Appendix 5

Local Water Management Strategy

REPORT

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LOT 1 BALDIVIS ROAD, BALDIVIS

LOCAL WATER MANAGEMENT STRATEGY

MARCH 2021

DEVELOPMENT
ENGINEERING
CONSULTANTS

Revision History:

Revision	Description	Checked	Approved	Date
0	Issued for client review	JPF	SRA	23rd July 2018
1	Client Comments incorporated into document and Landscaping Plan added	SRA	SRA	1st August 2018
2	Drainage basin calculations updated	JPF	SRA	28th September 2018
3	DWER comments of 22nd August 2018 and CoR comments of 28th September 2018 incorporated	JPF	SRA	17th October 2018
4	Updated layout and catchments	DMN	SRA	13th November 2019
5	Updated Calculations and Plans to Incorporate Shallow Water Table Design Using PC Sump	SRA	SRA	13th February 2020
6	Document updated to incorporate DWER comments dated 20th February 2020	SRA	SRA	5th June 2020
7	Document updated to incorporate DWER comments dated 12th June 2020	SRA	SRA	13th October 2020
8	Document updated to incorporate Council and DWER comments dated 28th October 2020	SRA	SRA	17th December 2020
9	Document updated to incorporate Council comments dated 22nd February 2021	SRA	SRA	22nd March 2021

Executive Summary

Estate Scale

- Drainage basins will be constructed in the public open spaces (POS) in the north-western and south-eastern corners of the site to cater for the major and minor storms. The basins will be designed to ensure all events up to and including the 1% annual exceedance probability (AEP) storm are infiltrated on-site.
- Bio-retention of a minimum 2% connected impervious area will be installed to the bases of the basins. The 63.2% AEP event will be limited to a maximum depth of 0.5m above this base. The 20% AEP event will be retained within a lower tier basin to minimise the drainage impact on the POS.
- The 1% AEP storm will be contained within the wider POS areas additional to the lower tier of the basin and below ground storage.
- Maximum Groundwater levels (MGL's) have been established to be a minimum of 1.7m beneath proposed site levels, based on site measurements and long term bore records.

Access Street Scale

- All piped drainage systems will be designed to accommodate the 20% AEP event.

Allotment Scale

- All lot owners will be encouraged to install rainwater tanks plumbed into their homes for household use to assist in containing minor events on-site in lieu of soakwells.
- Information packages will be provided as part of sales documentation to all lot purchasers to: (a) fully inform residential lot owners of the requirement to provide soakage facilities to dispose of on-site drainage equivalent to 2 by 1.5m diameter by 1.2m deep soakwells being some 4.24m^3 (5% AEP storm without outflow), commercial lot owners the equivalent of 1m^3/37m^2 of paved area (10% AEP storm without outflow), and owners of lots less than 300m^2 in area the equivalent of 2 by 1.2m by 1.2m soakwells being some 3.31m^3 (10% AEP storm without outflow); (b) encourage the use of plumbed rainwater tanks for household use in lieu of soakwells, and bores for irrigation purposes; (c) utilise water-efficient devices and appliances throughout their homes, and; (d) maximise use of water- and nutrient-wise plants, and minimise use of lawns.

Public Open Space Areas

- The basin constructed within the POS area will be designed to fully infiltrate all runoff up to and including the 1% AEP event.

1 Introduction

This LWMS report has been prepared as a stand-alone document to support the local structure plan (LSP) for Lot 1 Baldivis Road, Baldivis and will be used to guide the design and construction of the proposed drainage solutions for subdivision within the area. In effect this is an addendum to "Lots 312 and 313 and lots 2, 4, 5, 7 and 8 Eighty Road Baldivis – Local Water Management Strategy", May 2013 as the structure planning has been altered slightly.

The location of the site is shown in Appendix A, together with an aerial photograph of the existing site.

The site is located on the south-western corner of Fifty and Baldivis Roads, Baldivis.

1.1 Previous LWMS over this area

As part of the structure planning for "North Baldivis" an LWMS was prepared by Coterra Environment entitled "Lots 312 and 313 and Lots 2, 4, 5, 7 and 8 Eighty Road Baldivis – Local Water Management Strategy" which was approved by the Department of Water in May 2013 and the City of Rockingham (CoR) in June 2013.

The catchment plan for this site was incorporated within "Catchment 1" of the LWMS which included the whole of the land (Lot 1) which is the subject of this report. A copy of the catchment plan is included in Appendix A of this report. Although the structure plan included some preliminary planning for this area, the reporting did not include the specifics of Lot 1. The original planning allowed the effective area of Lot 1 to be wholly incorporated within a basin in Lot 1, however due to the change in layout over the site; the area has been split into two catchments to contain the 1% AEP storm in two drainage basins.

As shown, the measured groundwater levels did not specifically cover Lot 1 but bore SP1 was immediately west of the boundary of Lot 1.

As part of the previous LWMS work, the following stormwater management measures were proposed:

Stormwater management:

- Each catchment has a dedicated infiltration basin designed to contain and infiltrate up to the 100 year ARI (1% AEP) rainfall event.
- There will be no lot drainage connections to the road drainage network. Lots will infiltrate roof runoff via on-site soakwells.
- All stormwater from the road network for up to a 20% AEP event will be conveyed via the pipe network into the basins.
- Stormwater from events greater than 20% AEP event will be conveyed into the basins as overland flow within the road reserves.
- Appropriate vegetation will be planted in all the basins to provide additional water quality treatment during infiltration.

Groundwater management:

- The minimum levels will be around RL6.30mAD and maximum recorded groundwater levels will be 4.6m AHD and no subsoils are proposed.

- Post development catchment and basin infiltration areas are in similar proximity to areas where predevelopment infiltration would have occurred.
- All proposed basin inverts are significantly greater than the 0.3m separation distance requirement from groundwater

1.2 Drainage/Water Management Principles and Design Objectives

The following water sensitive design criteria, principles and objectives are to be pursued and/or implemented as part of the proposed development:

- *Water conservation and water efficiency*

  Objective: To maximise the reuse of stormwater and minimise the use of scheme water outside of the home, and to use water as efficiently as possible both within and outside of the home.

  Deliverable: All lot purchasers will be encouraged to install rain water tanks plumbed into their homes, to use water-efficient devices and appliances throughout their homes and to plant water- and nutrient-wise gardens.

- *Water quantity management and protection of property*

  Objective: To maintain the total water cycle balance within development areas relative to the predevelopment conditions.

  Deliverable: All post development runoff will be fully infiltrated on-site, mimicking the natural predevelopment conditions.

  Objective: To protect the built environment from flooding or water logging.

  Deliverable: All finished floor levels of lots to be a minimum 0.3m above the 1% AEP flood level.

  Deliverable: All finished floor levels of lots to be a minimum 1.2m above the maximum groundwater level (MGL).

  Deliverable: Detention basin to be provided to ensure that 1% AEP storm is disposed of on-site via infiltration without outflow.

- *Water quality management*

  Objective: To maintain and if possible improve the overall surface water and groundwater quality of the water leaving the development.

  Deliverable: Surface water will be routed to the basin and infiltrated on-site.

1.3 Planning Background

The subject land is currently zoned “Urban” under the Local Town Planning Scheme.

The proposed structure plan is detailed in Appendix A.

2 Proposed Development

2.1 Key Elements of the Local Structure Plan (LSP)

The site is located on the south-western corner of Fifty and Baldivis Roads within the suburb of Baldivis within the CoR. It covers an area of approximately 4ha of rural residential land.

The development proposal consists of approximately 40 single residential allotments averaging around 400m^2, a large commercial site of around 8,084m^2 and two POS areas totalling 3,830m^2.

2.2 Previous Land Use

The land is currently undeveloped and is generally uncleared, with an existing house and shed.

2.3 Finished Lot Levels

Finished lot floor levels will be set a minimum of 0.5m above the 1% AEP top water level (TWL) of the drainage basin and 0.3m above the 1% AEP hydraulic grade line (HGL) in the road system. This will ensure that major storms flood down roadways into POS in lieu of flooding lots.

A further criterion is that lots are to be a minimum of 1.2m above MGL.

3 Design Criteria

The drainage requirements for developments within this area are controlled by the requirements of the CoR and the Department of Water and Environmental Regulation (DWER), which are outlined below:

Item	Description	Requirement	Source/Comment
1	Water quality	63.2% AEP – 1 hr storm to be infiltrated on-site	DWER requirement
		Bio-retention of 2% connected impervious area when within 5m of groundwater	CoR requirement
2	ARI for pipe design	20% AEP	CoR requirement
3	ARI for compensating basin design	1% AEP without outflow from site	CoR requirement – No predevelopment flows currently exit the site.
4	Min. lot freeboard	0.5m above basin 1% AEP flood level	CoR requirement
		0.3m above 1% AEP HGL in road system	
5	Basin criteria		
	Side slopes	Max. 1 in 6	CoR requirement
	Retain existing trees in POS	POS layout to consider location & level of existing trees	CoR requirement
	Bio-retention area	Soil PRI > 10	CoR requirement

Item	Description	Requirement	Source/Comment
6	Runoff coefficients		
	Road reserve	0.7	Based on 90% runoff from paved area in road reserve
	Lots		
	Residential	$C_{1\%}$ – 0.11 $C_{<2\%}$ – 0 IL 13.60mm CL 9.71mm/hr	As per calculations in Appendix C.
	Commercial	$C_{1\%}$ – 0.28 $C_{<1\%}$ – 0 IL 24.43mm CL 4.57mm/hr	
	POS	0	
	Drainage basin	1	

4 Predevelopment Environment

4.1 Topography and Landform

The site gently rises from RL6.0mAHD at the north-eastern corner of the site adjacent to the Fifty Road/Baldivis Road intersection to RL7.5mAHD at the south-western corner of the site as shown in Drawing L03 in Appendix B. The average grade of the land is gentle at around 0.7%.

4.2 Soil Characteristics

The Perth Environmental Geology mapping[1] indicates that the site area consists of two major soil types as outlined below:

- The northern majority is M_4; being Guildford Formation silt, very pale brown, soft when moist, firm when dry, low clay content, of alluvial origin. It is noted that urbanisation may be undesirable due to a high water table, some flood risk and some potential in part for swelling and shrinkage.
- The small southern portion is S_8; being Bassendean Sand, very light grey at surface, yellow at depth, fine- to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin. It is noted as compatible with urbanisation, being well drained and a good groundwater recharge area.

The various areas of the site as classified in the geology mapping have been superimposed on Drawing L03 in Appendix B.

As the northern portion of the site is proposed to be filled to enable drainage to infiltrate in the POS at the south-eastern corner of the site, the issues suggested by the geology mapping are not likely to cause significant impact on the development. Our experience in the surrounding area indicates that the site is suitable for urbanisation, with the underlying material at the proposed drainage basin location being high permeability sands which will enable effective soakage.

Acid Sulphate Soil (ASS) mapping by DWER[2] indicates that the whole site has moderate to low risk of ASS occurring within 3m of natural soil surface, but high to

moderate risk of ASS beyond 3m of natural soil surface. Earthworks and excavations on-site are not proposed beyond 3m depth so ASS is not likely to be encountered.

4.3 Geotechnical

A geotechnical investigation was undertaken on the site by Structerre and reported in March 2020 and is included in Appendix F.

The investigations indicated that the expected area of M4 referred to in Section 4.2 were not present but in fact the site is underlain by deep natural porous sand, with measured site permeabilities of some 13m/day.

This is also supported by the authors experience in adjoining carried out in adjacent land holdings has confirmed that no clayey of the soil profile in the area. In addition to this, the borehole logs for the monitoring bores installed to the west of the site indicate that for the full depth of the drill, coarse sand was encountered. The drill records are included in Appendix E of this document.

4.4 Groundwater Aspects

4.4.1 General

Groundwater levels (GWLs) and flow directions are well documented from detailed investigations surrounding the site. Interpolation between UWMPs for the Spires North[3], Lot 5 Baldivis Road[4], Baldivis Parks[5] and Greenlea[6] indicates MGLs of RL4.6mAHD at the north-eastern corner of site to RL3.3mAHD at the south-western corner of site.

The results indicate that Baldivis Road is more or less a groundwater catchment boundary where the clayey substrate of the area east of Baldivis Road results in perching of infiltrated surface water. This is controlled by subsoil drainage within the adjoining Greenlea Park and Baldivis Parks developments and directed to the main drain to the east of Baldivis Road. The area west of Lot 1 consists of an unconfined groundwater aquifer within the sandy soils which falls steeply beyond the influence of the impervious soil base, which results in a mound beneath Baldivis Road.

The MGLs are plotted on Drawings L03 and L04 in Appendix B.

4.4.2 Predevelopment Groundwater Monitoring

1) Background Information on Data and Summary of Information Received

In addition to the tests on Lot 1 itself, there are several bores that have been used to establish the likely groundwater contours beneath Lot 1. As shown in Drawing L-03 in Appendix B, existing bores SP1 and SP2 (Spires), ZZ3 and BH3 (Greenlea) and MW28 (Baldivis Parks) are in close proximity to Lot 1.

The soil conditions east and west of Baldivis Road are different. While the subject site and the land west of Baldivis Road consists of an unconfined aquifer within a deep sand formation, the area east of Baldivis Road is a clay base with water controlled by a Water Corporation controlled Main Drain. Consequently, the area east of Baldivis Road is a perched aquifer controlled by drainage. The contours to the east of Baldivis Road were derived from the controlled groundwater levels proposed from the proposed drainage

systems in those abutting systems and information pertaining to the bores which is shown in Figure 3 from the Greenlea Park UWMP which is included in Appendix E.

2) Groundwater Level Information

The collated bore information on measured groundwater levels is outlined below in Table 4.1.

Table 4.1 – Groundwater Depth Results

Bore	SP1	SP2	MW28	MB1	MB2	MB3	MB4	MB5
RL Surface	**7.00**	**11.461**						
19/03/2015	**-**	**1.928**						
October 2016	**2.03**	**2.662**						
Nov 2009	**-**	**2.227**						
28/09/2005			**4.31**					
06/10/2005			**4.36**					
01/12/2005			**4.39**					
15/12/2005			**3.91**					
01/01/2006			**3.65**					
17/02/2006			**3.59**					
22/03/2006			**3.41**					
21/04/2006			**3.31**					
10/05/2006			**3.21**					
14/06/2006			**3.19**					
19/07/2006			**3.17**					
01/08/2006			**3.53**					
28/09/2006			**3.71**					
01/10/2006			**3.58**					
26/11/2006			**3.40**					
01/12/2006			**3.34**					
01/02/2007			**3.23**					
20/11/2018				**3.18**	**4.19**	**3.27**	**3.03**	**3.87**

As outlined in Table 4.1 monitoring relates to both internal and external bores.

The measured levels to the west in the unconfined aquifer were correlated with long term records of DWER bores to ensure that the 95 percentile groundwater contours could be established with reasonable certainty.

The regional data from the 2004[7] and particularly the 1997[8] Perth Groundwater Atlases is limited at the site location. The Atlas contours helped establish the shape of the MGL contours derived from the more detailed surrounding data; however the Atlas levels were largely disregarded in establishing MGL levels.

According to the 2004 Atlas, which generally designates the summer low GWL as measured from the relevant bores, the GWL beneath site is at around RL2mAHD.

According to the 1997 Atlas, which generally designates the winter high GWL as measured from the relevant bores, the GWL beneath site is at around RL4mAHD.

Based on the bore records for the site and the surrounding bores, the MGL's grade from RL4.2mAHD and 3.0mAHD at the on the western boundary of the site. The proposed base of basin in the south eastern corner of the site is around 1.0m above the MGL. The north western basin is around 1.60m above the MGL. Proposed lot levels range from RL6.60mAHD in the north eastern corner of the site to RL6.47mAHD in the south western corner of the site meaning the groundwater is between 2.4 and 3.6m below proposed allotment levels.

With a minimum separation distance of 2.4m, MGLs are unlikely to pose any threat to the proposed lots; therefore no further investigation will be required in this regard.

3) Groundwater Quality Information

Chemical analysis has been undertaken within bores MB1 to MB 5 and the information for that and adjoining bores is outlined in table 4.2 below.

Table 4.2 – Groundwater Quality test results

Sample ID	Date	Trigger	Nutrients		
			Total P	Total N	NH_4-N
		LOR	0.01	0.1	0.01
		Refer Below	0.8-12[1]	5 [1]	0.04 [2]
		LIWG	NG	NG	NG
SP1	25/09/2013		<0.05	1.7	0.03
SP2	25/09/2013		<0.05	2.3	0.03
SP2	15/01/2015		<0.05	2.1	0.01
MW28	06/10/2005		<0.1	<2.0	<1.0
MW28	01/02/2006		<0.1	<2.0	<1.0
MW28	22/03/2006		0.20	2.2	0.02
MW28	10/05/2006		<0.10	<2.0	<0.01
MW28	19/07/2006		N/A	10	0.32
MB1	20/11/2018		<0.01	0.4	0.05

Sample ID	Date	Trigger	Nutrients		
			Total P	Total N	NH_4-N
		LOR	0.01	0.1	0.01
		Refer Below	0.8-12[1]	5 [1]	0.04 [2]
		LIWG	NG	NG	NG
MB2	20/11/2018		0.04	0.5	0.14
MB3	20/11/2018		0.01	0.2	0.04
MB4	20/11/2018		0.02	90.2	0.22
MB5	20/11/2018		<0.01	0.5	0.26

1. Irrigation Guidelines ANZECC/ARMCANZ 2000, Chapter 9
2. Values for Wetland environments - Table 3.3.6 ANZECC/ARMCANZ 2000 Freshwater and Marine WQ Guidelines Chapter 3

In looking at the measured nutrient levels it is evident that all nitrogen and phosphorous levels are currently within allowable ANZECC limits, however the measured total Nitrogen at MB4 is significantly higher than other records.

We believe that the reason for this is that MB4 is located very close to an existing hatchery which we believe would have a significant impact on the nitrogen levels in the groundwater in the immediate vicinity of the hatchery. The general flow of groundwater is east to west; hence it is only the bore that is really close to the buildings that would measure the high levels. We would expect that this will decrease when the hatchery is ultimately decommissioned which will be necessary prior to residential development in the vicinity which is currently limited by an odour buffer.

In terms of post development measurements, given that the proposed basins are upstream of the hatchery the better measures of the predevelopment nitrogen levels would be MB1 and MB5.

The location of existing monitoring bores is shown on Predevelopment Catchment Plan L03 in Appendix B. It is proposed that these bores will be retained for future monitoring.

4.5 Surface Water Aspects

As shown in Drawing L03 Appendix B, the current site consists of a single catchment. The soil is permeable and in the rare event that runoff occurs, the catchment will drain north-east to the low area adjacent to the Fifty/Baldivis Road intersection and infiltrate.

4.6 Environmental Assets and Water-Dependent Ecosystems

According to the Geomorphic Wetlands Mapping[9], there are four conservation category wetlands in the area, the nearest being the Folly Pool Palusplain some 1.2km south-east

of site. The Opwin and Spot Swamps are located some 1.5km to the west, and the Tamworth Hill Swamp is located some 1.9km south-west.

The Folly Pool Palusplain is upstream of site, and all downstream wetlands are at sufficient distance to not be affected by the proposed development. In any case, runoff is proposed to be treated by a bio-retention facility in the drainage basin prior to infiltrating to groundwater.

4.7 Existing Infrastructure and Design Constraints

Sufficient capacity is available in the existing network adjacent to site to service its development.

The entire site is proposed to be sewered into existing infrastructure to the east along Baldivis Road. The existing sewer level does not constrain site levels.

The primary constraint on the site is drainage. Proposed development levels have been set to clear MGL, infiltrate in potentially difficult soils, and provide cover on pipes to accommodate the required gradients to the end of line basins.

