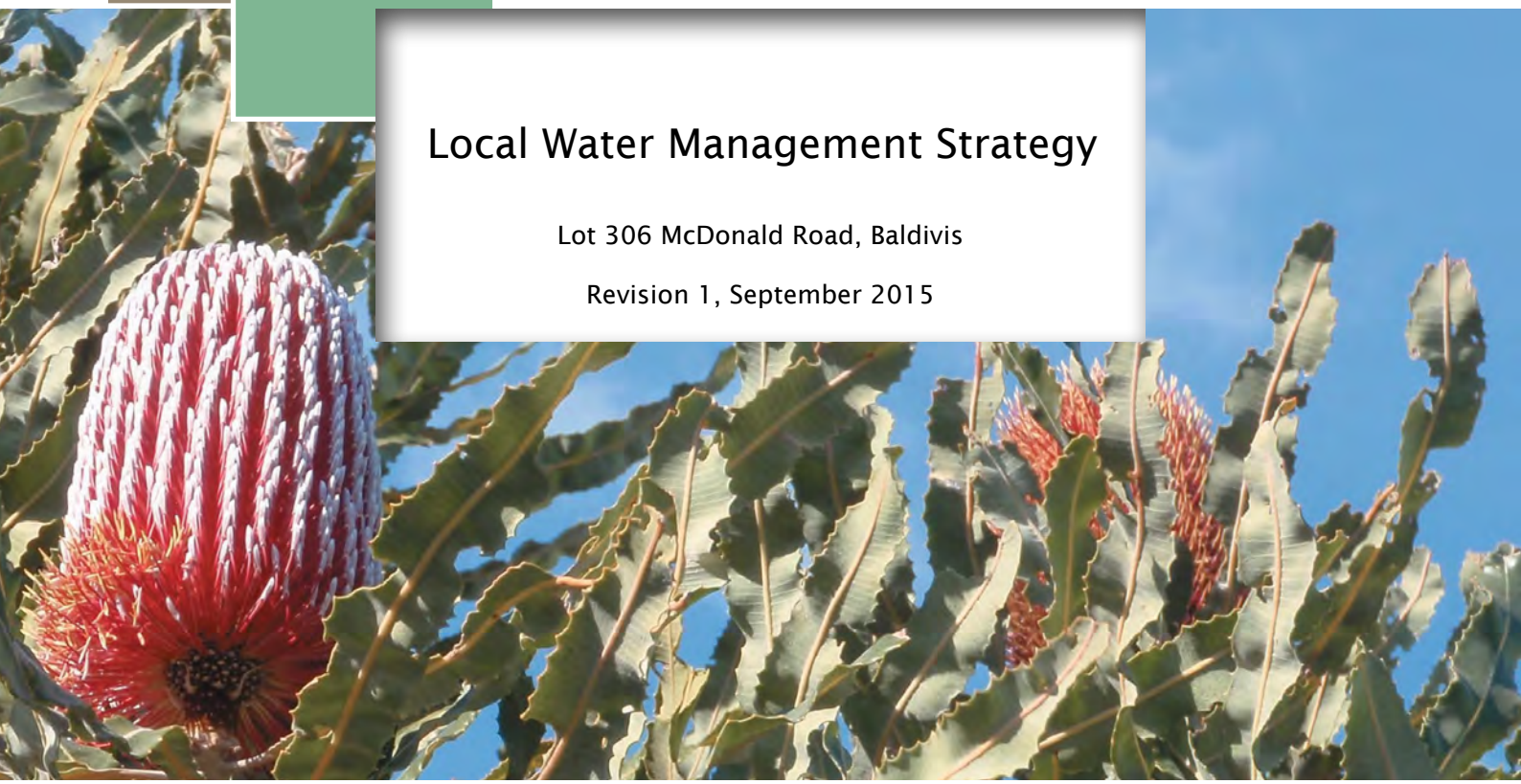
COTERRA ENVIRONMENT

Local Water Management Strategy

Lot 306 McDonald Road, Baldivis

Revision 1, September 2015



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COTERRA ENVIRONMENT

LOCAL WATER MANAGEMENT STRATEGY

Lot 306 McDonald Road, Baldivis

Revision 1, September 2015

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Notice

EXECUTIVE SUMMARY

This document outlines the Local Water Management Strategy (LWMS) for the site, which has been developed in accordance with the Better Urban Water Management (BUWM) guidelines (WAPC, 2008). The tables below provide an overview of the site and a summary of the design elements and requirements for best management practices. The LWMS check list is provided in Appendix A.

Site overview	Description
Site location	Lot 306 McDonald Road, Baldivis (see Figure 1)
Size	Approximately 18 ha
Proposed change in land use	The site is currently used for agricultural purposes. Residential development including roads and public open space is proposed in the northern portion of the site (zoned 'Urban'). The south west corner of the site is not proposed to be developed at this stage (zoned 'Rural').
Planning context	The portion of the site proposed for residential development (northern portion) is zoned correctly for the intended land use. A Structure Plan has been prepared to outline the nature and form of the proposed development (see Figure 2).
Hydrological constraints	▪ Historic agricultural/horticultural land use. ▪ Conservation Category Wetland located in southwest corner of the site (in the 'Rural' portion, not the developable portion). ▪ Gas pipeline (and easement) along the western boundary of the site.
Hydrological opportunities	▪ High permeability of site soils. ▪ Significant - adequate separation to groundwater across the site. ▪ No wetlands or watercourses within the 'Urban' portion of the site. ▪ Existing groundwater licence may be available for construction, plant establishment and ongoing public open space irrigation.

Key Elements	Key Issues
Water Conservation Strategy (Section 3)	▪ Wastewater will be disposed of to the regional sewerage system and household water will be supplied by the regional water supply scheme. Both are operated by the Water Corporation and the infrastructure requirements have already been investigated. ▪ The development will include the following water sustainability initiatives: ➢ Public Open Space will be landscaped effectively in order to reduce irrigation requirements. ➢ Water efficient fixtures and fittings will be mandatory within the buildings. ➢ Lots will be provided with a full landscaping package for front

Key Elements	Key Issues
	gardens. ➢ Community education will be encouraged to promote the homeowner's role in water resource protection. ▪ Public Open Space will be irrigated with groundwater. An existing groundwater licence is available for the site (GWL 180811).
Stormwater Management (Section 4)	▪ The site is comprised of a single catchment which drains to a bioretention area and infiltration basin which will infiltrate up to the 100 year ARI event. ▪ There will be no lot drainage connections to the road drainage network. Lots will infiltrate roof runoff via onsite soak wells. ▪ All stormwater from the road network for up to a 5 year ARI event will be conveyed via the pipe network into the basins. ▪ Stormwater from events greater than 5 year ARI event will be conveyed into the basin as overland flow within the road reserves. ▪ Appropriate nutrient stripping vegetation will be planted in the bioretention area and soil amendment provided for water quality treatment of the first flush event. ▪ Other non-structural controls will be used to manage water quality.
Groundwater Management (Section 5)	▪ No fill is required to manage separation to peak groundwater levels or for flood risk management. Recontouring of the site will be undertaken. ▪ Given the separation distances to groundwater, there will be no subsoil drainage. ▪ The infiltration basin will have a base more than 0.3 m higher than peak groundwater levels.
Monitoring (Section 6)	▪ Pre-development monitoring in line with BUWM was not necessary prior to the LSP/ LWMS stage due to the separation distances from groundwater across the majority of the site. Some pre development sampling was done however as part of the contamination assessment. ▪ Post-development monitoring will be undertaken quarterly for three years post-development at the existing monitoring bore locations.
Implementation (Section 7)	▪ Roles and responsibilities involved in the implementation of the LWMS are identified.

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1.0 INTRODUCTION

Spatial Property Group proposes to develop the majority of Lot 306 McDonald Road, Baldivis for residential purposes. The total lot area is approximately 18 ha. The northern 13 ha is proposed for residential development and the remaining 5 ha will remain rural.

For the purpose of this LWMS, both portions of the lot are described in the site characteristics as the drainage will be contained within the 'Rural' portion of the lot.

The site is located in the City of Rockingham (CoR), approximately 43 km south of Perth CBD (Figure 1).

1.1 Proposed Development and Planning Context

The portion of the site proposed for urban development is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) and 'Development' under the City of Rockingham Town Planning Scheme (TPS) No. 2. The remaining lot area is zoned 'Rural' under the MRS and TPS, and is therefore not currently proposed for residential development.

The site has been identified in the North Baldivis District Structure Plan (DSP) as part of the future urban growth of the North Baldivis precinct. The North Baldivis DSP was formulated by the CoR in recognition of the general designation of the North Baldivis locality as being suitable to accommodate future residential development. As such, CoR embarked on a comprehensive 'district level' structure planning exercise in the late 1990's over the potential urban cell east of Baldivis Road, spanning from Kerosene Lane in the north to the future Baldivis Town Centre to the south. This exercise culminated in the release of the Baldivis (North) District Structure Plan as formally adopted by Council in July 2000. The District Structure Plan outlined the preferred broad land use and district road framework for the study area.

In accordance with the objectives of the DSP, the proponent has commissioned the formation of a Local Structure Plan (LSP), providing a greater level of detail in respect to the structure plan design for the landholdings.

