.484
16	14.366	1.588	15.954
17	4.358	0.000	4.358
Bal	33.709	0	33.709
TOTAL	116.955	72.179	189.134

Area reductions have been provided for:

- each 1% of residential lots in a catchment with roofwater directed into eligible rainwater tank systems (reduce by 0.5%)
- each 1% of sites (by area) where there is no more than 10m² of impervious paving (for footpaths) and porous paving is exclusively used for driveways, other paths and hardstand areas (reduce by 0.1%).

As rainwater tanks have been provided for all buildings within the development, the maximum area reduction, totalling 50% has been achieved.

It has been assumed that 50% of sites (by area) will be able to achieve the objective for pervious paving, hence an additional reduction totalling 5% of the total wetland area has been applied.

The existing dams on the site have been incorporated into the wetland areas, in some catchments providing greater than the minimum required wetland area.

The adjusted wetland areas required for the development are shown in Table 4.5.2.

Table 4.5.2 Wetland areas required

Catchment	Deep Water Zone (m^2)	Macrophyte Zone (m^2)	Adjusted Area of Wetland Zone (m^2)
8	897	897	1,795
9	1,441	1,441	2,881
10*	(312)	(312)	(623)
12	653	653	1,306
13	904	904	1,809
14	1,079	1,079	2,158
15	614	614	1,229
16	159	159	357
TOTAL	7,290	7,290	14,580

* Catchment 10 is <5ha, therefore not requiring a wetland, as a wetland area will be provided in the location of the existing dam is has been sized accordingly

Drawing No GJ0495.1.8 shows the locations and sizes of the wetlands to be provided for the development. Minimum deepwater and macrophyte zone areas are indicated.

The locations of all proposed wetlands would be subject to detailed geotechnical assessment during the design and documentation process for the future Development Applications to TSC. The base of each wetland would be lined/sealed to prevent geotechnical instability (if necessary).

4.6 Bioretention Swale

Because the areas surrounding Precint J (Catchment 11) have been identified as a lowland rainforest Endangered Ecological Community (EEC), it is recommended that a bioretention swale be installed to provide adequate water quality treatment. Conceptual details are shown on Drawing No. GJ0495.1.9. It should be noted that a clean water diversion (in the form of catch drains and pipe drains) should be provided upstream of the proposed development. Provision should be made to retain the existing hydrologic regime by providing a number of outlets with flow spreaders as shown.

Provision would also be made to manage flows from the proposed development in Precinct J by installing rainwater storage tanks. In addition, on-site detention and retention would be included in the design of the bioretention swale by means of surface storage and infiltration through the base of the bioretention trench under the swale respectively.

The bioretention swale has been sized in accordance with TSC's MUSIC modelling guidelines in Design Specification D7, to provide equivalent treatment to a deemed to comply constructed wetland.

4.7 Treatment summary

Table 4.6.1 shows a summary of the required and provided water quality treatment measures for the entire development.

Table 4.6.1 Water quality treatment summary

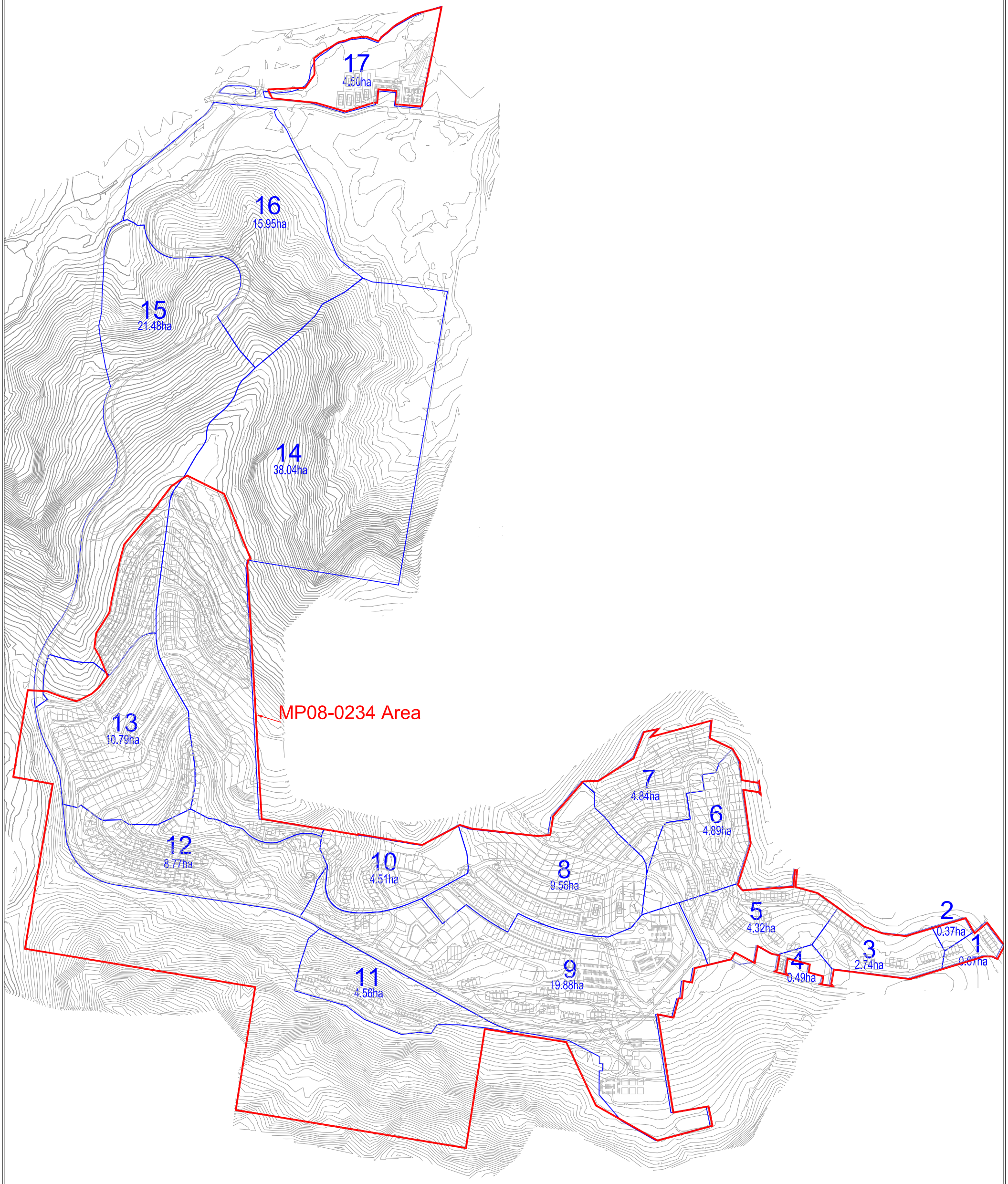
Catchment	Urban area (ha)	Treatment required	Treatment provided
1	0.668	GPT	GPT
2	0.366	GPT	GPT
3	2.739	GPT	GPT
4	0.487	GPT	GPT
5	4.316	GPT	GPT
6	4.812	GPT	GPT
7	3.740	GPT	GPT
8	7.976	Wetland 1795m²	Wetland 2,400m²
9	12.805	Wetland 2,881m²	Wetland 2,881m²
10	2.544	GPT	Wetland 3,050m²
11	1.246	GPT	Bio-swale
12	5.803	Wetland 1,306m²	Wetland 1,306m²
13	8.038	Wetland 1,809m²	Wetland 1,809m²
14*	9.591	Wetland 2,158m²	Wetland 2,158m²
15*	5.460	Wetland 1,229m²	Wetland 2,925m²
16*	1.588	Wetland 357m²	Wetland 357m²
TOTAL	72.179	Wetland 11,535m²	Wetland 16,886m²

* Catchments 14, 15 and 16 also receive runoff from areas proposed for future development (Stage 2) which may require further treatment in the future. The wetland on Catchment 15 is in the location of an existing waterbody and is oversized for treatment purposes, most likely catering fully for any future development within the catchment. The wetlands in catchments 13 and 15 are likely to need to be extended in the future and should be designed (at the detailed design stage) with this consideration.

Table 4.6.1 indicates the development will satisfy the TSC 'deemed to comply' guidelines for water quality treatment provided the recommended water quality treatment measures are implemented.

If the development were to be treated as a whole (rather than divided into separate catchment areas), the wetland area required to treat the urban portion of the development (72.179ha) would be 16,240m^2 once all area reductions are applied (which is also achieved by the above design).

It should be noted that the final choice of management measures used, their location and size will be subject to detailed survey and design. These details would be submitted to TSC with applications for approval to operational works.