To reduce the effect of drainage infrastructure on fill levels, upstream at-source soakage facilities have been considered as part of the preliminary design. This included swale drains in the western verge of Baldivis Road as well as rain gardens along suitable lot side boundaries. Unfortunately, these elements impart an unacceptable level of uncertainty in the design at this point in the project due to lack of available data and significant services on the western verge of Baldivis Road. Additional survey data of the existing site levels, vegetation condition and service locations is required to confirm their suitability, which will be further considered as part of detailed design at UWMP stage.

5 Water Sustainability Initiatives

5.1 General

The current state government requirement to increase the efficiency of water use in new developments to a target of less than 100kl per person per year is proposed to be implemented within the development.

This is proposed to be achieved by encouraging the use of:

- Water-wise appliances in the household through regulation and financial incentives to increase water efficiency.
- Rainwater tanks to supplement or replace scheme water for irrigation.
- Low water requirement plants and minimal turf in gardens and POS.

5.2 Individual Lot Owner Initiatives

Water conservation will be encouraged by the developer through the promotion of native, water-wise gardens and water-efficient household devices and appliances. All requirements for the purchaser will be outlined in their purchase contract and associated information handouts.

The information will also outline the case for all lot owners to use rainwater tanks plumbed into their homes to assist with the retention of the 63.2% AEP event.

5.3 Estate Public Open Space (POS) Initiatives

5.3.1 Aims

The drainage impacts of the POS will be managed to ensure that:

- The maximum depth of water within the drainage basin is limited to 0.5m and 1.2m during 63.2% AEP (1EY) and 1% AEP storms, respectively.
- The basin inlet will be directed to the bio-retention area in the lower tier of the basin, which will facilitate infiltration and treatment of the minor storms prior to overflow to the below ground storage, then subsequent spreading to the wider POS area, and hence maximise POS usability.
- Flush kerbs may be constructed abutting POS with direct runoff for infiltration in lower areas or swales for infiltration/conveyance to the drainage basin.
- Vegetation retention where practically possible.

Any proposed landscaping development of the POS will address the following objectives:

- minimise irrigation and fertiliser demands via appropriate species selection
- manage fertiliser application to minimise impacts on water quality
- weed management
- fauna protection

5.3.2 General POS initiatives

The treatment of the POS will typically consist of grassed areas with designated areas of native planting and mulching. All areas will be designed to minimise irrigation requirements with predominantly native plantings incorporated into the landscape design and the use of low water requirement grasses such as kikuyu.

Full landscape plans will be prepared at the time of subdivision in accordance with agreed requirements with the CoR, which will address the objectives outlined in Section 5.3.1.

5.3.3 Irrigation

5.3.3.1 Water sources and required allocations

For the POS irrigation the overall water use is limited to a maximum of 7,500kL/Ha/yr in accord with DWER requirements. Approximately 0.38Ha of the development is to be irrigated, which will require a maximum annual bore yield of some 2,875kL/yr.

As outlined in Appendix E, the “water wa” website indicates that the site has allocation (License Number 202900) of some 5,550kl per annum which is sufficient for the requirements.

Standard conditions require irrigation usage to be metered monthly and submitted annually in accord with DWER requirements.

Although street trees are typically not included in the allocation, these can be irrigated using hand watering or from an individual’s internal irrigation system if there is insufficient allowance within the available allocation.

5.3.3.2 Programming and irrigation minimisation

In general, watering will be 10mm three times per day for initial establishment over a period of approximately 1 month, depending on the weather and the time of the year. This will be reduced to 10mm once per day for a period of approximately 2 months dependent on the time of year. The watering is then reduced to 10mm every two days.

Establishment irrigation for street trees and POS planting is expected to be used for a period of 3 to a maximum of 5 years after planting, and disconnected thereafter.

Irrigation will be programmed and maintained to minimise the water used across the site, through monitoring and adjustment, and a water-wise watering regime.

The system will be checked regularly to detect faults and ensure water is being used effectively and efficiently. In general the system will be checked at a frequency of:

- November to April – Once per fortnight.
- May to October – Once per month.

All sprinklers will be checked to fully pop-up and retract, as well as provide adequate coverage, and bubblers and nozzles will be checked to be free of blockages. Particular attention will be paid to irrigation of transplanted mature trees and street trees to ensure they are receiving adequate water.

The watering regime for planted areas shall reflect the plants' needs appropriate to the plant type and natural rainfall, in accordance with the Water Corporation of WA "Waterwise" guidelines. Watering will be monitored throughout the year and adjusted accordingly to ensure appropriate watering. Watering (other than testing) will only take place within the hours stipulated by the Water Corporation (currently 6.00pm to 9.00am).

In general the Irrigation Schedule will be as outlined below, which is based on the landscape hydrozones:

- Turf will be separated from shrubbery and each will be supplied by different stations of irrigation and will be scheduled separately.
- Areas of turf subject to lower wear which are in sheltered environments and/or are not visually prominent will be scheduled to receive a lesser amount of irrigation than areas of turf which are subject to high levels of wear, in exposed environments and/or visually prominent locations.
- Lower water use shrubbery is scheduled to receive a lesser amount of water than higher water use shrubbery.
- Irrigation is to be progressively withdrawn from areas of native shrubbery.

As part of the landscape works, the topsoil in the landscaped areas will be improved to ensure free drainage and nutrient retention properties prior to planting.

6 Stormwater Management Strategy

6.1 Predevelopment Hydrology

As outlined in Section 4, the site grades gently down at around 0.7% from around RL7.5mAHD at the south-western corner to around RL6.0mAHD in the north-eastern

corner. A small portion of the site to the south consists of sand with excellent soakage characteristics. Although the northern portion of the site is designated on the regional mapping as potentially silty, the bore record for the monitoring bores indicated that the soils are generally sandy with reasonable soakage characteristics.

Although the topography indicates flow paths in a north-east direction, the flat grade and permeability of the surface allows infiltration to occur at a greater rate than runoff, so little or no runoff currently leaves the site. Based on this, it has been assumed that there is no predevelopment flow from the site. Drawing L-03 detailing the predevelopment catchment is included in Appendix B.

6.2 Pre- & Post Development Hydrology

The proposed drainage strategy is to infiltrate all stormwater on-site as close to the source as possible. Soakwells on lots and trapped pit bases in the road system are proposed to this end; however given the limited available opportunities for drainage disposal in the upper reaches of the catchments; the strategy ultimately relies on the two end-of-line infiltration basins. Soakage at-source without outflow will be employed up to and including the 5% AEP event for residential and 10% AEP event for commercial lots, and for the first 1.5-2mm of runoff in road reserves.

The drainage strategy is to split the catchment and drain to basins in the south east and north-west corners of the site. In general, the site sand has good soakage characteristics which will facilitate infiltration of the various storm events. Given that the site is within 5m of MGL, improved soil media and appropriate planting are proposed in the bio-retention area of the basin to ensure nutrient uptake prior to infiltration to groundwater.

The basin will be constructed as a three-tiered swale within the POS area as follows:

- Lower tier: with planted bio-retention area at base to treat minor event runoff, and the capacity to the 1EY 15mm event.
- Middle Tier/Upper Tier: which will provide overflow capacity for a minimum of the 10% AEP storm in the case of the Southern Basin, then will overflow to the higher tier. The Northern Basin will hold the whole of the 1% AEP in the two tiers.
- Upper tier: to form part of the wider usable POS area, to cater for the remaining storm events in excess of the 10% AEP for the southern basin only.

The site consists of two catchments draining both south-east and north-west from the centre of the site to the drainage basins in the POS areas. Drawing L-04 detailing the catchment boundaries and proposed drainages basin is included in Appendix B.

Modelling has been undertaken using the recently updated PC Sump software using the shallow water table calculations as required by the City of Rockingham. In general this model restricts outflow through the base and sides of the basin, thereby increasing the required capacity established from more empirical methods. The 2021 version (6.1) has resulted in a significant reduction in required volume which is much closer to the original empirical methods. The site sands on the sides of the basin have an assumed permeability of 5m/day within the model, which has been based on the percolation results in the geotechnical report (Refer Appendix 6) which indicates some 13m/day, but with allowance for a reduction in permeability following earthworks of the site.

Gross pollutant traps (GPTs) will be constructed at entry to the POS soakage area to ensure most litter and sediment is contained for easy cleaning.

The areas required to contain flows from the post development catchment are summarised in Table 6.1 below. Refer also to Appendices B and C for the catchment plan and detailed calculations.

Table 6.1 – Drainage basin details

Basin parameter	North Catchment	South Catchment
Impervious catchment (Ha) ($C_{1\%}$)	0.69	0.65
Storage provided (1%) (m^3)	522	535
Storage provided (10%) (m^3)	219	229
Storage provided (20%) (m^3)	140	165
Storage provided (1EY) (m^3)	40	58
Site area required (1%) (m^2)	863	1103
Site area required (10%) (m^2)	513	366
Site area required (20%) (m^2)	423	315
Site area required (1EY (m^2)	238	231
$TWL_{1\%}$ (mAHD)	6.0	5.9
Critical T_C (1%) (hrs)	9	2
Critical T_C (10%) (hrs)	3	3
Critical T_C (20%) (hrs)	3	2
Critical TC (63.2%) (1EY) (hrs)	6	1

6.3 63.2% AEP (1EY) event

6.3.1 General

The 63.2% AEP (1EY) event is typically accepted as generating the most dissolved nutrients and particulate matter in runoff. As the separation distance to MGL is less than 5m across the development, bio-retention is required to treat runoff prior to reaching groundwater.

It is proposed that the 63.2% AEP – 1 hour storm will be retained on-site without outflow in accordance with DWER requirements. This is proposed to be undertaken at the various levels as outlined in the following sections.

6.3.2 Lots

Lots will retain water on-site in rainwater tanks, infiltrate water in soakwells, or use a combination of both to ensure no outflow to the street drainage system. Residential lots are required be fitted with the equivalent of 2 by 1.5m diameter by 1.2m deep soakwells ($4.24m^3$) to achieve full retention of all storms up to the 5% AEP without outflow. Residential lots less than $300m^2$ in area are required to install the equivalent of 2 by 1.2m by 1.2m soakwells ($3.31m^3$), and commercial-type lots are required to be fitted with the equivalent of $1m^3/37m^2$ of paved area, with both retaining up to the 10% AEP storm without outflow.

When capacity of the on-site storage is reached, stormwater will surcharge from the soakwells/tanks and run overland to the street drainage system. It is noted that some additional infiltration will occur in back and front yards which will supplement the constructed on-site storage.

6.3.3 Streets

The 63.2% AEP (1EY) storm for roadways will largely be contained within the end-of-line basins without overflow to any surrounding POS areas.

Baldivis Road and Fifty Road Drainage will be directed into soakwell systems. Swales may be used as an alternative, but this will be dependent on the location of existing services.

Internally, drainage pits will be laid with open bases to permit soakage for small rainfall events thereby encouraging soakage at-source. The baseless pits will cater for around 1.5-2.0mm of rainfall.

Overland flow will be employed in lieu of piped drains where possible. Where roads are constructed adjacent to open space and opportunities for soakage are available, flush kerbs may be used in conjunction with swale drainage in lieu of a piped drainage system. As mentioned in Section 4.7, this is subject to detailed engineering design, final landscape design and agreement from the CoR at UWMP stage.

The 63.2% AEP – 1 hour event will be restricted to the bio-retention area in the lower tier of the basin, which will cause cause minimal inundation for lower ARI rainfall events, thereby maximising the usability of the POS area and associated swales. The bio-retention area will be installed in accordance with the *Adoption Guidelines for Stormwater Biofiltration Systems (CRCWSC, 2015)*.

GPTs will be installed prior to any inflow from the piped drainage system into the drainage basins to limit the siltation in the basins.

6.3.4 Detention basins

Beyond the measures employed in baseless pits and potential roadside swales, the remainder of the 63.2% AEP storm will be fully infiltrated within the lower tier basin and below ground storage areas. Details of the proposed basins are included on Drawing L-04 in Appendix B.

6.3.5 Non-structural measures

Non-structural measures will be employed to reduce the number of sources of nutrients as well as the amount of nutrients they produce. These measures are particularly important during house construction and garden establishment, and generally involve providing advice to limit sources of eroded particulate matter and the application of garden fertilisers in the new urban areas.

Non-structural minimisation of nutrient loading can effectively be achieved through:

- education of local residents and CoR maintenance personnel;
- implementing frequent street and stormwater maintenance programs – particularly during housing construction, and;

- Planting and maintaining appropriate native species.

6.4 20% AEP event

All piped drainage systems will be designed to accommodate the 20% AEP event, without any inundation of roadways.

6.5 1% AEP event

For the major event, volumes in excess of the 20% AEP storm for residential lots and the 10% AEP storm for smaller residential (<300m^2) and commercial-type lots will surcharge and run overland.

The commercial site is proposed to be filled to be higher than Baldivis Road and the internal driveways will be shaped to fall back to the internal road and overflow into the internal drainage system and the basin.

All roads within the estate will be designed to accommodate and direct extreme event flows toward the POS and compensating basins. The land will form the same catchment area as detailed in the post development plan in Appendix B.

6.6 Finished Lot Levels (Relative to the 1% AEP Flood Levels)

As outlined in Section 2.3, lots will be set to ensure major storms will be conveyed along roadways without flooding homes. The land is proposed to be finished a minimum of 0.3m above the TWL of the drainage basin and the HGL in the road system.

6.7 POS Credits

As outlined in the LSP document, all POS credit calculations have been based upon current "Liveable Neighbourhood" policy guidelines. According to the guidelines, 100% of the area covered by the 63.2% event of the compensating basin is typically not included as a 'usable' POS area, and the 20% AEP event is designated as a 'restricted' area. The area between the 63.2% and the 20% AEP normally attracts a 100% credit, provided it comprises less than 20% of the total POS allocation.

The POS area affected by the drainage basin is detailed in Table 6.1.

6.8 Best Management Practices Water Quality Targets

The DWER's Stormwater Management Manual[11] provides guidelines and information on best management practices that may be applied at land development and construction sites to improve stormwater management and environmental performance.

Poorly managed land development sites can often be a major source of pollution. Certain construction activities can allow pollutants to be transported via existing stormwater systems or overland flow to adjoining receiving water bodies.

The major sources of pollutants from construction activities in the case of this project will potentially be from:

- Eroded materials in the interim period between opening up the surface of the site and implementing the drainage management measures.
- Litter and waste storage areas – that allow materials to be blown by wind or washed away by rainfall into existing stormwater systems.

- Wash-down areas – poor practices can allow materials to enter stormwater systems.
- Placement and storage of delivered products – particularly sand and soil stockpiles where such materials may be tracked by vehicles, blown, or washed onto roads, which then get into existing stormwater systems.
- Dewatering activities – which can cause sedimentation of downstream water bodies.

Consequently no construction activities will commence on the site until an appropriate approved Environmental Management Plan (EMP) is prepared that fully addresses:

- litter and waste management practices (non-hazardous and hazardous materials);
- vehicle and equipment washing-down practices;
- water conservation practices;
- erosion and sediment control;
- product placement and storage practices;
- dewatering activities (if applicable), and;
- Any other practices that may adversely impact upon receiving water bodies.

This will be prepared by the contractor undertaking the civil works on the subdivision together with the engineering consultant.

The Best Management measures proposed for this project are:

- Non-structural measures to reduce nutrient loading.
- On-site retention of the 63.2% AEP – 1 hour storm.

Research has indicated that this approach will achieve reductions of at least 80% of total suspended solids, 60% of total phosphorus, 45% of total nitrogen and 70% of gross pollutants compared to a conventional drainage system.

7 Groundwater Management Strategy

7.1 Groundwater Level Management

MGLs for the site are plotted on Drawings L03 and L04 in Appendix B. In general MGLs are around 2m below proposed site levels with the exception of the drainage basin in the south-eastern corner of site.

The MGL grades steeply at around 2% beneath the basin, being at around RL4.3mAHD on the east side and around RL3.7mAHD on the west side. The base level of the lower tier is set at RL4.9mAHD, achieving separation distance to MGL of 0.6m minimum and 1m maximum, with an average of 0.8m.

Given the significant depth to groundwater in sand on the western side of the site, in combination with groundwater controls east of Baldivis Road, there is no need for further control of groundwater levels on-site.

7.2 Actions to Address Acid Sulphate Soils or Contamination

As mentioned in Section 4.2, the ASS mapping for the area indicates that the whole site has moderate to low risk of ASS occurring within 3m of natural soil surface, but high to moderate risk of ASS beyond 3m of natural soil surface. Construction work will not

exceed this depth, therefore there is little to no risk of the development proposal encountering any ASS soils.

8 The Next Stage – Subdivision and Urban Water Management

The structure plan area is under the ownership of a single land owner, so it is anticipated that the ultimate drainage strategy will generally fit within the framework of this LWMS.

The UWMP will build on the concepts of this report providing ongoing monitoring results and addressing the following major points:

- Further detail in the design of the detention basin.
- Detailed geotechnical investigations including testing of the PRI and permeability of the existing soils both at the surface and at the depth of the base of the basin.
- Further detail in landscape proposals.
- Testing of groundwater levels and quality for the purposes of irrigation of public open space.

Once this data is received, the approach outlined herein will be reviewed with detailed work required to:

- Finalise the design of the swale in the POS and potential above-ground storage upstream in the catchment.
- Detail the drainage basin including the inlet configurations and edge treatments to ensure the overall functional and aesthetic outcomes are satisfactory.
- Review the drainage calculations relative to final planning proposals for the site to ensure that the land use assumptions within the drainage calculations herein are consistent.

9 Monitoring

9.1 General

Post development monitoring is proposed to be undertaken over the site quarterly following the completion of the first stage. It is proposed to use the same suite of bores used for the pre- development monitoring as detailed in Drawing U-03 in Appendix B.

It is acknowledged that some of these bores may be impacted by the works and if this occurs, they will be reinstated as close as possible to their original locations but in a suitably accessible location.

The level will be measured and samples will be sent to a NATA registered laboratory to undertake the following tests:

Table 9.1 – Proposed Post Development testing regime

Test	Abbreviation	Trigger levels (Based on 10% Exceedance of Initial Levels) (mg/1)
Total Phosphorous	TP	0.044
Filterable Reactive Phosphorous		N/A
Nitrate and Nitrite	NOx	N/A
Ammonia-Nitrogen	NH_3	0.29
Total Kjeldahl Nitrogen	TKN	0.55
Salinity	EC or TDS	N/A
pH		N/A

The water will be sampled quarterly January, March, June and October commencing after the first stage of development has been completed and will be carried out for two years following completion of the last stage of civil construction and until hand over of the POS to the City of Rockingham, whichever is the latter.

Hand over to the City of Rockingham will occur two years after completion of establishment works. In the interim period, the developer will accept responsibility for the maintenance and monitoring of the landscaping and monitoring works.

An annual report will be submitted to the City of Rockingham and the DoW until 3 years after the completion of the last stage. Monitoring reports shall be delivered to the City of Rockingham Strategic Planning and Environment Department.

9.2 Contingency Response

The results will be compared between the initial results to those measured each year.

In the event that any of the indicators from the sampling exceeds the initial measurements by 10% for two consecutive samples, Council and DoW will be notified and the matter will be investigated at the developers cost.

The possible contingency measures are as follows:

1. Reduction in irrigation or fertiliser use in key areas and review of timing.
2. Soil amendment in high nutrient areas
3. Increased planting of water and nutrient thirsty plants in groundwater recharge areas.

The measures employed and the timing will be resolved at the time with the DoW and Council.

If standing water occurs within the basin areas for excessive periods of time within the maintenance period for the landscaping (That is two years following completion of the last stage of civil construction or until hand over of the POS to the City of Rockingham, whichever occurs first), the developer shall at its cost investigate the issue and provide a solution for approval by the Local Authority. Following agreement on a strategy, the developer shall implement the strategy and undertake any required rectification works at its cost.