The LSP design was completed by Creative Design + Planning and is presented in Figure 2. The structure allows for approximately 190 residential lots, 1.74 ha of Public Open Space (POS), a gas pipeline drainage easement and supporting road infrastructure.

1.2 Guidance and Previous Studies

This Local Water Management Strategy (LWMS) has been prepared to support the development of the LSP and summarise the urban water management strategies proposed for the site. It has been prepared accordance with the Better Urban Water Management (BUWM) guidelines (WAPC, 2008).

The strategy has been prepared in accordance with State Planning Policy 2.9: Water Resources (Government of WA, 2007) with specific reference to the following guidance documents and previous studies:

- Interim: Developing a Local Water Management Strategy (Department of Water, 2008)
- Western Australian State Water Plan (Government of Western Australia, 2007)
- Stormwater Management Manual for Western Australia (Department of Water, 2004-2007)
- Local Government Guidelines for Subdivisional Development Edition 2.2 (Institute of Public Works Engineering Australia, 2012)
- Baldivis (North) District Structure Plan (TBB *et al*, 2000).

1.3 Objectives

In the absence of a District Water Management Strategy (DMWS), the design objectives and criteria for this site have been derived from the Design Objectives for WSUD (Department of Water, 2008) (see Table 1).

Table 1 Design Objectives and Criteria

Element	Objective	Design Criteria
Water conservation strategy (potable and wastewater)	Achieve an efficient use of potable water.	Minimise the net use of water within residential dwellings to meet state government targets.
		Minimise water requirements for the establishment and maintenance of Public Open Space (POS)
Water quantity management	Manage post-development annual discharge volume and peak flow.	The 1 year 1 hour ARI event shall be compensated and infiltrated within residential lots.
		Excess runoff from lots and runoff from road networks up to the 1 in 5 year ARI event shall be conveyed via a pipe network so that roads are functional during a 1 in 5 year ARI event.
		Excess runoff from lots and runoff from roads above the 5 year ARI event will be conveyed via the road reserve.
		Post-development runoff rates are to be restricted to pre-development runoff rates up to the 100 year ARI event.
Water quality management	Maintain surface and groundwater quality.	Runoff up to the 1 year 1 hour ARI to be retained and treated within the development.
	Reduce the health risk from mosquitoes.	Drainage basins to be fully infiltrated or discharged within 96 hours.
Flood risk management	Manage flood risk to	Housing pads to be at least 0.3 m above the 100 year ARI surface water level within the road reserve.

	people and property.	Finished lot levels to be at least 0.5 m higher than the predicted 100 year ARI flood level in the engineered drainage basins.

2.0 SITE CHARACTERISTICS

2.1 Current and Adjacent Land Uses

The 'Urban' portion of the site proposed for development is currently used for agricultural purposes. The first farm buildings were constructed in the early 1960s and the land was gradually cleared for agriculture up until the 1980s. Approximately half of the 'Rural' portion of the lot in the south west corner is well vegetated, while the other half is cleared.

Surrounding land uses of relevance to the LWMS include:

- Residential development (proposed and under construction) to the north, west and east
- Rockingham Lakes Regional Park approximately 500 m to the south
- Lake Cooloongup approximately 800 m to the west
- Sand quarry located approximately 800 m north-east of the site

The Dampier to Bunbury Natural Gas Pipeline Corridor (DBNGP), also known as the Parmelia Gas Pipeline and a Water Corporation water main run along the western boundary and cuts across the south west corner of the site as illustrated in the LSP (Figure 2). Development is restricted within the pipeline corridor in accordance with Planning Bulletin 87 (WAPC, 2007). Drainage basins are not permitted within the gas pipeline easement. Any exceptions require written permission from the pipeline owner.

Adjacent land uses are highlighted in Figure 3.

2.2 Climate and Rainfall

The site has a Mediterranean climate with warm dry summers and cool wet winters. The average annual rainfall at the site is approximately 762 mm and average annual evaporation is approximately 1,752 mm (BoM, 2014). Rainfall and evaporation averages are presented in Table 2.

Table 2 Rainfall and Evaporation Average Statistics

Month	Av. Monthly Rainfall (mm)	Av. Daily Evaporation (mm)
January	11.7	8.5
February	19.6	8.0
March	19.5	6.3
April	39.9	3.9
May	98.7	2.4
June	145.2	1.8
July	147.5	1.8
August	114.7	2.3
September	78.6	3.2
October	40.1	4.7
November	31.8	6.5

Month	Av. Monthly Rainfall (mm)	Av. Daily Evaporation (mm)
December	11.8	7.9

Source: Bureau of Meteorology. Medina Research Centre (BoM, 2014)

2.3 Topography

Overall the site is elevated in the western and northern portion, and slopes downwards toward the eastern and southern portion of the site with a depression running north east from the south western corner (Figure 4).

The 'Urban' area elevation ranges from approximately 38 mAHD along the western boundary to approximately 5 mAHD in a depression in the south east, and rising to 8 mAHD in the far south east corner.

The 'Rural' area elevation varies from approximately 38 mAHD in the north west corner to 4 mAHD at the depression through the south east of the site.

2.4 Geology and Soils

2.4.1 Soil Description

2.4.1.1 Regional Information

Regional mapping (Churchward & McArthur, 1980) displayed in Figure 5 indicates that the entire 'Urban' area is comprised of two varying sands from the Spearwood Dune System:

- Cottesloe Sands - Sand (S7): pale yellowish brown, medium to coarse grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin.

- Limestone – Limestone (Ls1): pale yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithifield, surface kankar, or aeolian origin.

The south west corner of the 'Rural' area is Peaty Clay (Cps) – a dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin. This portion of the site is not proposed for development or drainage (Rural zoning).

The geology and soils of the site are shown in Figure 5.

2.4.1.2 Site Specific Information

Structerre Consulting Engineers undertook a site geotechnical investigation in May 2015. The investigation included the excavation of 7 test pits and 13 soil retrieval probe boreholes (Structerre, 2015). Figure 5 shows the test pit and borehole locations within the LSP area.

The results of this testing indicates that the ground conditions generally comprise of:

- 0.1 – 0.2 m (average 0.1 m): Topsoil. Although topsoil was not present at every test location.
- 0.3 – 1.6 m (average 0.6 m): Fill, comprised of SAND, trace silt, trace organic material, very loose to loose.
- 1.2 – > 2.5 m (average 2.3 m): SAND. Trace silt, loose to medium dense, locally very loose. Locally gravelly. Refusal on limestone was encountered while using a soil retrieval probe at BH11 (at 1.2 m), BH13 (at 1.3 m), and while using a 2t excavator at TP01 (2.1 m), TP06 (1.8 m) and TP07 (1.9 m).
- Non penetrated (>2.5m): Tamala LIMESTONE

In situ permeability testing was undertaken by Structerre at four borehole locations within the LSP area. The results of this testing are given in Table 3.

Table 3 Permeability Test Results

Test Location	Depth (m)	Measured Permeability (m/day)	Material
BH01	0.75 – 1.0	3.4	SAND trace silt
BH05	0.75 – 1.0	19.3	SAND trace silt
BH07	0.75 – 1.0	4.9	SAND trace silt
BH13	0.75 – 1.0	3.9	SAND trace silt

The Geotechnical Investigation is included in Appendix B.

2.4.2 Phosphorus Retention Index (PRI)

In the absence of site specific testing, the Department of Environment (*cited in* DoW, 2004-2007) and Department of Agriculture and Food general guidelines have been used to provide an indication of Phosphorous Retention Index (PRI) of different soil types.

Based on the geology, Table 4 suggests that the site would have a PRI of 5 to 12. This is further supported by the PRI mapping of the Peel-Harvey catchment area (EPA, 2008a) which indicates that the site is located within soils with a PRI of 5-20. This range of PRI is considered moderately adsorbing of phosphorous (Table 5).

Table 4 Relative permeability and PRI for various substrates

Substrate	Permeability (m/day)	PRI
Bassendean Sands	30+	0 - 0.5
Karrakatta Sands	10+	2 - 4
Cottesloe Sands	10+	5 -12

Substrate	Permeability (m/day)	PRI
Crushed limestone or lime sands	2-5	5 - 20
Natural clay or loam soils	<0.4	30 - 1,000+

Source: Department of Environment and Conservation

Table 5 PRI Fixation Properties

PRI (mL/g)	Description
Negative	desorbing
0–2	weakly adsorbing
2–20	moderately adsorbing
20–100	strongly adsorbing
>100	very strongly adsorbing

Source: Department of Agriculture and Food

2.5 Acid Sulphate Soils

The Acid Sulphate Soil (ASS) Risk Map shows all of the 'Urban' area to have 'low to nil' risk of ASS occurring within 3 m of the natural soil surface (WAPC, 2014a).

A small portion of the 'Rural' area in the south west corner of the site is classified as having High to Moderate risk of ASS occurring within 3 m of the natural soil surface (Figure 6). This area coincides with a natural wetland area (see Section 2.7 for more detail). No development or drainage is proposed within this high risk area.

An ASS investigation was undertaken in 2015. The ASS report (Emission Assessments, 2015a) identified the following;

- Soil samples were recovered from 36 locations across the site ranging from the surface to a depth of 5.5 mbgl. In total 337 primary soil samples were submitted for pHF and pHFOX field testing confirmed by subsequent laboratory analyses on a selection of 42 primary soil samples from all locations.
- A total of 24 soil samples were preliminarily identified as PASS.
- Soils identified as PASS were associated with a clayey sand horizon.
- Proposed cut and fill contours demonstrate that no such soils are expected to be excavated and fill material is to be introduced within these areas.