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

STORMWATER CATCHMENT BOUNDARIES

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 04/04/09	CHECKED

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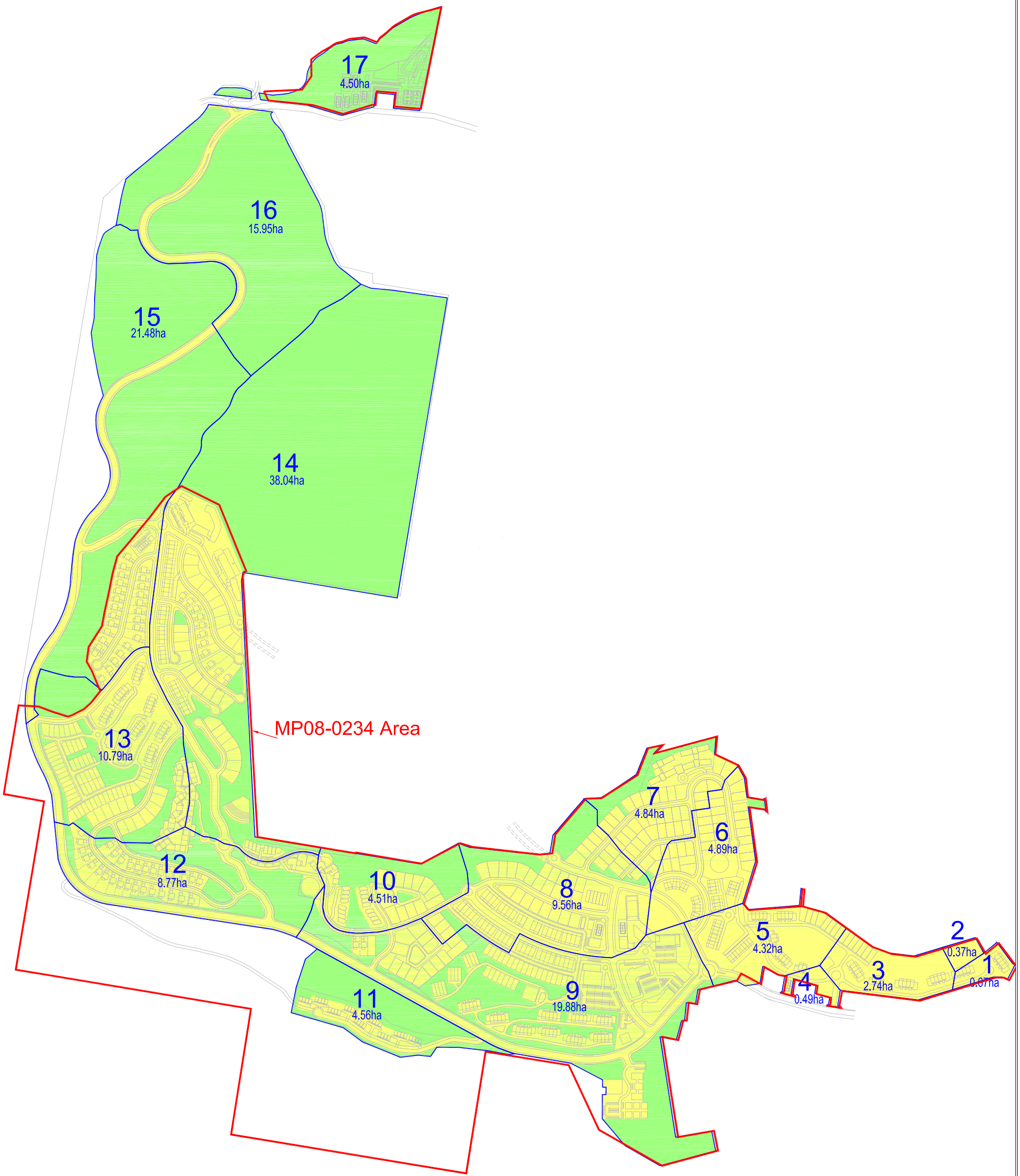

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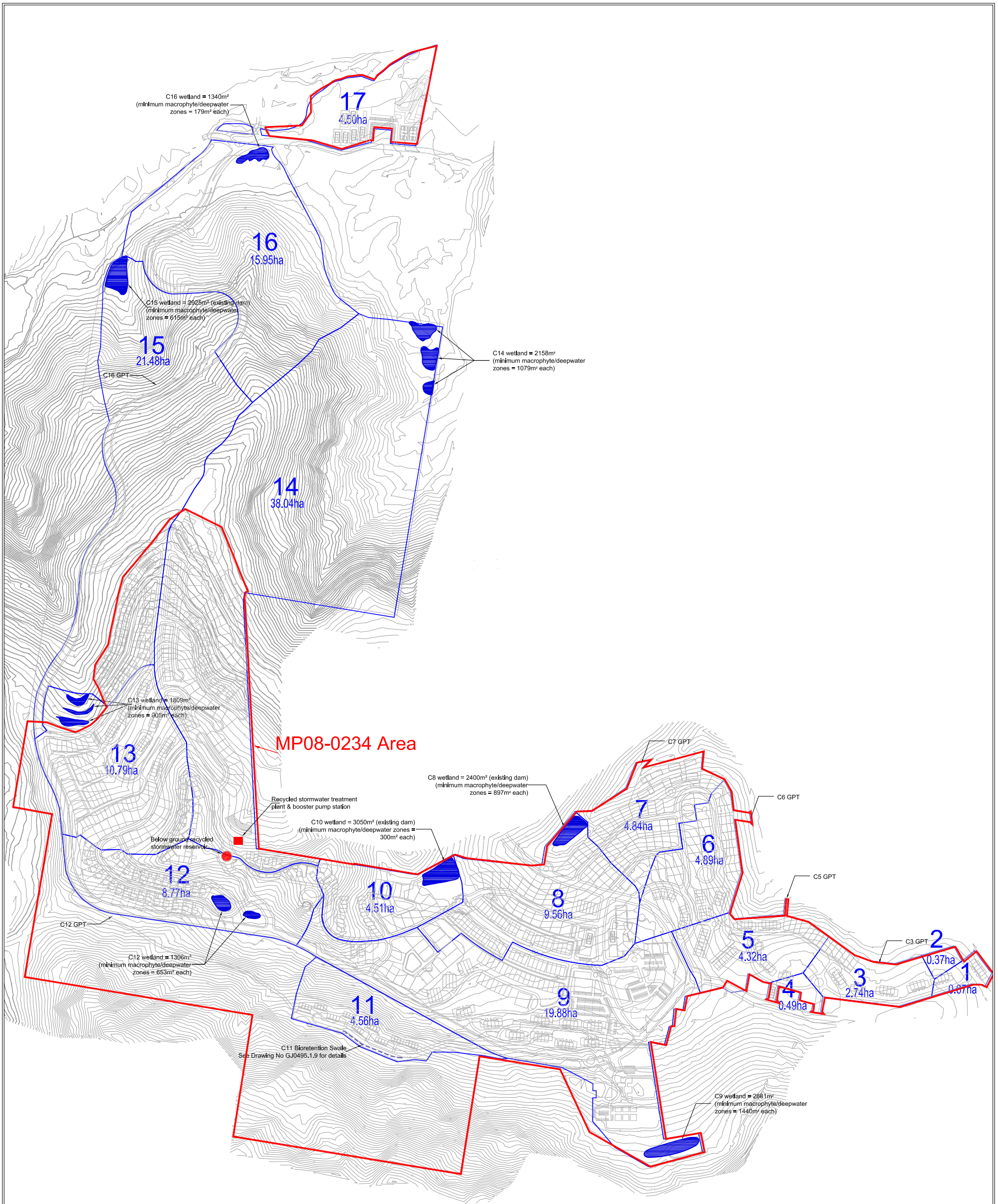
BILAMBIL HEIGHTS

DEVELOPED AND OPEN SPACE AREAS

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
		DATE 04/04/09	CHECKED	GJ0495.1.7



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

STORMWATER MANAGEMENT DEVICES

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 04/04/09	CHECKED

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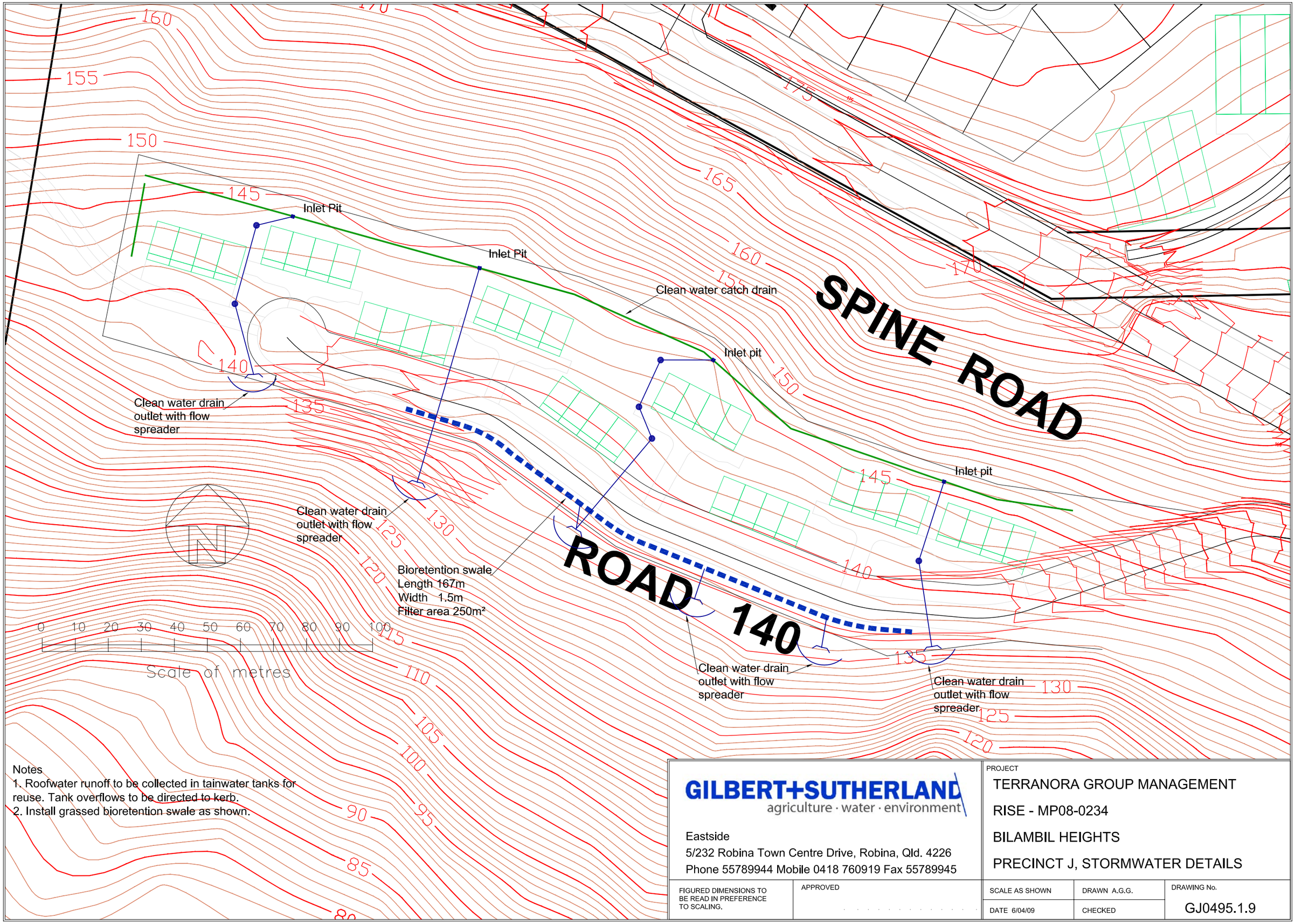

Notes
1. Roofwater runoff to be collected in tainwater tanks for reuse. Tank overflows to be directed to kerb.
2. Install grassed bioretention swale as shown.