10 Implementation

10.1 Commitments

The developer is committed to:

1) Physical outcomes – to be undertaken at the time of construction.

- Installing baseless manholes to ensure maximum soakage at source opportunities.
- Installing drainage systems to hold up to and including the 1% AEP storm event.
- Providing a water source for the open space areas.
- In-situ soil tests to assess viability as nutrient stripping media, at the base of the drainage basin. If the material does not meet the required specification as shown in Section 3, an alternative material will be provided for the basin bio-retention area.

2) Non-structural – to be undertaken as part of sales documentation, by providing information packages to all lot purchasers to:

- Fully inform residential lot owners of the requirement to install the equivalent of two 1.5m diameter by 1.2m deep soakwells, small residential lot owners the equivalent of 2 by 1.2m diameter by 1.2m deep soakwells and commercial-type lot owners the equivalent of $1m^3/37m^2$ paved area, prior to outflow into the drainage system, with potential supplementation with rainwater tanks.
- Encourage the use of plumbed rainwater tanks.
- Utilise water-efficient devices and appliances throughout their homes, and to encourage all purchasers to install water- and nutrient-wise plants.

3) Further investigation and reporting:

- Prepare a UWMP to support further detailed subdivision planning.
- Undertake geotechnical investigations.
- Undertake groundwater level and quality testing.

10.2 Maintenance Schedules (Incl. Roles & Responsibilities)

Maintenance schedules and arrangements will be resolved as part of the UWMP and will be dependent on the detailed design and operation of the mechanisms required. As a brief summary, Table 10.1 has been included to provide guidelines for likely maintenance responsibilities.

Table 10.1 – Proposed maintenance programme for the development

#	Drainage Element	Possible Maintenance and Inspection Frequency	Responsibility
1	Rainwater tank(s); soakwells and gutters	Annually inspect & clean-out (as necessary) – just prior to winter rains	Lot owner

#	Drainage Element	Possible Maintenance and Inspection Frequency	Responsibility
2	Swale areas and detention basin	During developer maintenance period (2 years in conjunction with Landscaping): Inspect, clean-out & maintain plants at ~fortnightly intervals (depending on loading) – as part of POS maintenance works	Developer
		After developer maintenance period: Inspect, clean-out & maintain plants (as required) as part of standard Council POS maintenance program	CoR
3	Drainage pipes and pits	During developer maintenance period (12 month Defects Liability Period): Inspect, clean-out & maintain structures annually – just prior to winter (& then again in Aug / Sept if necessary)	Developer
		After developer maintenance period: Inspect, clean-out & maintain structures at least annually – just prior to winter – but inspection frequency will need to be higher during home construction phase	CoR
4	GPT	During developer maintenance period (12 month Defects Liability Period): Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / July & again in Oct / Nov for the first two years	Developer
		After developer maintenance period: Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / Aug – but inspection frequency will need to be higher during home construction phase.	CoR
5	Base of compensating basin	Initial formal inspection & assessment of performance of bases (say) at around year 3 & then every 5 – 10 years.	CoR

10.3 Funding

The cost for the implementation of the capital water management measures will be borne by the developers. Maintenance costs will be borne by the developers for the periods as outlined in the maintenance schedule table in section 10.2 above.

10.4 Review

Following the approval of this document, it is not expected that the LWMS for this development will need to be reviewed as this forms the broad structure of the approach for the drainage in the area.

In general, minor amendments can be made provided they meet the outcomes sought within this report. In the event that the management measures used within the state have significantly changed, or the first subdivision application following the expiration of 4 years from the first subdivision approval, whichever is the later, the measures used for management of stormwater should be reviewed.

11 References

1. Rockingham: Part Sheets 2033 II and 2033 III, Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia, Gozzard J. R., 1983.
2. Acid Sulphate Soil Risk Map, Swan Coastal Plain (DWER-055), Department of Water and Environmental Regulation, Shared Location Information Platform, Landgate, 2017.
3. Lot 306 McDonald Road, Baldivis – "The Spires" North Development – Stages 1-6: UWMP, Development Engineering Consultants, February 2018.
4. Lot 5 Baldivis Road, Baldivis: UWMP, Development Engineering Consultants, October 2017.
5. Lots 104, 105, 541, 543, 544 and 1000 Baldivis Road, Baldivis – Baldivis Parks Development: UWMP, Development Engineering Consultants, November 2014.
6. Greenlea Estate, Baldivis: UWMP, Emerge Associates, February 2016.
7. Perth Groundwater Atlas (Edition 4), Department of Environment, 2004.
8. Perth Groundwater Atlas, Waters and Rivers Commission, October 1997.
9. Geomorphic Wetlands, Swan Coastal Plain (DBCA-019), Department of Biodiversity, Conservation and Attractions, Shared Location Information Platform, Landgate, 2018
10. Water Register, Department of Water and Environmental Regulation, accessed 20th July 2018.
11. Stormwater Management Manual for Western Australia, Department of Water, 2007.
12. Australian Rainfall and Runoff A Guide to Flood Estimation Volume 1, Institute of Engineers, 1987.

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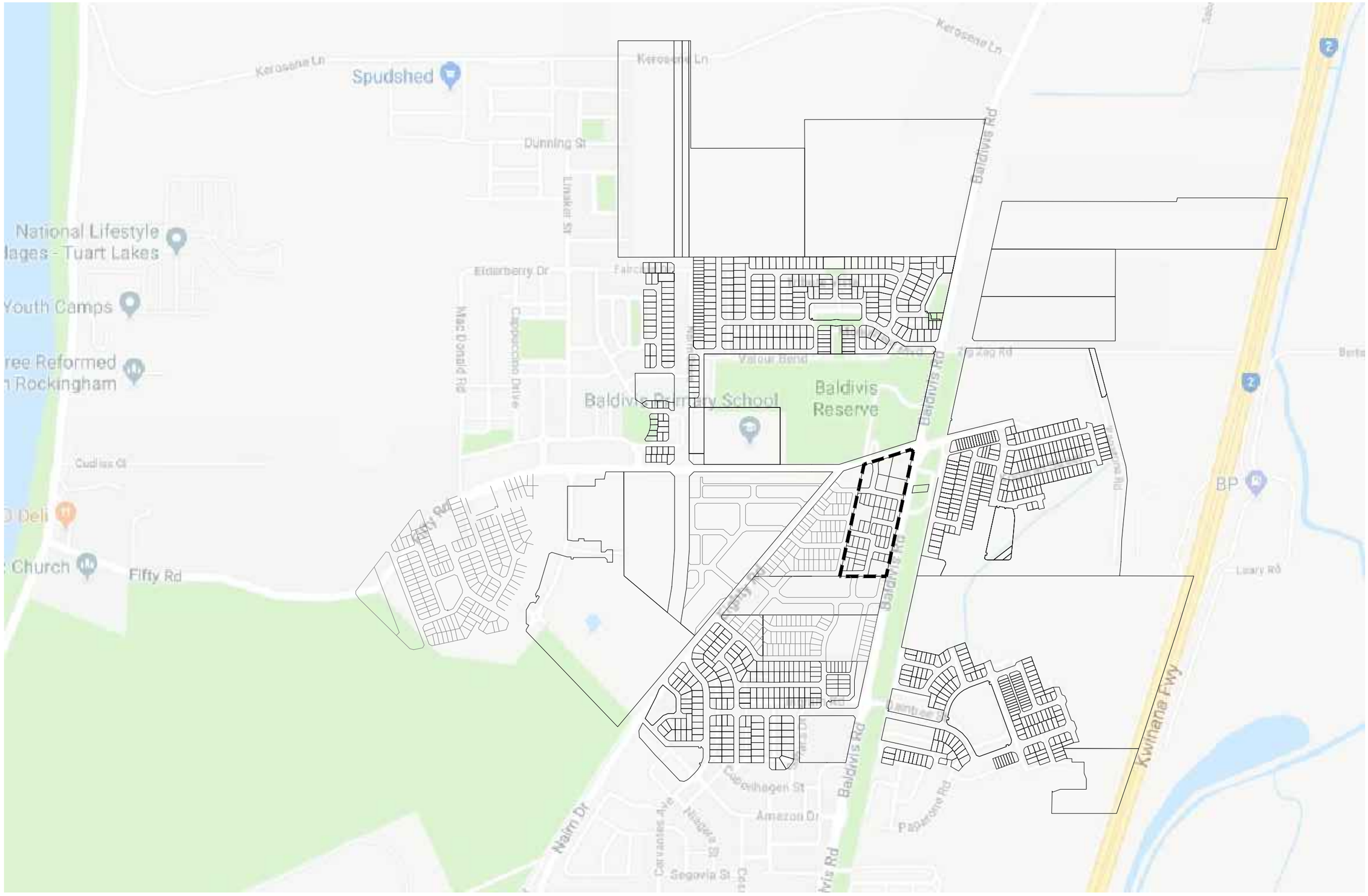
APPENDIX A

OVERALL PLANS

- **L01: Locality plan**
- **L02: Aerial photo plan**
- **Veris proposed subdivision plan**
- **Previous LWMS Catchment Plan**

LEGEND

SITE BOUNDARY



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No.	DATE	BY	REVISION
C	18/11/20	PMS	AMENDED TO SHOW LATEST PRECAL
B	26/9/19	JEG	REVISED LAYOUT
A	18/7/18	JEG	INITIAL ISSUE

CLIENT:
BALDIVIS HOMES PTY LTD

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WEST PERTH, 6005
WESTERN AUSTRALIA
Ph: (08) 9481 1900
Fax: (08) 9481 1700

PROJECT:
LOT 1 BALDIVIS ROAD BALDIVIS

W.A.P.C. No. -

DRAWING:
LOCALITY PLAN

CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
1:5000	JEG	SRA	C
DATE	DESIGNED	APPROVED	
18/7/18	JEG	SRA	

PROJECT NUMBER: **BDVTER80**
DRAWING NUMBER: **L01**

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LEGEND

SITE BOUNDARY

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B	25/9/19	JEG	REVISED LAYOUT	SRA
A	18/7/18	JEG	INITIAL ISSUE	SRA

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BALDIVIS HOMES PTY LTD

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PROJECT:
LOT 1 BALDIVIS ROAD BALDIVIS

W.A.P.C. No. -

DRAWING:
AERIAL PHOTO

CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
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DATE	DESIGNED	APPROVED	
18/7/18	JEG	SRA	

PROJECT NUMBER
BDVTER80 L02

DRAWING NUMBER
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LEGEND

- Application Area
- Existing Boundary
- Existing Contours / Survey
- Existing Water Infrastructure
- Existing Sewer Infrastructure
- Existing Power Infrastructure
- Proposed Boundary
- Indicative Future Boundary
- Full Movement Intersection
- Restricted Movement Intersection
- Odour Buffer
- Lots affected by Odour Buffer

LOT SUMMARY

Subject Site	4.0432ha
Existing	
Lot 1	4.0432ha
Proposed	
Residential Lots (Single Dwelling)(36)	1.7909ha
Public Open Space Reserves (2)	0.3831ha
Balance Lot 101	0.8395ha
Road Widening	0.0295ha

Lots impacted by odour buffer shall not be created until the odour buffer constraint is lifted, which may at some point reasonably occur within the lifespan of the subdivision approval. Otherwise should the odour buffer constraint still be in place at the expiration of the subdivision approval, a new application for subdivision would need to be made.

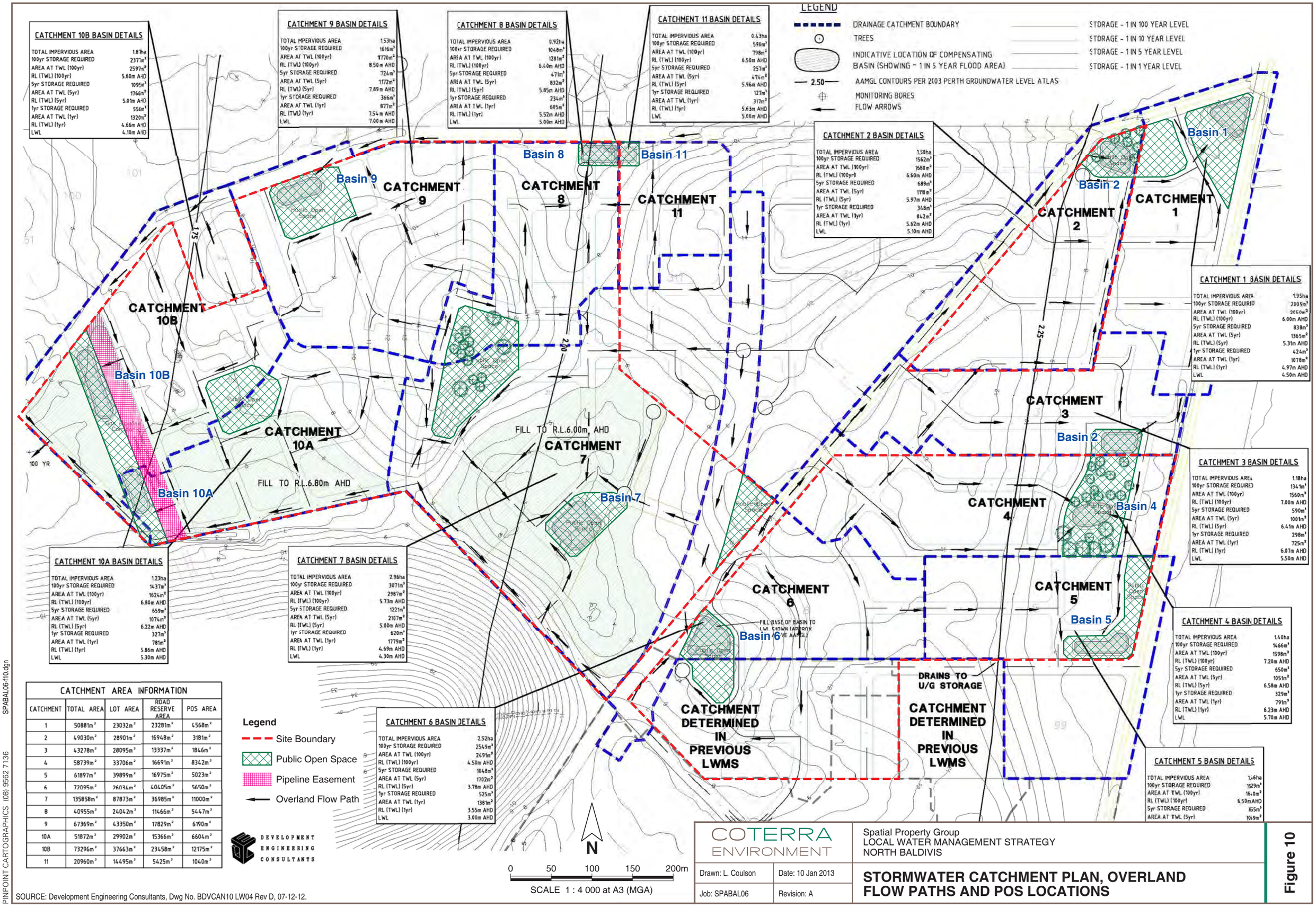
Subdivision Plan

Lot 1 Fifty Road, Baldivis

Date: 1 Sep 2020 Scale: 1:1000 @ A3 1:500 @ A1 File: **19-339 SU02A** Staff: JP GW Checked: GW

0 20m

element.
Level 18, 191 St Georges Terrace, Perth Western Australia 6000.
PO Box 7375 Cloisters Square, Perth Western Australia 6850.
T. +61 8 9289 8300 | E. hello@elementwa.com.au elementwa.com.au



CATCHMENT AREA INFORMATION				
CATCHMENT	TOTAL AREA	LOT AREA	ROAD RESERVE AREA	POS AREA
1	50881m²	23032m²	23281m²	4568m²
2	49030m²	28901m²	16948m²	3181m²
3	43278m²	28095m²	13337m²	1846m²
4	58739m²	33706m²	16691m²	8342m²
5	61897m²	39899m²	16975m²	5023m²
6	72095m²	26034m²	40405m²	5650m²
7	135858m²	87873m²	36985m²	11000m²
8	40955m²	24042m²	11466m²	5447m²
9	67369m²	43350m²	17829m²	6190m²
10A	51872m²	29902m²	15366m²	6604m²
10B	73296m²	37663m²	23458m²	12175m²
11	20960m²	14495m²	5425m²	1040m²

Legend
- Site Boundary
- Public Open Space
- Pipeline Easement
- Overland Flow Path

DEVELOPMENT ENGINEERING CONSULTANTS

N

0 50 100 150 200m

SCALE 1 : 4 000 at A3 (MGA)

SOURCE: Development Engineering Consultants, Dwg No. BDVCAN10 LW04 Rev D, 07-12-12.

