Appendix 7
Local Water Management Strategy (RPS)

LOCAL WATER MANAGEMENT STRATEGY

Heritage Park Phase Two, Baldivis





LOCAL WATER MANAGEMENT STRATEGY

Heritage Park Phase Two, Baldivis

Prepared by:

RPS

Level 2, 27-31 Troode Street,
WEST PERTH WA 6005
PO Box 170, WEST PERTH WA 6872

T: +61 8 9211 1111
F: +61 8 9211 1122
E: environment@rpsgroup.com.au
W: rpsgroup.com.au

Prepared for:

ROCKINGHAM PARK PTY LTD

c/o Mortons Urban Solutions

Unit 4 / 100 Railway Road

SUBIACO WA 6008

Report No: EWP15166.001
Version/Date: Rev 3, May 2017

Document Status

Version	Purpose of Document	Orig	Review	Review Date	Format Review	RPS Release Approval	Issue Date
Draft A	Draft for Client Review	KriFer	ShaMcS	07.04.16	DC 12.04.16		
Rev 0	Final for Issue	KriFer	ShaMcS	20.04.16	SN 22.04.16	T. Al-Hashimi	22.04.16
Rev 1	Final for Issue	KriFer	ShaMcS	22.06.16	DC 23.06.16	C. Davies	23.06.16
Rev 2	Final for Issue	KriFer	ShaMcS	21.12.16	SN 22.12.16	C. Davies	22.12.16
Rev 3	Final for Issue	KriFer	DanWil	0.3.05.17	SN 04.05.17	C. Davies	05.05.17

Disclaimer

SUMMARY

This Local Water Management Strategy (LWMS) has been prepared by RPS on behalf of Rockingham Park Pty Ltd to support the Structure Plan (SP) submission for Lots 986 and 993 Baldivis Road, Baldivis known as Heritage Park Phase Two (herein referred to as the site). Rockingham Park Pty Ltd is proposing to develop Lots 986 and 993 Baldivis Road, Baldivis as residential lots.

The site has an existing natural surface with clearance to regional groundwater of 0.2 m to over 4.0 m. Approximately half of the site has been mapped as having a sandy soil profile and with sandy fill to be brought onto the site; there will be opportunities for infiltration at the lot scale. The site contains no significant wetlands. An open secondary agricultural drain (governed by the Water Corporation) runs the length of the site close to the eastern boundary. This drain eventually connects to the Peel Main Drain, south of the site. A section of the existing site is mapped by the DoW as being subject to flooding in 100-year ARI rainfall events. Urban development has already occurred in many nearby areas in close proximity to the site, and the area immediately to the north already has an approved LWMS and approved UWMPs in support of development.

The LWMS will demonstrate the water sensitive urban design and total water cycle management principles as identified in the *Better Urban Water Management Guidelines* (WAPC 2008) will be implemented in the proposed development for the site. Implementation of the strategy will be undertaken in accordance with BUWM through the development and implementation of Urban Water Management Plans for individual stages of development within the site.

A summary of the site conditions that govern the design of the development and key design strategies are provided in Table 1.

Table 1: Key LWMS features

Key LWMS Elements	Design and Compliance to Objectives
Topography (Section 2.2)	▪ The site is low-lying and relatively flat. Pre-development elevation at the site ranges from approximately 9 m AHD in the north-west of the site, sloping down to 3 m AHD in the south-east. A Water Corporation drain that runs the length of site close to the eastern boundary including embankments, has an elevation of 4 m AHD to 3 m AHD.
Geology and Soils (Section 2.3)	▪ 1:50,000 geological mapping identified two geological units for the site, S8 SAND on approximately the western portion of the site and Mc2 CLAYEY SILT on the eastern portion of the site.
Acid Sulfate Soils (Section 2.4)	▪ DER regional mapping has classified the whole site as having a “moderate to low risk of Acid Sulfate Soil (ASS) occurring within three metres of the natural soil surface”. ▪ An Acid Sulfate Soil and Dewatering Management Plan (ASS DMP) will be required before construction activities commence.

Key LWMS Elements	Design and Compliance to Objectives
Groundwater (Section 2.6)	▪ The site is located within the Stakehill groundwater area and the Outridge sub-area. Aquifers within this area include the unconfined Perth Superficial Swan, semi-confined Leederville Aquifer and the confined Yarragadee Aquifer. ▪ Regionally groundwater flow is to the west, discharging to the Indian Ocean, however localised mounding of groundwater and the potential influence of the Peel Main Drain creates localised groundwater flow to the east. ▪ The water table is shallow, with pre-development groundwater levels ranging from 0.02 mbgl to 4.14 mbgl. ▪ Historic Maximum Groundwater Levels (MGLs) for the bores on site have been estimated to range from 4.50 m AHD (MW11) in the north-west of the site to 2.99 m AHD (MB4) in the south-east of the site. ▪ Pre-development groundwater quality was found to be generally slightly acidic to neutral, fresh to brackish salinity (measured as EC) with elevated concentrations of nutrients. All TP results were above the ANZECC (2000) guidelines for slightly to moderately disturbed lowland rivers in south-west Australia, and the majority of the TN and NOx-N results also exceeded ANZECC (2000) guidelines.
Surface Hydrology (Section 2.7)	▪ The site is within the Serpentine River Catchment, with the Peel Main Drain located immediately east of the Kwinana Freeway. DoW (2015) catchment scale flood modelling has identified that flooding on the site from a 100 year ARI event would be 0.06 m to 0.25 m in depth, at 3.75 m AHD to 3.95 m AHD. ▪ Apart from the Water Corporation constructed drain that runs the length of the site north to south along the eastern boundary, there are no watercourses on the site. This drain also collects drainage from a POS in the Phase One Heritage Park development and leaves the site via 700 mm diameter culverts underneath Serpentine Road to the south of the site.
Wetlands (Section 2.8)	▪ The eastern half of the site has been mapped as a multiple use wetland (UFI 15785), however there are minimal conservation or flood mitigation values associated with this now. Maramanup Pool located to the north-east of the site is a CCW (UFI 14687), however being hydraulically up gradient from the site on the other side of the Kwinana Freeway, the development is not expected to have an impact on the CCW.
Water Servicing (Section 3)	▪ All lots will be supplied with potable water from the Water Corporation Integrated Water Supply Scheme and will be connected to the Water Corporation reticulated sewer. The project engineers have been in correspondence with the Water Corporation to confirm this and this is documented in the Engineering Services Report.
Water Conservation Strategy (Section 4)	▪ Native, waterwise plants will be used within the POS and streetscapes as much as possible. Turf areas will be minimised and be kept to active recreational areas, detention basins and road verges. ▪ The development will incorporate one main POS area, which will retain the mature trees present on the site. This POS will also provide a drainage function. ▪ POS will be irrigated with groundwater abstracted under the GWL (164680), reducing the site's potable water demand. ▪ Education packages will be provided to all new homeowners to encourage waterwise practices within the home and garden and minimum standards of efficiency for water using fixtures and fittings in homes will be employed.

Key LWMS Elements	Design and Compliance to Objectives
Stormwater Management (Section 6)	▪ The stormwater drainage design demonstrates that the site is capable of maintaining pre-development flow rates up to the 100 year ARI (Average Recurrence Interval) event. ▪ Rainfall from the 1 year ARI event (15 mm rainfall event) will be detained and treated as close to source as possible. ▪ A pipe and pit network will convey stormwater up to the 5 year ARI event to either the POS drainage basin or the drainage basin in the south of the site. ▪ The basin will have at least 0.5 m clearance from the base of the bio-remediation basin to the MGL. ▪ For events greater than the 5 year ARI up to the 100 year ARI event, stormwater will move via overland flow in the road network to the drainage basins. ▪ The open drain that currently exists on the site will be converted to a 300 mm closed pipe and will discharge south of the site. The existing 700 mm diameter culvert under Serpentine Road will be replaced. This drain eventually connects to the Peel Main Drain at Karnup Road, approximately 1.8 km south of the site. The two basins on the site will have controlled outlets to the closed central drainage pipe. These controlled outlets will ensure a maximum discharge rate of 4.5 L/s/Ha from the site during a 100 year ARI storm event. This maximum allowable discharge rate was agreed with the DoW. ▪ Structural and non-structural controls will be used to improve stormwater quality. ▪ Imported fill will be required on the site to provide sufficient clearance for installation of the gravity sewer system and it will also provide at least 0.5 m clearance from the 100 year flood level to the minimum habitable floor level. The earthworks plan show that the finished lot levels range from 5.32 m AHD to 7.48 m AHD, which is well above the 100 year flood level at 3.75 m AHD to 3.95 m AHD across the site pre-development.
Groundwater Management (Section 7)	▪ Subsoil drains will be installed in sections of the road reserve, beneath the bio-filtration areas of the drainage basins as well as on the edge of the stand of remnant *E. rudis* to assist in infiltration and provide a controlled groundwater level. ▪ The bio-filtration area in the POS will be designed to FAWB (2009) guidelines, and will include soil amendment in the base of the infiltration basin, to assist in treating stormwater prior to infiltration into the groundwater. ▪ The bio-retention area of the POS will be vegetated with plants species that will have a high uptake of nutrients. ▪ Dewatering is likely to be required for the installation of services. This will be completed under an approved ASSDMP.
Monitoring Requirements (Section 8)	▪ Three years of post-development groundwater monitoring is proposed from seven bores around the site following 80% practical completion of the development. This will include monthly groundwater level monitoring during the winter period from May to October, and quarterly level and water quality sampling for physico-chemical parameters and nutrient analysis. ▪ Opportunistic surface water sampling will also be undertaken from the POS infiltration basin if sampling corresponds with major rainfall events. ▪ Results will be compared to the pre-development trigger values based on pre-development monitoring.
Implementation (Section 9)	▪ Roles and responsibilities for future stages of development are identified.