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TERRANORA GROUP MANAGEMENT
RISE - MP08-0234
BILAMBIL HEIGHTS
PRECINCT J, STORMWATER DETAILS

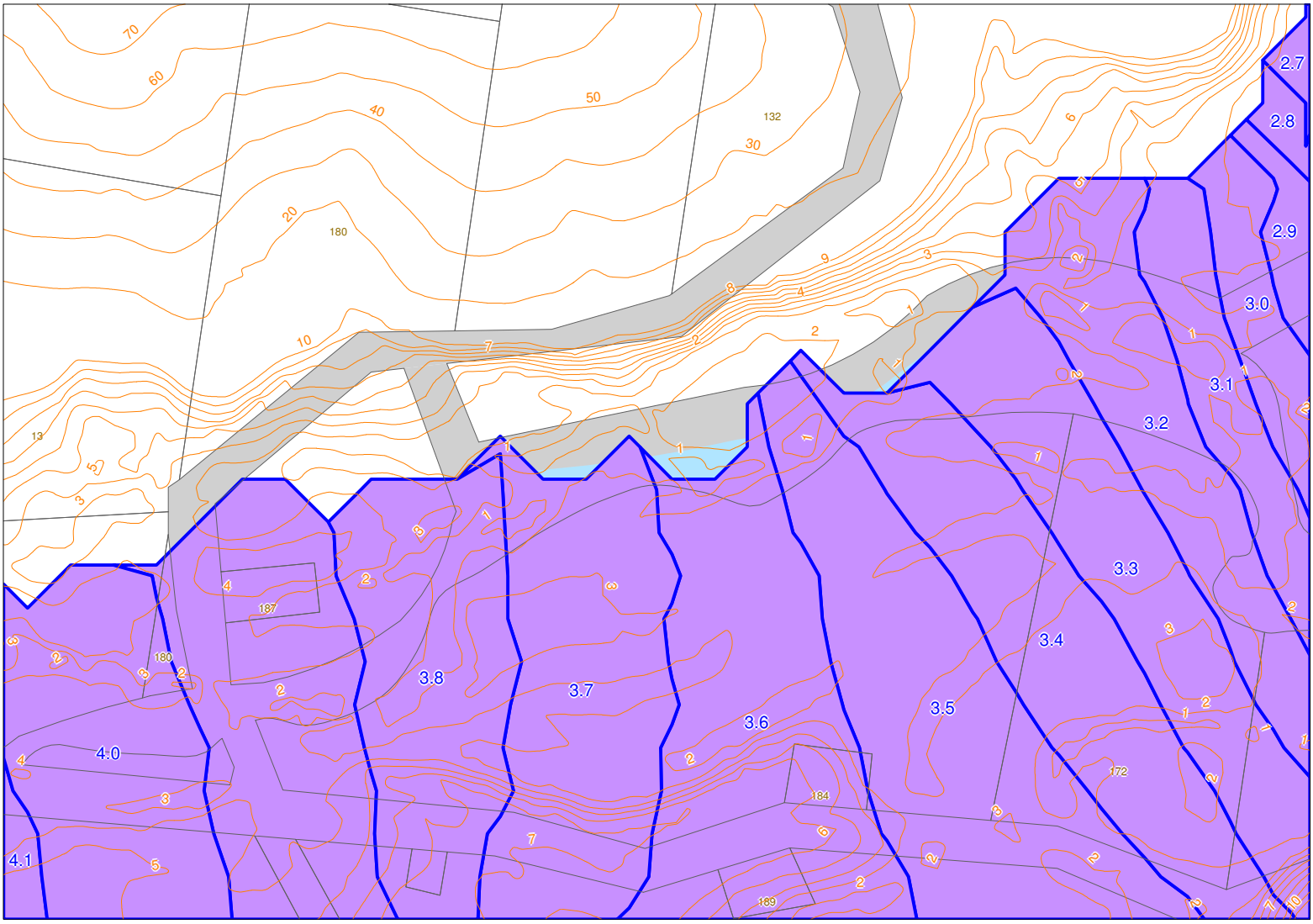
FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.G.G.	DRAWING No.
		DATE 6/04/09	CHECKED	GJ0495.1.9

5) Appendices

5.1 Appendix 1

5.1.1 Tweed Shire Council Flood Model Data

Enlighten Map



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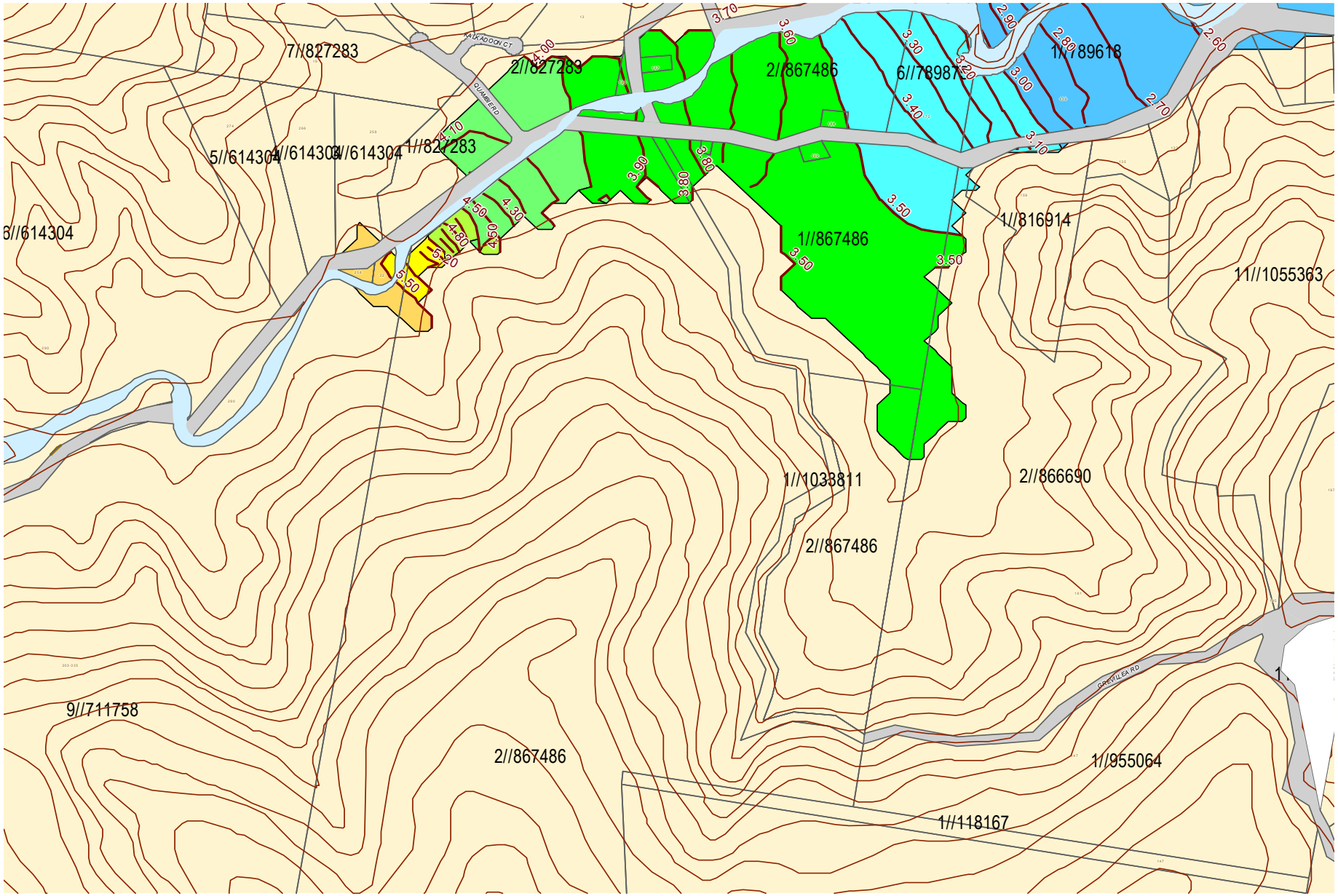
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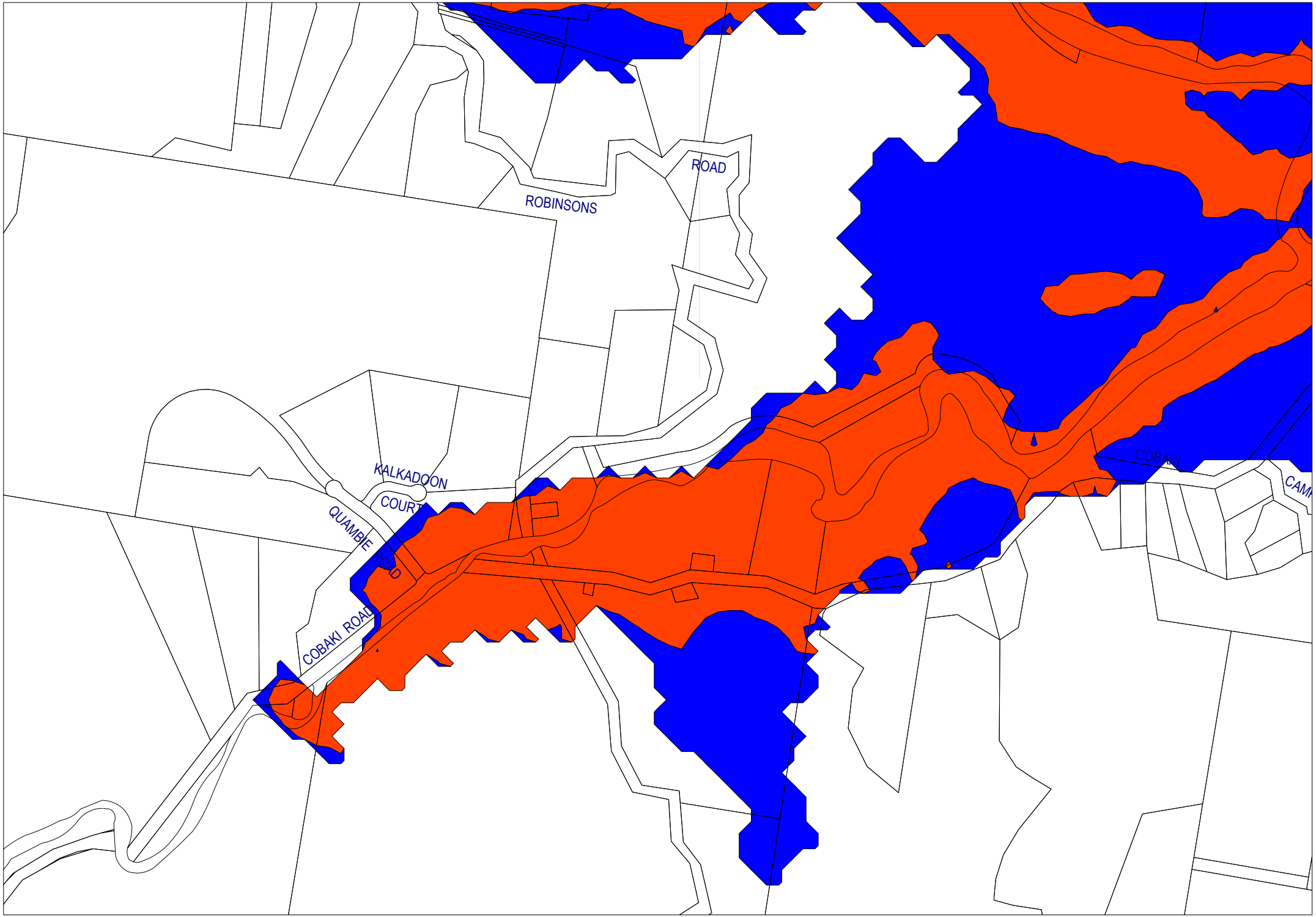
ROAD
ROBINSONS
KALKADOON
COURT
QUAMBIE
ROAD
COBAKI ROAD
COBAKI