COTERRA ENVIRONMENT	Spatial Property Group LOCAL WATER MANAGEMENT STRATEGY NORTH BALDIVIS
Drawn: L. Coulson	Date: 10 Jan 2013
Job: SPABAL06	Revision: A
STORMWATER CATCHMENT PLAN, OVERLAND FLOW PATHS AND POS LOCATIONS	**Figure 10**

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPABAL06-f10.dgn

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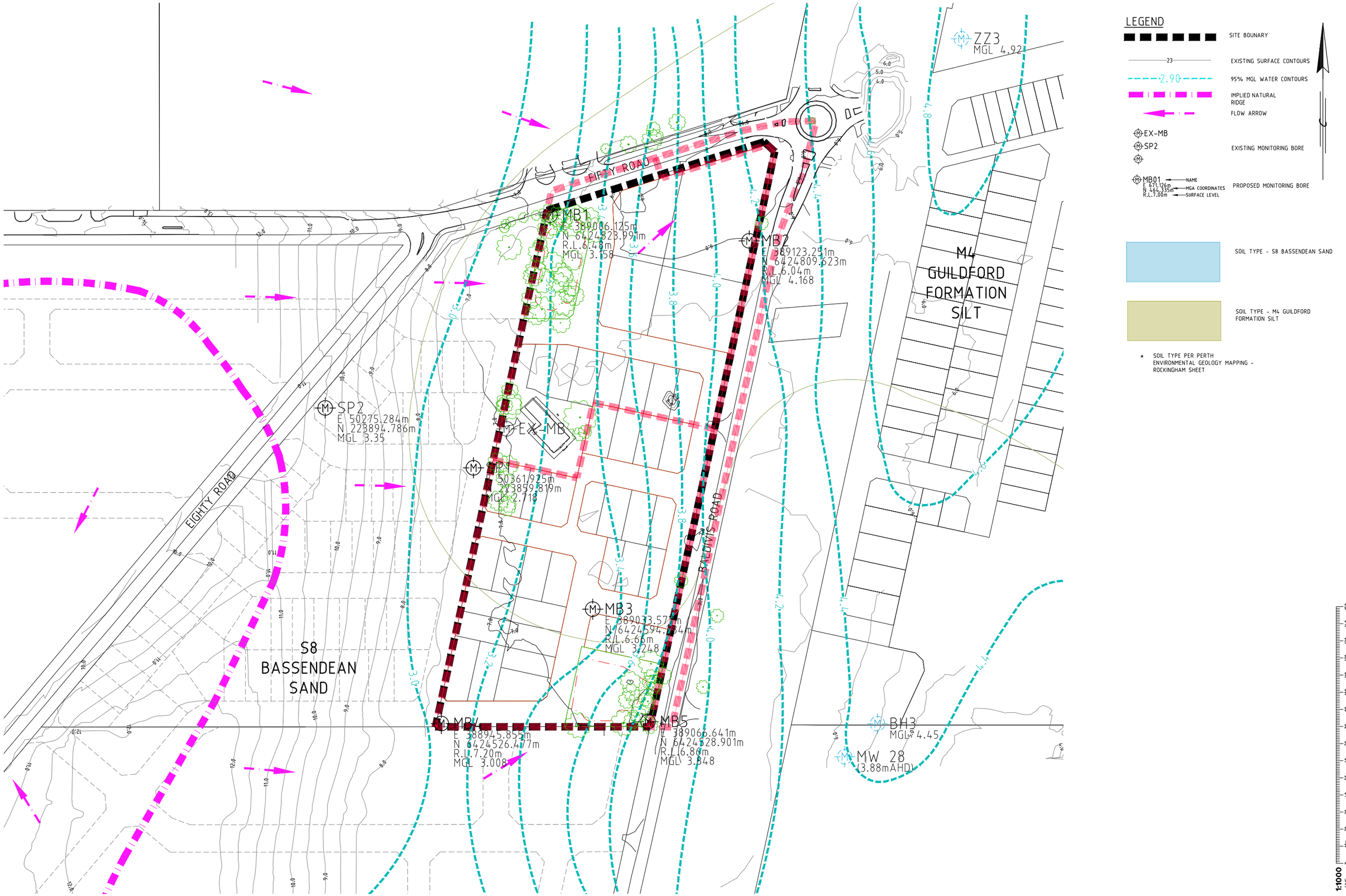
APPENDIX B

DRAINAGE CATCHMENT PLANS

- **L03: Pre-development catchment plan**
- **L04: Post development catchment plan**
- **L-05: Drainage Swales Plan and Sections**



No.	DATE	BY	REVISION	
D	18/11/20	PMS	UPDATED TO SHOW LATEST PRECAL, MGL CONTOURS UPDATED, MGL LEVELS ADDED	SRA
C	26/9/19	JEG	UPDATED LAYOUT PLAN	SRA
B	17/10/18	JEG	PROPOSED MONITORING BORES ADDED	SRA
A	18/7/18	JEG	INITIAL ISSUE	SRA

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PROJECT:
LOT 1 BALDIVIS ROAD BALDIVIS
W.A.P.C. No. -

DRAWING:
PRE DEVELOPMENT CATCHMENT PLAN
CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
1:1000	JEG	SRA	D
DATE	DESIGNED	APPROVED	
18/7/18	JEG	SRA	

PROJECT NUMBER
BDVTER80 L03
DRAWING NUMBER
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BASIN DETAILS

TOTAL IMPERVIOUS AREA (1% AEP)	0.72ha
1% AEP STORAGE REQUIRED	554m³
AREA AT TWL (1% AEP)	768m²
RL (TWL) (1% AEP)	6.00m AHD
10% AEP STORAGE REQUIRED	214m³
AREA AT TWL (10% AEP)	478m²
RL (TWL) (10% AEP)	5.45m AHD
20% AEP STORAGE REQUIRED	138m³
AREA AT TWL (20% AEP)	411m²
RL (TWL) (20% AEP)	5.28m AHD
1EY STORAGE REQUIRED	71m³
AREA AT TWL (1EY)	238m²
RL (TWL) (1EY)	5.10m AHD
PEAK OUTFLOW (1% AEP)	0.0l/s

BASIN DETAILS

TOTAL IMPERVIOUS AREA (1% AEP)	0.66ha
1% AEP STORAGE REQUIRED	517m³
AREA AT TWL (1% AEP)	910m²
RL (TWL) (1% AEP)	5.90m AHD
10% AEP STORAGE REQUIRED	240m³
AREA AT TWL (10% AEP)	353m²
RL (TWL) (10% AEP)	5.54m AHD
20% AEP STORAGE REQUIRED	172m³
AREA AT TWL (20% AEP)	333m²
RL (TWL) (20% AEP)	5.35m AHD
1EY STORAGE REQUIRED	70m³
AREA AT TWL (1EY)	231m²
RL (TWL) (1EY)	5.00m AHD
PEAK OUTFLOW (1% AEP)	0.0l/s

LEGEND

- CATCHMENT AREA
- EXISTING SURFACE CONTOURS
- FINISHED SURFACE CONTOURS
- 95% MGL WATER CONTOURS
- DRAINAGE BASIN
- FLOW ARROW
- MB01 — NAME; E 649,541m, N 494,638m; 5.4–0.00m — SURFACE LEVEL; 2.5m — DEPTH; Ø150 — BORE DIAMETER — MONITORING BORE
- 63.2% AEP STORAGE
- 20% AEP STORAGE
- 10% AEP STORAGE
- 1% AEP STORAGE
- PROPOSED DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT
- PROPOSED SUB-SOIL DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT
- EXISTING DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT

CATCHMENT DATA

CATCHMENT	TOTAL (m²)	LOT AREA (m²)	COMMERCIAL LOT AREA	ROAD RESERVE (m²)	POS (m²)
NORTH	19811	5463	8393	4202	1753
SOUTH	21170	12453	-	6633	2084
BALDIVIS RD	5761			5761	

NOTE:
REFER TO DRAWING BDVTER80 L05
FOR BASIN DETAILS

1:1000 (A1)

No.	DATE	BY	REVISION	
G	13/10/20	PMS	10% AEP TWL AMENDED, OVERFLOW NOTES ADDED	SRA
F	5/6/20	JEG	1EY LEVEL ADJUSTED IN STORM CELLS	SRA
E	12/2/2020	JEG	AMENDED UNDERGROUND STORAGE AND BASIN LEVELS	SRA
D	7/2/20	JEG	BASIN REDESIGN, CATCHMENTS AMENDMENTS	SRA
C	24/10/19	BWB	BASINS AMENDED TO NEW CATCHMENTS, BASIN DETAILS UPDATED	SRA
I	24/03/21	PMS	BASINS AMENDED	SRA
H	18/11/20	PMS	AMENDED TO SUIT LATEST PRECAL, BASINS AMENDED TO SUIT COUNCIL COMMENTS	SRA

CLIENT: MGP BALDIVIS PTY LTD

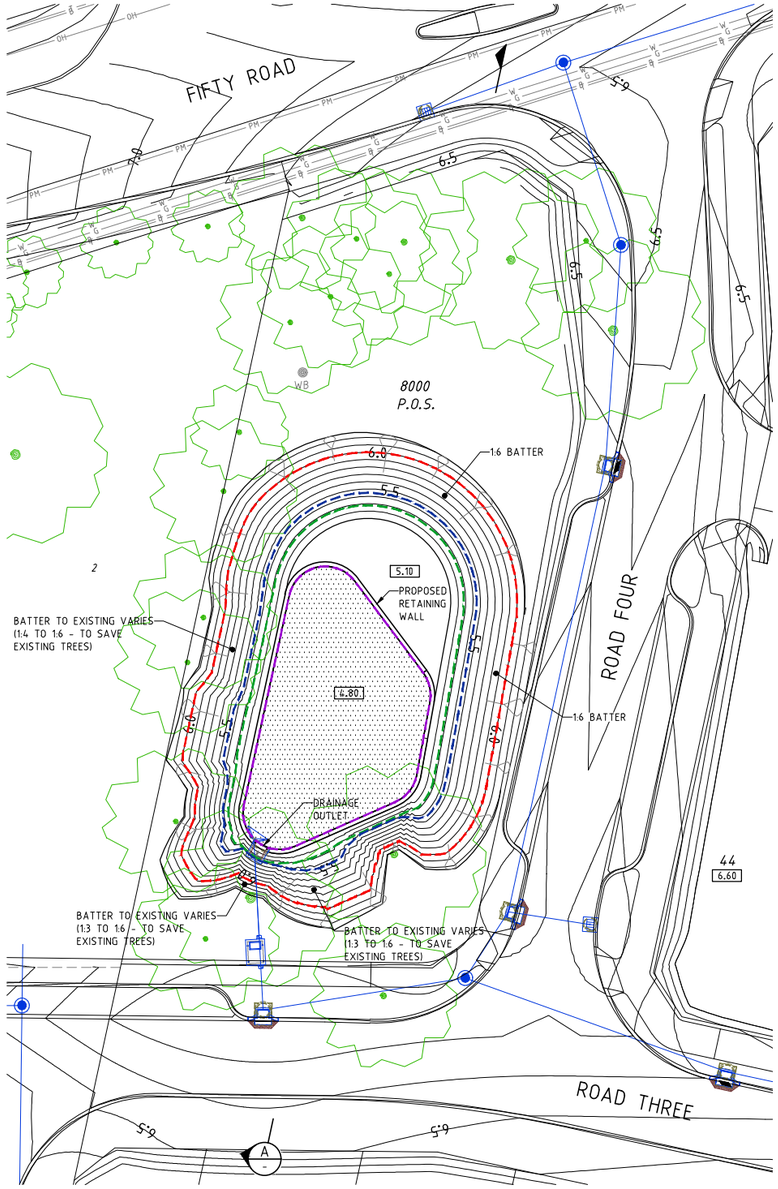
DEVELOPMENT ENGINEERING CONSULTANTS
SUITE 3, 123A COLIN ST, WEST PERTH, 6005 WESTERN AUSTRALIA
Ph: (08) 9481 1900
Fax: (08) 9481 1700

PROJECT: LOT 1 BALDIVIS ROAD BALDIVIS
W.A.P.C. No. -

DRAWING: POST DEVELOPMENT CATCHMENT PLAN
CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
1:1000	JEG	SRA	I
DATE	DESIGNED	APPROVED	
18/7/18	JEG	SRA	

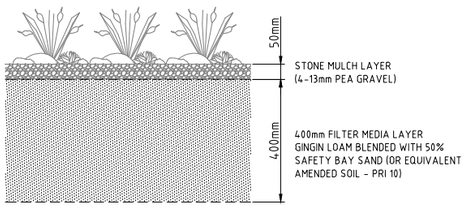
PROJECT NUMBER / DRAWING NUMBER: BDVTER80 L04
S:\TER\BDVTER80\Drawings\BDVTER80 L04.dwg25/03/2021



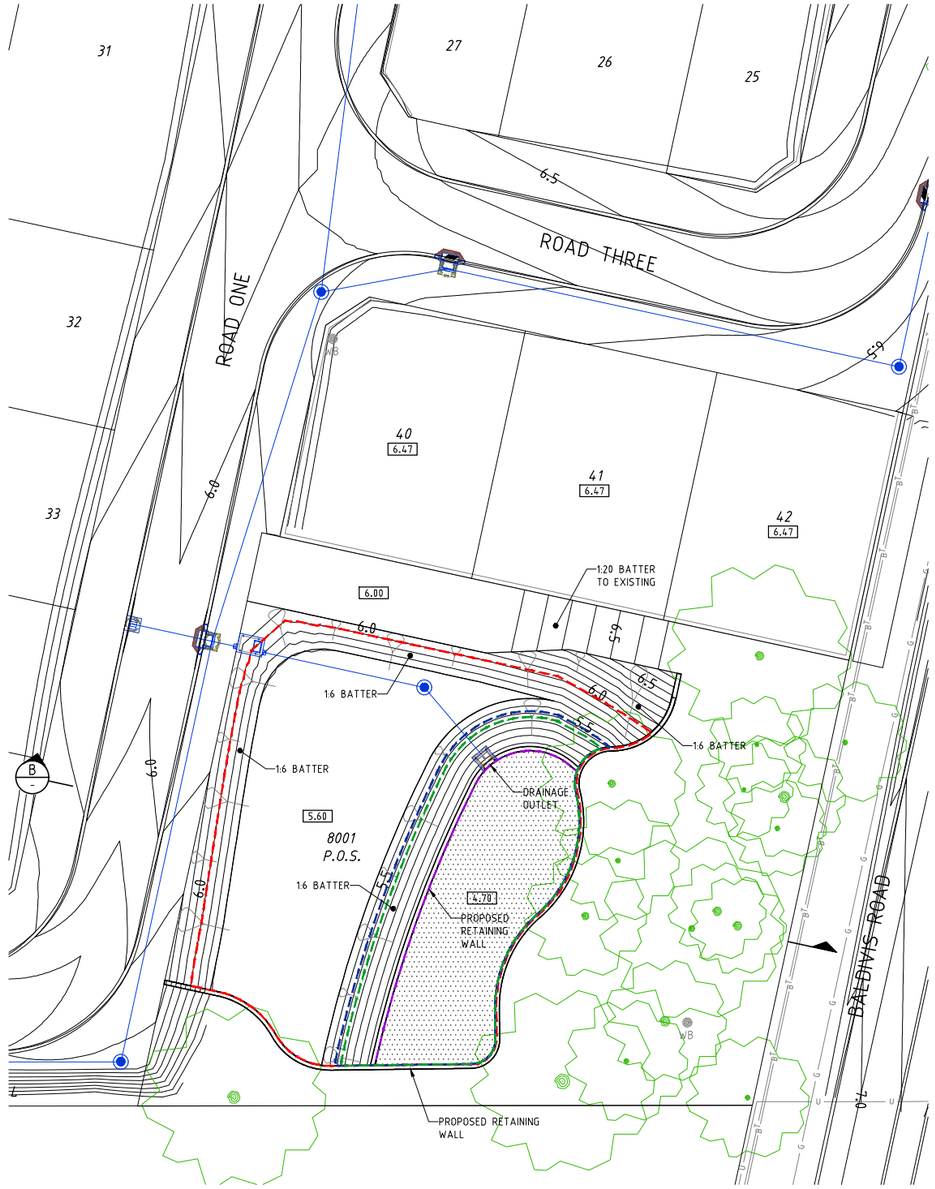
NORTH CATCHMENT BASIN PLAN
1:250

LEGEND

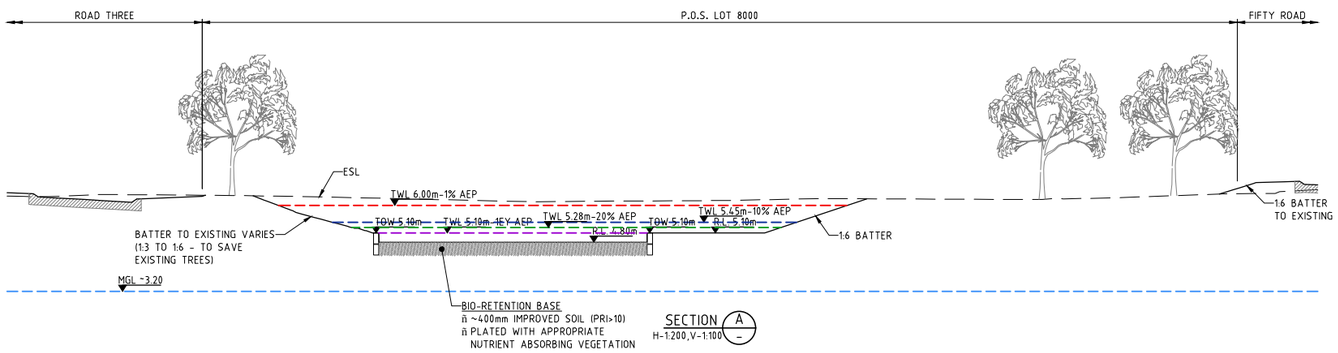
- 23 — FINISHED SURFACE CONTOURS
- DRAINAGE BASIN
- 63.2% AEP STORAGE
- 20% AEP STORAGE
- 10% AEP STORAGE
- 1% AEP STORAGE
- PROPOSED DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT
- PROPOSED SUB-SOIL DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT
- EXISTING DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT

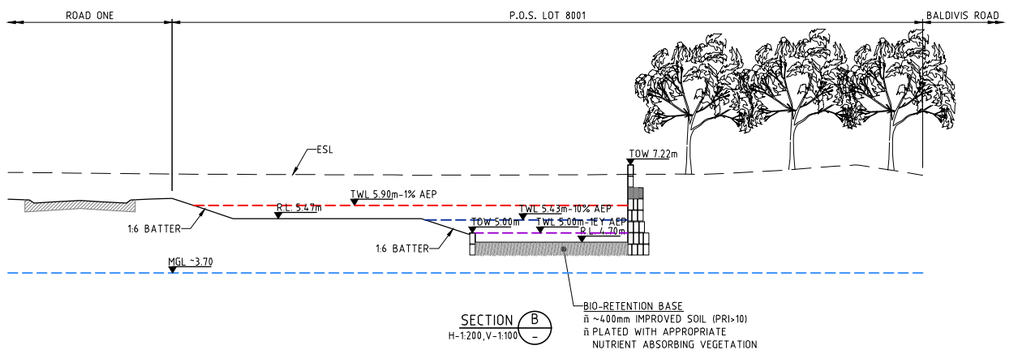


BIOFILTER ELEMENTS SECTION
N.T.S.



SOUTH CATCHMENT BASIN PLAN
1:250





HORIZ.- 1:200
VERT.- 1:100
(A1)

1:250
(A1)

No.	DATE	BY	REVISION
B	24/03/21	PMS	BASINS AMENDED — SRA
A	18/11/20	PMS	INITIAL ISSUE — SRA

CLIENT: MGP BALDIVIS PTY LTD

DEVELOPMENT ENGINEERING CONSULTANTS
SUITE 3, 123A COLIN ST,
WEST PERTH, 6005
WESTERN AUSTRALIA
Ph: (08) 9481 1900
Fax: (08) 9481 1700

PROJECT: LOT 1 BALDIVIS ROAD BALDIVIS
W.A.P.C. No. -

DRAWING: DRAINAGE SWALES PLAN & SECTIONS
CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
AS SHOWN	PMS	PMS	B
DATE	DESIGNED	APPROVED	
NOV '20	PMS	SRA	

PROJECT NUMBER / DRAWING NUMBER
BDVTER80 L05
S:\TER\BDVTER80\Drawings\BDVTER80 L05.dwg25/03/2021

DEVELOPMENT
ENGINEERING
CONSULTANTS

APPENDIX C

DRAINAGE CALCULATIONS

- **Drainage basin calculations**
- **At-lot detention calculations**

PCSump Version 6.1

Environmental and Water Resource Software

Project Number/Name: Lot 1 Baldivis Road, Baldivis

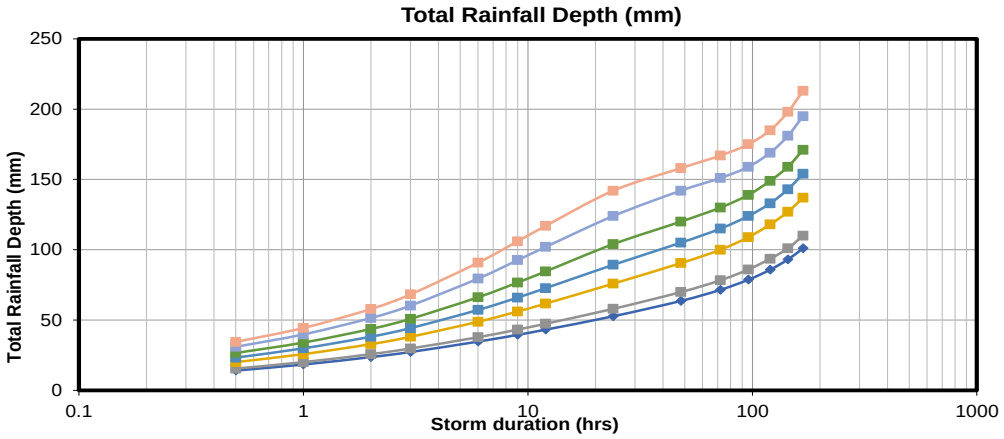
Project Description: Northern Basin

Model Selection:	Shallow Water Table Model
Design AEP(EY)/ARI	1% AEP (100 year ARI)
Design Rainfall Region:	Perth Metro
Design Rainfall Location:	Medina
Latitude:	-32.236185
Longitude:	115.805323
Temporal Pattern:	West Flatlands
Climate Change Selection (Y/N)	N
Effective Service Life	
Consequence of Failure	
Adjustment Applied	