TABLE OF CONTENTS

Page

TABLES

(contained within report text) **Page**

FIGURES

(contained within report text) **Page**

(compiled at rear of report)

GRAPHS

(contained within report text) **Page**

APPENDICES

1.0 INTRODUCTION

This Local Water Management Strategy (LWMS) has been prepared by RPS on behalf of Rockingham Park Pty Ltd to support the Structure Plan (SP) submission for Lots 986 and 993 Baldivis Road, Baldivis known as Heritage Park Phase Two (herein referred to as "the site"). The site is located approximately 45 km south of Perth central business district within the City of Rockingham (Figure 1). The site is 18.83 ha in size and is proposed to be developed for residential purposes, with lot sizes ranging from R25 to R60. The development will also include 2.09 ha of public open space.

This Local Water Management Strategy (LWMS) has been prepared to support the Structure Plan (SP) and details the integrated total water cycle water management strategies to be implemented for the site, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, a groundwater management strategy and a plan for implementation of subdivision plans.

1.1 Planning Background

The WAPC proposed a minor amendment to the Metropolitan Region Scheme (MRS) to rezone the site from rural to urban in June 2015, and the site was rezoned in October 2015 (WAPC 2015).

A District Water Management Plan (DWMS) was prepared by Greencap in April 2015 to support the amendment to the MRS, which was considered satisfactory by the Department of Water to support the rezoning of the land (WAPC 2015). Limitations to rezoning the site was previously due to insufficient wastewater treatment capacity, however this has since been addressed with the construction of the East Rockingham Wastewater Treatment Plant. The Environmental Protection Authority (EPA) assessed the MRS Amendment and advised that the appropriate level of assessment was "Scheme Not Assessed – Advice Given". This advice was in relation to flora and vegetation and terrestrial vegetation, to retain the remnant vegetation on Lot 993 in public open space, which has been incorporated into the concept plan for the site.

The Baldivis South District Structure Plan (DSP) provides non-statutory framework for the urbanisation of land south of Safety Bay Road, Baldivis. The site was not identified for urban purposes in the DSP, but is an extension of urban land within this cell.

Following on from this, the City of Rockingham have initiated an amendment to the Local Planning Scheme (LPS) No. 2. and this report has been prepared to support the LSP amendment.

1.1.1 Local Structure Plan – Proposed Development

The Structure Plan is shown in Figure 2 and the design includes the following land uses:

- 2.2294 ha of Public Open Space (POS) and drainage
- 0.1041 ha drainage reserve
- R25-R50 residential development.

The proposed development plan for the site has considered the pre-development environment and the constraints posed by existing vegetation, the tramway reserve and drainage issues, and used this information to inform and guide structure plan development.

1.2 Scheme Zoning

The site is bounded by land zoned urban to the north, land reserved for primary regional roads to the east (Kwinana Freeway), land zoned rural to the south and land reserved for Parks and Recreation to the west (the tramway reserve) (WAPC 2015).

1.3 Design Objectives

This report has been prepared in accordance with State Planning Policy 2.9: Water Resources (Government of Western Australia 2007a) and has also been developed with reference to the following guidance documents:

- Better Urban Water Management (WAPC 2008)
- Interim: Developing a Local Water Management Strategy (DoW 2008a)
- Stormwater Management Manual for Western Australia (DoW 2004–2007)
- Western Australian State Water Plan (Government of Western Australia 2007b).

The Better Urban Water Management framework (WAPC) integrates water management into the land use planning process to ensure planning strategies include total water cycle management and Water Sensitive Urban Design (WSUD).

This report will detail the integrated water management strategies that will be implemented at the site. Integrated water management will be achieved at the site through the following design objectives:

- Minimise irrigation requirements for the POS and streetscapes.
- Reduce potable water consumption within both residences and public open space.
- Incorporate where possible, low maintenance, cost-effective landscaping and stormwater treatment systems.

- Effectively manage the risk to human life, property damage and environmental degradation from water contamination and stormwater flooding.
- Ensure peak post-development flows are maintained within pre-development levels.
- Maintain and if possible improve water quality (surface and groundwater) within the development in relation to pre-development water quality.
- Promote infiltration of run-off as close to source as possible and mimic pre-development conditions.
- Implement best management practices in regards to stormwater management.

1.4 Previous Environmental Studies

Environmental and technical studies already completed for the site and relevant to this report include:

- North-east Baldivis flood modelling and drainage study, Supporting the North-east Baldivis drainage and water management plan (DoW 2015)
- Heritage Park Phase Two, District Water Management Strategy, Rockingham Park (Greencap 2015)
- Heritage Park Development, Baldivis, Geotechnical Plan (SKM 2008a)
- Heritage Park, Baldivis, Geotechnical Investigation and Assessment (SKM 2008b)
- Environmental Assessment – Heritage Park Estate Lots 986 and 993 Baldivis Road, Baldivis (ENV 2007)
- Nutrient and Drainage Management Plan, Heritage Park Private Estate, Baldivis Road, Baldivis (RPS Bowman Bishaw Gorham 2006).

2.0 EXISTING ENVIRONMENT

The following chapter describes the characteristics of the sites pre-development environment, which identifies the key constraints and opportunities of the site for application of water sensitive urban design with land use change. These constraints and opportunities have been used to inform the development of a suitable Local Water Management Strategy (LWMS) for the site.

2.1 Existing and Historical Land Use

The site includes Lots 986 and 993 Baldivis Road, in the suburb of Baldivis, within the City of Rockingham, Western Australia. The site location is shown in Figure 1.

The site is approximately 18.83 ha in size and is bounded by the Phase 1 Heritage Park residential development to the north, Serpentine Road then rural landholdings to the south, Kwinana Freeway to the east, and the heritage tramway reserve and Baldivis Road to the west. Baldivis is a developing residential suburb with the greater surrounding area being urban development.

Historically the land has been used for grazing of livestock. The majority of native vegetation has historically been cleared with remnant strands of trees left along the drainage line that runs parallel down the eastern boundary of the site and another strand of trees within the centre of Lot 993.

2.2 Topography

The site is relatively low-lying and gently sloped. Elevation contours of the site range from approximately 9 metres Australian Height Datum (m AHD) in the north-west corner of the site and slopes down to approximately 3 m AHD in the south-east. The drainage line that runs through the site on the east has steeper embankments that range in elevation from 4 m AHD to 3 m AHD, but has a low grade along its length. The topography of the site is shown in Figure 3.

2.3 Geology and Soils

Regional geological mapping at 1:50,000 scale (Gozzard 1983), indicates that the site consists of two geological units:

- S8 SAND – very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin as relatively thin veneer over C2, M4 and Mc2.

- Mc2 – CLAYEY SILT – dark greyish brown, mottled in part, soft when wet, plastic in part, blocky, variable clay content, of alluvial origin.

S8 SAND is located on the western half of the site, while Mc2 CLAYEY SILT occupies approximately the eastern half of the site (Figure 4). The S8 SANDS are associated with the Bassendean System. These sands typically have moderate phosphorus retention capacity and thus a lower nutrient export risk, as well as a low risk of water logging and erosion. The Mc2 CLAYEY SILT is associated with the Pinjarra system and has high nutrient absorption, low permeability and high waterlogging risk. However, clean fill will be used on the site to raise the finished lot level and the PRI and the permeability of this soil will be determined once it has been imported onto the site.

Detailed geotechnical investigations will be undertaken at the UWMP stage, and compared to regional mapping, including detailed testing of hydraulic conductivity.

2.4 Acid Sulfate Soils

The Department of Environment Regulation (DER) Acid Sulfate Soil (ASS) Risk Mapping has classified the whole site as having a moderate to low risk of ASS occurring within three metres of the natural soil surface (Figure 5).

Further investigation is likely to be required to determine if ASS is present on the site. Dewatering and other disturbance activities will be managed through an approved Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) at the subdivision stage of the site. This is a separate approval process to the LWMS (through the DER), with outcomes to be reported and inform the UWMPs for the site.

2.5 Contaminated Sites

A review of the DER Contaminated Sites Database (DER 2015) did not identify any registered contaminated sites within the site boundary or within a 5 km radius of the site. A Preliminary Site Investigation (PSI) has been completed for the site, which confirmed that there was no contamination on the site.

2.6 Groundwater

2.6.1 Aquifers

The site lies within the Stakehill Groundwater Area and the Outridge sub-area. The aquifers in this area include the Perth – Superficial Swan, Leederville and Yarragadee North. Details on the aquifers from the Rockingham-Stakehill Groundwater management plan (DoW 2008) are provided as follows:

- Superficial Swan – The water table is shallow (about 2 m AHD) and the unconfined aquifer is about 25 m thick, mainly consisting of clayey limestone. Groundwater is recharged mainly through infiltration of rain. Groundwater flow discharge occurs radially to the coast, into the Serpentine River, Lake Walyungup and through downward leakage into the Rockingham Sand Aquifer, Salinity varies between 500–1000 mg/L TDS; some areas associated with wetlands exceed 1000 mg/L TDS.