5.2 Appendix 2

5.2.1 Watersmart practice note No.4

water SMART

PRACTICE NOTE 4

Rainwater tanks

WaterSmart development involves simple design and management practices that take advantage of natural site features and minimise impacts on the water cycle. It is part of the contemporary trend towards more 'sustainable' solutions that protect the environment and cost less.

This **WaterSmart Practice Note** explains how to design and configure domestic rainwater tanks.

- **Gravity & pressure systems**
- **Dual supply systems**
- **How to configure tanks**

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Rainwater tanks

Introduction

This Practice Note describes how to design and configure various types of domestic rainwater tank systems, including gravity systems, pressure systems and dual supply systems. There is currently an enormous resurgence of interest in using rainwater tanks due to their many economic and environmental benefits.

In urban areas, domestic water supply is typically met by importing large volumes of treated water from neighbouring catchments, often at considerable cost. At the same time, similar volumes of roofwater are discarded unused via stormwater drainage systems that have significant erosion, sedimentation and flooding impacts.

Whilst all mains water is treated to drinking water standards, as little as 1% of domestic water consumption is actually used for drinking. Hot water, toilet flushing, laundry and outdoor uses represent the bulk of domestic water consumption (about 90%), but these uses do not require water to be treated to such a high standard. Such uses can be satisfactorily supplied using rainwater collected from roofs and stored in tanks. Benefits include significant water supply cost savings and substantial reductions in stormwater discharges.

It is often mistakenly assumed that using rainwater solely for outdoor uses (such as garden watering) will produce substantial mains water savings. Mismatches between seasonal rainfall and outdoor water use patterns can result in poor utilisation of rainwater, resulting in long periods during which tanks are either empty or full. This problem can be remedied by using rainwater to supply interior uses such as toilet flushing. Not only does this ensure that stored rainwater is utilised at a relatively constant rate, but it allows rainwater to refill the storage more often. Using rainwater for various uses (such as toilet flushing and garden watering), each with different usage patterns, can result in optimum mains water savings and large reductions in stormwater discharges.

System overview

A rainwater harvesting system consists of the following key elements (see Figure 1):

- house roof
- roof gutters
- first flush device
- rainwater tank
- pump
- overflow to garden areas, infiltration trenches and street drainage system.

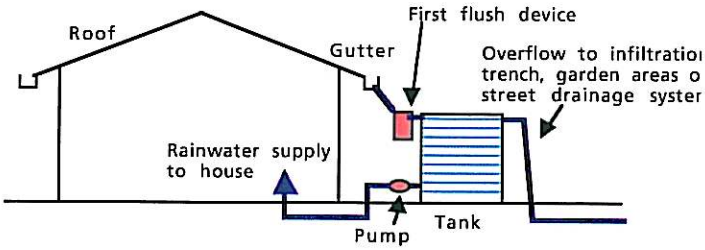

Fig 1: Key elements of a domestic rainwater system

Depending on site conditions, user requirements and budget, rainwater tank systems can be installed using a variety different configurations, including:

- installing tanks above- or below-ground
- using gravity or pressure systems
- using dual supply systems
- including a detention volume inside the tank for additional stormwater management.

Gravity systems

Gravity systems involve placing the tank on a stand (see Figure 2). Such systems are widely used in rural areas for household supply, and are also increasingly being installed in urban areas for supplying water for drinking and garden watering purposes.

Rainwater tanks

In gravity systems, rainwater is collected from the roof and directed to the tank via a first flush device. All connections to outdoor and household fixtures depend on gravity alone. Water pressure at each fixture is governed by the difference in height between the tank and the fixture.

To achieve a water pressure similar to that of normal mains water, the tank needs to be positioned 20 metres vertically above fixtures. This is generally not practicable. However, many household water uses such as toilets, laundry tubs and garden hoses do not require such high water pressures. Gravity systems are often quite adequate for these purposes.

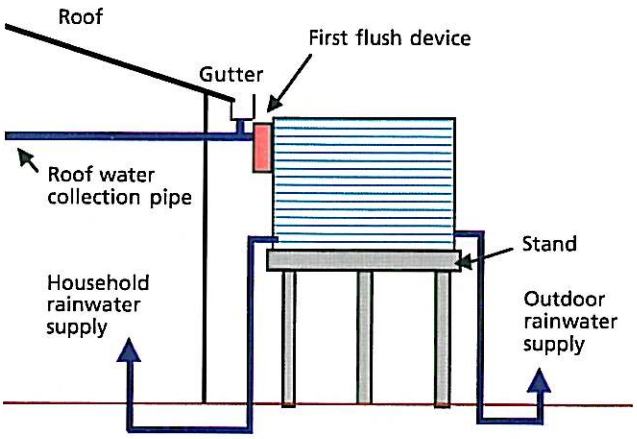

Fig 2: Configuration for a gravity system

Pressure systems

A pressure system involves using a pump to deliver rainwater to household or garden fixtures. Pressure systems are required where the tank cannot be installed at a sufficient height to provide acceptable pressure (see Figure 1), or if the tank is installed underground (see Figure 3).

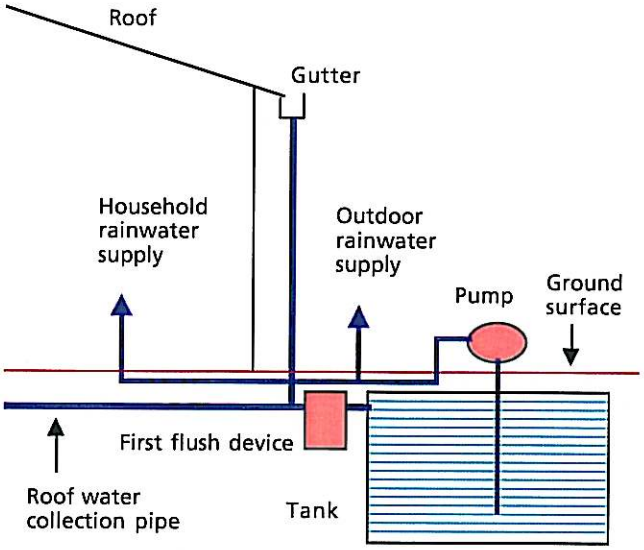

Fig 3: Configuration for a pressure system

Dual supply systems

Dual supply systems utilise both rainwater & mains water. Under this system, a rainwater tank is topped up with mains water when the tank level is low (due to dry weather or high usage). This ensures an extremely reliable water supply, whilst also providing significant cost savings and stormwater management benefits.

Required tank capacity will depend on the number of persons in the household, water use, rainfall and roof area, but 5,000–15,000 litres is generally sufficient. Smaller tank sizes can also provide considerable benefits. When designing the tank system, provision should be made for each of the following storage components (see Figure 4):

- minimum storage (or mains water top up zone) to ensure that water supply is always available
- rainwater storage zone
- air gap for additional stormwater management
- anaerobic zone (water is drawn from above this zone to ensure that sediment is not entrained).

Rainwater tanks

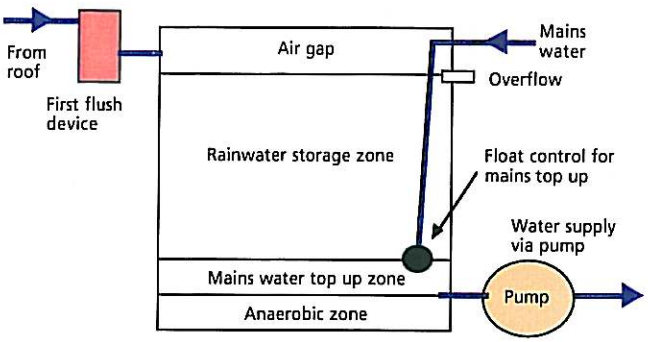

Fig 4: Storage components for a dual supply system

The minimum storage volume (mains water top up zone) is the maximum daily water use that is expected from the tank, less the potential daily volume of mains water (about 250–750 litres). If the volume of stored water falls below the minimum storage volume, the shortfall can be overcome by topping up the tank with mains water to the required level. A simple float valve system can be installed to do this automatically.

The rainwater storage zone comprises the total volume available in the tank to store rainwater below the overflow pipe. The air gap between the overflow pipe and the top of the tank can be used to provide 'stormwater detention', thereby delaying the delivery of excess roof water to the drainage system. The rainwater storage zone and the overlying air gap provide both stormwater retention and detention.

The plumbing configuration for a dual supply system is shown in Figure 5. Tank water is directed to fixtures via a small pump. When tank levels are low (such as during prolonged dry weather), the tank is topped up with mains water via a trickle system. This reduces peak demand on the mains water distribution network. The tank can be bypassed in the event of a pump or power failure.

When designing an above-ground tank, it is important to take into account the amount of site area required for the tank. A 5,000 litre tank will occupy an area of about 2 square metres, whilst a 15,000 litre tank will occupy 6 square metres.

First-flush devices

A first-flush device separates the first part of rainfall from entry to the rainwater tank (see Figure 6). This is required to prevent dust or other material on roof or gutters surfaces from contaminating tank water. The device operates by filtering roof runoff through a mesh screen to capture leaves and debris. The first part of runoff is stored in the chamber to slowly trickle through a small hole whilst cleaner water at the top of the chamber passes into the rainwater tank.