Swale Selection (Y/N)	N

Total Rainfall Depth (mm)

Duration	EY	Annual Exceedance Probability (AEP)					
	1 EY	50%	20%	10%	5%	2%	1%
30 min	14.1	15.5	20.1	23.3	26.6	31	34.5
1 hour	18.4	20.1	25.8	29.9	34	39.8	44.4
2 hour	23.7	25.8	32.9	38.2	43.7	51.5	57.9
3 hour	27.3	29.8	38.1	44.3	50.9	60.3	68.3
6 hour	34.7	37.8	48.8	57.2	66.2	79.5	90.8
9 hour	39.5	43.3	56.1	66	76.7	92.6	106
12 hour	43.2	47.4	61.7	72.7	84.6	102	117
24 hour	52.7	58	75.9	89.3	104	124	142
48 hour	63.6	69.9	90.5	105	120	142	158
72 hour	71.5	78.3	100	115	130	151	167
96 hour	78.7	86	109	124	139	159	175
120 hour	85.8	93.6	118	133	149	169	185
144 hour	93.1	101	127	143	159	181	198
168 hour	101	110	137	154	171	195	213



Basin:

Type	Area (ha)	IL (mm)	CL (mm/hr)	PL(%)
Roads	0.4595			30.0%
Comm Lots	0.8089	24.43	4.57	

Resi Lots	0.5464	13.6	9.71	
Basin	0.0936			0.0%
POS	0.1094			100.0%

Basin Parameters:

Soil Characteristics:	
Saturated Hydraulic Cond. (m/day)	5
Clogged Layer Permeability (m/day)	
Clogged Layer Thickness (mm)	
Soil Suction (cm)	
Porosity	
Aquifer Storage Coefficient	0.2
Base of Aquifer (mAHD)	-16
Design Groundwater Level (mAHD)	4.2
Initial Conditions:	
Water Depth in Basin (m)	0
Wetting Front Depth (m)	0
Initial Degree of Soil Saturation (%)	0%
Basin Geometry:	
Stage-Area-Volume Relationship Entered (Y/N)	Y
Base Length (m)	17
Base Width (m)	14
Average Slope (1 in X)	5.5
Basin Base Elevation (mAHD)	4.8
Maximum Allowable TWL (mAHD)	6

Stage-Area-Volume Relationship:

Stage (mAHD)	Area (m^2)	Volume (m^3)
4.8	238	0
5.1	238	71
5.1001	336	73
6	863	593

Pipe Outflow:

Entrance Type	
Pipe Diameter (mm)	
Pipe Length (m)	
Upstream Invert Level (mAHD)	
Downstream Invert Level (mAHD)	

Weir Outflow:

Weir Type:	
Weir Coefficient	
Weir Width (m)	
Weir Level (mAHD)	

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Northern Basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	34.5	1%	0.65	5.45	0.55	276	541	8
	2	1 hour	44.4	1%	0.81	5.61	0.39	368	635	7
	3	2 hour	57.9	1%	0.97	5.77	0.23	457	725	9
	4	3 hour	68.3	1%	1.03	5.83	0.17	492	761	8
	5	6 hour	90.8	1%	1.09	5.89	0.11	527	796	5
	6	9 hour	106.0	1%	1.1	5.90	0.10	535	804	10
	7	12 hour	117.0	1%	0.96	5.76	0.24	454	722	1
	8	24 hour	142.0	1%	0.76	5.56	0.44	339	605	7
	9	48 hour	158.0	1%	0.42	5.22	0.78	142	406	2
	10	72 hour	167.0	1%	0.3	5.10	0.90	75	338	9
Critical	***6***	***9 hour***	***106.0***	***1%***	***1.1***	***5.90***	***0.10***	***535***	***804***	***10***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Northern Basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	23.3	10%	0.36	5.16	0.84	107	370	8
	2	1 hour	29.9	10%	0.44	5.24	0.76	155	419	5
	3	2 hour	38.2	10%	0.52	5.32	0.68	198	462	3
	4	3 hour	44.3	10%	0.55	5.35	0.65	215	480	4
	5	6 hour	57.2	10%	0.51	5.31	0.69	193	457	2
	6	9 hour	66.0	10%	0.48	5.28	0.72	176	440	5
	7	12 hour	72.7	10%	0.4	5.20	0.80	132	396	5
	8	24 hour	89.3	10%	0.25	5.05	0.95	58	238	8
	9	48 hour	105.0	10%	0	4.80	1.20	-	238	10
	10	72 hour	115.0	10%	0	4.80	1.20	-	238	10
Critical	***4***	***3 hour***	***44.3***	***10%***	***0.55***	***5.35***	***0.65***	***215***	***480***	***4***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Northern Basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	20.1	20%	0.31	5.11	0.89	81	344	7
	2	1 hour	25.8	20%	0.34	5.14	0.86	97	361	7
	3	2 hour	32.9	20%	0.41	5.21	0.79	137	401	5
	4	3 hour	38.1	20%	0.41	5.21	0.79	136	400	5
	5	6 hour	48.8	20%	0.38	5.18	0.82	120	383	7
	6	9 hour	56.1	20%	0.36	5.16	0.84	108	372	1
	7	12 hour	61.7	20%	0.33	5.13	0.87	90	353	4
	8	24 hour	75.9	20%	0.1	4.90	1.10	25	238	10
	9	48 hour	90.5	20%	0	4.80	1.20	-	238	1
	10	72 hour	100.0	20%	0	4.80	1.20	-	238	10
Critical	***3***	***2 hour***	***32.9***	***20%***	***0.41***	***5.21***	***0.79***	***137***	***401***	***5***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Northern Basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	14.1	1 EY	0.15	4.95	1.05	34	238	1
	2	1 hour	18.4	1 EY	0.17	4.97	1.03	40	238	6
	3	2 hour	23.7	1 EY	0.16	4.96	1.04	37	238	3
	4	3 hour	27.3	1 EY	0.14	4.94	1.06	32	238	3
	5	6 hour	34.7	1 EY	0.1	4.90	1.10	24	238	5
	6	9 hour	39.5	1 EY	0.03	4.83	1.17	6	238	6
	7	12 hour	43.2	1 EY	0	4.80	1.20	-	238	9
	8	24 hour	52.7	1 EY	0	4.80	1.20	-	238	1
	9	48 hour	63.6	1 EY	0	4.80	1.20	-	238	1
	10	72 hour	71.5	1 EY	0	4.80	1.20	-	238	1
Critical	***2***	***1 hour***	***18.4***	***1 EY***	***0.17***	***4.97***	***1.03***	***40***	***238***	***6***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSump Version 6.1

Environmental and Water Resource Software

Project Number/Name: Lot 1 Baldivis Road, Baldivis

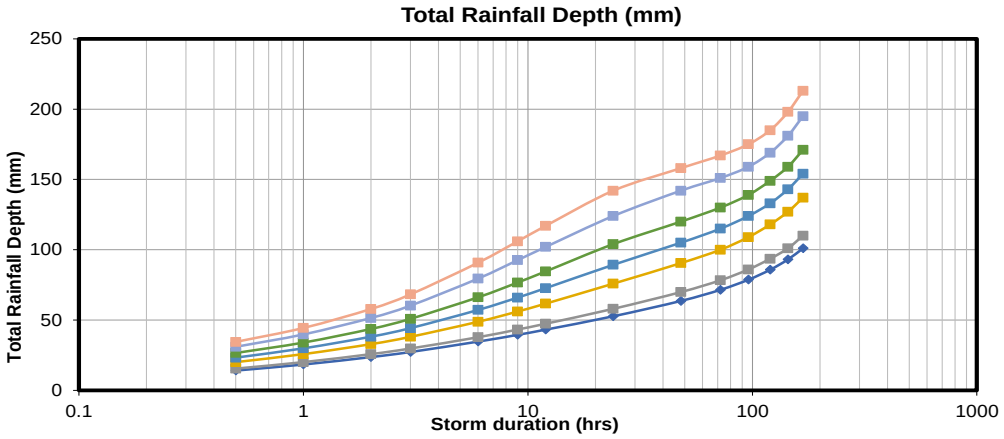
Project Description: Southern basin

Model Selection:	Shallow Water Table Model
Design AEP(EY)/ARI	1% AEP (100 year ARI)
Design Rainfall Region:	Perth Metro
Design Rainfall Location:	Medina
Latitude:	-32.236185
Longitude:	115.805323
Temporal Pattern:	West Flatlands
Climate Change Selection (Y/N)	N
Effective Service Life	
Consequence of Failure	
Adjustment Applied	

Swale Selection (Y/N)	N

Total Rainfall Depth (mm)

Duration	EY	Annual Exceedance Probability (AEP)					
	1 EY	50%	20%	10%	5%	2%	1%
30 min	14.1	15.5	20.1	23.3	26.6	31	34.5
1 hour	18.4	20.1	25.8	29.9	34	39.8	44.4
2 hour	23.7	25.8	32.9	38.2	43.7	51.5	57.9
3 hour	27.3	29.8	38.1	44.3	50.9	60.3	68.3
6 hour	34.7	37.8	48.8	57.2	66.2	79.5	90.8
9 hour	39.5	43.3	56.1	66	76.7	92.6	106
12 hour	43.2	47.4	61.7	72.7	84.6	102	117
24 hour	52.7	58	75.9	89.3	104	124	142
48 hour	63.6	69.9	90.5	105	120	142	158
72 hour	71.5	78.3	100	115	130	151	167
96 hour	78.7	86	109	124	139	159	175
120 hour	85.8	93.6	118	133	149	169	185
144 hour	93.1	101	127	143	159	181	198
168 hour	101	110	137	154	171	195	213



Basin:

Type	Area (ha)	IL (mm)	CL (mm/hr)	PL(%)
Roads	0.6703			30.0%
Comm Lots		24.43	4.57	

Resi Lots	1.2723	13.6	9.71	
Basin	0.1039			0.0%
POS	0.0765			100.0%

Basin Parameters:

Soil Characteristics:	
Saturated Hydraulic Cond. (m/day)	5
Clogged Layer Permeability (m/day)	
Clogged Layer Thickness (mm)	
Soil Suction (cm)	
Porosity	
Aquifer Storage Coefficient	0.2
Base of Aquifer (mAHD)	-16
Design Groundwater Level (mAHD)	3.8
Initial Conditions:	
Water Depth in Basin (m)	0
Wetting Front Depth (m)	0
Initial Degree of Soil Saturation (%)	0%
Basin Geometry:	
Stage-Area-Volume Relationship Entered (Y/N)	Y
Base Length (m)	21
Base Width (m)	11
Average Slope (1 in X)	4.9
Basin Base Elevation (mAHD)	4.7
Maximum Allowable TWL (mAHD)	5.9

Stage-Area-Volume Relationship:

Stage (mAHD)	Area (m^2)	Volume (m^3)
4.7	231	0
5	231	189
5.6	383	252
5.6001	923	255
5.9	1117	557

Pipe Outflow:

Entrance Type	
Pipe Diameter (mm)	
Pipe Length (m)	
Upstream Invert Level (mAHD)	
Downstream Invert Level (mAHD)	

Weir Outflow:

Weir Type:	
Weir Coefficient	
Weir Width (m)	
Weir Level (mAHD)	

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Southern basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	34.5	1%	1.01	5.71	0.19	368	996	8
	2	1 hour	44.4	1%	1.08	5.78	0.12	438	1,041	10
	3	2 hour	57.9	1%	1.15	5.85	0.05	507	1,085	9
	4	3 hour	68.3	1%	1.14	5.84	0.06	500	1,080	2
	5	6 hour	90.8	1%	1.13	5.83	0.07	485	1,071	1
	6	9 hour	106.0	1%	1.13	5.83	0.07	491	1,075	1
	7	12 hour	117.0	1%	0.96	5.66	0.24	310	959	5
	8	24 hour	142.0	1%	0.54	5.24	0.66	214	291	7
	9	48 hour	158.0	1%	0.02	4.72	1.18	10	231	9
	10	72 hour	167.0	1%	0	4.70	1.20	-	231	10
Critical	***3***	***2 hour***	***57.9***	***1%***	***1.15***	***5.85***	***0.05***	***507***	***1,085***	***9***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Southern basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	23.3	10%	0.29	4.99	0.91	183	231	5
	2	1 hour	29.9	10%	0.57	5.27	0.63	217	299	6
	3	2 hour	38.2	10%	0.64	5.34	0.56	225	317	2
	4	3 hour	44.3	10%	0.65	5.35	0.55	226	320	4
	5	6 hour	57.2	10%	0.24	4.94	0.96	151	231	7
	6	9 hour	66.0	10%	0.18	4.88	1.02	116	231	10
	7	12 hour	72.7	10%	0.09	4.79	1.11	53	231	10
	8	24 hour	89.3	10%	0	4.70	1.20	-	231	10
	9	48 hour	105.0	10%	0	4.70	1.20	-	231	1
	10	72 hour	115.0	10%	0	4.70	1.20	-	231	10
Critical	***4***	***3 hour***	***44.3***	***10%***	***0.65***	***5.35***	***0.55***	***226***	***320***	***4***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Southern basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	20.1	20%	0.2	4.90	1.00	128	231	8
	2	1 hour	25.8	20%	0.25	4.95	0.95	155	231	2
	3	2 hour	32.9	20%	0.26	4.96	0.94	164	231	9
	4	3 hour	38.1	20%	0.22	4.92	0.98	140	231	6
	5	6 hour	48.8	20%	0.14	4.84	1.06	88	231	3
	6	9 hour	56.1	20%	0.09	4.79	1.11	59	231	3
	7	12 hour	61.7	20%	0.05	4.75	1.15	28	231	10
	8	24 hour	75.9	20%	0	4.70	1.20	-	231	10
	9	48 hour	90.5	20%	0	4.70	1.20	-	231	1
	10	72 hour	100.0	20%	0	4.70	1.20	-	231	1
Critical	***3***	***2 hour***	***32.9***	***20%***	***0.26***	***4.96***	***0.94***	***164***	***231***	***9***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

PCSUMP
Environmental and Water Resource Software

Project Number / Name:

Lot 1 Baldivis Road, Baldivis

Project Description:

Southern basin

Model Selection: **Shallow Water Table Model**

Results:

	Design Storms				Maximum (Mean of Temporal Patterns)					
	Storm	Duration [hrs]	Rainfall Depth [mm]	EY/AEP [%]	Depth [m]	Level [mAHD]	Clearance to Allowable TWL [m]	Volume [m^3]	Area [m^2]	Temporal Pattern No.
	1	30 min	14.1	1 EY	0.07	4.77	1.13	43	231	1
	2	1 hour	18.4	1 EY	0.09	4.79	1.11	58	231	2
	3	2 hour	23.7	1 EY	0.09	4.79	1.11	55	231	3
	4	3 hour	27.3	1 EY	0.05	4.75	1.15	34	231	1
	5	6 hour	34.7	1 EY	0	4.70	1.20	2	231	10
	6	9 hour	39.5	1 EY	0	4.70	1.20	-	231	10
	7	12 hour	43.2	1 EY	0	4.70	1.20	-	231	9
	8	24 hour	52.7	1 EY	0	4.70	1.20	-	231	1
	9	48 hour	63.6	1 EY	0	4.70	1.20	-	231	1
	10	72 hour	71.5	1 EY	0	4.70	1.20	-	231	1
Critical	***2***	***1 hour***	***18.4***	***1 EY***	***0.09***	***4.79***	***1.11***	***58***	***231***	***2***

Notes:

Temporal pattern matching closest to mean water level

If Water Level is coloured Red, Maximum Capacity of the Basin has been Exceeded

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: **Lot 1 Baldivis Road, Baldivis**

Client: **Baldivis Homes Pty Ltd**

Location: **At-lot detention calculations to establish runoff coefficient**

Designer: **JPF**

Location:	**Lot 1 Baldivis Road**			
Nearest grid cell:	**Latitude**	**32.3125(S)**	**Longitude**	**115.8125(E)**

Data to be input

Rainfall AEP (percentage)	1	ARI	v Descriptor v
1EY impervious catchment (Ha)	0.025	100	Infrequent
Required storage (1EY - 1hr) (m^3)	3.881		

Catchment details	Paved area	Unpaved area	Total
Lot area (m^2)			**400.00**
Proportion paved	**70%**	**30%**	**100%**
Area paved (Ha)	**0.028**	**0.012**	**0.040**
Runoff coefficient (C_{10})	0.90	0.00	
ARI multiplier	1.00	1.20	
Runoff coefficient (C_y)	0.90	0.00	
Impervious area (Ha)	**0.025**	**0.000**	**0.025**

Effective C **0.63**

AEP	ARI	Effective C	Multiplier
63.2	1	0	-
50	1.44	0	-
20	4.48	0	-
10	9.49	0	-
5	20	0	-
2	50	0.05	-
1	100	0.11	-

Volume and dimensions of available storage

Area above ground inundated to 0.03m deep (backyard and front yard) (m^2)	40.00	0.03	1.20
Storage provided manholes/pipe (m^3)	-		
Number of soakwells	2.00		
Diameter of soakwells (m)	1.50		
Depth of each soakwell (m)	1.20		
Storage required soakwells (m^3)	**4.24**		
Strorage provided (m^3)	5.44		
Effective Initial Loss (mm)	**13.60**		
Soakage rate (L/s/m^2)	0.020	*1.70*	*m/day*

NOTE: All water is retained in soakwells up to and including 5% AEP (1 in 20yr ARI) without surcharge. For greater AEP storms water will surcharge soakwells and soak over an area of 40m² to a maximum depth of 30mm within the lot, and then enter the road drainage system.