- Leederville Semi-Confined – Semi-confined aquifer that occurs at depths from 20–50 m below ground surface (about 200 m thick). Recharge occurs outside the Rockingham GWA, east of Serpentine River. Discharge occurs into the Rockingham Aquifer and west of the subarea to the ocean. Groundwater salinity is mainly 500–1000 mg/L TDS except in the north where it is up to 3000 mg/L TDS, with salinity generally increasing towards the coast where the salt-water interface exists.

- Yarragadee Confined – is a confined aquifer that is confined beneath the South Perth Shale at a depth of 250–350 m below ground surface, Recharge occurs outside of the Rockingham groundwater area along the eastern edge of the Swan Coastal Plain. Discharge is inferred to occur offshore. Groundwater salinity ranges from about 1000–10,000 mg/L TDS to about 500 m below the base of the South Perth Shale, with the seawater interface likely to occur well offshore.

2.6.2 Groundwater Levels

2.6.2.1 Regional Groundwater Levels

The Department of Water's Perth Groundwater Atlas (DoW 2015a) does not have historical maximum groundwater contours for the site, however the contours generated from May 2003 monitoring data show the groundwater levels for the site were around 2 m AHD.

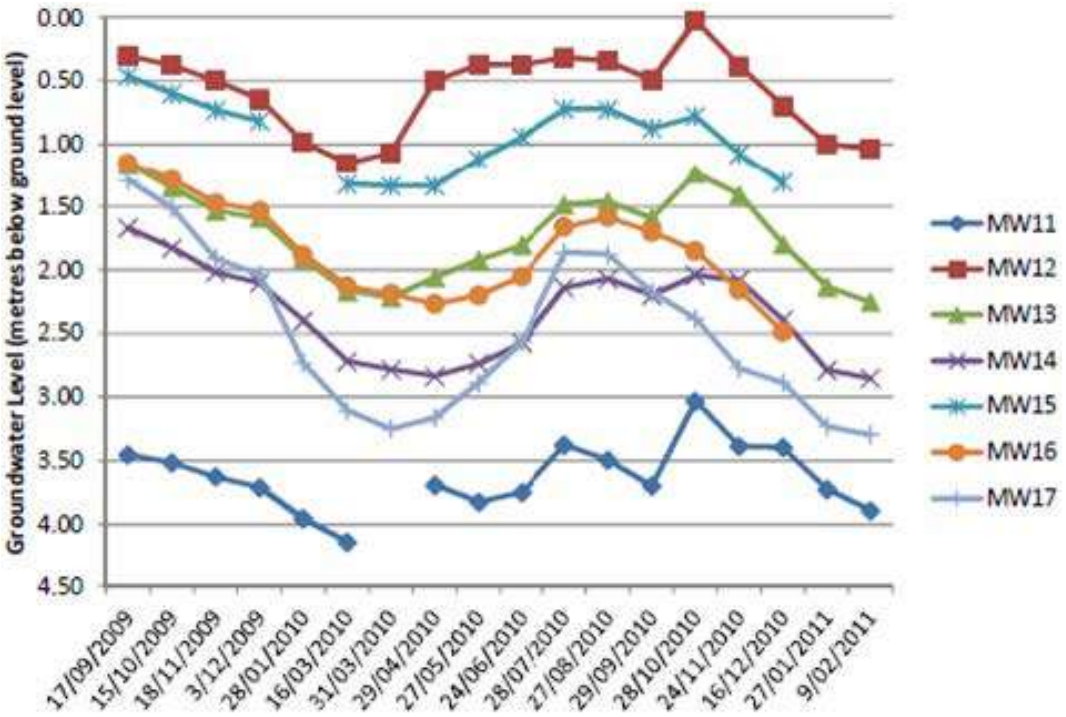
Regionally, groundwater flows in a westerly direction towards the coast, however on-site groundwater monitoring suggests that locally, groundwater flow is influenced by the on-site agricultural drain, Peel Main Drain and the Serpentine River and flows in a south-easterly direction. This was also the case for other investigations of groundwater in the

Baldivis area (RPS 2015). Groundwater monitoring and modelling results presented in an LWMS for Lots 460–463 Baldivis Road found that groundwater moved in an easterly direction towards the Peel Main Drain. It was also reported that localised groundwater mounding occurred with groundwater levels being higher than shown from the regional monitoring bores (RPS 2015).

There are two Department of Water monitoring bores that are located approximately 600 m to the north-west of the site (AWRC ref. No. 61410080 and 61410081). These bores are located on the eastern side of the Peel Main Drain. The hydrographs for these bores (Appendix 1) show that the groundwater levels are seasonally influenced, with a slight downward trend since monitoring began in these bores in the mid-1970s.

2.6.2.2 Site Groundwater Levels

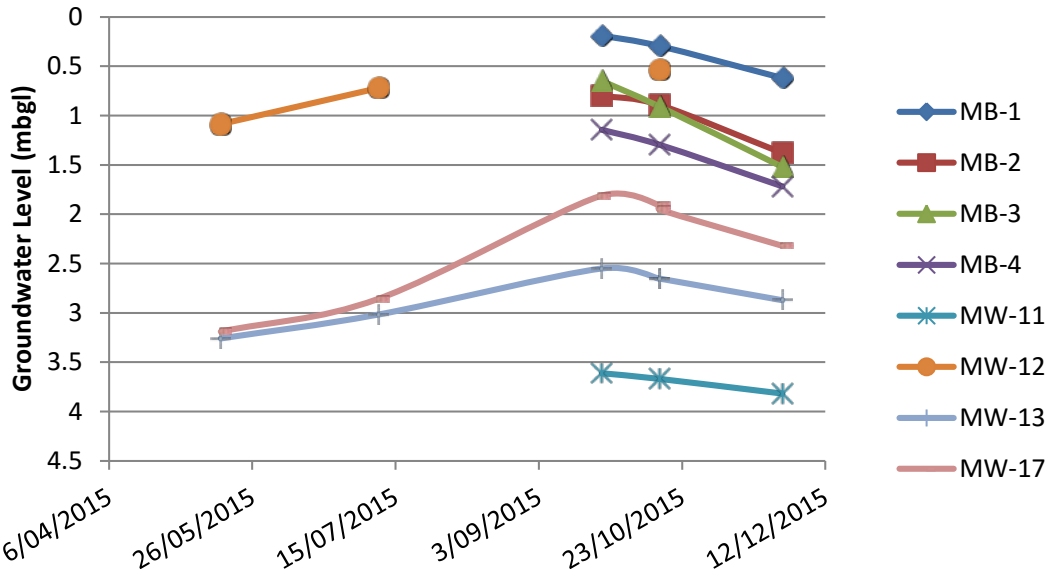
Greencap Pty Ltd completed pre-development groundwater level monitoring from a period from September 2009 to February 2011, covering two winter peaks from seven monitoring bores located on the site (MW11, MW12, MW13, MW14, MW15, MW16 and MW17). On-site groundwater level monitoring by Greencap found that the water table was shallow, with groundwater levels ranging from 0.02 metres below ground level (mbgl) (from MW12 on 28 October 2010) to 4.14 mbgl measured from MW11 on 16 March 2010 (Greencap 2015), as can be seen in Graph 1.



(Source: Greencap 2015)

Graph 1: Pre-development Groundwater Levels (Metres Below Ground Level) for the Site

RPS installed four additional bores on the site (September 2015) in order to provide a more spatially diverse monitoring network, targeting the proposed location of the POS and drainage basins. These bores were monitored from September to November 2015 in order to obtain the peak groundwater level data for 2015 and provide updated data for the engineering drainage design and finished floor levels of the development. This groundwater monitoring data returned groundwater levels similar to the previous monitoring ranging from 0.19 mbgl (from MB1 on 25 September 2015) to 3.818 mbgl (from MW11 on 27 November 2015) as shown in Graph 2.



Graph 2: Pre-development Groundwater Levels (Metres below Ground Level) for Monitoring Completed in 2015

The lithological and construction bore logs are provided in Appendix 2 and the groundwater levels are provided in Appendix 3. The location of the Greencap monitoring bores and the recently installed RPS monitoring bores, as well as the DoW monitoring bores used in the Maximum Groundwater Level (MGL) calculations are shown in Figure 6.

2.6.2.3 Maximum Groundwater Levels

Maximum groundwater levels (MGLs) across the site were calculated using the following information:

- The site bores MW11-MW17 were monitored from September 2009 to February 2011 and bores MW11, MW17 and the recently installed bores MB1–MB4 were monitored from September to November 2015 to determine the MGLs measured from the on-site bores. The MGL typically occurs at the end of the winter period in September–October. The preliminary MGL for each bore was taken from the monitoring that occurred for that individual bore – i.e. for MW12 the preliminary MGL was taken from the monitoring that occurred from September 2009 to February 2011, while for MW11 the preliminary MGL was taken from the monitoring that September 2009 to February 2011 and the 2015 monitoring.

- To determine the historic MGL for the site, the MGL since 1980 from five superficial DoW bores (AWRC: 61410071, 61610080, 61410081, 61410063, 61410064) was obtained. The difference from the historic maximum for the regional bores was added to the site bores recent MGLs to create a historic MGL for the site.

- The preliminary historic MGLs for the bores on site ranged from 4.501 m AHD (MW11) in the north-west to 2.992 m AHD (MB4) in the south-east of the site.

- MW13 has not been included in the mapping, as there appears to be a difference between the original surveyed height of the bore (Greencap 2015) and the current height. This might be a reflection of site soil stockpiling and/or amendment to the height of the bore casing. Given there is uncertainty around this bore and its data's integrity, it was removed from the assessment.