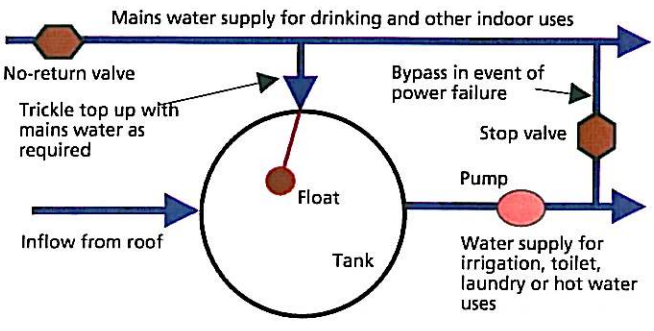

Fig 5: Configuration for a dual supply system

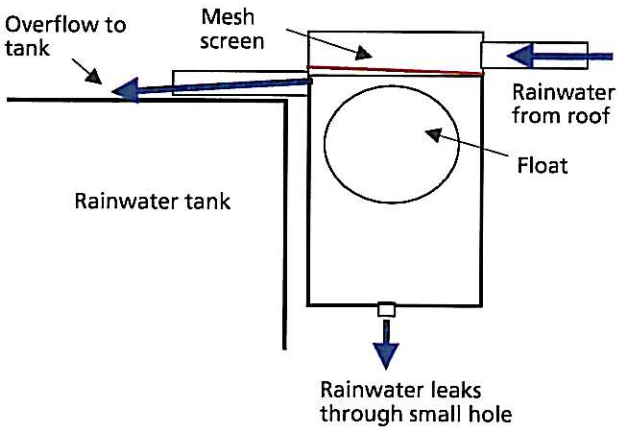

Fig 6: Basic design features of a first flush device

water SMART

PRACTICE NOTE 4

Rainwater tanks

Roofs & gutters

Rainwater should not be collected from roofs painted with lead-based or tar-based paints, or from asbestos roofs. Galvanised iron, Colorbond™, Zincalume™, slate or ceramic tiles provide acceptable water quality. Special roof guttering is not required. Normal guttering is sufficient provided that it is kept clear of leaves and debris.

Water quality

There is growing scientific evidence to confirm traditional knowledge and practice that water sourced from rainwater tanks is acceptable for most household uses. For example, research undertaken by the University of Newcastle has shown that domestic roofwater is of acceptable quality for toilet, hot water and outdoor uses. This research also showed such water, when used in hot water systems, complied with the *Australian Drinking Water Guidelines* provided that temperature settings greater than 50°C were maintained. (Relevant Australian Standards require domestic hot water systems to be set at 60°C, and hot water to be delivered to the house at 50°C).

It is not recommended that rainwater be used for drinking unless it is passed through an approved filtration system. This should be sufficient to remove possible contamination from accumulated soil and leaves in gutters, faecal material (deposited by birds, lizards, rodents and possums) and dead animals in gutters or tanks. Acceptable water quality can be maintained by:

- installing mesh screens over all inlets and outlets to prevent leaves, debris and mosquitoes from entering the tank
- installing a first-flush device to discard the first part of rainfall
- regularly cleaning gutters of leaves and debris.

Regulatory issues

Health departments

State government health departments do not prohibit the use of rainwater for drinking or other purposes. They do however recommend proper use and maintenance of rainwater tanks, and provide guidelines for this (see Cunliffe, 1998). The focus of published guidelines is on drinking water quality. No guidelines exist for outdoor, toilet, laundry and hot water uses.

Water supply authorities

Water supply authorities cannot prohibit the reuse of rainwater or stormwater on private land. However, they do require the installation of an appropriate backflow prevention device to prevent contamination of mains water by rainwater or stormwater (see 'Design Standards' below).

Local councils

Rainwater tanks and stormwater retention devices may require development consent. However, a growing number of councils have declared rainwater tanks to be 'exempt development' (which does not require consent) provided that certain requirements relating to size, height and siting are satisfied. If a development application is required, details should be provided as to:

- location and relationship to nearby buildings
- the configuration of inlet/outlet pipe and overflow pipe
- storage capacity, dimensions, structural details and proposed materials
- the purposes for which the stored water is intended to be used.

Local councils cannot prohibit the reuse of rainwater or stormwater provided the quality of the water is fit for the proposed purpose. Where a council is a water supply authority, it can require the installation of a backflow prevention device.

Rainwater tanks

Design standards

Chapter 7 of the *Australian Drinking Water Guidelines* (NHMRC, 1996) contains guidance on the management of small potable water supplies. Cunliffe (1998) provides a complete coverage of the topic. There are no recognised standards for the reuse of stormwater for secondary quality purposes.

Australian Standard *AS/NZ 3500.1.2-1998: National Plumbing and Drainage - Water Supply - Acceptable Solutions* provides guidance on the design of stormwater and rainwater reuse systems. The standard categorises cross connection between mains water supply and a domestic roofwater tank as a low hazard connection. This requires a non-testable backflow prevention device, such as:

- no physical connection between the tank and the mains water system
- an air gap
- a reduced pressure zone device (RPZD)

An air gap refers to a physical separation between the mains water and rainwater supplies within the tank. This is a simple, reliable and maintenance-free solution. A RPZD is a mechanical device that separates mains and other water supplies. It requires regular servicing and replacement. Under AS/NZ 3500.1.2-1998, dual supply systems that utilise an air gap or a RPZD can be configured as shown in Figures 7 and 8 respectively.

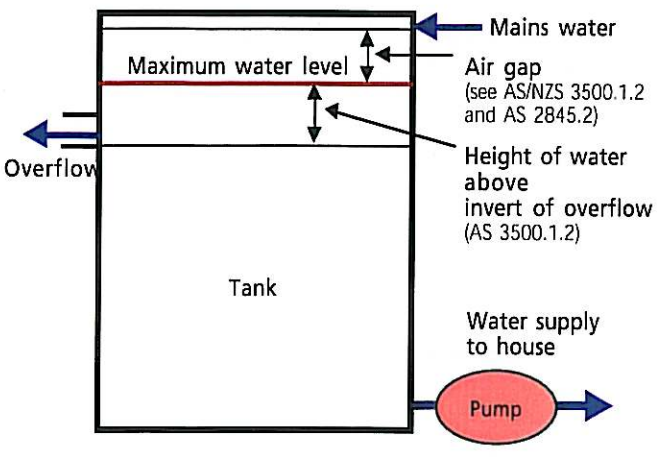

Fig 7: Backflow prevention using an air gap

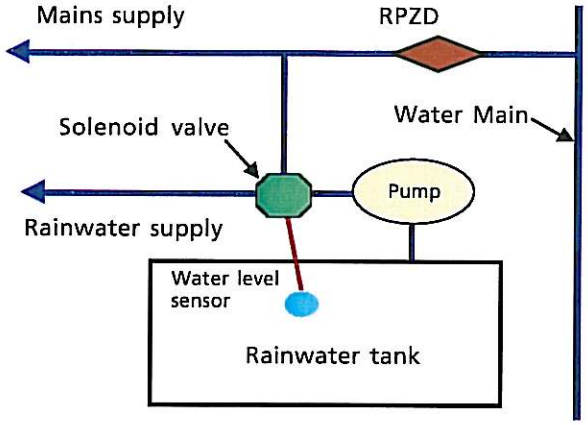

Fig 8: Backflow prevention using a RPZD

Materials & products

Concrete

Concrete tanks can be purchased in a ready-made form or constructed on-site. They can be placed above- or below-ground. Concrete tanks can be subject to cracking although careful construction techniques will minimise the potential.

Fibreglass & plastic

Fibreglass tanks are constructed from similar materials as fibreglass boats and can be used in above-ground installations. Plastic or poly tanks are constructed using food-grade polyethylene that has been UV-stabilised and impact modified. These tanks are strong and durable.

Metal

Galvanised iron tanks are constructed from steel with a zinc coating, and can be used in-above ground installations. This tank is strong and durable, but can be subject to corrosion if copper pipe for the household water service is connected to the tank. The first section of plumbing connected to the tank should be UPVC or other non-metallic material. Zincalume™ tanks are constructed from steel with a zinc/ aluminium coating. They are similar to galvanised iron tanks. Aquaplate™ tanks

Rainwater tanks

are made from Colorbond™ lined with a food-grade polymer. They can be used in above-ground installations. This tank is strong, durable and corrosion resistant. When cleaning the tank, it is important to avoid damaging the polymer lining.

Maintenance

A rainwater tank system requires very little maintenance. Regular maintenance tasks are:

- cleaning the first flush device every three to six months
- removing leaves and debris from the inlet mesh on the tank every three to six months
- removing leaves and debris from the gutters every three to six months
- checking the level of sediment in the tank every two years.

Tanks require occasional cleaning. The frequency of cleaning will depend on the amount of sediment and debris that enters the tank. A first flush device and adequate mesh screens on all tank inlets and outlets will ensure that the majority of sediment and debris does not enter the tank. This will reduce the frequency of cleaning to every 10 years or so.

Costs & savings

Tank costs vary from place to place. Indicative 2002 prices (without installation) are as follows.

Material	Capacity	
	4,500 litres	9,000 litres
Aquaplate™	$540	$860
Galvanised iron	$440	$640
Polymer	$670	$1,150
Concrete	$1300	$1,800

Small household pumps with pressure controllers can be purchased for $300 to $400.

Installation costs are also highly variable. The cost to fully install a 4500 litre above-ground rainwater tank for indoor and outdoor use can range from $1300 to $2100. Underground installation will usually add about $2000 to the cost. This system will provide the home owner with a water saving of about $50 to $110 per year, reduce stormwater discharges to the environment, reduce water demand on rivers and dams, and improve water quality in downstream stormwater catchments.