Volume of storage required is 1m^3 per	**59.42**	**m^2**	**of paved lot area**
Volume of storage required is 1m^3 per	**73.51**	**m^2**	**of total lot area**

T_C (min)	T_C (hr)	I (mm/hr)	Q_{IN} (L/s)	Total V_{IN} (m^3)	Q_{OUT} (soakage) (L/s)	Effective Continuing Loss (mm/hr)	V_{OUT} (soakage) (m^3)	Net storage (after soakage) (m^3)	V_{OUT} required (m^3)	Q_{OUT} (L/s)
10	0.17	131.00	9.2	5.50	1.08	**9.71**	0.65	4.85	0.00	0.00
15	0.25	106.00	7.4	6.68	1.08	**9.71**	0.97	5.71	0.27	0.30
20	0.33	89.10	6.2	7.48	1.08	**9.71**	1.29	6.19	0.75	0.62
30	0.50	69.10	4.8	8.71	1.08	**9.71**	1.94	6.76	1.32	0.74
45	0.75	53.10	3.7	10.04	1.08	**9.71**	2.91	7.12	1.68	0.62
60	1.00	44.10	3.1	11.11	1.08	**9.71**	3.88	7.23	1.79	0.50
90	1.50	34.20	2.4	12.93	1.08	**9.71**	5.83	7.10	1.66	0.31
120	2.00	28.60	2.0	14.41	1.08	**9.71**	7.77	6.64	1.20	0.17
150	2.50	25.00	1.8	15.75	1.08	**9.71**	9.71	6.04	0.60	0.07
180	3.00	22.50	1.6	17.01	1.08	**9.71**	11.65	5.36	0.00	0.00
240	4.00	19.00	1.3	19.15	1.08	**9.71**	15.54	3.61	0.00	0.00
300	5.00	16.70	1.2	21.04	1.08	**9.71**	19.42	1.62	0.00	0.00
360	6.00	15.00	1.1	22.68	1.08	**9.71**	23.31	-0.63	0.00	0.00
480	8.00	12.60	0.9	25.40	1.08	**9.71**	31.08	-5.68	0.00	0.00
720	12.00	9.76	0.7	29.51	1.08	**9.71**	46.62	-17.10	0.00	0.00
960	16.00	8.02	0.6	32.34	1.08	**9.71**	62.16	-29.82	0.00	0.00
1440	24.00	5.95	0.4	35.99	1.08	**9.71**	93.23	-57.25	0.00	0.00
2880	48.00	3.35	0.2	40.52	1.08	**9.71**	186.47	-145.95	0.00	0.00
4320	72.00	2.35	0.2	42.64	1.08	**9.71**	279.70	-237.07	0.00	0.00

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lot 1 Baldivis Road, Baldivis

Client: Baldivis Homes Pty Ltd

Location: At-lot detention calculations to establish runoff coefficient - commercial-type site

Designer: SRA

Location:	**Lot 1 Baldivis Road**			
Nearest grid cell:	**Latitude**	**32.3125(S)**	**Longitude**	**115.8125(E)**

DEVELOPMENT ENGINEERING CONSULTANTS

Data to be Input

		ARI	v Descriptor v
Rainfall AEP (Percentage)	1	100	Infrequent
1EY Impervious Catchment (Ha)	0.810		
Required Storage (1EY - 1hr) (m^3)	124.740		

Catchment Details	Paved Area	Unpaved area	Total
Lot Area (SQM)			**10000.00**
Proportion Paved	**90%**	**10%**	**100%**
Area Paved (Ha)	**0.900**	**0.100**	**1.000**
Run-Off Co-efficient(C10)	0.90	0.00	
ARI Multiplier	1.00	1.20	
Run-Off Co-efficient(Cy)	0.90	0.00	
Impervious Area(Ha)	**0.810**	**0.000**	**0.810**

Effective C
0.81

AEP	ARI	Effective C	Multiplier
63.2	1	0	-
50	1.44	0	-
20	4.48	0	-
10	9.49	0	-
5	20	0.09	-
2	50	0.21	-
1	100	0.28	-

Volume and Dimensions of Available Storage

Area above ground inundated to 0.03m deep (backyard and front yard) (m^2)	-	0.03	-
Storage provided manholes/pipe (m^3)	-		
Number of Soakwells	40.00		
Diameter of soakwells (m)	1.80		
Depth of each soakwell (m)	2.40		
Storage required soakwells (m^3)	**244.29**		
Strorage provided (m^3)	244.29		
Effective Initial Loss (mm)	**24.43**		
Soakage rate (l/s/m^2)	0.020	*1.70 m/day*	

NOTE: All water is retained in soakwells up to and including 10% AEP (1 in 10yr ARI) without surcharge. For greater AEP storms water will surcharge soakwells and enter the road drainage system.

Volume of storage required is 1m^3 per	**40.93**	**m^2**	**of total lot area**
Alternatively storage required is 1m^3 per	**36.84**	**m^2**	**of paved area**

T_C (mins)	T_C (hrs)	I (mm/hr)	Q_{IN} (l/s)	Total V_{IN} (m^3)	Q_{OUT} (soakage) (l/s)	Effective Continuing Loss (mm/hr)	V_{OUT} (soakage) (m^3)	Net storage (after soakage) (m^3)	V_{OUT} required (m^3)	Q_{OUT} (l/s)
10	0.17	131.00	294.8	176.85	12.68	**4.57**	7.61	169.24	0.00	0.00
15	0.25	106.00	238.5	214.65	12.68	**4.57**	11.42	203.23	0.00	0.00
20	0.33	89.10	200.5	240.57	12.68	**4.57**	15.22	225.35	0.00	0.00
30	0.50	69.10	155.5	279.86	12.68	**4.57**	22.83	257.02	12.73	7.08
45	0.75	53.10	119.5	322.58	12.68	**4.57**	34.25	288.34	44.04	16.32
60	1.00	44.10	99.2	357.21	12.68	**4.57**	45.66	311.55	67.26	18.69
90	1.50	34.20	77.0	415.53	12.68	**4.57**	68.49	347.04	102.75	19.03
120	2.00	28.60	64.4	463.32	12.68	**4.57**	91.33	371.99	127.70	17.74
150	2.50	25.00	56.3	506.25	12.68	**4.57**	114.16	392.09	147.80	16.43
180	3.00	22.50	50.6	546.75	12.68	**4.57**	136.99	409.76	165.47	15.32
240	4.00	19.00	42.8	615.60	12.68	**4.57**	182.65	432.95	188.66	13.10
300	5.00	16.70	37.6	676.35	12.68	**4.57**	228.32	448.03	203.74	11.32
360	6.00	15.00	33.8	729.00	12.68	**4.57**	273.98	455.02	210.73	9.76
480	8.00	12.60	28.4	816.48	12.68	**4.57**	365.30	451.18	206.89	7.18
720	12.00	9.76	22.0	948.67	12.68	**4.57**	547.96	400.72	156.43	3.62
960	16.00	8.02	18.0	1039.39	12.68	**4.57**	730.61	308.78	64.49	1.12
1440	24.00	5.95	13.4	1156.68	12.68	**4.57**	1095.91	60.77	0.00	0.00
2880	48.00	3.35	7.5	1302.48	12.68	**4.57**	2191.83	-889.35	0.00	0.00
4320	72.00	2.35	5.3	1370.52	12.68	**4.57**	3287.74	-1917.22	0.00	0.00

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APPENDIX D

DRAINAGE DETAILS

- **Plan E landscape concept plan**

ENTRY STATEMENT (FEATURE WALL / ARTWORK)

FEATURE DECIDUOUS TREES ON STREET CORNERS (IE. BRACHYCHITON SP)

NATIVE GROUNDCOVER PLANTING UNDER EXISTING TREES

RETAIN SIGNIFICANT TREES

FEATURE BENCH SEATS

FLAT TURF AREA FOR VERSATILE USE SPACE

SEATING AREA WITH POSSIBLE DECK STRUCTURE OVERLOOKING BASIN

SLOPING TURF AREA

UNDERGROUND WATER STORAGE

LIMESTONE BLOCK RETAINING WALL

PLANTED DRAINAGE BASIN WITH LOW WETLAND SPECIES

SLOPING 1:3 VEGETATED BANKS WITH NATIVE GROUNDCOVER AND TREE PLANTINGS

BOULEVARD WITH FEATURE ROAD PAVEMENT LINED WITH DECIDUOUS TREES IE. PYRUS SP

EXISTING TREES TO RETAIN

SIGNIFICANT TREES

LOT 1, BALDIVIS ROAD

LANDSCAPE CONCEPT PLAN - POS NORTH

MARCH 2021

JOB NO. 1802501

1:150 @ A1

C1.101

REV E

0 1.5 3 6 9 15m

PLAN E

LANDSCAPE ARCHITECTS

414 ROKEBY RD SUBIACO WA 6008

T: (08) 9388 9566 E: mail@plane.com.au

STREET TREE PLANTING
IE. TUARTS

UNDERGROUND WATER STORAGE

WINDING GREY CONCRETE PATHWAY

FEATURE BENCH SEATS

FEATURE DECIDUOUS TREES (IE. BRACHYCHITON SP)

FLAT TURF AREA FOR VERSATILE USE SPACE

PLANTED DRAINAGE BASIN WITH LOW WETLAND SPECIES

RETAIN SIGNIFICANT TREES

LIMESTONE BLOCK RETAINING WALL

NATIVE GROUNDCOVER PLANTING UNDER EXISTING TREES

EXISTING TREES TO RETAIN

SIGNIFICANT TREES

LOT 1, BALDIVIS ROAD

LANDSCAPE CONCEPT PLAN - POS SOUTH
MARCH 2021

JOB NO. 1802501
1:150 @ A1

C1.102

REV E

0 1.5 3 6 9 15m

PLAN E
LANDSCAPE ARCHITECTS
414 ROKEBY RD SUBIACO WA 6008
T: (08) 9388 9566 E: mail@plane.com.au

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APPENDIX E

- **95 Percentile Groundwater Calculations**
- **DWER Bore Locations**
- **Previous LWMS Groundwater Plan**
- **Measured Groundwater Levels Bores SP1 and SP2 in 2013 and 2016**
- **Greenlea UWMP MGL levels and CGL adjustment plans.**
- **Groundwater license details from Water WA Website**

Comparison Between DWER Bore Records and Site Measured Records

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DWER records - 2018

	Last 20 years				Difference between:		
Bore	AAMGL	Historic MGL	95th %ile MGL	2018 MGL	2018 MGL & AAMGL	2018 MGL & historic MGL	2018 MGL & 95th %ile MGL
61410063	1.749	2.525	2.351	2.377	-0.628	0.148	-0.026
61410064	1.955	2.560	2.490	2.508	-0.554	0.052	-0.018
61410073	1.685	2.028	2.002	N/A	N/A	N/A	N/A
Average					**-0.628**	**0.100**	**-0.022**

On-site monitoring records - 2018

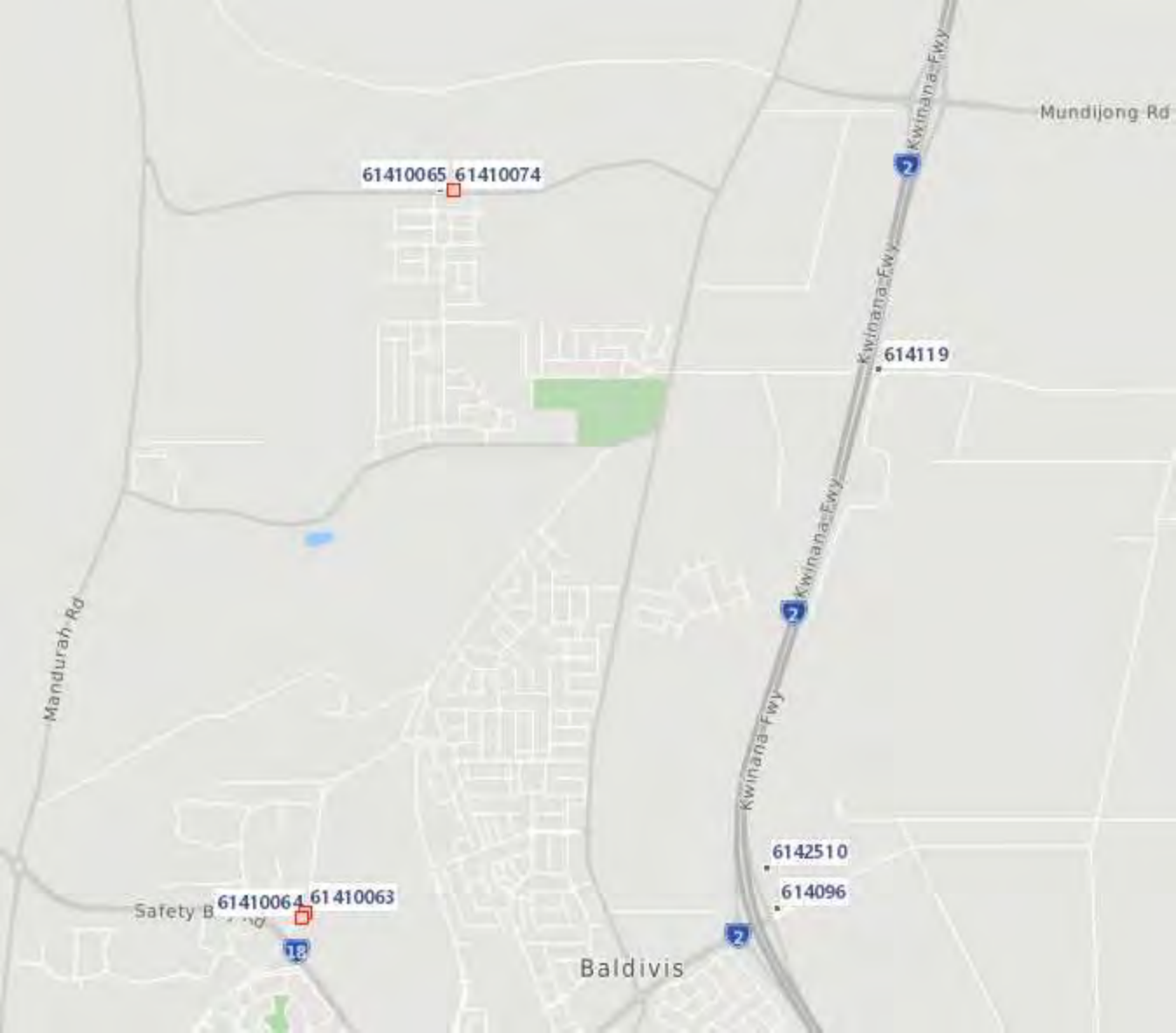
Bore	Recorded level (mAHD)	Add diff. between 2018 & 95th %ile	Effective 95th %ile GWL	Add diff. between 2018 & AAMGL	Effective AAMGL
MB1	3.180	-0.022	3.158	-0.628	2.552
MB2	4.190	-0.022	4.168	-0.628	3.562
MB3	3.270	-0.022	3.248	-0.628	2.642
MB4	3.030	-0.022	3.008	-0.628	2.402
MB5	3.870	-0.022	3.848	-0.628	3.242

DWER records - 2016

	Last 20 years				Difference between:		
Bore	AAMGL	Historic MGL	95th %ile MGL	2016 MGL	2016 MGL & AAMGL	2016 MGL & historic MGL	2016 MGL & 95th %ile MGL
61410063	1.749	2.525	2.351	1.737	0.012	0.788	0.614
61410064	1.955	2.560	2.490	1.728	0.227	0.832	0.762
61410073	1.685	2.028	2.002	N/A	N/A	N/A	N/A
Average					**0.012**	**0.810**	**0.688**

On-site monitoring records - 2016

Bore	Recorded level (mAHD)	Add diff. between 2016 & 95th %ile	Effective 95th %ile GWL	Add diff. between 2016 & AAMGL	Effective AAMGL
MW1	1.495	0.688	2.183	0.012	1.507
MW2	1.725	0.688	2.413	0.012	1.737
SP1	2.030	0.688	2.718	0.012	2.042
SP2	2.662	0.688	3.350	0.012	2.674
SP9	1.437	0.688	2.125	0.012	1.449
NBAL01	1.735	0.688	2.423	0.012	1.747
NBAL03	2.140	0.688	2.828	0.012	2.152


Mundijong Rd
61410065
61410074
Kwinana Fwy
614119
Kwinana Fwy
Kwinana Fwy
Mandurah Rd
6142510
614096
61410064
61410063
Safety B
Baldivis

N

0 50 100 150 200m

SCALE 1 : 5 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Topographic Contour
- Groundwater Contour (mAHD)

Depth to Groundwater

- <1m
- <2m
- <3m
- <4m
- <5m
- <6m
- <7m
- <8m
- <9m
- <10m
- <11m
- <12m
- <13m

Lot 313
Lot 312
Lot 2
Lot 4
Lot 8
Lot 5
Lot 7

FIFTY ROAD
MCDONALD ROAD
EIGHTY ROAD
INGRAM ROAD
BALDIVIS ROAD

6 425 000mN
6 424 500mN
6 424 000mN
387 500mE
388 000mE
388 500mE
389 000mE

CONTOUR SOURCE: Landgate, March 2011.
CADASTRAL SOURCE: Landgate, December 2010.
GROUNDWATER CONTOURS SOURCE: DoW, May 2003.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2010.

SPABAL06-f05.dgn
PINPOINT CARTOGRAPHICS (08) 9562 7136

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
NORTH BALDIVIS

Drawn: R. Epworth | Date: 21 Mar 2012
Job: SPABAL06 | Revision: A

PREDEVELOPMENT SEPARATION DISTANCES TO GROUNDWATER

Figure 5

GROUNDWATER SAMPLE LOG & FIELD CHEMICAL DATA

Site name: BALDWIN RD
Location: LOT 1 BALDWIN RD

Date: 20/11/18
Name: MM
Casing Diameter: 50MM

Well No.	Time	PID (ppm,)	SWL (mBTOC)	Depth of Well (mBTOC)	Purged Volume (L)	Temp (oC) (±3%)	E. Cond (µS/cm) (±3%)	TDS (mg/L) (±3%)	DO (mg/L) (±10%/0.2)	pH (±0.1)	ORP (±10mv)	Odour	Sheen	Colour	Turbidity	Sediment Load	Notes
MB3	13:05	–	3.918	5.934	1.0	19.0	1115	871	1.37	5.83	150.7	NIL	NIL	GREYISH	LOW	MOD	CLOUDY GREY, NO IRON
	13:08				2.0	18.9	1187	877	1.34	5.70	146.3	↓	↓	↓	↓	LOW	SHEENING.
	13:11				3.0	19.0	1216	890	1.30	5.69	142.6			C/LESS		↓	
	13:14				4.0	18.9	1267	929	1.34	5.67	135.1			↓			
	13:17				5.0	18.8	1261	929	1.35	5.67	134.1						
	13:20				6.0	18.8	1270	936	1.31	5.67	132.5						
	13:23				7.0	18.9	1279	939	1.34	5.67	132.0	↓	↓	↓	↓	↓	
MB5	13:34	–	3.616	5.928	1.0	19.4	481.5	350	0.14	6.44	-41.6	WEAK	NIL	GREYISH	LOW	LOW	WEAK SULPHUR ODOUR
	15:37				2.0	19.4	477.1	346	0.12	6.36	-38.0						
	13:40				3.0	19.4	457.3	340	0.11	6.33	-37.5						
	13:43				4.0	19.4	465.2	339	0.10	6.35	-37.9						
	13:46				5.0	19.4	469.1	341	0.10	6.32	-41.5						
	13:49				6.0	19.4	468.3	340	0.10	6.33	-41.6	↓	↓	↓	↓	↓	
MB4	14:04	–	4.703	6.466	1.0	19.6	2324	1688	3.66	6.60	99.0	NIL	NIL	GREYISH	MOD	MOD	CLOUDY GREEN, NO IRON
	14:08				2.0	19.5	2344	1703	3.76	6.60	104.2				LOW	LOW	SHEENING.
	14:11				3.0	19.5	2355	1709	3.98	6.57	106.9						
	14:14				4.0	19.6	2367	1716	3.97	6.55	108.3						
	14:16				5.0	19.6	2359	1716	4.24	6.53	110.7.						
	14:18				6.0	19.5	2387	1735	4.57	6.51	111.9						
	14:21				7.0	19.5	2373	1722	4.57	6.49	112.2	↓	↓	↓	↓	↓	
EXMB	14:40	–	4.367	–	–	19.1	3809	278	0.49	7.03	82.6	NIL	NIL	C/LESS	LOW	LOW	GRAB SAMPLE COLOURLESS
MB1	14:58	–	3.919	5.835	1.0	18.6	1639	1215	0.16	6.95	43.6	NIL	NIL	GREYISH	LOW	LOW	
	15:00				2.0	18.6	1645	1222	0.14	6.93	35.1						GREYISH, NIL ODOUR +
	15:02				3.0	18.5	1647	1222	0.10	6.92	25.7.						NO IRON SHEENING.
	15:05				4.0	18.5	1629	1209	0.09	6.89	20.6						
	15:08				5.0	18.5	1612	1202	0.08	6.88	15.2						
	15:11				6.0	18.5	1619	1202	0.09	6.88	14.0	↓					

1m of 50 mm well length=~1.96 L

(Dup) / Split collected from Monitor Well #: MB5. (DUP-1)

Sampling Method : PERI-PUMP (LOW FLOW)