The ASS Assessment is provided in Appendix C.

2.6 Contamination

2.6.1 Preliminary Site Investigation

In accordance with the activities identified within the *Potentially Contaminating Activities, Industries and Landuses* (DEP, 2004) a number of potential sources of contamination were recognised. As such, a *Preliminary Site Investigation (PSI) for Contamination* and an Analysis Quality Plan report (Emissions Assessments, 2014) was prepared for the site in accordance with DEC requirements.

A search of the DER's Contaminated Sites Database undertaken as part of the PSI indicated that the site has not been reported as a known or suspected contaminated site. It is noted that Chimes Estate to the east (up-hydraulic gradient) has been classified as "remediated for restricted use". The classification states that the groundwater has heavy metal and nutrient contamination on the southern half of the site.

The PSI indicated that part of the site is currently used as a market garden operated by Trodan Produce (WA) Pty Ltd. Trodan Produce records are included in Appendix C of the PSI and indicate that all application of fertilisers, pesticides and herbicides are applied in accordance with industry standard practices (Emissions Assessments, 2014). The PSI is provided in Appendix C.

The PSI identified the following potential sources of contamination:

- Current and historical market gardening
- Rural/grazing activities
- Storage of fuels and chemicals within sheds and pump houses
- Abandoned above ground storage tank and old vehicles
- Termiticide applications beneath residential dwelling
- Rubbish Piles
- Potential asbestos containing materials in fencing and house

2.6.2 Detailed Site Investigation

A detailed site investigation (DSI) was undertaken in 2015. The results and conclusions of this investigation are summarised below (Emission Assessments, 2015b).

Soil and groundwater investigations undertaken by Emissions Assessment (2015b) included the sampling and analysis of 101 primary soil locations and six groundwater monitoring wells between January and February 2015. Groundwater quality is discussed in Section 2.8.2 below.

Field observations recorded during soil sampling indicate that the site had geology largely representative of natural material (Spearwood Sands). Limestone was encountered at depth. Analytical results of the soil sampling reported concentrations of all analytes below HIL and HSL values, with TRH exceeding ecological protection criteria (ESLs) at two targeted surface locations. Soils at the site were not considered to pose a risk to human health. Two minor occurrences of TRH were detected above ecological screening levels in surface soils. These are considered unlikely to pose a significant risk to relevant ecological receptors.

Soil remedial works are not considered required as no risks to human health have been identified and there were only two isolated ESL occurrences, which are considered not to pose a significant risk to human health and/or the environment. Based on the above finding and conclusions, no further investigations are considered required and clearance of the WAPC condition was recommended.

The DSI is provided in Appendix C.

2.7 Surface Water

2.7.1 Wetlands

There are no wetlands within the 'Urban' portion of the site.

The Opwin Swamp (Unique Identifier 6400) is located within the south west corner of the 'Rural' area (Figure 7). This dampland is classified as a Conservation Category Wetland (CCW) (WAPCb, 2014).

CCW wetlands are the highest priority wetlands and support a high level of ecological attributes and functions. No activity is permitted which may lead to loss or degradation of the wetland. A set-back (typically 50 m) is usually required to protect CCWs (EPA, 2008b). The 'Urban' area and drainage area is outside this 50 m buffer.

2.7.2 Watercourses and Features

Lake Cooloongup is located approximately 800 m west of the site, and the Peel Main Drain is located approximately 1.5 km east of the site. Given the significant distance of these waterbodies from the site, the site is not considered to be at risk of flooding from either waterbody.

There are no other natural watercourses or waterbodies within or near to the site.

2.8 Groundwater

The site is underlain by three primary aquifers (DoW, 2014a):

- Perth Superficial Swan Aquifer – consists of Quaternary and Late Tertiary sediments. The aquifer consists mainly of quartz sands, calcareous sands and limestone. The aquifer may be up to 60 m thick and has variable salinity (1000-1500 mg/L).
- Perth Confined Leederville Aquifer – major confined aquifer overlain by the superficial formations on the Swan and Scott Coastal Plains. The formation may reach up to 650 metres thick and may be artesian. The groundwater is generally fresh (500-1000 mg/L).
- Perth Confined Yarragadee Aquifer – largest aquifer in the Perth Basin, reaching 3000 metres thickness and covering an area stretching from north of Dongara to the Serpentine area south of Perth. Groundwater salinity is variable (1000-1500 mg/L).

2.8.1 Groundwater Levels

2.8.1.1 Regional Data

The Perth Groundwater Atlas (DoW, 2014b) indicates that the minimum groundwater level contours are at approximately 1.5 to 1.75 mAHD across the site.

The Department of Water recently undertook groundwater modelling for the Lower Serpentine area to determine the maximum groundwater contours (DoW, 2012). This investigation suggests that the maximum groundwater level is likely to vary between approximately 3.0 to 3.5 mAHD across the site.

Regional water quality data from the surrounding WIN database bores is relatively sparse and intermittent (DoW, 2014c). There are 14 bores close to the site (<500 m) but these only contain at most one groundwater monitoring record each and the record datum is unknown.

The closest long term DoW owned and operated WIN bore lies approximately 700 m north east of the site (ID 61410073). Records are available from 1975 to 2014 and indicate declining groundwater levels since the 1980s. The maximum groundwater level over the 39 year record period is 2.93 mAHD while the maximum groundwater level in the last 10 years (Jan 2004 – September 2014) is 1.99 mAHD. Similarly, the AAMGL over the record period is 2.02 mAHD while the AAMGL over the last 10 years is 1.63 mAHD.

Plate 1 shows the groundwater levels recorded at the WIN Bore. Figure 8 shows the location of the WIN bore and the DoW modelled groundwater contours.

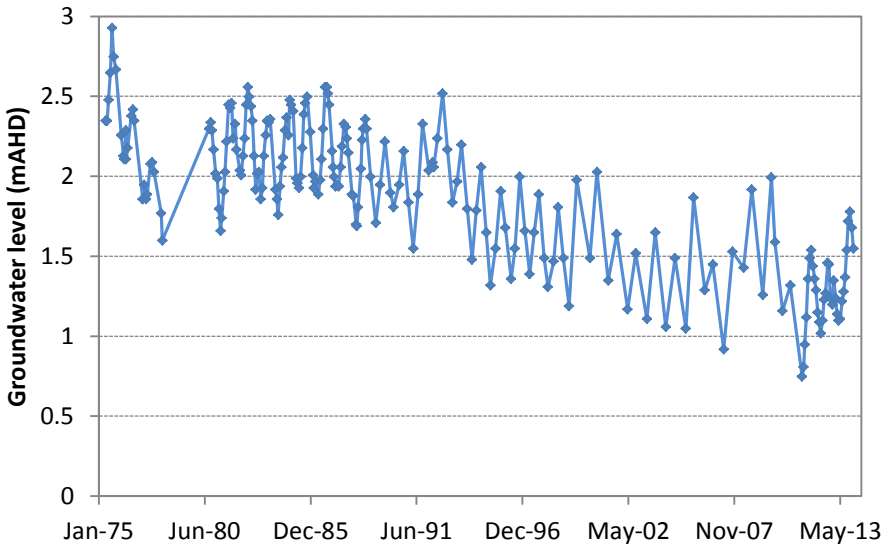

Plate 1 Groundwater Levels at WIN Bore 61410073

2.8.1.2 Site Data

Liaison with the Department of Water (DoW) confirmed that given the significant separation distance to groundwater across the majority of the site, the usual site specific groundwater level monitoring required for the LWMS, as per the *Water*

Monitoring Guidelines for Urban Water Management Strategies and Plans (DoW, 2012), would not be required in this case. It was agreed that regional information, combined with some adjacent monitoring from the Spires Estate would provide sufficient data. This is discussed further in Section 6.1. The correspondence with DoW is provided in Appendix D.

As mentioned, the proponent has undertaken monitoring at Spires Estate, to the south of this site, between August 2012 and November 2013. One of the bores (NBAL01) is located approximately 540 m south of the eastern site boundary as shown in Figure 8. The MGL at NBAL01 was 1.930 mAHD and the AAMGL was 1.77 mAHD.

In addition, following that DoW negotiation, some groundwater level data was collected on site as part of the DSI. Monitoring was undertaken at the approximate peak groundwater period. The results of this monitoring have also been included and are given in Table 6. The monitoring bore locations are shown in Figure 8.

Table 6 Groundwater Level Monitoring Results

Bore ID	Sampling date	GW Level (mbgl)	GW Level (mAHD)
MW1	23/09/2014	12.660	1.640
	30/10/2014	12.662	1.638
MW2	23/09/2014	4.641	1.809
	30/10/2014	4.636	1.814
MW3	23/09/2014	2.708	1.822
	30/10/2014	2.716	1.814

The groundwater level data indicates that groundwater levels are in the order of 1.64 to 1.82 mAHD across the site in the peak period. This equates to a separation distance of 2.71 m (MW3) to 12.66 m (MW1) at the bore locations, and an overall approximate separation distance of 2.7 m to 36.4 m across the 'Urban' area.