Useful websites

CSIRO Urban Water Program: www.dbce.csiro.au/urbanwater

CRC for Catchment Hydrology: www.catchment.crc.org.au

Peter Coombes, University of Newcastle: www.eng.newcastle.edu.au/~cegak/Coombes

Environment Australia: www.greenhouse.gov.au/yourhome

Environmental Conservation Planning: www.rain-harvesting.com

Michael Mobbs: www.sustainablehouse.com.au

BDP Environment Design Guide: The Royal Australian Institute of Architects

Product suppliers

Bushman Tanks: 02 6361 8750

Cessnock Tank Works: 02 4991 2558

Jenory Concrete Tanks: 02 4932 4298

National Pumps and Irrigation: 02 4934 8696

Rainwater tanks

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No. 4	Rainwater Tanks
No. 5	Infiltration Devices
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No. 7	Landscape Measures
No, 8	Landscape Practices
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No.11	Site discharge index

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Principal Author: Peter Coombes. Design and Layout by Planning Plus.

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5.3 Appendix 3

5.3.1 Typical domestic-wastewater flow design allowances (AS/NZS 1547:2000)

APPENDIX 4.2D

TYPICAL DOMESTIC-WASTEWATER FLOW DESIGN ALLOWANCES

(Informative)

Source	Typical wastewater flow allowance in L/person/day (see Note 1)	
	On-site roof water tank supply	**Reticulated community or a bore-water supply**
Households with standard fixtures (including automatic washing machine)	140	180
Households with standard water reduction fixtures (see Note 2)	115	145
Households with full water-reduction facilities (see Note 3)	80	110
Households with extra wastewater producing facilities	170	220
Households (blackwater only)	50	60
Households (greywater only)	90	120
Motels/hotels		
- guests, resident staff	140	180
- non-resident staff	30	40
- reception rooms	20	30
- bar trade (per customer)	20	25
- restaurant (per diner)	20	30
Community halls		
- banqueting	20	30
- meetings	10	15
Restaurants (per diner)		
- dinner	20	30
- lunch	15	25
Tea rooms (per customer)		
- without restroom facilities	10	15
- with restroom facilities	15	25
School (pupils plus staff)	30	40
Rural factories, shopping centres	30	50
Camping grounds		
- fully serviced	100	130
- recreation areas	50	65

NOTES:

1 These flows are minimum rates unless actual flows from past experience can be demonstrated.

2 Standard water-reduction fixtures include dual flush 11/5.5 litre water closets, shower-flow restrictors, aerator faucets (taps) and water-conserving automatic washing machines.

3 Full water-reduction fixtures include the combined use of reduced flush 6/3 litre water closets, shower-flow restrictors, aerator faucets, front-load washing machines and flow/pressure control valves on all water-use outlets. Additionally, water reduction may be achieved by treatment of greywater and recycling for water closet flushing (reclaimed water cycling).

5.4 Appendix 4

5.4.1 Secondary supply performance estimate

Job No:	GJ0495-1
Client:	Terranora Group Management
Project:	RISE
Date:	17/04/2009
Description:	Estimated supply reliability for Rise Development - Stages 1 and 2 combined

Secondary Supply Performance	ML/yr	%
Total Usage	172.2	
Rainwater (treated)	138.2	80.3%
Stormwater (treated)	26.2	15.2%
Imported (mains)	7.9	4.6%
Total roof rainfall	368.2	
Roof rainfall collected	331.4	90.0%
General losses	36.8	10.0%
Collectable rainwater	331.4	
Rainwater used	138.2	41.7%
Rainwater to runoff	193.1	58.3%

Overall Water Balance	ML/yr	%
Usage		
Indoor	149.1	59.8%
Outdoor	58.9	23.6%
Irrigation	41.3	16.6%
Total	249.4	
Supply		
Reticulated mains	85.0	34.1%
Rainwater	138.2	55.4%
Stormwater	26.2	10.5%
Total	249.4	

General Case versus IWCM

Usage	General Case	IWCM Case	% reduction
Indoor	212.8	149.1	29.9%
Outdoor	85.5	58.9	31.1%
Irrigation	45.1	41.3	8.3%
Total	343.4	249.4	27.4%
Supply			
Reticulated mains	343.4	85.0	75.2%
Rainwater	0	138.2	
Stormwater	0	26.2	
Total	343.4	249.4	

6) Attachments

6.1 Attachment 1

6.1.1 Stormwater Management Plan

GILBERT+SUTHERLAND
agriculture · water · environment

Stormwater Management Plan
Proposed RISE Development (MP08-0234)
Bilambil Heights, West Tweed
New South Wales

Prepared for:
Terranora Group Management
C/- Steve MacRae Development Services

April, 2009

Document control

Document:	**GJ0495-1_SMP_RAG2D.doc**	Gilbert & Sutherland P/L ABN 56 077 310 840
Title:	**Stormwater Management Plan, Proposed RISE Development (MP08-0234), Bilambil Heights, West Tweed, New South Wales**	Originating Office: Robina
Project Manager:	Allan Genn	Eastside 5/232 Robina Town Centre Drive, Robina Q4226 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@groupgs.com
Author:	Allan Genn	
Client:	Terranora Group Management	Also at Kawana and Brisbane
Client Contact:	C/- Steve MacRae, Steve MacRae Development Services	
Client Reference:		
Synopsis:	This management plan establishes responsibilities and procedures for the management of erosion, sediment and stormwater during the construction and operational phases of this project.	

Revision History

Revision #	Date	Edition By		Approved By	
1	16/04/09	AGG		AGG	LJV

Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10
Terranora Group	1									
G&S file & library	2									

Summary

The New South Wales Minister for Planning agreed on September 30, 2008 to consider the site as a potential State Significant site (reference No. MP 08-0234) and has authorised the submission of a Concept Plan. Subsequently the NSW Department of Planning issued a list (dated February 6, 2009) of the Director General's Environmental Assessment Requirements (DGEAR's) for the proposed development.

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by Terranora Group Management Pty Ltd to prepare an Integrated Water Cycle Assessment and Stormwater Management Plan (SWMP) for a proposed residential subdivision known as RISE at Bilambil Heights.

This Stormwater Management Plan provides procedures aimed at achieving site specific stormwater quality objectives during the construction and operational phases. Ideally it should be included in the contract documents for the earthworks, roadworks and drainage construction works in this project.

Table of contents

1) Stormwater management plan

1.1 Objectives and implementation

1.1.1 Objectives

The principle objective of this SWMP is to provide mitigation measures to minimise the potential impacts of the development.

Additionally, the SWMP provides information on specific site management issues relating to potential environmental impacts from the development during the construction and operational phases.

The control measures detailed in this SWMP have been developed to minimise impacts on the environment and achieve the following objectives:

- appropriate stewardship of natural resources,
- protection of downstream flora and fauna habitats,
- confirmation of the success of impact control measures by the means of monitoring during the construction of each stage,
- compliance with statutory requirements, and
- preservation of the existing groundwater conditions.

1.1.2 Implementation

The management plan requires the Proponent to mitigate the potential environmental impacts associated with the construction of the subdivision works.

It is intended that the SWMP will provide a set of performance criteria and guiding principles with which the engineering designs for the development will comply. The plans and specifications forming part of the construction contract for each stage should also include these performance criteria.

1.2 SWMP structure

This SWMP acknowledges the environmental impacts associated with the development and details strategies to mitigate them.

Each control strategy is based upon proven environmental management methods and is presented as a commitment. The commitments made within this document will form the basis of future assessments, which will be made available to the Tweed Shire Council for review.

1.2.1 Site-specific objectives

The stormwater quality objectives and environmental management strategies detailed in this SWMP are designed to comply with relevant laws and regulations while acknowledging the specific characteristics and localised environmental context of the site. The application of relevant legislation, guidelines and standards may necessitate specific consideration of unique or unusual natural and/or human factors in the local environment. Where necessary, variations to the relevant guidelines may be sought and, where approved, included in this SWMP.

This SWMP includes tables detailing objectives and management strategies for both the construction and operational phases of the development. The party responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the issue, the performance criteria, the implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the SWMP. The format is presented below for reference purposes.

#.# Title

Person responsible	This is the person or party who has accepted the responsibility of implementing the SWMP provisions detailed on this page

Issue	The issue with which the table deals
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria
Monitoring	The monitoring requirements which will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.
Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.
Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective action	The action to be implemented in case a performance requirement is not reached and the party(s) responsible for action.

Commitment #
A promise made by management.

An objective of the tabular format is to allow for change and allow the management plan to be a working document. If items need altering, changes may be made (after the appropriate consultation with the statutory authorities) to the individual tables.

1.3 General commitments

Commitment 1
The Proponents undertake to comply with the environmental implementation strategy as contained within the approved Stormwater Management Plan (SWMP).

Commitment 2
The Proponents undertake to fulfil all commitments made in this SWMP and to carry out their activities on the project site in accordance with relevant current statutory requirements and approved amendments

1.4 Compliance

Compliance with the provisions of this SWMP requires the objectives and management strategies contained herein to be both reasonable and achievable within the context of the approval(s) to which they relate. Incidents and/or failures that involve factors beyond the control of the responsible party(s) and the response and/or corrective actions taken by the responsible party(s) should be considered in assessing compliance with this SWMP.

1.5 Definitions

In this SWMP the terms have the following meanings:
SWMP means the approved Stormwater Management Plan and includes any amendments that may be approved from time to time;
Development means the development of the site for the purposes of dwelling houses and other land uses;
TSC means Tweed Shire Council;
Proponent means the person undertaking the development of the land and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the SWMP;
DECC means New South Wales Department of Environment & Climate Change

1.6 Contact details

The following persons are responsible for the implementation of the management measures described in the individual tables of the SWMP.

Contractor's Site Manager
The name and address of the Contractor and its representative will be notified to Council by the Consulting Engineer prior to the commencement of each contract/stage of the project.

Consulting Engineer
Unless advised otherwise the Consulting Engineer is:

Company:	VKL Consulting
Address:	189 Ferry Road
	Southport Qld 4211
Contact Details:	Mr Keith Vinnicombe
Phone:	55031400
Facsimile:	55031411

Environmental Consultant
Unless advised otherwise the Environmental Consultant is:

Company	Gilbert & Sutherland Pty Ltd
Address:	12, Riverwalk One
	140 Robina Town Centre Drive
	PO Box 4115
	Robina Q 4230
Contact Details:	Mr Neil Sutherland
Phone:	55789944
Facsimile:	55789945

2) Management of potential impacts – background and construction phase

The SWMP requires the Proponent to mitigate the potential environmental impacts associated with the construction of the subdivision works.

Prior to commencement of construction in any stage, detailed erosion and sediment control plans will be prepared, based on the requirements of this SWMP and the NSW Landcom, *Managing Urban Stormwater Soils and Construction*,[1] and submitted to and approved by Council.