GROUNDWATER SAMPLE LOG & FIELD CHEMICAL DATA

Site name: Lot 1 BALDIVIS RD
Location: BALDIVIS

Date: 20/11/18
Name: MM
Casing Diameter: 50MM

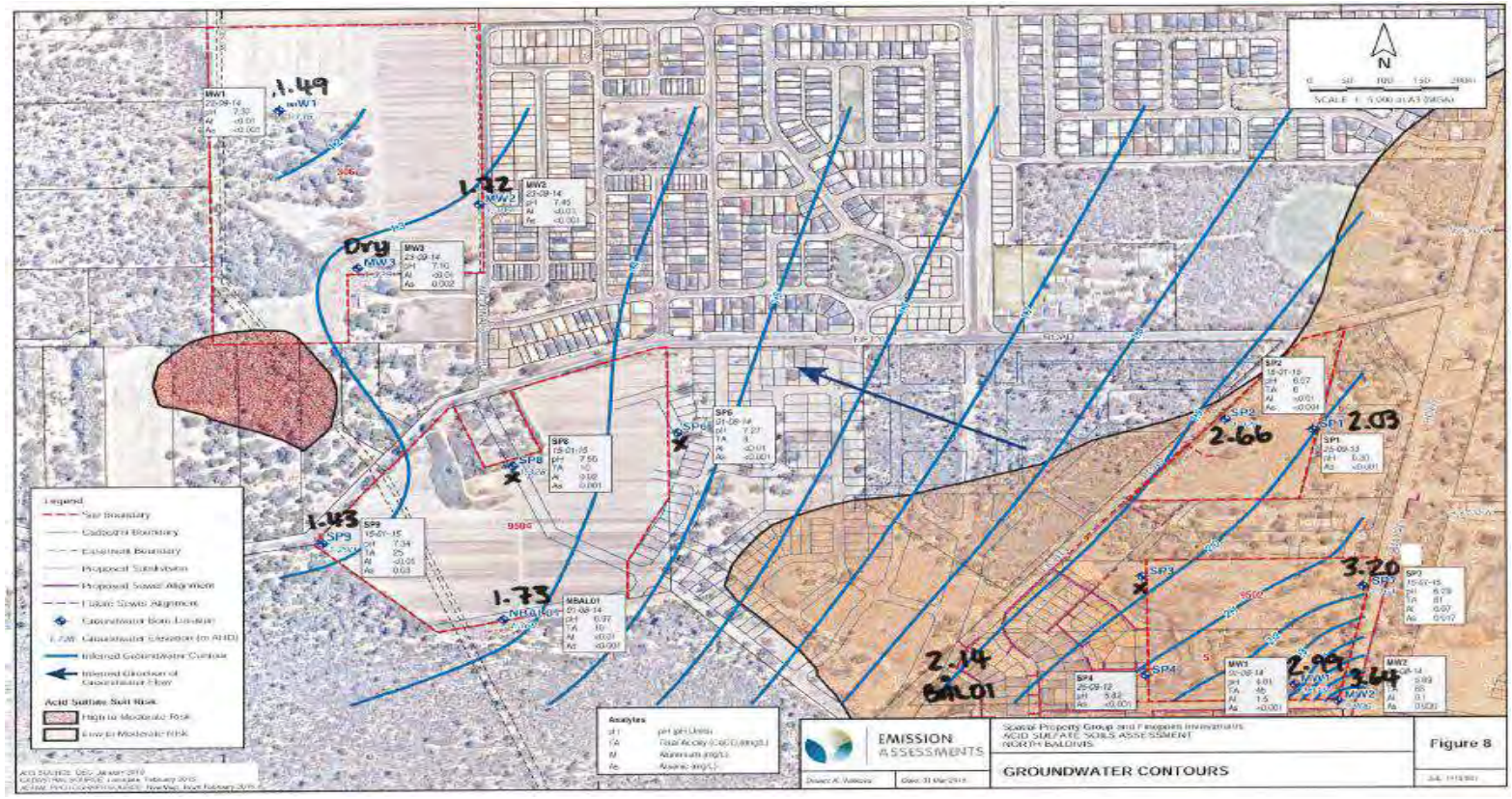
Well No.	Time	PID (ppm$_v$)	SWL (mBTOC)	Depth of Well (mBTOC)	Purged Volume (L)	Temp (oC) (±3%)	E. Cond (µS/cm) (±3%)	TDS (mg/L) (±3%)	DO (mg/L) (±10%/0.2)	pH (±0.1)	ORP (±10mv)	Odour	Sheen	Colour	Turbidity	Sediment Load	Notes
MB2	15:27	—	2.473	4.631	1.0	20.4	482.2	343	0.12	6.85	-54.7	NIL	NIL	C/LESS	LOW	LOW	NO IRON SCREENING, WATER
	15:30				2.0	20.3	501	357	0.05	6.75	-61.7	↓	↓	↓	↓	↓	CONTENT BECOMING BROWNISH
	15:33				3.0	20.3	490.1	350	0.06	6.75	-59.2	↓	↓	BROWN	↓	↓	@ 3.0L
	15:36				4.0	20.2	471.3	337	0.05	6.69	-58.1	↓	↓	↓	↓	↓	
	15:39				5.0	20.2	471.9	337	0.05	6.69	-58.1	↓	↓	↓	↓	↓	STABLE RECHARGE.
	15:42				6.0	20.2	472.7	338	0.05	6.68	-59.0	↓	↓	↓	↓	↓	

1m of 50 mm well length=~1.96 L

Dup / Split collected from Monitor Well #: MB5 (DUP1)

Sampling Method : PERI-PUMP (LOW FLOW)

	October 2016 event					Previous Studies			
	Groundwater Level (mbtoc)	TOC stick up (m)	Groundwater Level (mbgl)	Approx ground level (mAHD)	Approx Groundwater Level (mAHD)	LWMS groundwater contours (mAHD)	Difference between Oct16 and LWMS contours	Emission Assessment level	Difference between Oct 16 and Emission Assessment level
SP1	5.79	0.82	**4.97**	7	2.03	2	0.03	-	-
SP2	9.168	0.83	**8.338**	11	2.662	1.9	0.762	1.928	0.734
SP3	Destroyed/Missing								
SP4	Destroyed/Missing								
SP6	Destroyed/Missing								
SP7	3.925	0.43	**3.495**	6.7	3.205	2.2	1.005	2.161	1.044
SP8	Non viable - caved in								0
SP9	4.013	0.45	**3.563**	5	1.437	1.3	0.137	1.29	0.147
MW1 (Baldivis Rd)	4.237	0.63	**3.607**	6.6	2.993	2.4	0.593	2.319	0.674
MW2 (Baldivis Rd)	3.22	0.56	**2.66**	6.3	3.64	2.7	0.94	2.806	0.834
NBAL01	3.465	0.51	**2.955**	4.69	1.735	1.4	0.335	1.368	0.367
NBAL02	Destroyed/Missing								
BAL01	5.82	0.46	**5.36**	7.5	2.14	1.9	0.24		
MW1 (McDonald Rd)	13.455	0.65	**12.805**	14.3	1.495	1.2	0.295	1.136	0.359
MW2 (McDonald Rd)	5.365	0.64	**4.725**	6.45	1.725	1.3	0.425	1.309	0.416
MW3 (McDonald Rd)	Damp Bottom	0.47	**Dry**	4.53	N/a	1.3	N/a	1.329	-



EMISSION ASSESSMENTS

Table 8
Groundwater Level Data

Well ID	Gauging Date	Top of Collar (mAHD)	Total Well Depth (mbtoc)	Water Level (mbtoc)	Water Level (mAHD)	Water Column (m)
Lot 306 McDonald Rd						
MW1	19/03/2015	14.965	15.520	13.829	1.136	1.965
MW2	19/03/2015	7.039	7.465	5.730	1.309	2.220
MW3	19/03/2015	5.012	5.158	3.683	1.329	1.960
Lot 2 Eighty Rd						
SP2	19/03/2015	11.461	12.181	9.533	1.928	2.65
Lot 9502 Baldivis Road						
SP7	19/03/2015	7.153	8.165	4.992	2.161	3.17
Lot 9504 Fifty Rd						
SP8	19/03/2015	8.668	10.460	7.340	1.328	3.12
SP9	19/03/2015	5.725	7.847	4.435	1.290	3.41
NBAL01	19/03/2015	5.248	5.364	3.880	1.368	1.48
Lot 5 Ingram Rd						
MW1	19/03/2015	7.104	7.305	4.785	2.319	2.52
MW2	19/03/2015	7.309	4.165	4.503	2.806	-0.34

Notes:
mbtoc = meters below top of casing
mAHD = meters above Australian Height Datum

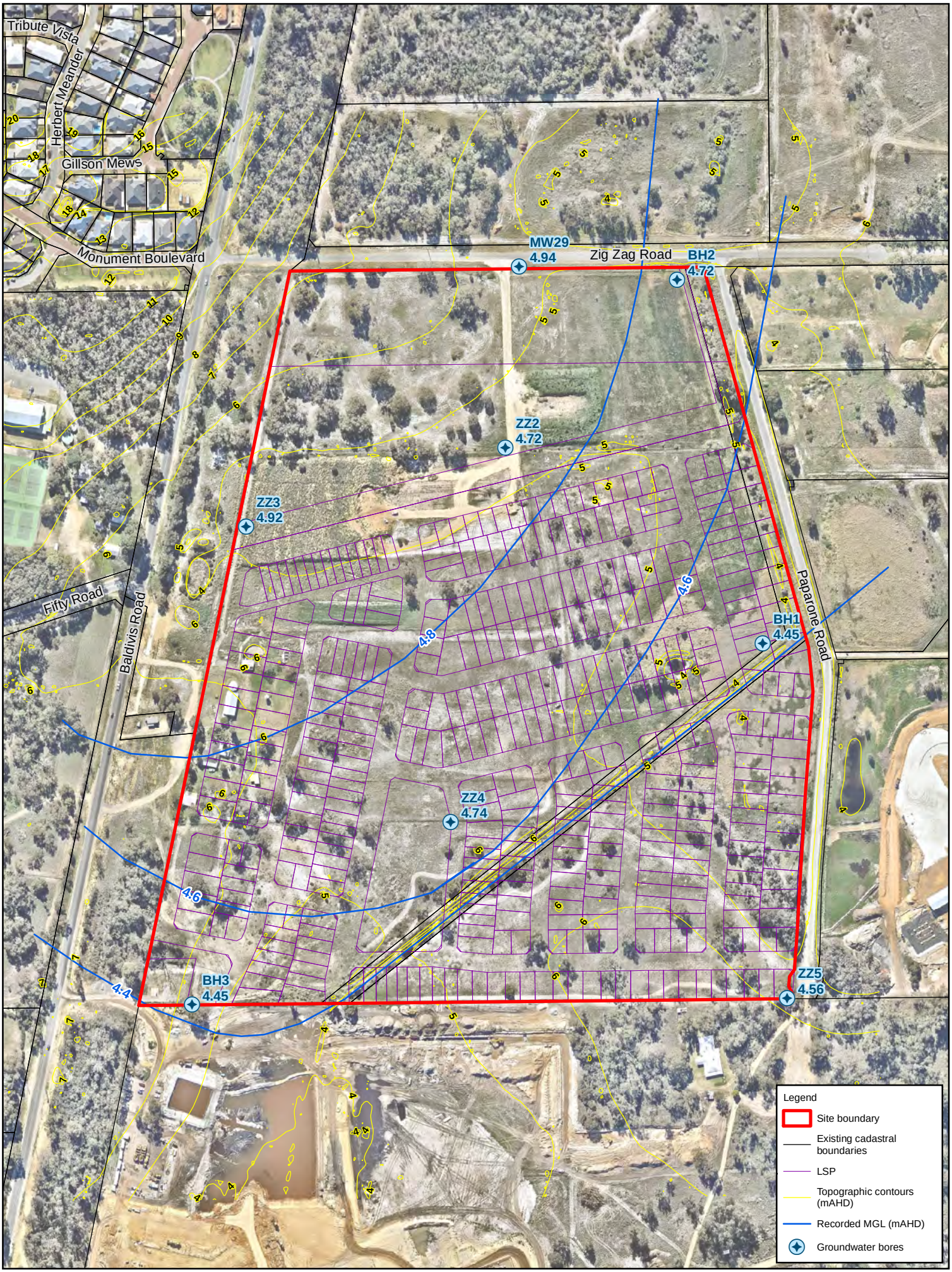


Figure 3: **Pre-development topography and MGL**

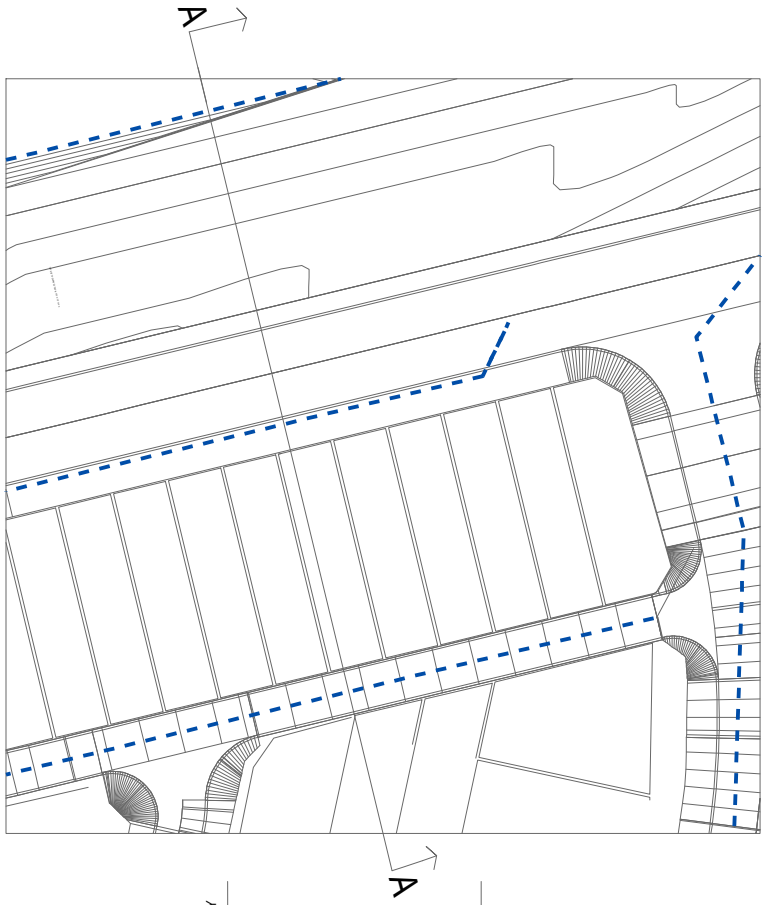
Project:	Urban Water Management Plan Greenlea Estate, Baldivis
Client:	Peet No.73 Pty Ltd

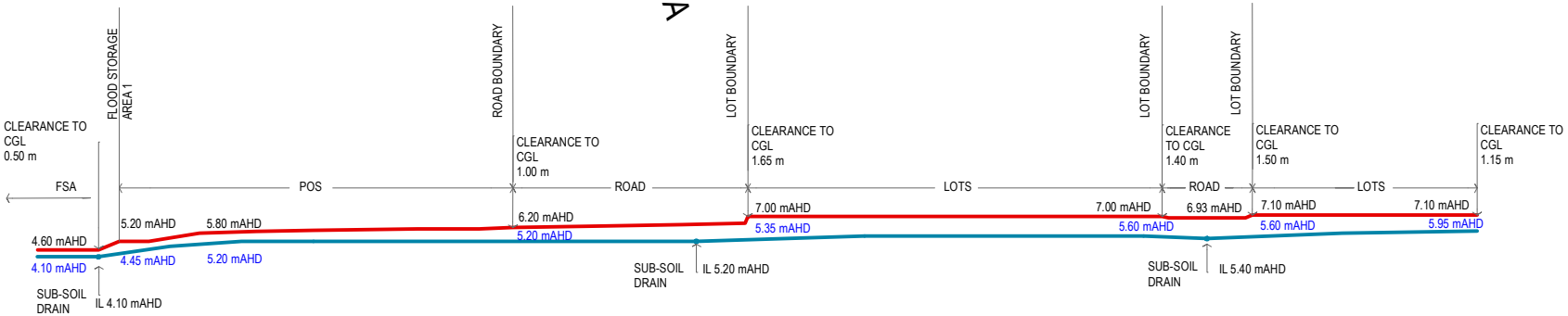
Plan Number: EP15-024(04)--F21a

Drawn:	KNM	Date:	25/01/2016
Approved:	DPC	Date:	28/01/2016
Checked:	RLE	Scale:	1:4,000@A4

0 50 100 150 Metres

emerge ASSOCIATES
Integrated Science & Design





SECTION A-A

Figure 11: Indicative CGL and Phreatic Surface

Project:	Urban Water Management Plan Greenlea Estate, Baldivis
Client:	Peet No.73 Pty Ltd

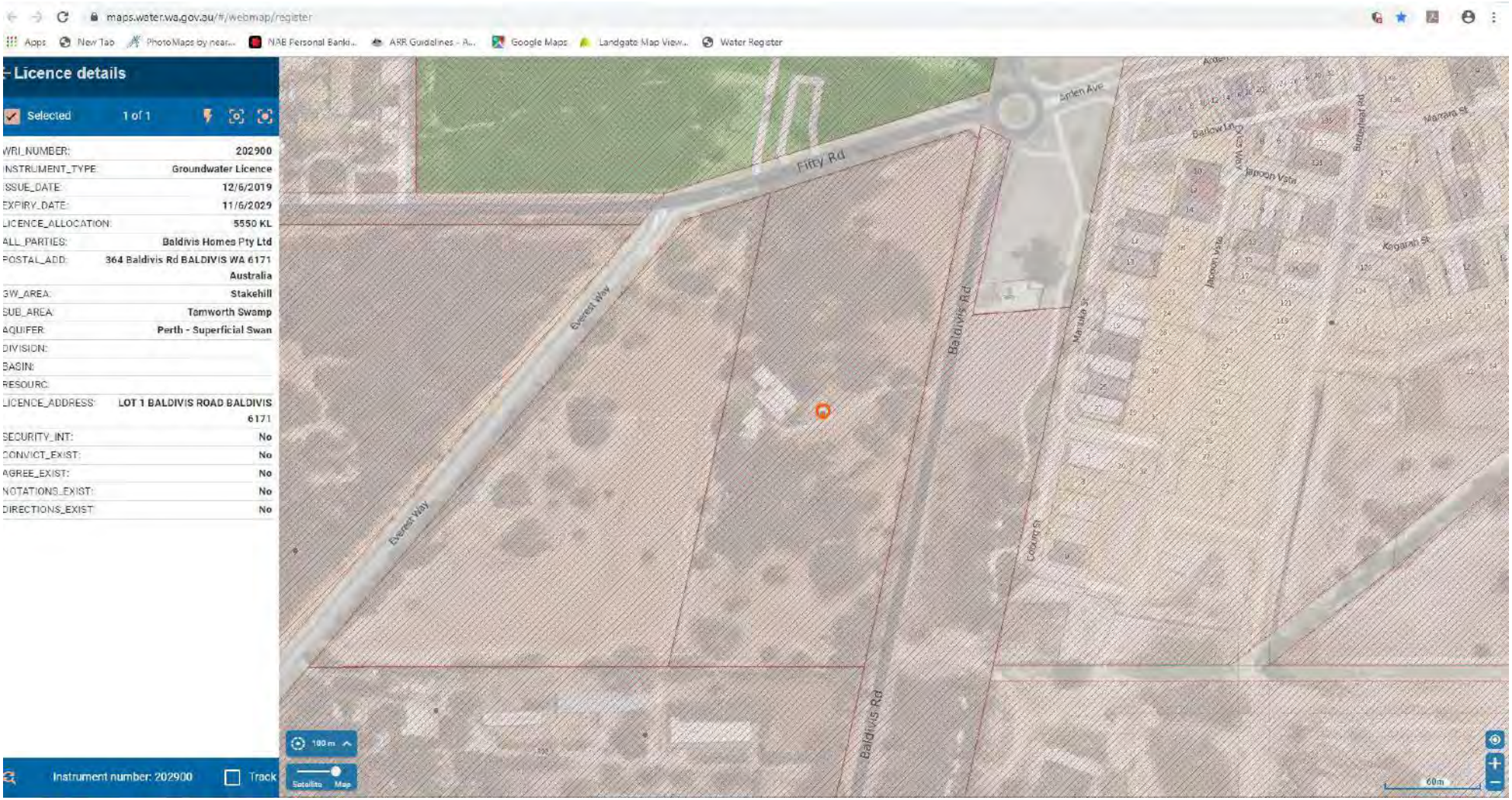
Legend

Phreatic surface	7.00 mAHD	Design surface level
Design surface	5.35 mAHD	Controlled groundwater level (CGL)
Sub-soil drainage		