The site specific levels witnessed at both this site and the adjacent Spires Estate indicate that the levels are 1.68 to 1.86 m lower than the levels indicated by the DoW serpentine groundwater modelling.

2.8.1.3 Maximum Groundwater Levels

Given the regional, local and site specific data collected all indicated the peak groundwater levels to be just below 2mAHD, it is considered that the DoW modelled results are not accurate to the current local conditions. Engineering design has therefore been based on groundwater contours from monitored data rather than the modelled data.

The maximum groundwater levels for the regional and site specific data have been summarised in Table 7 below for ease of comparison:

Table 7 Maximum Groundwater Levels

Bore ID	Description	Timeframe	MGL (mAHD)	AAMGL (mAHD)
61410073	Department of Water bore, 700 m northeast of the	2004-2014	1.99	1.63

	site			
NBAL01	Monitoring bore from nearby development. 540 m south of the eastern site boundary	Aug 2012-Nov 2013	1.930	1.77
MW1	On site – located on the site's western boundary	September – October 2014	1.64	-
MW2	On site – located on the site's eastern boundary	September – October 2014	1.81	-
MW3	On site – located at the proposed basin location	September – October 2014	1.82	-

2.8.2 Groundwater Quality

2.8.2.1 Regional Data

The Perth Groundwater Atlas (DoW, 2014b) indicates that groundwater salinity of the superficial aquifer ranges from 1000 mg/L to 1,500 mg/L TDS across most of the site which is considered brackish. The groundwater salinity underlying the eastern boundary of the site is slightly less saline, ranging from 500 to 1000 mg/L TDS.

Regional water quality data from the surrounding WIN database bores is relatively sparse and intermittent (DoW, 2014c). Salinity readings taken from the closest 12 WIN bores range from 210 to 1220 mg/L TDS.

One of the surrounding WIN bores contains some further measurements as presented in Table 8.

Table 8 Regional Groundwater Quality Data

WIN site ID	Sample Date	Temp (°C)	pH	$N0_3$ (mg/L)	SO_4 (sol) (mg/L)	$CaCO_2$ (mg/L)
Bore 20024047	August 1977	25	7.4	9	86	346

The nitrogen levels (represented by nitrate) are significantly higher than the equivalent ANZECC freshwater (FW) guidelines (0.7mg/l). There are no nitrate guidelines for irrigation water however this is discussed further in Section 2.8.2.2 below.

2.8.2.2 Site Data

Site specific groundwater quality monitoring was undertaken as part of the DSI (Appendix C). Liaison with DoW confirmed that this monitoring would be sufficient for pre-development monitoring, as shown in the correspondence provided in Appendix D.

Samples were analysed for a wide range of parameters including nutrients (TN, TP, NOx, TKN, Ammoniacal-N, FRP), physiochemical parameters, metals, pesticides, hydrocarbons, speciated phenols, and volatile organic compounds.

The results of the monitoring indicated that;

- Total nitrogen levels were in the order of 2.3 - 31 mg/L, exceeding ANZECC (2000) water quality guidelines for long term irrigation (5 mg/L), but being within the lower end of the range for short term irrigation (25-125mg/l).
- Total phosphorus levels ranged from 0.07 – 0.59 mg/L, also exceeding ANZECC (2000) water quality guidelines for long term irrigation (0.05 mg/L) but being within the lower end of the range for short term irrigation (0.8-12mg/l)
- Toluene and Total Recoverable Hydrocarbons (C_6-C_9) were identified at low levels in MW3. These levels did not exceed relevant guideline values.

Metals and nutrients in groundwater can be attributed to widespread past land uses including farming and market gardening activities. These contaminants could have posed a risk to Opwin Swamp and Spot Swamp immediately down-hydraulic gradient of the site however, groundwater collected at the western site boundary, immediately up-hydraulic gradient of Spot Swamp, generally reported the lowest concentrations of nutrients. This indicates that the groundwater has not been impacted by former on-site market gardening activities (Emission Assessments, 2015b). Additionally, given the number of decades that these intensive agricultural land uses had been occurring, the vegetation in nearby wetlands, existing trees and bushland at the site are in overall good health indicating the presence of contaminants above (Emission Assessments, 2015b).

The groundwater quality (particularly nutrients) at the site is anticipated to improve over time given the change in land use from rural/market gardens to urban both onsite and in the wider Baldivis area (which is acknowledged as having less nutrient loading potential).

Regarding quality for irrigation usage, the short term irrigation guidelines are based on an irrigation period of 20 years while long term guidelines are based on a 100 year irrigation period. The long term nitrogen guideline value was established to ensure there was no decrease in crop yield, as high nitrogen concentrations can affect some sensitive crops such as apricots, grapes, sugar-beets and cotton during the later flowering and fruiting stages. These sensitive species are not proposed in the landscape concept plan, which predominately comprises native waterwise species and turf. The long term phosphorous guideline was established to prevent bio-clogging of irrigation equipment. Given the above, the existing groundwater quality is considered suitable for the proposed irrigation uses within the LSP given they are within the short term guidelines (20 years) and water quality is expected to improve over time with the change in land use.

The results of the monitoring undertaken are provided in Appendix C.

2.9 Aboriginal Heritage

A desktop investigation found that the subject site contains no indigenous heritage sites (DIA, 2014).

If Aboriginal artefacts or sites are uncovered during construction, works will cease and a suitably qualified expert will be brought in to survey the potential site, and if required, obtain approval under the Aboriginal Heritage Act 1972.

3.0 WATER USAGE STRATEGY

3.1 Household Water Supply and Disposal

Potable water will be supplied through connection to the regional water supply scheme operated by Water Corporation. The connection has been confirmed with Water Corporation, and will connect into the existing 250 mm water main along McDonald Road/Fifty Road.

Wastewater will be disposed of through a connection to the mains sewerage system which is operated by the Water Corporation (Baldivis North Sewer District). The sewer will be connected into the existing McDonald Road waste water pump station.

3.2 Household Water Conservation

Water conservation measures will be adopted to create a 'Waterwise' development. The water conservation strategy will reduce scheme water demand through incorporating a variety of effective initiatives in the areas of residential water use, POS landscaping and irrigation.

The proposed water consumption targets for water use per capita in the *State Water Plan* identify consumption targets of 100kL/person/year including no more than 40-60kL/person/year of scheme water.

Based on the proposed development size and density, the development would yield approximately 190 lots, and require approximately 46 ML/annum for residential water use.

3.2.1 Household Water Use Efficiency

Household water use efficiency will be required through compliance with the 5 Star Plus Codes: Energy Use in Houses Code and Water Use in Houses Code (Department of Housing and Works, 2007a,b). The following requirements will be mandatory for each dwelling and the responsibility of the lot owners:

- All homes must have a gas hot water system with a minimum 5 stars WELS rating (or a solar hot water system, or a high energy efficient electric heat pump).
- 3 or 4 stars WELS rated water efficient fittings and fixtures must be fitted.
- All hot water outlets in new homes will be located close to the hot water system or a recirculating hot water supply to minimise wastage of energy and water.
- New homes must be plumbed to enable connection to an improved water supply at a later date (water tanks, bore water), and enable connection to a grey water diversion scheme.

3.2.2 Waterwise Landscaping

Lots will be provided with a full landscape package for the front gardens, which will incorporate a selection of Waterwise species, planting layout and water conservation irrigation package. This will reduce the overall water demand for irrigation of lots.

3.2.3 Community Education

Purchasers will be made aware of the importance of the home owner's role in saving and protecting water resources. This information will be provided within the sales centre and builder displays, describing the following water conservation information:

- Highlight the use of Waterwise landscaping techniques in public open space areas and display homes, describing the techniques employed.
- Benefits of water efficient gardens and how to minimise the extent of water-consuming planting.
- Guidance on fertiliser types and regimes and how to minimise the extent of fertiliser-dependent planting.
- Responsible irrigation techniques and the recommended irrigation times based on climatic and soil conditions.
- Water Corporation watering restrictions and rosters.
- Description of the local stormwater management design and responsible practices to assist with stormwater management (e.g. fertiliser and pesticide application, car washing detergents and practices, lawn and garden cutting disposal, and other techniques for minimising stormwater run-off pollutants).

3.3 Public Open Space

3.3.1 Landscape Design

Formalised Public Open Space (POS) will incorporate passive and active recreational opportunities through open parks and neighbourhood parks. Approximately 1.74 ha of POS and 1.57 ha of streetscape will be provided within the development (see Figure 2).

The landscaping of these spaces will include the use of predominantly endemic or native plant species. Limited use of exotic species is proposed in key areas for amenity and effect. Drip lines, spray irrigation and manual watering will be used for temporary irrigation of plants requiring establishment, depending on the most

appropriate application. Spray irrigation will be used for densely planted garden beds and turf in formalised POS areas and other community gardens (DEP, 2001).

POS irrigation will be scheduled based on site characteristics, application rates, plant types and monthly climate variations. Irrigation scheduling will be configured to encourage deep root growth during plant establishment and application intervals will be progressively reduced following plant establishment to maximise irrigation efficiency. All landscaping and irrigation works will be installed by a reputable contractor experienced in the Waterwise concepts being employed.

The POS concept landscape plan is included in Appendix E. POS designs and plans will be subject to review at the detailed planning stage and information will be included in subsequent UWMPs.