The development should be built in stages to minimise the potential for soil erosion and water pollution. This would enable the site to be progressively rehabilitated as the development proceeds.

As soon as is practicable after the completion of the earthworks, the disturbed areas will be reseeded to establish a fast-growing cover crop which will minimise erosion and movement of sediment across and off the site. On steeper slopes and the road cuttings, it is likely that hydromulching and/or placing of hoop pine mulch will be required.

Wherever possible the site will remain grassed and otherwise undisturbed until construction commences.

Although no MUSIC modelling has been completed for the construction phase, it is evident that temporary sedimentation ponds and other sediment control measures should be installed during this phase.

Prior to commencement of earthworks in any stage, temporary sedimentation ponds should be installed. The exact number, location and size will be determined at the detailed design stage concurrently with the development of the staging plan. All runoff from disturbed areas is to be collected by means of surface drains and diverted to a sedimentation pond. Where practicable, runoff from undisturbed areas should be diverted around disturbed areas and away from the sedimentation pond. The temporary sedimentation ponds may be removed when the site has been revegetated, after completion of the bulk earthworks.

Other control measures such as (but not limited to) temporary sedimentation basins, silt fences and contour drains should be installed and maintained in accordance with recommendations contained in the NSW Landcom, *Managing Urban Stormwater Soils and Construction*.

Erosion and sediment control measures must be installed in disturbed areas during the building construction phase in accordance with the requirements of Council's *Sediment and Erosion and Control Guidelines for Builders and Developers*. These measures should be maintained until landscaping has been completed and becomes established.

The soils identified on the site are assessed as low to very low fertility soils. Nevertheless, it is considered that nutrient transport from the site during the construction phase should be minimised by implementation of appropriate control measures.

The following detachable pages detail the provisions of this SWMP for the construction phase.

[1] Landcom, 2004, 'Managing Urban Stormwater, Soils and Construction' 4th Edition, March 2004.

2.1 Construction phase dust management.

Person responsible	Contractor's Site Manager.

Issue	Minimisation of movement of dust offsite.
Operational policy	To achieve acceptable air quality standards through the control of the movement of dust offsite from site works.
Performance criteria	The target level for complaints by nearby residents is no more than one in any seven day period. Ambient air quality should not deteriorate by more than 30% over a period of seven consecutive days. Dust deposition at any nearby residence should not exceed 100mg/m^2/day.
Implementation strategy	The minimisation of the movement of dust offsite will be achieved through the following onsite practices: All permanent bunds and reshaped areas will be revegetated within 10 days after completion of earthworks (including excavation and backfilling of services trenches). Stockpiling onsite will be minimised where possible. An onsite water cart will be available at all times. The site will be watered daily and additional watering will be conducted during high-risk times such as high winds and low rainfall and after receipt of complaints. All dust creating activities to cease if wind speed exceeds 10m/sec. Contractors' staff to be trained to implement dust minimisation measures.
Monitoring	Daily inspections will be carried out to verify that dust mitigation measures are being implemented. Dust monitoring will be conducted upon receipt of complaints by residents. If dust monitoring is to take place, the following will occur: Temporary dust deposition gauges will monitor the movement of dust offsite at the nearest residences adjacent to the proposed stages and within the predominant wind directions. Monitoring will be undertaken in accordance with AS 3580.10.1(1991).
Auditing	Management to examine the complaints register weekly and review corrective action taken.
Reporting	The contractor to notify DECC of a possible environmental nuisance on receipt of 3 or more dust complaints in any 24 hour period. Receipts will be provided to TSC upon request. Complaints by residents are to be recorded in a Complaints Register and notified to TSC.
Identification of incident or failure	Any dust-related complaints by residents will indicate a failure of the dust control measures.
Corrective action	Locate the source of the dust and implement the following measures: Apply water sprays to vegetation Cover or water exposed areas If dust persists, cease the dust creating activities. All dust complaints to be addressed in consultation with council officers.

Commitment 3
Dust generated during the construction of the subdivision works will be managed to ensure that dust movement offsite is controlled.

2.2 Construction phase sediment and erosion controls

Person responsible	Contractor's Site Manager, Consulting Engineer

Issue	Sediment and Erosion Controls.
Operational policy	To prevent the displacement of sediment and soil across and offsite.
Performance criteria	Offsite discharges to comply with requirements for suspended sediments as detailed in Section 2.5 of the SWMP. No visual indication of erosion on stages under construction, including evidence of rilling (an indicator of sheet erosion).
Implementation strategy	Prior to commencement of construction in any stage, detailed erosion and sediment control plans shall be submitted to and approved by TSC. Erosion and sediment control devices shall be installed prior to commencement of work in each stage in accordance with the approved plans and to the reasonable satisfaction of TSC. Temporary erosion measures (eg. silt fences) are to be employed onsite during construction where reasonably deemed necessary by TSC from an assessment of slope and soil type. Such measures should be in accordance with the recommendations in the IE Aust. Qld. Soil Erosion and Sediment Control Guidelines. Stockpiled soil should be stored/bunded in a manner to prevent soil being washed offsite (i.e. bunding where necessary.) Outside the construction area of each stage existing surface water conditions should be maintained wherever possible.
Monitoring	Carry out visual inspections weekly and after rainfall events to ensure that erosion measures are in place and operational to suit the activities taking place at the time. Surface water quality to be monitored monthly (refer to the Section titled 'Surface Water Monitoring' which details monitoring of surface water and stormwater quality).
Auditing	Visual inspections to be carried out monthly and after rainfall events to verify that control measures are in place and properly maintained.
Reporting	Reporting only required if insufficient sediment and erosion measures are identified.
Identification of incident or failure	Signs of erosion on site. Damaged or failed erosion control devices. Falling stormwater quality as identified by Environmental Contractor. Build-up of sediment.
Corrective action	Apply remedial measures to improve sediment and erosion measures, for example: silt fences, shake down areas.

Commitment 4
Best management practices will be implemented into work practices throughout the construction of the subdivision works to minimise erosion and sediment transport offsite.

2.3 Construction phase surface water monitoring on site

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Surface water controls on site – temporary sedimentation ponds.
Operational policy	To maintain stormwater quality conditions of runoff during the construction phase.
Performance criteria	All water discharged from the site during the construction phase should comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria Type
pH	6.5 – 9.0	Range
Turbidity	50NTU	Maximum

Implementation strategy	Stormwater control should be achieved by directing as much runoff as practicable from disturbed areas to temporary sedimentation ponds. 'Clean' runoff from undisturbed areas should be diverted around disturbed areas if possible. All samples must be analysed at a NATA registered laboratory for the indicators listed in 'Monitoring' below.
Monitoring	Surface water monitoring during construction should be conducted in all temporary sedimentation basins for the parameters listed above. Flow rates are to be estimated and recorded at the time of sampling. Sampling frequency is to be monthly and during the first rainfall event (>25mm in any 24hr period) each month. Daily visual surveillance of water bodies for changes in conditions.
Auditing	The Consulting Engineer to audit stormwater quality results to verify that all discharges comply with the performance criteria above.
Reporting	Result sheets to be compiled for monitoring results. All results to be kept on site for inspection by local and state government officers at all times. Monthly reports to TSC including raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines.
Identification of incident or failure	Degradation of surface water quality (i.e. Suspended Solids) at the monitoring points to below the levels specified in 'Performance Criteria' above prior to discharge. Visible changes in water body conditions.

Corrective action	If the test result for any parameter fails to meet the performance criteria, then weekly monitoring shall commence and continue until the recorded value/s meet the performance criteria. If a pH is detected outside the criteria range, then such waters should be contained, and the pH adjusted to within the range of 6.5 to 9.0 prior to release. If total suspended solids exceed the water quality criteria for this parameter, then water may need to be contained on site for a period sufficient to allow suspended solids to settle out prior to release, or settling should be aided by dosing with flocculation agents at the rate recommended by the manufacturer (for example Gypsum at dose rate of 30kg/100m^3). Erosion control devices should be immediately inspected and cleaned if necessary. Additional devices should be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas should be reviewed with regard to sediment and silt control.

Commitment 5

The Proponent will take all reasonable steps to ensure that all waters discharged from the site meet the performance criteria set out above.

2.4 Construction phase surface water monitoring – permanent treatment measures

Person responsible	Contractor's Site Manager, Consulting Engineer, Environmental Consultant

Issue	Surface water controls, permanent treatment measures.
Operational policy	To maintain water quality condition of receiving waters during the construction phase.
Performance criteria	All water discharged from the site during the construction phase should comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria type
pH	6.5-9.0	Range
Suspended Solids	<50mg/L	Maximum
Dissolved Oxygen (field measured)	>6.0mg/L	Minimum
Total N	<0.75mg/L	Maximum
Total P	<0.10mg/L	Maximum
Oil and Grease	None visible	Maximum

Implementation strategy	Surface water samples to be collected during the first rainfall event (>25mm in 24 hours) each month from the monitoring points and analysed at a NATA registered laboratory. Monitoring results should be reviewed after 6 months and sampling frequency revised in consultation with Council Officers. Stormwater control should be achieved by directing as much runoff as practicable from disturbed areas to the temporary control measures. 'Clean' runoff from undisturbed areas should be diverted around disturbed areas if possible.
Monitoring	Surface water monitoring during construction should be conducted at the monitoring points for the parameters shown above. Flow rates are to be estimated and recorded at the time of sampling. Sampling frequency is to be after the first rainfall event (>25mm in 24hours) each month. Daily visual surveillance of water bodies for changes in conditions.
Auditing	The consulting engineer to audit stormwater quality results to verify all discharges comply with the performance criteria.

Reporting	Results sheets to be compiled for monitoring results relating to water quality of water bodies. All results to be kept on site for inspection by local and state government officers at all times. Monthly reports to TSC including raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines.
Identification of incident or failure	Degradation of surface water quality at the monitoring points to below the levels specified in 'Performance Criteria' above prior to discharge. Apparent visual changes in water body conditions.
Corrective action	Locate the source of the contaminant. Take all possible actions to contain and control the contaminant. Investigate the cause of the contamination and take action to prevent a recurrence. If the test result for any parameter fails to meet the performance criteria, then weekly monitoring shall commence and continue until the recorded value/s meets the performance criteria. For example: If total suspended solids exceed the stormwater quality criteria for this parameter, then water may need to be contained on site for a period sufficient to allow suspended solids to settle out prior to release, or settling shall be aided by dosing with flocculation agents at the rate recommended by the manufacturer. Erosion control devices should be immediately inspected and cleaned if necessary. Additional devices should be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas should be reviewed with regard to sediment and silt control. If Total N levels are high, check upstream stormwater quality. Check fertiliser application rates on landscaping work on site and adjust as required. If Total P levels are high, check effluent disposal practices upstream. Check fertiliser rates on landscaping work on site and adjust as required. If Oil and Grease levels are high, locate the source of the contamination and clean up source and contaminated waters in consultation with Council officers.