Plan Number: EP15-024(04)--F62

Drawn:	KNM	Date:	12/02/2016
Approved:	DPC	Date:	15/02/2016
Checked:	RLE		

emerge ASSOCIATES
Integrated Science & Design


maps.water.wa.gov.au/#/webmap/register
Apps
New Tab
PhotoMaps by near...
NAB Personal Banki...
ARR Guidelines - A...
Google Maps
Landgate Map View...
Water Register
Licence details
Selected 1 of 1
WRI_NUMBER: 202900
INSTRUMENT_TYPE: Groundwater Licence
ISSUE_DATE: 12/6/2019
EXPIRY_DATE: 11/6/2029
LICENCE_ALLOCATION: 5550 KL
ALL_PARTIES: Baldivis Homes Pty Ltd
POSTAL_ADD: 364 Baldivis Rd BALDIVIS WA 6171 Australia
GW_AREA: Stakehill
SUB_AREA: Tamworth Swamp
AQUIFER: Perth - Superficial Swan
DIVISION:
BASIN:
RESOURC:
LICENCE_ADDRESS: LOT 1 BALDIVIS ROAD BALDIVIS 6171
SECURITY_INT: No
CONVICT_EXIST: No
AGREE_EXIST: No
NOTATIONS_EXIST: No
DIRECTIONS_EXIST: No
Instrument number: 202900
Track
Fifty Rd
Everest Way
Everest Way
Baldivis Rd
Baldivis Rd
Amen Ave
Ballow Lane
Jarvis Way
Jarvis Way
Jarroon Vista
Jarroon Vista
Butterfield Rd
Mamara St
Kogarah St
Manuka St
Coburn St
100 m
Satellite
Map
60 m

DEVELOPMENT
ENGINEERING
CONSULTANTS

APPENDIX F

- **Structerre Geotechnical Report dated March 2020**

STRUCterre consulting

Doc: GE2.1.1

GEOTECHNICAL INVESTIGATION

For: MGP Baldivis Pty Ltd

Project Address: Lot 1 #364 Baldivis Road, Baldivis

Project Number: D234620

Job Number: J343515

Revision Number: 0

Date: 19/3/2020

TABLE OF CONTENTS

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Phone (+618) 9205 4500 | Fax (+618) 9205 4501 | Email wageotecheng@structerre.com.au | Web www.structerre.com.au
ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

1. PROJECT DETAILS

1.1. Introduction

At the request of James Priestly of MGP Baldivis Pty Ltd, Structerre Consulting (Structerre) have conducted a Geotechnical Investigation at Lot 1 #364 Baldivis Road, Baldivis. The purpose of the investigation was to provide the following for residential subdivision purposes:

- An assessment of subsurface soil profile and groundwater conditions across the proposed area of development;
- Site classification in accordance with AS 2870-2011 Residential Slabs and Footings;
- Wind Classification in accordance with AS 4055-2012 Wind Loads for Housing;
- Recommendations for stormwater drainage design;
- Recommendations on earthworks and site preparation; and
- Provision of a footing detail considering anticipated surface movement and sand pad thickness.

Structerre were provided with a site plan prepared by Element showing surface contours, dimensions of the proposed strata lots, the existing building and the location in relation to the site boundaries.

Terms of reference for this investigation were presented in a Structerre Consulting proposal reference Q84685 (dated 6 March 2020), which was submitted to and accepted by MGP Baldivis Pty Ltd.

1.2. Site Description

The site is located at Lot 1 #364 Baldivis Road, Baldivis, City of Rockingham. Baldivis Road lies to the east of the site with Fifty Road to the north, residential property to the south and a vacant lot to the west.

The site slopes up gently towards the southwestern corner as is the surrounding topography. At the time of the field investigation an existing house and shed occupied the site. The front and the rear areas of the property were covered in vegetation with small to medium sized trees.

1.3. Field Investigation – Scope of Works

The field investigation was carried out on 16 & 17 March 2020 and comprised:

- 14 x Sample Retrieval Probes (SRP) to a depth of 2.5m over the site for material assessment and soil profiling;
- 6 x In situ percolation tests to determine the permeability of the materials within the upper 1.0m; and
- 14 x Perth Sand Penetrometer (PSP) tests in accordance with AS 1289.6.3.3-1997 to a depth of 1.0m for evaluation of relative densities of the upper layers.

The borehole and PSP test locations are shown on the attached site plan in Appendix 1.

Suitably qualified geotechnical personnel from Structerre supervised the fieldwork and all fieldwork, interpretation and terminology used in this report are in accordance with the guidelines presented in AS1726-2017 Geotechnical Site Investigations.

2. DESK STUDY

2.1. Geological Setting

The Rockingham sheet 1: 50,000 Environmental Geology Series (Part Sheets 2033 II and 2033 III, 1986) prepared by the Geological Survey of Western Australia indicates that the following geological layer underlies the site:

- SAND (S7) – pale yellowish brown, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted of residual origin (Sand derived from Tamala Limestone Qts).

2.2. Ground Surface and Groundwater Level

The Perth Groundwater Atlas (Waters & Rivers Commission) indicates the ground surface level at this site was approximately 10.0m Australian Height Datum (AHD).

The May 2003 groundwater level at the site was approximately 2.0m AHD. It should be noted that the groundwater levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

2.3. Earthquake Coefficient

In accordance with AS 1170.4-2007 Structural Design Actions the site is located within an area with an earthquake acceleration coefficient of 0.09.

2.4. Wind Classification

In accordance with AS 4055-2012 Wind Loads for Housing, wind classification of this site falls within the non-cyclonic “N1” category.

3. RESULTS OF THE INVESTIGATION

3.1. Subsurface Soil Profile

The subsurface soil profile presented below was determined from the ground conditions encountered within the boreholes and through the interpretation of the PSP test results:

Table 1 – Subsurface Soil Profile

Depth to Base of Strata (m)	Material Description
0.1	Topsoil
Not Penetrated (>2.5m)	NATURAL: SAND (fine to medium grained), non-plastic, trace silt, very loose grading to dense

The soils encountered are consistent with the expected site conditions as predicted from the Environmental Geology Map. It is important to note that there may be pockets of fill on site that are deeper than that encountered by the investigation boreholes. The subsurface soil conditions encountered are presented in the bore logs, within Appendix 3.

3.2. Groundwater

Groundwater was not encountered in any of the boreholes during or immediately after drilling. However, based on the Perth Groundwater Atlas, the groundwater is expected to be encountered approximately 8.0m below the existing ground level.

3.3. Percolation Testing

Percolation testing of the in-situ soils was undertaken in six locations. Results of the testing are summarised below:

Table 2 – In Situ Percolation Test Results

Test Location	Testing Depth	Soil Type	Permeability
BH1	0.75 - 1.0m	SAND	13.3m/day
BH4	0.75 - 1.0m	SAND	13.6m/day
BH6	0.75 - 1.0m	SAND	12.8m/day
BH10	0.75 - 1.0m	SAND	12.8m/day
BH13	0.75 - 1.0m	SAND	12.7m/day
BH14	0.75 - 1.0m	SAND	14.5m/day

4. GEOTECHNICAL CONSTRUCTION CONSIDERATIONS

4.1. Site Classification

AS 2870-2011 Residential Slabs and Footings provides guidance on site classification for residential slabs and footing design based on the expected ground surface movement and depth of expected moisture changes.

Table 3 – Classification Based on Site Reactivity

AS 2870-2011 Residential Slabs and Footings - Clause 2.1.2 Table 2.1	
Class	**Foundation**
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes (0<ys≤20mm)
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes (20<ys≤40mm)
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes (40<ys≤60mm)
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes (60<ys≤75mm)
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes (ys>75mm)
Clause 2.1.3 Classification of other Sites	
P	Sites which include soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions and site that cannot be classified in accordance to Table 2.1

Based on results of this investigation the site can be upgraded to a Class “A” in accordance with AS 2870-2011 provided that all unsuitable materials are removed and replaced with engineer-controlled sand fill materials in accordance with the earthwork recommendations outlined in Section 4.3 of this report.

4.2. Drainage

The site is suitable for on-site disposal of stormwater runoff subject to the proposed development. For on-site disposal of stormwater runoff, soakwells of sufficient sizes are required, and should be positioned a minimum of 1.2m or the depth of soakwell (whichever is greater) from any proposed or existing foundations (including those beyond the boundaries of the site) to reduce the risk of differential settlement.

To aid with the design of on-site stormwater drainage, groundwater levels and field permeability results are presented in Section 3 of this report.

4.3. Earthworks

All earthworks shall be undertaken in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments and are to include the following:

- All unsuitable materials to be stripped and removed from the site. Unsuitable materials include topsoil, deleterious and organic materials.
- It is considered that the near surface sand material requires improvement. Therefore, it is proposed to excavate and stockpile the materials for reuse, provided it is free from clay/silt (i.e. <5%), deleterious and organic materials. The depth of excavation may vary depending on conditions encountered and is subject to inspection. However, it is envisaged that the average depth of excavation would be approximately 0.6m. Should the site levels be reduced the excavated materials can be reused or removed off site.
- Excavation should not be greater than 2.0m and/or undermine the surrounding structures. A 1V: 2H slope should be maintained for temporary excavations. If excavation is required closer than the 1V: 2H slope would allow or deeper, it is recommended that this office be contacted for retaining system design.

- Proof compact the exposed base. The compaction requirements are set out in the table below, as per AS 3798-2007:

Table 4 – Compaction Requirements

Item	Application	Minimum relative compaction, %	
		Minimum density ratio (Standard Compaction Effort) (Cohesive soils)	Minimum density index (Cohesionless soils)
1	Residential - lot, fill, house, sites	95	70
2	Commercial – fills to support minor loadings, including floor loading of up to 20kPa and isolated pad or strip footings to 100kPa	98	75
3	Fill to support pavements a) General fill Subgrade (to a depth of 0.3m)	 95 98	 70 75

- After excavation and proof compaction, the excavated base is to be inspected and approved by a representative from this office prior to backfilling. At this stage it can be assessed whether any further materials need to be removed or whether further compaction of the base is required.
- The ground level should be built up to design levels with the stockpiled sand FILL and imported fill, if required. The imported fill should consist of free draining sand with not more than 5% passing a 75µm sieve and be free of organic matter and other deleterious materials. The fill materials should be placed in layers not exceeding 300mm loose thickness and compacted to achieve a minimum 8 PSP blows over the interval 150 – 450mm, 9 PSP blows over the interval 450 – 750mm and 11 PSP blows over the interval 750 -1050mm.
- After remedial earthworks have been completed, the earthworks should be inspected and approved by a representative from this office.

4.4. Indicative California Bearing Ratio (CBR)

The indicative California Bearing Ratio (CBR) value of the subgrade material, following earthworks can be estimated from the site investigation results and would be appropriate for preliminary design purposes. The indicative value is shown in the below table:

Table 8 – Indicative CBR Values

Material	Indicative CBR (%)	Compaction
SAND (In situ or Imported Fill)	12	95% of MMDD*

* Implies the maximum dry density ratio using Modified compaction in accordance with AS 1289 5.2.1-2003.

For detailed design and construction of the pavements, it is recommended that the CBR values be verified with laboratory Soaked CBR testing on the anticipated subgrade material.

5. CONCLUSIONS

A site investigation has been carried out at the site of the proposed residential development to assess the geotechnical conditions. Parameter and design recommendations are incorporated in the body of the report. The following conclusions have been drawn from the site investigation:

- The average subsurface soil profile encountered comprised topsoil to 0.1m and underlain by SAND trace silt to the investigated depth of 2.5m.
- Groundwater or perched water was not encountered across the site to the depth of 2.5m.
- It is considered that the site is suitable for on-site drainage.
- The site can be classified as Class “A” in accordance with AS 2870-2011 provided that the recommended earthworks are undertaken.
- The full scope of the recommended earthworks is presented in Section 4.3, but generally comprises:
    - Stripping of topsoil and unsuitable materials
    - Proof compaction of the base
    - Placement of sand fill to required level
    - Compaction to final level

6. LIMITATION OF FIELD INVESTIGATIONS

This report has been prepared in accordance with generally accepted consulting practice for MGP Baldivis Pty Ltd using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions.

If ground conditions encountered during construction are different to that described in this report, this office should be notified immediately.

For and behalf of

STRUCTERRE CONSULTING

Margie Mortera
Geotechnical Assistant

Authorised By: David Harding
Employee Title: Geotechnical Supervisor

Job #	Revision	Authored	Checked	Authorised
J343515	0	MM	DH	MEC

7. REFERENCES

Department of Water – Perth Groundwater Atlas

Geological Survey of Western Australia 1:50,000 Environmental Geology Series

AS 1170.4-2007 Structural design actions – Earthquake actions in Australia

AS 1289.6.3.3-1997 Methods of testing soils for engineering purposes – Soil strength and consolidation tests – Determination of the penetration resistance of a soil – Perth sand penetrometer test

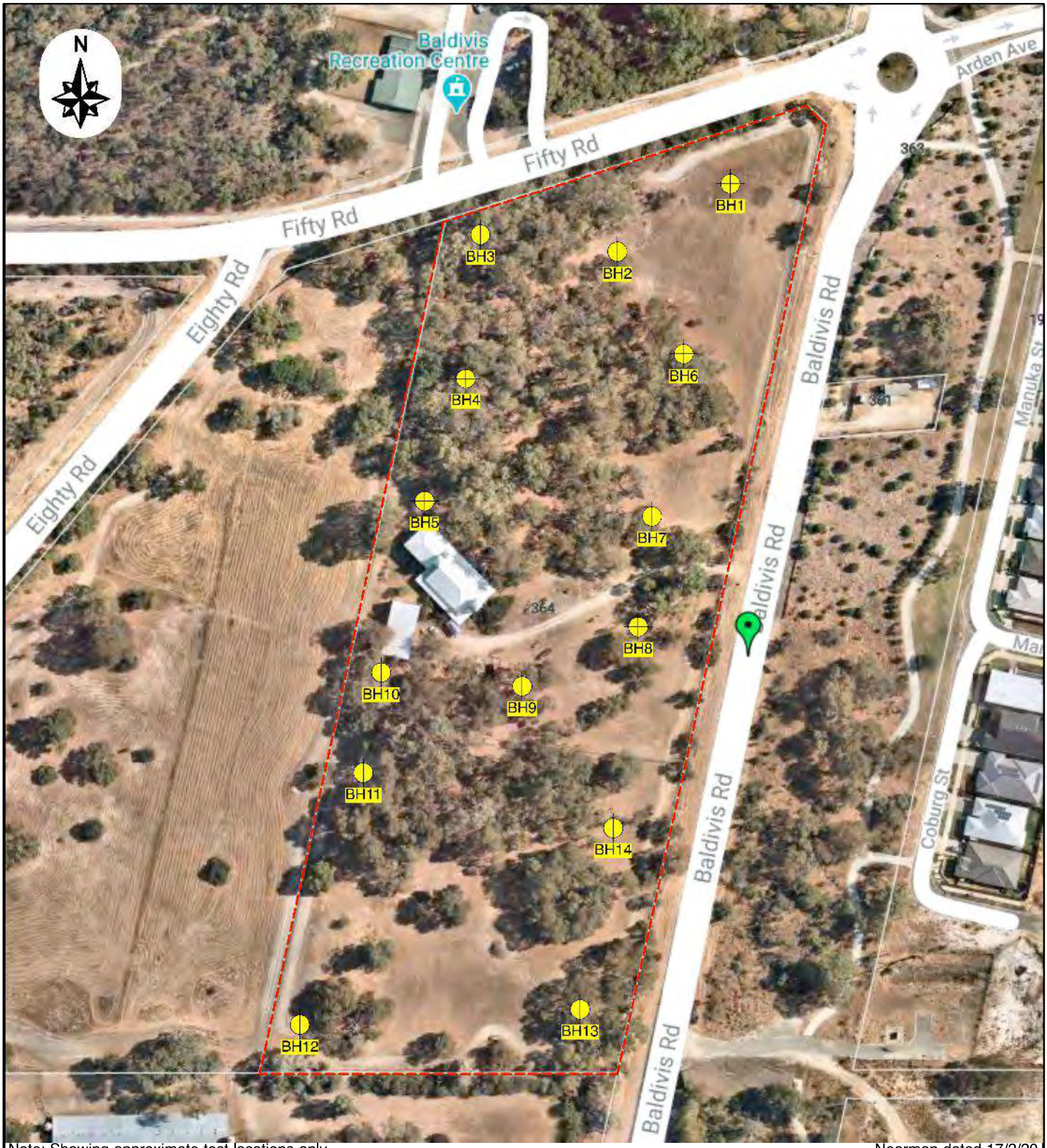
AS 1726-2017 Geotechnical Site Investigation

AS 2870-2011 Residential Slabs And Footings

AS 3798-2007 Guidelines On Earthworks For Commercial And Residential Developments

AS 4055-2012 Wind Loads For Housing

APPENDIX 1 – SITE LOCATION MAP



Note: Showing approximate test locations only

Nearmap dated 17/2/20

LEGEND

BH Borehole

STRUCterre consulting

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TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Lot 1 #364 Baldivis Road, Baldivis
PROJECT #:	D234620
JOB #:	J343515
CLIENT:	**MGP Baldivis Pty Ltd**
SCALE:	NTS
TITLE:	Geotechnical Investigation Site Plan
DATE:	17 Mar '20
DRAWN BY:	MM
CHECKED BY:	DH

DOC: GE:3.001

APPENDIX 2 – SITE PHOTOS

PHOTO 1

PHOTO 2

STRUCterre consulting

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TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Lot 1 #364 Baldivis Road, Baldivis
PROJECT #: D234620	CLIENT: **MGP Baldivis Pty Ltd**
JOB #: J343515	
SCALE: NTS	TITLE: Site Photographs
DATE: 17 Mar '20	DRAWN BY: MM / CHECKED BY: DH

APPENDIX 3 – BORELOGS

STRUCterre consulting engineers

Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH01**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	389115
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	64224845

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L - MD					
		trace silt, yellow/brown						
			D					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH02**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L - MD					
		trace silt, yellow/brown	D				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

WA | QLD | NSW | VIC

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH03**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	L - MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH04**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	L - MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH05**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L					
		trace silt, yellow/brown	D				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH06**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L					
		trace silt, yellow/brown	D				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH07**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	L					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

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Test No. **BH08**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L - MD					
		trace silt, yellow/brown						
			D					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH09**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L					
		trace silt, yellow/brown	D				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH10**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples: Depth	Samples: Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH11**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	VL - L					
		trace silt, yellow/brown	MD				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH12**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	L - MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH13**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4, 8, 12, 16)	Samples Depth	Samples Type	Moisture	Water Level
0		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Bassendean Sand)						
		trace silt, yellow/brown	L - MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Lot 1 #364 Baldivis Road, Baldivis

Client MGP Baldivis Pty Ltd

Test No. **BH14**

Project No.	D234620	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J343515	**Date**	17/03/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)						
		trace silt, yellow/brown	L - MD					
1							D	
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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