- Local and regional drainage features were also considered. Surveyed spot heights of the drain on-site were included and a nominal 300 mm was added as a top water level in the drain, which would coincide with a maximum groundwater level. Similarly, spot heights along the Peel Main Drain were also added.

- A number of dummy points were also added north and south of the site to prevent the groundwater contours skewing.

- The modelled MGL contours were determined by interpolating between the points using the Kriging method, with a cell size of 10 m and a grid measuring 1,200 m by 1,200 m. The final MGL contours for the site have been estimated to range from approximately 4.4 m AHD to 2.8 m AHD as shown in Figure A.

- Spot heights from a 2006 site survey were used for site elevation, which was used to determine the depth to MGL. Estimated depth to MGLs across the site ranges from zero (with ponding and inundation likely) to a clearance up to 5.5 m as shown in Figure B and Figure C respectively.

- Please note however that the Kriging method used for the generation of MGLs joins the contours between bores. Due to there being fewer data points for groundwater levels than elevation, the depth to MGL contours is an estimation and may show ponding where there is not.

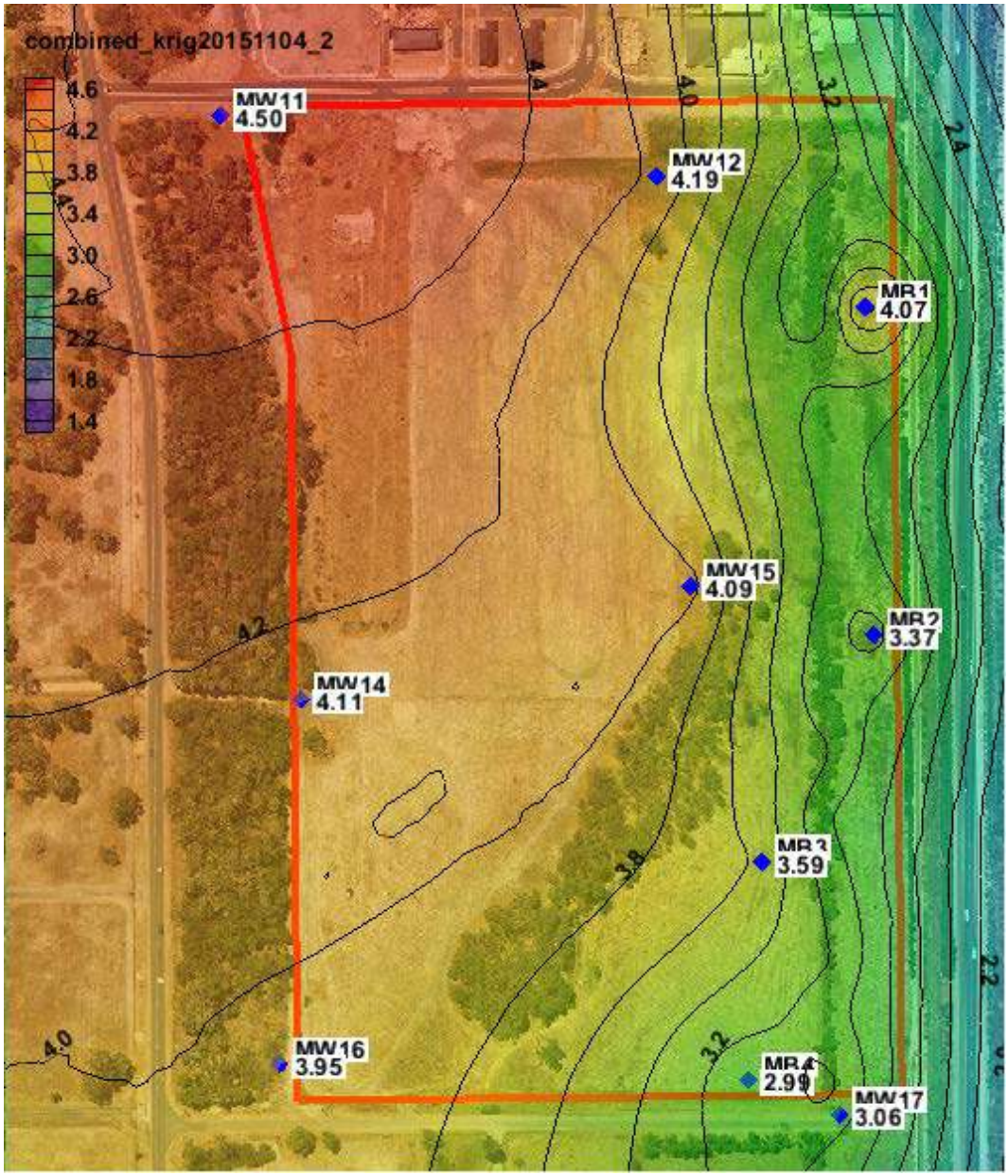


Figure A: Site MGL Contours (m AHD)

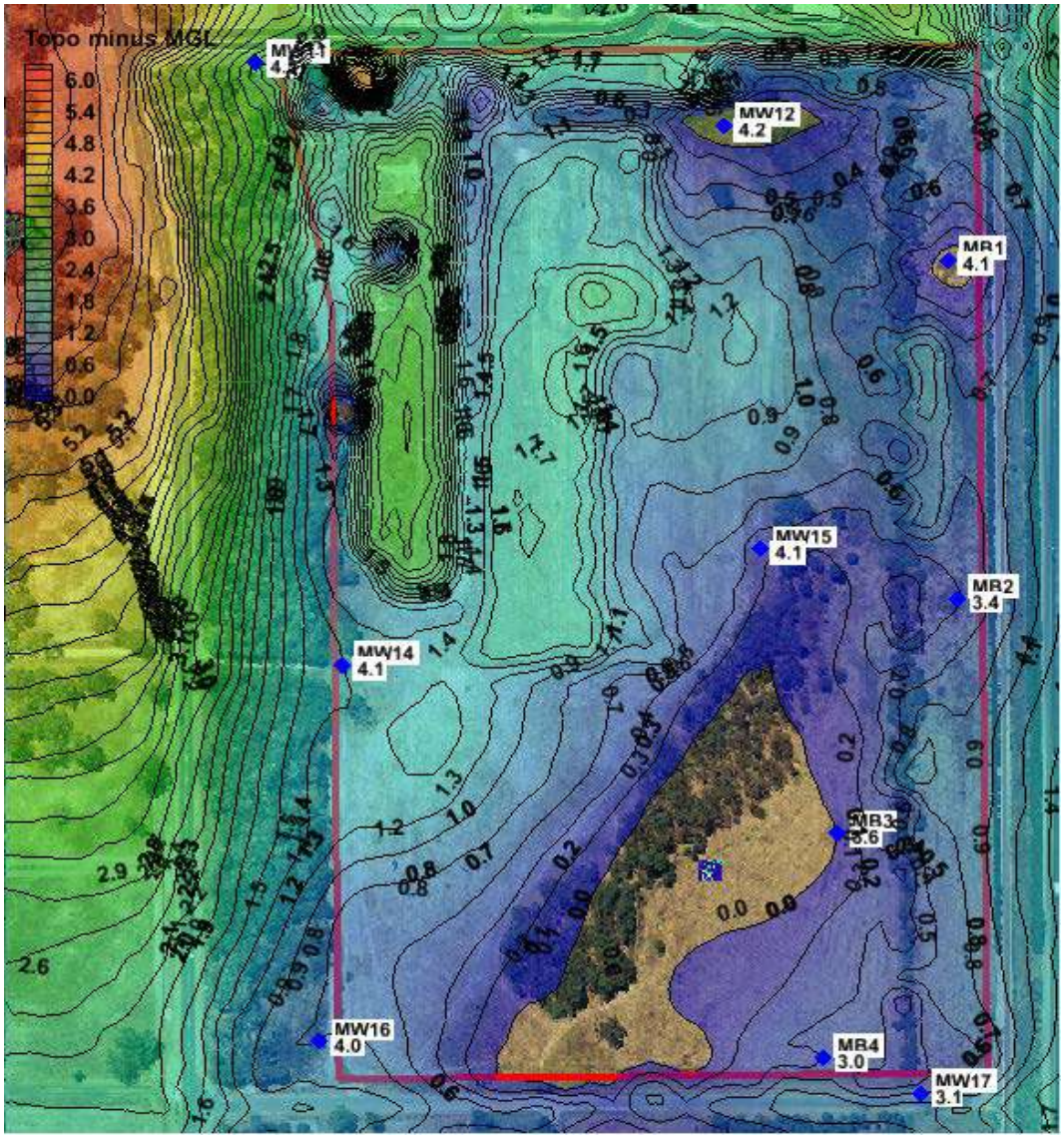


Figure B: Elevation Minus Contours (m) – Depicting a Depth to Groundwater (MGL) from the Existing Surface