Commitment 6

Surface water quality should be maintained during the construction of the subdivision works in accordance with the criteria detailed above.

2.5 Construction phase contractor management

Person responsible	Consulting Engineer

Issue	Contractor management.
Operational policy	To ensure the proponent's duty of care is met by ensuring the Contractor is aware of his responsibilities under the terms of the SWMP and the DECC.
Performance criteria	Contractor is fully aware of their responsibilities under the terms of the SWMP.
Implementation strategy	Review of the SWMP and the construction phase contracts by the proponent. Periodic checks to be made by an independent Environmental Consultant. Training for construction staff in implementation of SWMP provisions.
Monitoring	Weekly site inspections to be carried out.
Auditing	Inspections will be carried out monthly during the construction phase by an Environmental Consultant for every stage of development.
Reporting	Full details to be available to the contractor together with suggested corrective actions if required.
Corrective action	To be detailed at the time.

Commitment 7

A proactive program of contractor management will be implemented.

3) Management of potential impacts – on maintenance phase

3.1 Intent

This part of the SWMP specifies those matters which must be complied with by the Proponent during the 6 months 'on-maintenance period', being the period after construction but before Tweed Shire Council assumes responsibility for the subdivision works. The Proponents' obligations in this Section of the SWMP conclude at the end of the maintenance period for each stage.

3.2 Implementation

At the completion of the construction of the development's civil works, the GPT's should be cleaned out to become part of the permanent stormwater quality control treatment train.

3.3 On maintenance phase sediment and erosion controls

Person responsible	Contractor's site manager, consulting engineer.

Issue	Sediment and erosion controls.
Operational policy	To prevent the displacement of sediment and soil across and offsite.
Performance criteria	Offsite discharges to comply with requirements for suspended sediments as detailed in Section 3.4 of the SWMP.
Implementation strategy	Temporary erosion and sediment control devices shall be maintained in an operational state during the maintenance period.
Monitoring	Temporary erosion control measures are to be inspected monthly and after rainfall events. Permanent stormwater quality control structures (GPT's, basins etc.) are to be inspected monthly and after rainfall events.
Auditing	Quarterly inspections to be carried out by an independent Environmental Consultant.
Reporting	Reporting only required in the event of failure of the sediment and erosion control measures.
Identification of incident or failure	Signs of erosion on site Build up of sediment Falling stormwater quality
Corrective action	Repair temporary sediment and erosion control measures. Check permanent measures for build up of sediment and clean out as necessary.

Commitment 8

Erosion and sediment control devices will be maintained during the on-maintenance period until the risk of soil erosion and sediment transport is considered negligible.

3.4 On maintenance phase surface water monitoring

Person responsible	Contractor's Site Manager, Environmental Consultant.

Issue	Surface water monitoring in new permanent water bodies.
Operational policy	To establish stable surface water conditions and verify that development management is appropriate.
Performance criteria	All water discharged from the site should comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria type
pH	6.5-9.0	Range
Suspended Solids	<50mg/L	Maximum
Dissolved Oxygen (field measured)	>6.0mg/L	Minimum
Total N	<0.75mg/L	Maximum
Total P	<0.10mg/L	Maximum
Oil and Grease	None visible	Maximum
Chlorophyll-a	10µg/L	Maximum
Algal Cell Count	20,000cells/mL	Maximum

These performance criteria may be adjusted upon submission of suitable background data and justification of the use of '<10% above background levels' for relevant parameters. Any amendment to the performance criteria must receive written approval by TSC prior to alteration of the approved SWMP.

Implementation strategy	Surface water entering and exiting the development shall be monitored at the environmental monitoring points during the 'On-maintenance' period. Surface water monitoring shall be undertaken at the discharge points from the development stages until stable water quality criteria have been established. Monitoring will also be undertaken during flood events where practicable. This monitoring will allow water quality comparisons to be made.
Monitoring	Surface water monitoring for all parameters will be conducted monthly at all monitoring points. To revert to construction phase provisions if problems are identified. If problems are identified, laboratory analysis at a NATA registered laboratory for the parameters listed above until such a time as TSC is satisfied that the Proponent's duty of care under the DECC has been discharged. These provisions will conclude at the end of the 'on maintenance' period.
Auditing	The Proponent to audit water quality results quarterly to verify that discharges comply with the performance criteria.

Reporting of monitoring results	Monitoring test results are to be compiled on monthly result sheets. Monthly reports containing raw data and an interpolation sheet to be sent to TSC. Results to be available at all times.
Identification of incident or failure	Fall in surface water quality at the environmental monitoring points.
Corrective action	Identify reason for deterioration in surface water quality to identify if it is linked to the development. Take necessary steps to address the problem such as improved temporary sediment and erosion controls.

Commitment 9

Subdivision works will be maintained during the maintenance period to ensure surface water quality complies with the water quality criteria detailed above.

3.5 On maintenance phase maintenance

Person responsible	Contractor's Site Manager, Consulting Engineer.

Issue	Maintenance
Operational policy	To maintain the stormwater quality control structures to ensure adequate performance during the maintenance period.
Performance criteria	The control measures are maintained and operational.
Implementation strategy	Ensure inlets and outlets are not blocked and are structurally stable. All waste to be disposed of at council approved waste facilities.
Monitoring	Monthly inspection of control structures during the maintenance period. Any recurring problems with the control structures to be rectified during the maintenance period. Structures also to be inspected following major rainfall events.
Auditing	The Proponent to carry out quarterly inspections to verify that the stormwater quality control structures are properly maintained by the contractor.
Reporting of monitoring results	Record inspection details. Record details of all maintenance activities (including volume of silt removed from each GPT or other control structure) and include in monthly reports to TSC. Results to be available to DECC at all times.
Identification of incident or failure	Blockage of stormwater system. Re-entrainment of trapped sediments. Deterioration of water quality within or downstream of control structure.
Corrective action	Clean or maintain stormwater control structure as appropriate. Take necessary steps to address the problem to prevent a recurrence.

Commitment 10

Stormwater quality control structures will be adequately maintained during the maintenance period to ensure continued performance.

4) Management of potential impacts – operational phase

4.1 Intent

This part of the SWMP specifies those matters that must be complied with by TSC and/or by the Community Title Scheme Body Corporate after it assumes responsibility for the subdivision works.

4.2 Implementation

Permanent stormwater quality control structures are to be monitored and maintained as detailed in the following tables.

4.3 Operational phase surface water monitoring

Person responsible	Tweed Shire Council

Issue	Surface water monitoring.
Operational policy	To verify that stable surface water conditions are maintained.
Performance criteria	All water discharged from the site will comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria type
pH	6.5-8.0	Range
Suspended Solids	<15mg/L	Maximum
Dissolved Oxygen (field measured)	>6.0mg/L	Minimum
Total N	<0.75mg/L	Maximum
Total P	<0.10mg/L	Maximum
Oil and Grease	None visible	Maximum
Chlorophyll-a	10µg/L	Maximum
Algal Cell Count	20,000cells/mL	Maximum
Faecal Coliforms	1,000cfu/100mL	Maximum

Implementation strategy	Surface water entering and exiting the development shall be monitored at the environmental monitoring points during the operational phase of the development. Monitoring will also be undertaken during flood events where practicable. This monitoring will allow water quality comparisons to be made.
Monitoring	Surface water monitoring will be conducted for all parameters quarterly for 12 months then half yearly. To revert to construction phase provisions if problems are identified. If problems are identified, laboratory analysis at a NATA registered laboratory for Suspended Solids, Total N, and Total P until such a time as TSC determines the cause of the problem and rectifies it.
Auditing	Council to audit water quality results quarterly to verify that discharges comply with the performance criteria.
Reporting of monitoring results	Monitoring test results are to be compiled annually. Annual reports containing raw data and an interpretation to be made available to all persons on request. Results to be available at all times.
Identification of incident or failure	Fall in surface water quality at the environmental monitoring points.
Corrective action	Identify reason for deterioration in surface water quality to identify if it is linked to the development and/or the treatment structures. Take necessary steps to address the problem such as a public education program regarding fertilisers and other nutrients.

4.4 Operational phase maintenance of treatment measures

Person responsible	Tweed Shire Council

Issue	Operation and maintenance of the treatment measures.
Operational policy	To maintain the stormwater quality control structures to ensure adequate performance during the operational period.
Performance criteria	The control measures are maintained and operational. Pollutant concentration of stormwater released from the treatment system to satisfy the quality criteria set out in Section 4.3.
Implementation strategy	Ensure inlets and outlets are not blocked. Ensure that sediment accumulation does not impair operation of GPT.
Monitoring	Water sampling to be carried out according to Section 4.3. If elevated levels are found for any parameter, commence weekly sampling and testing for the parameter concerned and if possible examine the composition/constituents of the pollutant. Establish complaints register and record details of complaints. Inspect control structures after rainfall events. These inspections are to be recorded.
Auditing	TSC to carry out quarterly inspections to verify that monitoring has been carried out and that action has been implemented if required to correct any shortcomings.
Reporting of monitoring results	Monthly reports to TSC. Record details of all maintenance activities. Results to be available to DECC at all times.
Identification of incident or failure	Water quality of outflow fails to meet the release criteria. Complaints from residents about odours or increased mosquito numbers.
Corrective action	Clean or maintain stormwater control structure as appropriate.

5) Administration of the SWMP

5.1 Amendment of the SWMP

The proponent may make application to TSC to amend the provisions of this SWMP. The application shall:

a. be in writing;
b. specify the provisions of the SWMP to which the application relates; and
c. state how the proposed amendment(s) achieve the objectives of the provisions to which the amendment(s) relate.

TSC shall approve the amendment(s) where TSC is satisfied acting reasonably that the proposed amendment(s) achieve the objective of the provisions to which the amendment(s) relates.

5.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this SWMP have clearly defined responsibilities under the Environmental Planning and Assessment Act 1979 to report any incidents likely to cause material or serious environmental harm.