3.3.2 Irrigation Supply

As detailed above, approximately 1.74 ha of POS will be provided within the proposed development. In addition, the development will contain approximately 1.5 ha of additional streetscape landscaping (including temporary sales office and car parking landscaping). At a rate of 7,500 kL/ha/annum the amount of water needed to fulfil irrigation requirements (including irrigation of the public access way/fire access track outside the LSP area) is approximately 31,340 kL/annum.

The irrigation water supply for the site will be obtained from the Perth Superficial Aquifer - Stakehill Subarea. An existing groundwater licence (licence number GWL180811(1)) will be used for construction, plant establishment and post development POS irrigation. The licence provides an allocation of 78,150 kL/annum for all of these purposes.

The licence is provided in Appendix F.

4.0 STORMWATER MANAGEMENT

The proposed drainage strategy is in line with the over-arching drainage strategy outlined in the Baldivis (North) District Structure Plan. The site will achieve effective stormwater management through the implementation of Water Sustainable Urban Design (WSUD) principles and Best Management Practices (BMPs) to address runoff quantity and quality post development. Both water quality and quantity in minor and major storm events will be managed in line with the BUWM guidelines (WAPC, 2008).

4.1 Overall Drainage Strategy

The proposed drainage strategy includes infiltration of stormwater generated from impermeable surfaces post development.

4.2 Lot Drainage

The *Decision Process for Stormwater Management in WA* (DoE and SRT, 2005) recommends that the 1 year ARI event should be retained or detained on-site as high in the catchment as possible, unless it can be clearly demonstrated that it is impractical due to site conditions.

Given the majority sandy geology and the significant separation to groundwater across the 'Urban' portion of the site, lot drainage will be infiltrated via soakwells where possible. As the size and arrangement of individual lots have not been confirmed at this stage, it has been assumed that all lots will have the ability to accommodate soakwells. It will be the lot owner's responsibility to provide and install soakwells.

4.3 Road Drainage

The road runoff will all be directed towards, and treated and infiltrated within a bioretention area and infiltration basin located to the south west of the LSP area within the 'rural' zoned portion of Lot 306.

4.3.1 Catchment Areas

The developable portion of the site is comprised of a single catchment (approximately 13.4 ha) draining to a dedicated infiltration basin just within the 'Rural' portion of the site.

The catchment includes runoff from a portion of Elderberry Drive in the north while the remainder of Elderberry Drive drains north to the Baldivis North drainage system, or west to the Paradiso drainage system. This approach has been agreed with the neighbouring landowners, and incorporated in their drainage design.

The eastern catchment boundary excludes McDonald Road to the east. This is an existing road which currently has its own drainage strategy.

The post-development catchment area is shown in Figure 9.

4.3.2 Conveyance System

A piped conveyance system will be used to convey road runoff for up to a 5 year ARI event. Any stormwater from events greater than the 5 year ARI event will be conveyed as overland flow within the road reserves. A plan of the piped drainage network across the site will be provided in the UWMP.

The method of entry for stormwater into the basins will be via a piped inlet for events up to a 5 year ARI (i.e. from the piped drainage conveyance system), and for events over 5 year and up until the 100 year ARI the method of entry will be via overland flow. The event plan is provided in Figure 9.

4.3.3 Bioretention Area and Infiltration Basin

A bioretention area and infiltration basin will be located in the north eastern corner of the 'Rural' portion of the site, adjacent to the 'Urban' area.

Initially stormwater runoff will enter the bioretention area where the first flush will be treated (see Section 4.4.2 for further information). In larger events, stormwater will naturally overtop the bioretention area and enter the larger infiltration basin. The basin will contain and infiltrate all stormwater events up to the 100 year ARI rainfall event. The bioretention area and basin details, and plan and cross section view are provided on Figure 10.

Drainage modelling was carried out by Development Engineering Consultants (DEC) using engineering modelling derived from the Rational Method to determine approximate basin sizing requirements. The basin has been sized on the basis of 80% effective runoff from road reserve areas, as per CoR requirements (*Pers. Comm.* Steve Allen, Development Engineering Consultants).

An infiltration rate of 0.013 l/s/m^2 (1.12 m/day/m^2) has been applied in the infiltration basin. Infiltration testing showed percolation results ranging from approximately 3m/day to 19m/day, with results of 3.4m/day in the basin area. The infiltration rate used in the basin drainage design is 1.12m/day which is more conservative than the geotechnical results. The infiltration rate is based on an empirical method based on known infiltration rates in the area.

Drainage modelling details and results are presented in Table 9. The detailed engineering calculations are provided in Appendix G.

Table 9 Drainage Design Details

Parameter	Basin
Catchment area (ha)	13.4
Basin base (mAHD)	3.0
Basin Capacity (m^3)	2,043
1 Year ARI Event	
Critical Storm Duration (hrs)	8
Time of Inundation (hrs)	18
Effective Impervious Area (EIA) (ha)	2.07
Storage required (m^3)	544

Parameter	Basin
Area at TWL (m^2)	2,172
TWL (mAHD)	3.61
Depth of water in 1 Yr event (m)	0.61
5 Year ARI Event	
Critical Storm Duration (hrs)	4
Time of Inundation (hrs)	25
Effective Impervious Area (EIA) (ha)	2.70
Storage required (m^3)	744
Area at TWL (m^2)	2,274
TWL (mAHD)	3.70
Depth of water in 5 yr event (m)	0.70
100 Year ARI Event	
Critical Storm Duration (hrs)	16
Time of Inundation (hrs)	70
Effective Impervious Area (EIA) (ha)	3.10
Storage required (m^3)	2,031
Area at TWL (m^2)	2,885
TWL (mAHD)	4.20
Depth of water in 100 yr event (m)	1.20

4.3.4 Separation Distances

4.3.4.1 <u>100 year TWL to Finished Floor Levels</u>

The BUWM guidelines require:

- At least 0.5 m separation between finished lot levels and the 100 year ARI flood level in the main drainage infrastructure.
  - The minimum lot levels in the development are adjacent to the infiltration basin and are approximately 5.26 mAHD. This equates to a separation distance to the 100 year ARI level in the basin of approximately 1.06 m. This exceeds the 0.5 m required.
- At least 0.3 m separation between minimum habitable floor level and the 100 year ARI level in the road reserve is required (Local Government Guidelines for Subdivisional Development and Australian Rainfall and Runoff recommendation).
  - During the 100 year event some short term inundation in the road reserve surrounding the central POS may occur due to the localised low point occurring in this location causing a back log before it is able to drain via the pipe network to the basin. The detailed earthworks and road levels have not yet been determined therefore the top water level (TWL) in mAHD is unknown at this stage. Current modelling shows that approximately 150mm of inundation will

occur in the road reserve. An indicative area of inundation is shown in Figure 11.

- Further information (TWLs) will be provided during detailed design stage within the UWMP. The drainage design will ensure that habitable floor levels in this area are a minimum of 300mm above the TWL described above, and emergency accessibility will be achievable.

4.3.5 Disease Vector and Nuisance Insects

Based on an infiltration rate of 1.12 m/day during the critical 100 year ARI event the basin will infiltrate within approximately 70 hours. This is less than the maximum infiltration time (96 hours) for the prevention of disease vector and nuisance insects.

4.4 Water Quality Treatment

4.4.1 Gross Pollutant Traps

Gross Pollutant Traps (GPTs) are to be installed at the entrance to the basin, which will remove any litter and sediment from stormwater runoff. Subsequently, this will prevent clogging and will maintain stormwater quality prior to infiltration.

4.4.2 Bioretention Area

The majority of pollutants are transported in the smaller rainfall events. Figure 10 and Appendix E shows the bioretention area (1 year ARI event).

The DoW identifies the following objectives for biofilters and bioretention areas (DoW, 2011);

- Vegetated area to aid aesthetics, assist in pollutant removal and maintain hydraulic conductivity of the filter media.
- Small layer of stone mulch to suppress weeds and retain moisture in filter media.
- A thicker layer of filter media for;
  - Plant establishment
  - Filtration of fine sediments and colloidal particles
  - Sorption of heavy metals and nutrients by soil particles
  - Pollutant decomposition by soil bacteria
- Transition layer to avoid clogging of the drainage layer.
- Free draining layer with subsoil pipe (if required) or infiltration form the base if applicable.

In order to achieve these objectives, the bioretention area in the basin has been designed with the following;

- DoW consider approximately 2% of the effective impervious area is required to adequately treat first flush events. The EIA (1 year) for the catchment is 2.07ha. The area of the bioretention area is approximately 678sqm which equates to 3.2% of the EIA for the 1 year ARI or 2.2% of the EIA for the 100 year ARI.

- Vegetation will be planted in the bioretention area to help prevent erosion, maintain soil infiltration as well as to remove particulate and soluble pollutants, particularly nitrogen. The plants will be appropriately selected based on their intended function aimed at nitrogen removal using native vegetation as much as possible. The plant species used within the basin will be identified within the subsequent Urban Water Management Plan (UWMP).

- Stone mulch will be used beneath the vegetation to ensure no 'floating' potential.

- The filter media will consist of a gingin loam blended with approximately 50% safety bay sand. The amended soil will be further amended with mulch and hardwood chips. This will consist of a minimum depth of 0.5m of amendment (approximately 2.5-3.0mAHD) and a minimum PRI of 10.