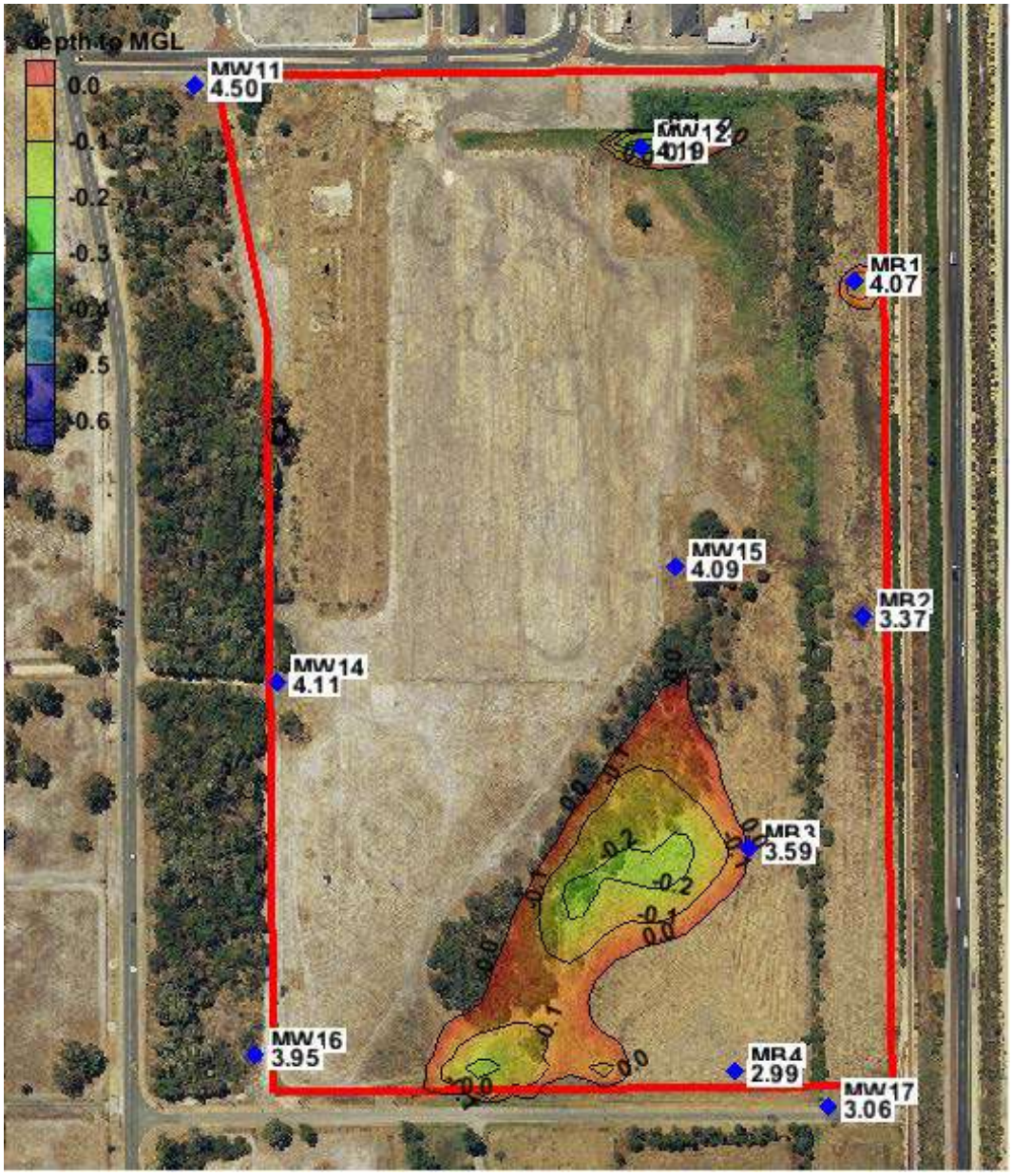


Figure C: MGL above Existing Topographic Contours (M) – Depicting Areas of Inundation during Periods of Maximum Groundwater Elevation (Pre-development)

2.6.3 Groundwater Quality

Data obtained from groundwater monitoring bores within a 5 km radius around the site from the DoW Water Information Reporting Database (2015c) found there was minimal groundwater quality data available. pH was variable ranging from 9.9 to 4.3, averaging 7.22, while EC ranged from 331 µS/cm to 29,100 µS/cm, averaging 4,127 µS/cm. For nutrients, total phosphorus was found to be elevated above SCCP targets and the ANZECC (2000) guidelines for moderately to slightly disturbed lowland river ecosystems. Nutrient concentrations elevated above the ANZECC (2000) are common in the east Baldivis area (RPS 2015), and is likely a reflection of the historical agricultural practices.

Table 2: Summary Statistics for Nutrient Data from Bores within a 5 km Radius of the Site

Parameter	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)	ANZECC (2000)	SCCP Short-term	SCCP Long-term and Peel-Harvey WQIP
TP	0.209	0.03	0.49	0.065	0.20	0.10
P (sol)	0.043	<0.01	0.14			
NO_x	0.22	<0.02	1	0.15		
NO_2 (sol)	0.0027	0.0025	0.0026			
NO_3-N (sol)	0.468	<0.02	3.8			
NH_3-N (sol)	0.33	0.02	0.94	0.08		

(Source: DoW 2015)

A pre-development groundwater quality monitoring program was undertaken by Greencap which included quarterly field physico-chemical measurements of pH, electrical conductivity (EC), and collecting samples to be analysed in a laboratory for a suite of nutrient and metal analysis from four bores (MW11, MW15, MW16 and MW17). pH measurements of groundwater from MW11, MW15 and MW16 were slightly acidic to neutral, while pH measurements from MW17 were neutral to slightly alkaline. Salinity measured as EC was fresh from bores MW11, MW15 and MW16, while groundwater from MW17 returned brackish results (Mayer et al. 2005). Mean field results are supplied in Table 3.

Table 3: Mean Physico-chemical pH and EC Measurements for Pre-development Groundwater Monitoring

Bore ID	pH	EC
	units	µs/cm
MW11	5.17	340
MW15	5.57	230
MW16	5.15	70
MW17	7.57	1,530

(Source: Greencap 2015)

The groundwater monitoring program in 2015 (which also included three monitoring events completed by Greencap) also including measuring field physico-chemical parameters. The results are included in Appendix 3 and the mean results are presented in Table 4. These results are comparable to the previous physico-chemical results.

Table 4: Mean Physico-chemical Results for the 2015 Monitoring Program

Bore ID	pH	EC	Redox	Temp
	units	µs/cm	mV	°C
MB1	6.36	419	-93	16.9
MB2	6.43	391	-121	17.4
MB3	5.82	156	41	17.9
MB4	6.60	2934	32	17.4
MW11	6.46	411	52	20.3
MW12	6.18	314	-24	16.4
MW13	5.87	368	312	20
MW17	7.07	1367	53	18.3

Nutrient concentrations from pre-development monitoring were found to be elevated above relevant guideline values, likely a reflection of the site having previously been used for grazing. All TP results were above the ANZECC (2000) guidelines for slightly to moderately disturbed lowland rivers in south-west Australia (hereafter referred to as the ANZECC (2000) guidelines. These guidelines have been used, as the end water body would likely be the Peel Main Drain, due to the localised mounding and south-easterly flow of groundwater from the site. All TP results apart from one were above the Swan Canning Cleanup Program long-term target (Swan River Trust 2003) and the Peel Harvey target for the Peel Main Drain (EPA 2008) of 0.1 mg/L, and nine of the 11 samples were also above the short-term SCCP targets.

TN was also found to be elevated, with eight of the eleven samples above the ANZECC (2000) guidelines and the SCCP long-term targets and six samples being above the SCCP short-term targets. NO_X-N also often exceeded the ANZECC (2000) guidelines. Mean nutrient results for samples taken from the four bores are presented in Table 5, and all the results are tabulated in Appendix 3.

Table 5: Mean Nutrient Results for Pre-development Groundwater Monitoring

Bore ID	TP	Phosphate	TN	NO_x-N	NH_4-N	TKN
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW11*	5.9	0.78	14	0.56	4.5	13
MW15	0.76	0.35	2.61	0.46	0.15	2.13
MW16	1.64	0.19	3.23	0.79	0.07	2.47
MW17	0.18	0.02	2.45	0.19	0.02	2.31
SCCP short term targets[1]	0.2		2.0			
SCCP long term targets[1]	0.1		1.0			
Peel Harvey WQIP[3]	0.1					
ANZECC 2000[2]	0.065		1.2	0.15	0.08	

(Source: Greencap 2015)

Shading denotes concentrations above the relevant guideline values
[1] Swan Canning Cleanup Program targets (SRT 2003)
[2] Guidelines for slightly disturbed lowland rivers in south-west Australia (ANZECC 2000)
[3] Water quality objectives for nutrients in the Serpentine River (EPA 2008)
* There was only one sample taken for MW11

Analysis of a suite of eight heavy metals found that cadmium concentrations were below the laboratory limit of reporting (LoR) for all samples taken from the four bores, and all mercury concentrations apart from one sample were also below the LoR. All copper concentrations were above the ANZECC (2000) guidelines. There were also some exceedances above the ANZECC guidelines for arsenic, lead, mercury and zinc. Unfortunately, iron was not included in the analysis suite, to determine if there is a potential problem for the irrigation system. No other metal concentrations were above the Long-term Irrigation Water Guidelines (ANZECC 2000). Mean metal concentrations are provided in Table 6, and the full results are provided in Appendix 3.

Table 6: Mean Heavy Metal Concentrations for Pre-development Groundwater Monitoring

Bore ID	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW11*	<0.001	<0.0001	<0.1	0.012	<0.001	<0.0001	0.001	<0.2
MW15	0.006	<0.0001	<0.005	0.005	<0.001	<0.0001	0.003	0.165
MW16	0.009	<0.0001	0.051	0.043	0.035	0.0015	0.004	0.028
MW17	0.030	<0.0001	0.018	0.014	0.012	<0.0001	0.010	0.055
ANZECC (2000)[1]	0.024	0.0002		0.0014	0.0034	0.0006	0.011	0.008
LIWG[2]	0.10	0.01	0.1	0.2	2	0.002	0.01	2

(Source: Greencap 2015)

* There was only one sample taken for MW11
1 Guidelines for slightly disturbed lowland rivers in south-west Australia (ANZECC 2000)
2 Long-term irrigation water guidelines (ANZECC 2000)

2.7 Surface Hydrology

The site is part of the Serpentine River catchment, which has a catchment area of 1,700 km^2. The Serpentine River upstream of the confluence with the Peel Main Drain has been converted into a regional drain, while downstream of the confluence with the Peel Main Drain the river has a broad flood plain with a number of interconnecting wetlands (SKM 2010).

The Peel Main Drain is located entirely on the Swan Coastal Plain and eventually joins the Serpentine River approximately 3 km south of Karnup Road (DoW 2015b), to the south of the site. The grade of the drain is low and it is predominantly a trapezoid drain 20–25 m wide. Water Corporation have stipulated that a typical allowable discharge flow rate to the Peel Main drain for a 100 year ARI event is 4.5 L/sec/ha.

There are no permanent water bodies located on the site, although there is a Water Corporation rural agricultural drain that runs the length of the eastern side of the site, flowing north to south. A 300 mm diameter pipe from a POS drainage basin in the Phase One Heritage Park development discharges into this drain at the northern boundary of the site. This drain continues south of the site through 700 mm diameter culverts

underneath Serpentine Road. This drain connects to a drainage line on the eastern side of the Kwinana Freeway, approximately 1.2 km south of the site, and joins the Peel Main Drain at Karnup Road, approximately 1.8 km south of the site. There has been insufficient water in this drain to take pre-development surface water quality samples during the monitoring conducted to date.

The EPA has set that the median load of total phosphorus flowing into the Peel Estuary from the Serpentine River should be less than 21 tonnes. This is estimated to require a 66% reduction of the TP concentration coming from the Peel Main Drain (EPA 2008). Kelsey et al. (2011) through more recent modelling, identified that the target average annual phosphorus load for the Serpentine catchment should be 0.29 kg/ha/year. Some water quality data is available for the Peel Main Drain, south of Karnup Road at the gauging station AWRC 614121. EC (compensated to 25 °C) was typically brackish and averaged 1,296 µS/cm, and nutrients are elevated, with TN concentrations averaging 1.8 mg/L and TP concentrations averaging 0.31 mg/L. Nutrient concentrations in the drain running under the Kwinana Freeway at monitoring site AWRC 6142672, were elevated above the ANZECC (2000) guidelines (DoW 2015b).

2.7.1 100 Year Flood Plain Levels

A flood plain management strategy was developed for the Serpentine River by SKM in 2010, which has recently been superseded by the *North-east Baldivis Flood Modelling and Drainage Studies* (DoW 2015c). This study identified that a section on the eastern edge of the site is within the flood plain and will be affected by flooding. The depth of flooding in a 100 year Average Recurrence Interval (ARI) event has been modelled to range from 3.75 m AHD to 3.95 m AHD, not accounting for localised stormwater drainage.

The DoW has recommended that any proposed development that is located outside of the floodway is considered acceptable with respect to major flooding. The DoW has recommended that a minimum habitable floor level of 4.25–4.45 m AHD is provided to ensure adequate flood protection (i.e. 500 mm freeboard). The flood plain mapping is shown in Figure 7. No flooding of the site resulting from inflow from the Peel Main Drain is expected during the 5 year ARI event.

2.8 Wetlands

The Department of Parks and Wildlife Swan Coastal Plain Geomorphic Wetland Mapping (27-08-2015) has mapped approximately the eastern half of the site as a multiple use wetland (UFI 15785), as shown in Figure 8. The wetland is mapped in association with the Mc2 soil type. However, these wetlands have few ecological attributes and functions remaining (City of Rockingham 2014).

Maramanup Pool located approximately 700 m to the north-east of the site is mapped as a Conservation Category Wetland (CCW) (UFI 14687) and (UFI 15918). However, due to the distance away from the site and being hydraulically up gradient from the site, development is not expected to have any impact on these wetlands.

2.9 Vegetation and Flora

Vegetation mapping by Heddle et al. (1978) identified two different vegetation complexes of the Swan Coastal Plain on the site, related to the underlying soil profiles:

- Karrakatta Complex Central and South – predominantly open forest of *Eucalyptus gomphocephala – Eucalyptus marginate – Corymbio calophylla* and woodland of *Eucalyptus marginata – Banksia* species.

- Serpentine River Complex – closed scrub of *Melaleuca* species and fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along the streams.

On the site the Serpentine River Complex is located on the eastern boundary of the site with the Karrakatta Complex located over the rest of the site. However, the majority of the site has historically been cleared of native vegetation and consists of predominantly introduced grass species. A linear strip of native vegetation exists along the drain and a band of trees is located in the southern half of the site associated with the Serpentine River Complex. A vegetation survey of the site was completed in 2007 and found the remnant stands of trees were "open woodland of *Eucalyptus rudis* subsp. *rudis* over *Astartea fascicularis* and weeds", with the condition of the vegetation being "degraded" to "completely degraded" (ENV 2007). A strand of *Melaleuca* sp. is also present in the north-west corner of the site. No threatened or priority flora were identified to occur on the site.

The regional tramway located to the west of the site is an area of significant remnant bushland. The vegetation within the precinct to the west of the site is Karrakatta vegetation complexes in overall good condition (City of Rockingham 2014).

A Bush Forever Site (419) associated with Maramanup Pool is located immediately east of the Kwinana Freeway. Due to the site being separated from the Bush Forever site by the Kwinana Freeway, development on the site will not have an impact on the Bush Forever Site. The vegetation associations and the bush forever site are shown in Figure 9.

2.10 Fauna

Due to the extensive historic clearing that has occurred, there is limited fauna habitat on the site. The strands of trees that exist on the site may potentially provide fauna habitat, however a fauna survey conducted by ENV in 2007 did not find any evidence of fauna habitat.

The tramway provides three broad fauna habitat sites: *Eucalyptus* and *Melaleuca* woodland, *Eucalyptus-Corymbia-Banksia* woodland, and scattered native trees. A number of black cockatoo breeding trees have been identified in the tramway immediately adjacent to the site (City of Rockingham 2014).

2.11 Heritage

A search of the Department of Aboriginal Affairs, Aboriginal Heritage Inquiry database (DAA 2015) did not identify any Aboriginal heritage places within the site boundary. The closest heritage place is 660 m south of the site, ID 4347, which has been identified as artefacts/scatter. To the east and south of the site is the registered site ID 3582 associated with the Serpentine River. Development on the site will not impact on these heritage places.

A search of the Heritage Council WA (2015) State Register of Heritage Places has confirmed that the site is not on the heritage list.

2.12 Summary of Key Constraints and Opportunities

Based on the above appreciation of the predevelopment site characteristics, the following key constraints and opportunities are identified to inform the water management strategy of the site.

- The site is within the area assessed by the *North-east Baldivis Flood Modelling and Drainage Study* (DoW 2015c). The depth of flooding in a 100 year event has been modelled to range from 3.75 m AHD to 3.95 m AHD at the site. A minimum habitable floor level of 4.25–4.45 m AHD is recommended by DoW to ensure adequate flood protection (i.e. 500 mm freeboard).

- The Water Corporation (James Wegner and Kanex Kanagaratnam pers. comm. 2015) deferred to DoW on the allowable discharge rate from the development to the existing drain infrastructure and the Peel Main Drain.

- RPS consulted with Damon Grace and Paola Duarte at the DoW (pers. comm. 2015) to ascertain both flood levels and modelled discharge rates based on the outcomes of the *North-east Baldivis Flood Modelling and Drainage Study* (DoW 2015c). The outcomes of the discussions were that DoW does not have a preferred discharge flow rate from this site, as the model is too coarse. The culvert at Serpentine Road was modelled but the cell size is too coarse to interpret a meaningful maximum flow rate restriction for this area. In the absence of any site specific restrictions to maximum discharge flow rate restrictions, it was agreed with DoW that the site should consider using the current discharge restriction of 4.5 L/sec/ha for a 100 year ARI event as this is the typical discharge peal rate flow rate stipulated by Water Corporation for drainage entering the Peel Main Drain along the Baldivis development corridor.

- The final MGL contours for the site have been modelled to range from approximately 4.4 m AHD to 2.8 m AHD as shown in Figure A. Estimated depth to MGLs across the site ranges from zero (with ponding and inundation likely) to a clearance up to 5.5 m.

3.0 WATER SERVICING

3.1 Potable Water Supply

All lots within the development will be connected and supplied with potable water from the Water Corporation Integrated Water Supply Scheme (IWSS). The project engineers have been in correspondence with the Water Corporation to confirm there is capacity within the network.

Water Corporation have advised that the northern section of Lot 986 can be serviced off the existing DN200 water main in Furioso Green, while the remaining area of the site could be serviced by extending the DN200 water main in Furioso Green, however the installation of a DN150 water main in Baldivis Road may also be required.

3.2 Wastewater Servicing

Lots will be connected to the Water Corporation reticulated gravity fed sewer network. Phase One of the Heritage Park residential development is connected to the pump station on Magenta Crescent. The Baldivis South Pump Station on Magenta Crescent has recently been connected to the East Rockingham Wastewater Treatment Plant located on Chesterfield Drive.

The northern section of the site can be serviced by an existing DN150 sewer main in Furioso Green, with the remainder of the site requiring construction of approximately 550 m sewer main extending from Serpentine Road to the Baldivis South Interim Pump Station, which will be constructed in 2016.