- Beneath the filter media will be a layer of sand which will also allow infiltration to groundwater.

- The bioretention area will allow infiltration from the base to groundwater given the sandy nature of the existing soils on site (no subsoil pipe required).

4.4.3 Non Structural Controls

Non-structural controls can be used to provide additional stormwater quality management. These include public awareness and community education establishing operation and maintenance activities and controlling land use management. The following will be considered during the detailed design stage for the site:

- Nutrient control through landscaping - appropriate native plant species selected with a recommended fertiliser, pesticide and irrigation regime.

- Waste Management Plan, such as:
  - Prompt removal of litter when discovered.
  - Providing sufficient public facilities for rubbish disposal.

- Regular street sweeping.

- Maintenance of the vegetated basin to remove sediment, litter and excess vegetation.

- Community signage will be used (where necessary) to provide stormwater protection messages (e.g. spill contact details, illegal dumping penalties, public education, etc.).

- Information packs will be provided to each new home and business owner:
  - Drainage structural controls in place and their objectives.
  - How to prevent pollution from entering the stormwater conveyance system.
  - The importance of correct fertiliser and pesticide application.
  - How to report illegal waste dumping or report spills.

All development construction projects, including road and infrastructure construction, will be subject to sediment and erosion control measures which will be confirmed during detailed design stage.

4.5 Interaction with Opwin Wetland

The Opwin Wetland is located in the south western corner of Lot 306, within the 'Rural' area. As previously identified in Section 2.7 the Opwin Wetland is a CCW. In order to ensure minimal disturbance to the wetland a number of measures have been put in place, as detailed below:

- A 50 m buffer between the edge of the wetland and any drainage infrastructure or lot boundaries. The drainage basin will be located approximately 160 m from the CCW and therefore significantly exceeds this requirement.
- The hydrological regime will be maintained post development by mimicking the pre development regime of infiltration recharging the aquifers and subsequently the wetlands (using the methods described in Section 4.1)
- Water quality will be maintained to ensure that there are no adverse impacts to the wetland water quality and ecosystems. This will be achieved through the measures described in Section 4.4.

5.0 GROUNDWATER MANAGEMENT

5.1 Fill Management

Post development lot levels will mimic the pre development topography. No major earthworks or cut and fill excavation will be undertaken. Minor earthworks will involve re-sculpting the current landform. An indicative earthworks plan is provided in Appendix H.

5.1.1 Separation Distances

5.1.1.1 Lots levels to Groundwater

The minimum lot level proposed is approximately 5.26 mAHD. These lots are located adjacent to the drainage basin and the MW3 bore and as such the peak groundwater level at MW3 (1.82 mAHD) has been adopted for this location. This equates to a minimum separation distance of 3.44 m.

This is greater than the 1.2 m separation distance requirement as per the BUWM requirements, therefore no fill is required.

5.1.1.2 Basin Base to Groundwater

The base invert of the basin is set at 3.0 mAHD. This will be approximately 1.2 m above the peak groundwater levels in the basin location (approximately 1.8 mAHD).

This is greater than the 0.3 m separation distance requirement as per the BUWM guidelines. This will ensure the basin remains functional during wet periods and to ensure that stormwater is appropriately treated prior to reaching the groundwater table.

5.1.1.3 Soakwell Base to Groundwater

At least 0.3 m separation distance will be provided between the base of soakwells beneath lots and the base of the soakwells within the basin and peak groundwater levels to ensure that the soakwells remain operational during high groundwater periods.

Based on an average soakwell depth of 1.2 m and an approximate minimum lot level of 5.26 mAHD, separation from the base of soakwells to groundwater will be a minimum of 2.26 m for lots.

Soakwells within the basin will be shallower, with a maximum depth of 0.9 m. As detailed in Section 5.1.1.2, there is approximately 1.2m separation distance below the base of the basin. In order to ensure there is a minimum of 0.3 m separation between the base of the soakwells and the groundwater, shallower soakwells will be used to ensure infiltration occurs.

5.2 Subsoil Drainage

Subsoil drainage is not required as a mechanism to groundwater levels due to the large separation distance to groundwater across the site (approximately 2.7 – 35 m).

6.0 MONITORING

6.1 Pre-Development Monitoring

Consultation with DoW was undertaken regarding the pre development monitoring required for this site (see Appendix D). Site specific pre-development monitoring was not considered necessary prior to the LSP/ LWMS stage due to the large separation distances to groundwater across the majority of the site and the adjacent monitoring in the Spires Estate which was conducted from August 2012 to November 2013.

However following this consultation, some site specific monitoring was undertaken as part of the DSI. This was undertaken during the peak period (September – October 2014). Monitoring was undertaken for two events and included water levels and water quality analysis (Appendix C) at three bores on site.

6.2 Post Development Monitoring

6.2.1 Monitoring

Groundwater monitoring will be undertaken post-development on a quarterly basis for a period of three years at the same three bores as pre-development DSI sampling (Figure 8). Post development monitoring will begin at practical completion of the development.

Groundwater monitoring will be undertaken for the following parameters:

- Groundwater levels
- In situ analysis; pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), redox.
- Lab analysis; total nitrogen (TN), ammonia-N, total kjeldahl nitrogen (TKN), nitrate/nitrite-N, total phosphorus (TP) and filtered reactive phosphorus (FRP).

Laboratory samples will be analysed by a NATA accrediated laboratory. In order to address quality assurance and quality control (QAQC) requirements, two QAQC samples will be collected and analysed for each quarterly monitoring event.

6.2.2 Contingency Response

6.2.2.1 Trigger Values

The trigger values presented in Table 10 below are derived from the maximum pre-development quality levels at the bores on site (Appendix C). If post development water quality parameters exceed by more than 10% for two consecutive sampling events contingency measures will be employed as outlined below.

Table 10 Trigger Values (Pre-Development plus 10%) (mg/L)

Bore	Total Nitrogen	Total Phosphorus
MW1	33.00	0.65
MW2	34.10	0.08
MW3	2.53	0.19

6.2.2.2 Contingency Measures

If a water quality trigger values are exceeded, an investigation will commence to determine the likely causes, the likely impacts and available contingency measures.

The following responses will be considered in the event that the deterioration of water quality is attributed to the site:

- Definition of source contaminants – following identification, more accurate solutions can be determined to target the parameter of concern.
- Reduction of fertilisers in key areas contributing to water quality deterioration.
- Adjustments of fertiliser regime to give nutrients to vegetation only when it is required. This could be determined by leaf tissue analysis.
- Increase planting of deep rooted vegetation in the bioretention area or basin to increase nutrient uptake.
- Re-instate resident awareness campaign to reduce nutrients leaving individual lots.

6.2.3 Reporting

The results of the monitoring will be reported annually to the DoW and to the City of Rockingham, along with any contingency responses required/implemented.

7.0 IMPLEMENTATION

The effective implementation of the LWMS requires ongoing involvement by the relevant stakeholders. The roles and responsibilities associated with the site are summarised in Table 11.

7.1 Roles and Responsibilities

Table 11 Roles and Responsibilities for Implementation

Principals	Role	Responsibility	Timescales
Water Usage Strategy	Provision of water supply infrastructure	Proponent	Prior to construction
	Provision of wastewater sewers	Proponent	Prior to construction
	Provision of front landscaping packages	Proponent	During house design and installation
	Provision of educational information	Proponent	During house design and installation
Stormwater Management	Soakwells for roof drainage	Lot owner	During house design and installation
	Design and construction of stormwater infrastructure	Proponent	Following detailed engineering design
	Maintenance of the infiltration basin	Proponent	Post development until handover to council
	Non-structural controls	Proponent	Post development until handover to council
Monitoring	Groundwater monitoring	Proponent	Quarterly for three years post-development
	Reporting	Proponent	Annually for three years post-development
Further Work	The preparation of UWMP	Proponent	At subdivision stage

7.2 Further Requirements

The preparation of a UWMP will be required as a condition of subdivision approval and will include, but not be limited to, the following design measures in more detail:

- Compliance with this LWMS to the satisfaction of the City of Rockingham and DoW.

- Details of the existing environment including the inclusion of updated data (e.g. groundwater data).

- Detailed stormwater drainage design including final basin dimensions and locations.

- Final subdivision layout including final cut and fill levels, minor and major drainage layouts and overland flow paths.

- Identification of 100 year inundation levels in road reserves and required 300mm separation distances are achieved.

- Management of subdivisional works, including details of dust suppression if required.

- Landscaping design for the POS areas and vegetated drainage areas finalised, including species selection, and fertiliser regimes and irrigation requirements.

- Finalised implementation plan including roles and responsibilities of all parties involved, including maintenance requirements, frequency and duration for the drainage system and non structural controls.