4.0 WATER CONSERVATION STRATEGY

4.1 Proposed Strategy

The State Water Plan (2007b) is a strategic policy and planning framework to meet the state's water demands to the year 2030. One of the key targets is to reduce potable water consumption to 40 kL–60 kL per person per year. In order to meet this target, several water saving initiatives to reduce potable water use will be investigated and implemented where practical within the development. The development will comply with the following objective:

- No potable water should be used outside the homes and buildings and achieve efficient use of scheme water, where alternative water sources are available.

Methods that will be utilised to achieve the potable water consumption target include:

- water efficient fixtures and fittings to be installed in households
- irrigation of POS with groundwater
- landscaping design will incorporate waterwise native plants to reduce irrigation demand and turf will be limited to areas of active recreation and infiltration basins
- while irrigation of front gardens will be the responsibility of the owner, waterwise education packages will be provided to all new homeowners to encourage waterwise practices within the home and garden.

4.2 Household Water Conservation

The Building code of Australia sets minimum standards of efficiency for water using fixtures and fittings in homes. These include:

- All tap fittings, except bath outlets, garden taps and toilets must be a minimum 4-star WELS rated.
- All showerheads must be a minimum of 3-star WELS rated.
- An outdoor private swimming pool or spa associated with a Class 1 building must be supplied with a cover or blanket.

- All internal hot water outlets (such as taps, showers and washing machine water supply fittings) must be connected to a hot water system or a re-circulating hot water system with pipes installed and insulated in accordance with AS/NZS3500.

- Lot owners will be encouraged to install greywater systems for the irrigation of individual household landscaping.

Lot owners will also be encouraged to install rainwater tanks. Rainwater tanks can be connected to water using fixtures such as toilets, washing machines and external taps to reduce potable water demand as well as assisting in reducing stormwater run-off.

4.3 POS Irrigation

A groundwater licence (164680(8)) issued by the DoW for 83,030 kL/yr from the Perth-Superficial Swan Aquifer, covers Lots 986 and 993, which is Phase Two of the Heritage Park development, as well as Phase One of the Heritage Park development and the Parkland Heights development, nearly 3 km to the west of the site. The current groundwater licence covers the period from 6 September 2016 to 4 February 2024 for the purposes of:

- irrigation of up to 0.2 ha if POS (portion of road reserve)
- irrigation of up to 6.2 ha of POS
- dust suppression for earthworks and construction purposes.

A copy of the groundwater licence is included in Appendix 4.

The concept plan for the Phase Two Heritage Park development includes one large POS 1.98 ha in size. There will be an initial plant establishment irrigation requirement, as well as a long-term irrigation requirement. As a conservative estimate using a standard irrigation rate of 7,500 kL/ha/yr, approximately 14,850 kL will be required for the irrigation of POS for the site. The actual volume will be lower than this as not all plants will require that irrigation rate or long-term irrigation. Irrigation of up to 2 ha of POS has been allocated for the site.

There will be no irrigation requirement for the drainage area in the south of site.

As a groundwater licence has already been obtained for the site, no other alternative water sources such as wastewater will be investigated to be used for the irrigation of POS.

5.0 LANDSCAPE PLAN

The landscaping design will incorporate a number of measures to minimise the long-term irrigation requirement and create a waterwise urban development. The Landscape Master Plan is included as Appendix 5.

The site incorporates one large POS in the centre of the site 1.98 ha in size as well as a 0.10 ha drainage basin in the south-eastern corner of the site. The POS will retain the majority of the stand of remnant *Eucalyptus rudis* in the centre of the site and will provide a drainage function as well as a turf kick-about area, path network, and playground facilities.

The planting design of the streetscape and POS will consist of predominantly endemic native species. Street trees will be selected to provide shade and enhance the natural environment. The POS will incorporate a bio-filtration area that will be sized to 2% of the connected impervious area and will treat the 1 year ARI event. This bio-filtration basin will be located outside of the stand of remnant trees on the site, to ensure they are not inundated on a regular basis. The species selected for the bio-filtration basin will include native sedges and rushes and will be selected based on their ability to uptake nutrients and facilitate the drainage required. Cross-sections of the POS including the drainage basin are provided in the Landscape Master Plan in Appendix 5.

The POS design will incorporate further detail including a species list at the UWMP stage.

6.0 STORMWATER MANAGEMENT

6.1 Design Criteria

Key design criteria for the site are outlined in Table 7 and have been established consistent with criteria specified in the key reference documents previously outlined in Section 1.3. These design criteria are used in Section 6, 7 and 8 together with the identified constraints and opportunities of the predevelopment environment (Section 2) to establish the water management strategy for the site.

Table 7: Design Criteria

Strategy Element	Criteria
Stormwater	
Flood Protection (100 year)	▪ Provide 100 year ARI (1%AEP) floodways for safe passage of regional flood flows adjacent to the development area. ▪ Provide 1 in 100 year ARI (1% AEP) storage areas within the site for attenuation of local stormwater and discharge to allowable rates as specified by DoW or Water Corporation. ▪ Establish minimum habitable floor levels at 0.5 m above the 100 year ARI (1% AEP) flood levels. ▪ Provide flood paths for overland flows with the development area which exceed the capacity of piped drainage. ▪ Allowable ouflow adopted is 4.5 L/s/ha for the 100 yr ARI (1% AEP), consistent with Water Corporation (2000). ▪ Outflow from the site will occur via 300 mm diameter culvert to the south.
Serviceability (five year)	▪ Provision of 1 in 5 year (18% AEP) storage areas for local stormwater for attenuation of local stormwater. ▪ Road drainage system to be designed so that roads will be passable in the 1 in 5 year (18% AEP) event.
Ecological Protection (one year)	▪ 1 in 1 year 1 hour (15 mm) storm event to be retained on site. ▪ Bio-retention areas established at 2% of connected impervious areas. ▪ Establishment of storage invert levels no lower than seasonal maximum groundwater levels. ▪ Implement structural (e.g. gross pollutant traps) and non-structural controls to maintain and if possible improve water quality.
Groundwater	
Fill Requirement and Subsoil Drainage	▪ Provide subsoil drainage where required to control any post-development groundwater rise. ▪ Establish development levels with acceptable clearance above post-development groundwater levels.
Acid Sulfate Soils and Contamination	▪ If required, criteria and management of Acid Sulphate Soils to be handled as a separate process to LWMS consistent with DoE (2004) requirements.

6.1.1 Drainage Basin Arrangement and Design

The drainage basin arrangement and the revision of the urban design from the DWMS has been based on discussions with the City of Rockingham and the City's preference to maximise the area of active POS, and the retention of existing vegetation in the POS all of which is presented in the Landscape Master Plan in Appendix 5 of the LWMS.

The drainage basin areas have been calculated based on the design criteria currently provided by the DoW:

- retain on site and infiltrate the first 15 mm rainfall event. Consideration will be given to additional bio-retention areas (such as raingardens, road side swales, median swales and tree pits) during the detailed design stage and following discussion with the City of Rockingham, which will be reported on in the UWMP.

- treating the 2% connected impervious area

- control the permitted discharge to the recommended peak flow rate of 4.5 L/sec/Ha as discussed and agreed with Paola Duarte in the Urban Water Planning Branch in October 2015. The final agreement to comply with 4.5 L/sec/Ha was based on the fact the DoW indicated in an email (Appendix 6) that the DoW "model developed for the NE Baldivis area is a coarse, catchment scale model and at this particular location (Lot 993) unfortunately we do not explicitly model the drains nor the culvert. The 2D model does not register discharge rates at the boundary of the lot so I'm guessing the discharge through the culvert must be very nominal". Agreement was then reached that the 4.5 L/sec/Ha that is currently used for flows into the Peel Main Drain along the development corridor should be adhered to for this development.

6.2 Drainage Engineering Plans

The stormwater drainage system for the site has been completed by Mortons Urban Solutions and is consistent with the strategies that were discussed in the DWMS (Greencap 2015). Water Sensitive Urban Design (WSUD) principles and Best Management Practices (BMP) have been incorporated to control water quality and quantity for both minor and major events.

The drainage design for the minor and major events is discussed in the following subsections. Further details are also provided in Appendix 6 including drainage and engineering plans, basin sizing details and cross-sections and relevant correspondence with the DoW and CoR. Appendix 6 includes the following drawings and plans:

- Post Development Catchment Plan 28602-LWMS-100
- Basin 2 Plan and Sections 28602-LWMS-101
- Basin 1 Plan and Sections 28602-LWMS-102

- Roadworks and Drainage Site Plan 28602-ALL-100
- Roadworks and Drainage Plan 28602-ALL-101 to 28602-ALL-106
- Existing Surface Plan 28602-BE020 & 28602-BE-021
- Bulk Earthworks Plan 28602-BE-030 & 28602-BE-031.

RPS has prepared Figure 10 at the rear of the report which provides details on the catchment plan and catchment areas with directions of stormwater flow, as well as the indicative location of the subsoils to be installed. The full extent and layout of the subsoil drainage will be provided in the subsequent UWMP following further detailed design.

The key basins details (volumes, top water levels (TWLs) and inundation areas for the 1, 5 and 100-year events, and locations of drainage inlets and outlets) are provided in Appendix 6 in plans 28602-LWMS-101 and 28602-LWMS-102.