8.0 REFERENCES

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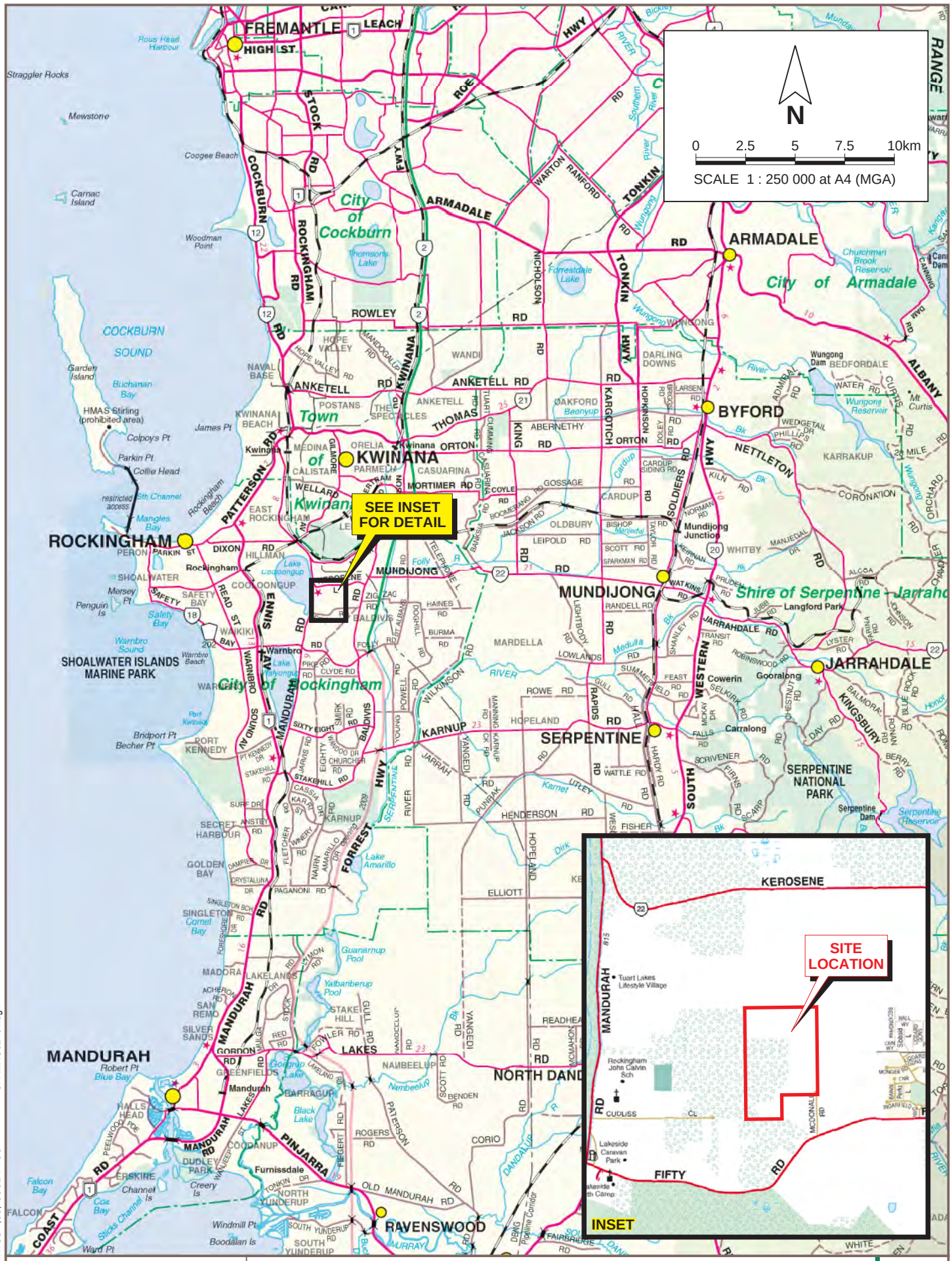
FIGURES



COTERRA ENVIRONMENT	Spatial Property Group LOCAL WATER MANAGEMENT STRATEGY LOT 306 MCDONALD ROAD, BALDIVIS		Figure 1
Drawn: K. Chandler	Date: 29 Apr 2014	**SITE LOCATION**	
Job: SPAMAC02	Revision: A		

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-f01.dgn

Creative DESIGN+PLANNING

DRAFT

SOURCE: Creative Design and Planning, Dwg No. SPGBD-2-001F, 26-08-2015.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: R. Epworth	Date: 10 Sep 2015
Job: SPAMAC02	Revision: A

LOCAL STRUCTURE PLAN

Figure 2

AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2014.

SPAMAC02-I03.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: K. Chandler	Date: 16 Jan 2015
Job: SPAMAC02	Revision: A

SURROUNDING LAND USES

Figure 3

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-f04.dgn

N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

299

14

102

1

6 425 250mN

2

Lot 306

9002

40 35 30 25 20 15 10 5

45

12

6 425 000mN

5

MCDONALD ROAD

34

16

100

52

305

53

51

100

101

387 500mE

387 750mE

Legend

- Current Site Boundary
- Lot 306 Boundary
- Cadastral Boundary
- Easement Boundary
- Topographic Contour

CADASTRAL SOURCE: Landgate, March 2014.
AERIAL PHOTOGRAPH SOURCE: Landgate, flown December 2014.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: K. Chandler | Date: 16 Jan 2015

Job: SPAMAC02 | Revision: A

TOPOGRAPHY

Figure 4

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-f05.dgn

N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

387 750mE

6 425 250mN

6 425 000mN

387 500mE

S7

LS1

Cps

TP01 TP02 TP03 TP04 TP05 TP06 TP07

BH01 BH02 BH03 BH04 BH05 BH06 BH07 BH08 BH09 BH10 BH11 BH12 BH13

Lot 306

299 14 102 1 2 12 34 9002 305 53 51 100 52 16

40 35 30 25 20 15 10 5 45

Legend

- Current Site Boundary
- Lot 306 Boundary
- Cadastral Boundary
- Easement Boundary
- Topographic Contour
- Borehole Location
- Test Pit Location
- Permeability Test Location

Environmental Geology

Cps PEATY CLAY - dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin

LS1 LIMESTONE - light, yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin

S7 SAND - pale and olive yellow, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin

CADASTRAL SOURCE: Landgate, March 2014.
AERIAL PHOTOGRAPH SOURCE: Landgate, flown December 2014.
TEST LOCATIONS SOURCE: Structerre, Project No. D111360, 12 May 2015.
GEOLOGY SOURCE: Geological Survey of WA 1:50,000. Environmental Geology Series.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: C. Hopkirk | Date: 9 Sep 2015
Job: SPAMAC02 | Revision: A

SOILS AND GEOLOGY

Figure 5

N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

299

14

102

1

6 425 250mN

2

Lot 306

9002

12

6 425 000mN

34

16

MCDONALD ROAD

100

52

305

53

51

100

101

387 500mE

387 750mE

Legend

- Current Site Boundary
- Lot 306 Boundary
- Cadastral Boundary
- Easement Boundary
- High to Moderate Risk of Acid Sulfate Soil

ASS SOURCE: DEC, January 2010.
CADASTRAL SOURCE: Landgate, March 2014.
AERIAL PHOTOGRAPH SOURCE: Landgate, flown December 2014.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: K. Chandler	Date: 16 Jan 2015
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ACID SULFATE SOIL RISK

Figure 6

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-f07.dgn

N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

299

14

102

1

6 425 250mN

2

Lot 306

9002

12

6 425 000mN

34

16

52

305

53

6400

387 500mE

51

100

101

387 750mE

Legend

- Current Site Boundary
- Lot 306 Boundary
- Cadastral Boundary
- Easement Boundary

Geomorphic Wetlands

- Conservation Category
- 50m from CCW
- 6400 Wetland UFI

WETLAND SOURCE: DER, November 2013.
CADASTRAL SOURCE: Landgate, March 2014.
AERIAL PHOTOGRAPH SOURCE: Landgate, flown December 2014.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: K. Chandler | Date: 16 Jan 2015

Job: SPAMAC02 | Revision: A

GEOMORPHIC WETLANDS AND BUFFERS

Figure 7

6 426 000mN

6 425 000mN

386 000mE

387 000mE

388 000mE

MW1

MW2

MW3

Lot 306

NBAL01

NBAL02

NBAL03

MANDURAH ROAD

FIFTY ROAD

ROAD

N

0 50 100 150 200 250m

SCALE 1 : 7 500 at A3 (MGA)

Legend

- Current Site Boundary
- Lot 306 Boundary
- Cadastral Boundary
- Easement Boundary
- Lower Serpentine Maximum Groundwater Contour
- Minimum Groundwater Contour
- DoW WIN Bore Location
- Groundwater Monitoring Well Location
- Monitoring Bore Location

CADASTRAL SOURCE: Landgate, March 2014.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2014.
MINIMUM GROUNDWATER CONTOUR SOURCE: Department of Water, May 2003.
MAXIMUM GROUNDWATER CONTOUR SOURCE: Department of Water, March 2012.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

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GROUNDWATER

Figure 8

SPAMAC02-f08.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

CATCHMENT AREA INFORMATION				
TOTAL AREA	RESIDENTIAL LOT AREA	RURAL LOT AREA	ROAD RESERVE AREA	POS AREA
13.54Ha	7.46Ha	1.28Ha	2.94Ha	1.86Ha

LEGEND

- CATCHMENT AREA
- GROUND WATER CONTOURS
- DRAINAGE BASIN
- FLOW ARROW
- MB01 — NAME; 693.065m AHD; 507.782m; 84 - 0.00m — SURFACE LEVEL; DEPTH; Ø50 — BORE DIAMETER — MONITORING BORE
- 1 IN 1 YEAR STORAGE
- 1 IN 5 YEAR STORAGE
- 1 IN 10 YEAR STORAGE
- 1 IN 100 YEAR STORAGE

To North Baldivis Development

To Paradiso Develoment

McDONALD ROAD

FAIRCHILD DRIVE

KEMPSEY STREET

POORINDA LANE

MOLONGLO CRESCENT

INGARFIELD DRIVE

KELLETT ROAD

ELDERBERRY DRIVE

P.O.S.

FUTURE RURAL LOT

BASE RL 3.0m

BASE RL 1.00m

RESTRICTION - GAS PIPELINE

BASIN DETAILS

TOTAL IMPERVIOUS AREA (100yr)	3.10ha
100yr STORAGE REQUIRED	2031m³
AREA AT TWL (100yr)	2885m²
RL (TWL) (100yr)	4.20m AHD
TOTAL IMPERVIOUS AREA (5yr)	2.70ha
5yr STORAGE REQUIRED	744m³
AREA AT TWL (5yr)	2274m²
RL (TWL) (5yr)	3.70m AHD
1yr STORAGE REQUIRED	544m³
AREA AT TWL (1yr)	2172m²
RL (TWL) (1yr)	3.61m AHD
PEAK OUTFLOW (10yr)	0 l/s

DEVELOPMENT ENGINEERING CONSULTANTS

SOURCE: Development Engineering Consultants, Dwg No. BDVCAN30 L04, Rev G, 04-09-15.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: R. Epworth | Date: 10 Sep 2015
Job: SPAMAC02 | Revision: A

CATCHMENT PLAN 1-100 YEAR ARI EVENTS

Figure 9

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-109.dgn

N

0 5 10 15 20m

SCALE 1 : 500 at A3 (MGA)

BASE RL 3.0m

BASE RL 3.5m

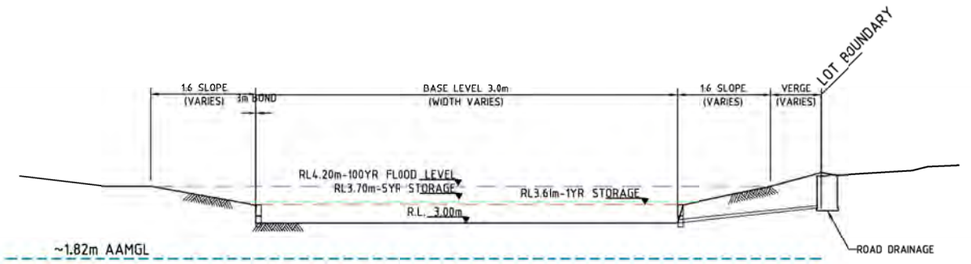
A

LEGEND

- CATCHMENT AREA
- 23 — FINISHED SURFACE CONTOURS
- 2.90 — GROUND WATER CONTOURS
- DRAINAGE BASIN
- FLOW ARROW
- MB01 — NAME; E 683.865m; N 497.782m; R.L. 4.00m — SURFACE LEVEL; 3.5m — DEPTH; Ø 150 — BORE DIAMETER — MONITORING BORE
- 1 IN 1 YEAR STORAGE
- 1 IN 5 YEAR STORAGE
- 1 IN 10 YEAR STORAGE
- 1 IN 100 YEAR STORAGE

BASIN DETAILS

TOTAL IMPERVIOUS AREA (100yr)	3.10ha
100yr STORAGE REQUIRED	2031m³
AREA AT TWL (100yr)	2885m²
RL (TWL) (100yr)	4.20m AHD
TOTAL IMPERVIOUS AREA (5yr)	2.70ha
5yr STORAGE REQUIRED	744m³
AREA AT TWL (5yr)	2274m²
RL (TWL) (5yr)	3.70m AHD
1yr STORAGE REQUIRED	544m³
AREA AT TWL (1yr)	2172m²
RL (TWL) (1yr)	3.61m AHD
PEAK OUTFLOW (100yr)	0 l/s



SECTION A

PLAN

DEVELOPMENT ENGINEERING CONSULTANTS

SOURCE: Development Engineering Consultants, Dwg No. BDVCAN30 L05, Rev G, 04-09-15.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

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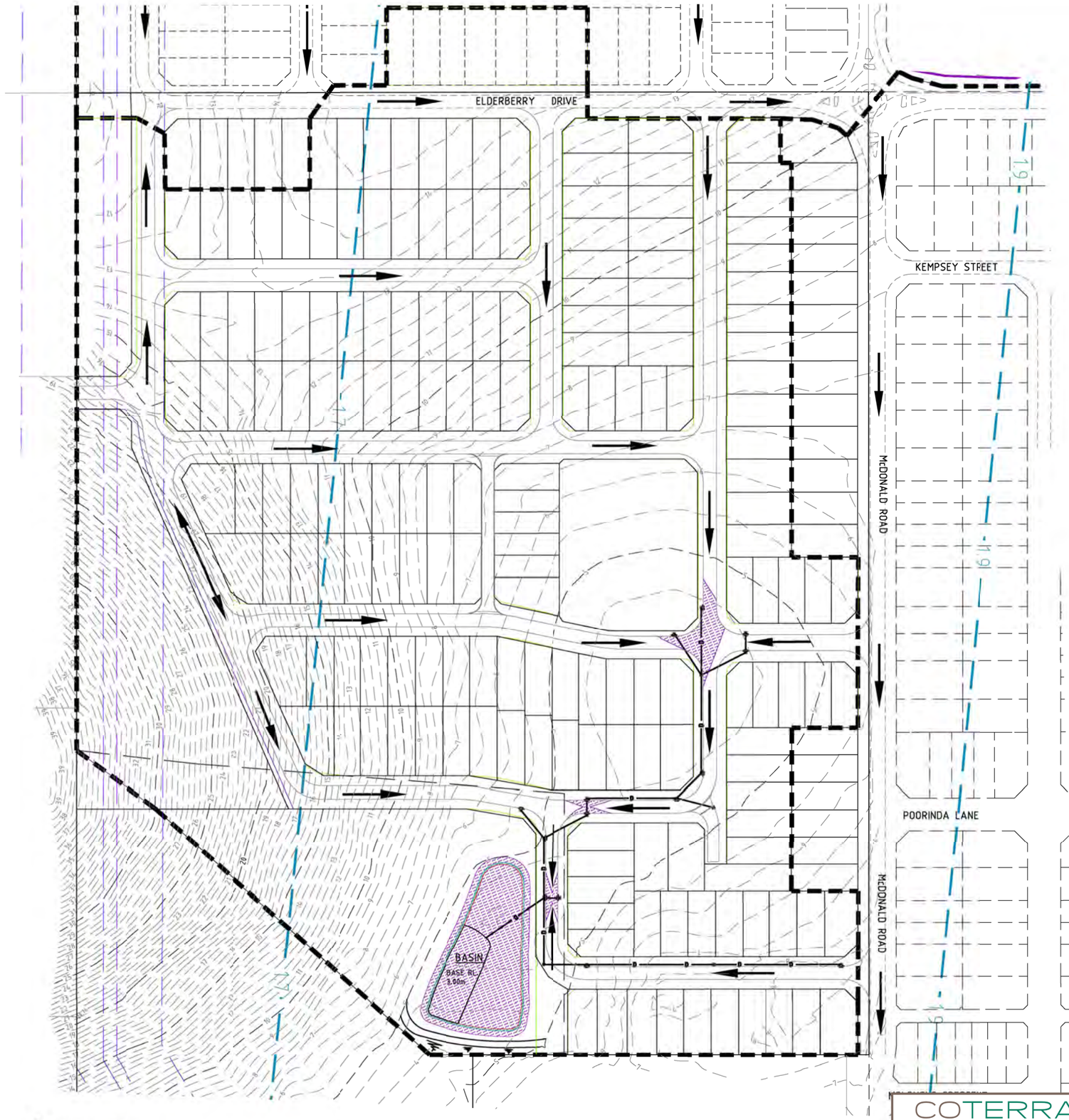
Job: SPAMAC02 | Revision: A

PRELIMINARY BASIN DESIGN AND CROSS SECTION

Figure 10



N

0 20 40 60 80 100m

SCALE 1 : 2 000 at A3 (MGA)

LEGEND

- CATCHMENT AREA
- FINISHED SURFACE CONTOURS
- GROUND WATER CONTOURS
- 100 YR FLOOD AREA
- FLOW ARROW
- MONITORING BORE (MB01, NAME; E 683.865m, N 507.782m, R.L. 0.00m, SURFACE LEVEL; 2.5m, DEPTH; Ø150, BORE DIAMETER)
- 1 IN 1 YEAR STORAGE
- 1 IN 5 YEAR STORAGE
- 1 IN 10 YEAR STORAGE
- 1 IN 100 YEAR STORAGE

DEVELOPMENT ENGINEERING CONSULTANTS

SOURCE: Development Engineering Consultants, Dwg No. BDVCAN30 L06, Rev E, 04-09-15.

COTERRA ENVIRONMENT

Spatial Property Group
LOCAL WATER MANAGEMENT STRATEGY
LOT 306 MCDONALD ROAD, BALDIVIS

Drawn: R. Epworth	Date: 10 Sep 2015
Job: SPAMAC02	Revision: A

100 YEAR INUNDATION AREA

Figure 11

PINPOINT CARTOGRAPHICS (08) 9562 7136 SPAMAC02-f11.dgn