6.3 Minor Drainage System

The aim of the minor drainage system is to retain, treat and infiltrate the smaller rainfall events as close to source as possible. The 1-year ARI events (15 mm rainfall event) will be treated via bio-filtration in order to remove nutrients and other pollutants. The bio-retention areas are sized at a minimum of 2% of the connected equivalent impervious area. Lots greater than 300 m^2 will infiltrate smaller events through the use of soakwells. A pipe and pit system within the internal road network will be used to convey stormwater generated from impervious road surfaces within the site to one of two infiltration basins. The engineering plans and landscape master plan provide current preliminary concepts of the possible form for the bio-retention systems with the development site which will be further detailed during the UWMP stage.

Consideration will be given during detailed design to the inclusion of additional bio-retention areas within the streetscape (such as raingardens, road side swales, median swales and tree pits). For example, drawing 28602-LWMS-100 (in Appendix 6) illustrates potential rain garden locations to be further investigated at the UWMP stage. The inclusion of these additional bio-retention areas will be confirmed at UWMP stage in consultation with the City of Rockingham and will be reported on in the subsequent UWMP for the site.

6.3.1 Lot Scale

Soakwells will be located on lots greater than 300 m^2 and will be used to retain and infiltrate lot-generated rainfall from up to and including the 1 year 1 hour ARI event (15 mm rainfall event). For events larger than this the soakwells will surcharge onto the landscaped surface of the lot and either be detained or infiltrate into the soil. For events greater than the 5 year ARI up to the 100 year ARI event, run-off generated from the lots will flow across the lot via overland flow to the road drainage system. This allows for more stormwater to be infiltrated as close to source as possible and reduces the

short term peak flows to the drainage system. Fill which will be required on the site to raise the finished lot levels above the 100 year flood level and to allow grade on the sewer system, will also allow clearance to groundwater and will have a high permeability and thus the site will be suitable for the use of soakwells. Lots smaller than 300 m^2 will be directly connected to the closed pipe drainage system. The lots that will be directly connected to the stormwater drainage system are shown in Appendix 6, Diagram 28601-ALL-100, and also in 101, 102, 103, 104, 105, 106. The direct connection is illustrated as a blue line from the lot.

6.3.2 Road Verges

There are two post-development catchments for the site, and run-off will be directed towards one of two basins. Basin 1 is located in the main POS and Basin 2 is located in the south-eastern corner of the site.

Run-off from the 1 in 1 year ARI (15 mm rainfall) event will be retained and treated within the bio-filtration area of the POS. The bio-retention area has been sized to a minimum of 2% of the connected impervious area. The 1 year ARI connected equivalent impervious catchment area for Basin 1 is 42,590 m^2, and the base of the bio-retention area is 896 m^2, which is 2.1%. The connected impervious area for Basin 2 is 10,959 m^2 and the basin area is 221 m^2 (2.0% of the connected impervious area). The bio-retention area will be planted with reeds, sedges and other plant species that will be selected based on their ability to uptake nutrients and basin will also contain soil amendment to retain nutrients. The bio-filtration area will be planted in accordance with *Vegetated guidelines for stormwater biofilters in the south-west of Western Australia* (Monash 2014) and will be designed in accordance with Adoption Guidelines for Stormwater Biofiltration Systems (Payne et al. 2015). After treatment, the smaller events will be infiltrated into a subsoil system located under the basin's bio-retention area.

A pit and pipe system located within the road reserve will be utilised to convey surface water from rainfall events up to and including the 5 year ARI event to either the infiltration Basin 1 located in the POS for the majority of the site run-off or to the drainage sump (Basin 2) for run-off generated from the south-eastern section of the site. The location of the pipe and pit system is shown on the Roadworks and Drainage Plan 28602-ALL-101 to 28602-ALL-106.

The open drain that currently exists on the site will be converted to a 300 mm closed pipe and will convey the stormwater that enters the site from Phase 1of the Heritage Park development to the south, via culverts under Serpentine Road.

6.4 Major Drainage System

For all rainfall events greater than the 5 year ARI event up to and including the 100 year ARI event, run-off will be conveyed via overland flow paths along the road to the drainage basins.

No permanent water bodies are proposed for the site, and the design of the development will ensure that stormwater will be discharged off site via the culverts at the south or infiltrated within 96 hours following the peak critical storm duration in order to prevent mosquito and midge breeding conditions. If required, a mosquito management plan can be prepared at subdivision stage.

6.4.1 Basin Design

The vegetated bio-filtration basin within the POS has been designed to treat and infiltrate the 1 year ARI events, with larger events up to the 100 year ARI being detained within a greater area of the basin. An outlet has been provided from the basins which will connect to the closed pipe that discharges to culverts under Serpentine Road. The remnant trees that will be retained in the POS will be located outside of the bio-retention area, as shown in drawing 28602-LWMS-102 (Appendix 6).

6.4.1.1 Basin 1

The infiltration Basin 1 has 1:6 side slopes, with the invert of the bio-retention area of the basin at 4.0 m AHD, which will have 0.5–0.7 m clearance from the MGL. For events greater than the 1 year ARI event up to the 5 year ARI event, a larger area of the retention basin will be inundated which has an invert of 4.5 m AHD, with the 100 year events also inundating an area of the basin with an RL of 4.77 m AHD. The clearance to the MGL for these areas is 0.65–0.7 m and 0.7–1.37 m respectively.

The stand of remnant trees will also become inundated in the 100 year event, with stormwater overtopping the grassed bund separating the remnant trees from the infiltration basin in this sized event. The stand of remnant trees is currently approximately at the MGL. As previously discussed with the CoR, approximately 150 mm fill (maximum) will be placed around the flooded gums in accordance with arborist specifications as well as the proposed installation of subsoils to assist in draining this area, without having a detrimental impact on the vegetation.

In a 5 year storm event, the drainage impacted area accounts for less than 20% of the total POS area (16.6%), which is in compliance with Liveable Neighbourhood requirements. The inlet of Basin 1 is set at 4.0 m, which is the top of the bubble-up pit and an outlet will be set at 4.95 m AHD, which will connected to the closed pipe that outlet to the culverts under Serpentine Road. The central POS is able to detain the 100 year ARI event on-site without discharge; therefore the outlet is required only for extreme events greater than 100 year ARI. Emptying of the central POS following large rainfall events will occur via infiltration and is facilitated by subsoil drainage.

Cross-sections of Basin 1, as well as areas of inundation and top water levels for the 1, 5 and 100 year ARI events of Basin 1 are provided in drawing 28602-LWMS-102 (Appendix 6), with the details also summarised in Table 8.

Table 8: Drainage Detention Details for Basin 1 (Main POS)

Event	MGL (m AHD)	Depth to MGL (m)	TWL (m AHD)	Maximum Depth of Water to Basin Invert (4.0 m AHD)(m)	Detention Storage Volume (m^3)	Inundation Area (m^2)	Area of POS Inundated (%)
1	3.3–3.5	0.5–0.7	4.50	0.50	695	2,582	13.0
5	3.3–3.7	0.65–0.7	4.79	0.79	1,577	3,282	16.6
100	3.3–3.8	0.7–1.37	4.90	0.90	3,041	8,705	43.9

6.4.1.2 Basin 2

A summary of the drainage detention details for Basin 2 is provided in Table 9. This basin invert will be set at 3.9 m AHD, with approximately 0.9 m clearance to the MGL and will have 1:6 side slopes. Cross-sections of Basin 2, as well as areas of inundation and top water levels for the 1, 5 and 100 year ARI events of Basin 2 are provided in drawing 28602-LWMS-101(Appendix 6). The inlet to Basin 2 is at 3.9 m AHD at the top of the bubble-up pit and the outlet from Basin 2 is proposed to be set at 4.4 m AHD.

Table 9: Drainage Detention Details for Basin 2 (South-east Drainage Basin)

Event	MGL (m AHD)	Depth to MGL (m)	TWL (m AHD)	Depth of Water to Basin Invert (3.9 m AHD)(m)	Detention Storage Volume (m^3)	Inundation Area (m^2)	Area of Total Site POS Inundated (%)
1	3	0.9	4.30	0.40	129	426	42.7
5	3	0.9	4.51	0.61	229	546	54.7
100	3	0.9	4.53	0.63	311	560	56.1

Infiltration within the basins has been designed using a long-term infiltration rate of 1.75 m/day. The maximum time for retained stormwater to be infiltrated from basins (basin emptying time) was modelled using a design long-term infiltration rate of 1.75 m/day. The basin emptying time following the 100 year ARI event is 13 hours for the main POS (Basin 1) and 9 hours for Basin 2. This meets the requirements in regards to mosquito management.

6.5 Flood Management

As mentioned in Section 2.7.1, 100 year flood levels from the Peel Main Drain have been modelling to range from 3.75 m AHD to 3.95 m AHD. Imported fill will be used on site to raise the development, primarily for the purpose of connection to the Water

Corporation Sewer Network. Finished lot levels will range from 5.32 m AHD to 7.48 m AHD, and thus exceed the required 0.5 m separation from the 100 year flood levels to the minimum habitable floor level.

DoW flood modelling found that the 1:5 ARI event would not cross to the western side of the Kwinana Freeway, and thus no major flooding from drainage onto the site is expected for this size event.

Flood advice, flood levels, and permitted discharge rates have been discussed with DoW.

6.6 Surface Water Discharge to the Peel Main Drain

The site is located within the Water Corporation's Peel Main Drain catchment and outflows are subject to flow rates determined by the Water Corporation (2000), which was confirmed with DoW Flood Protection Branch (pers. comm. Paula Duarte, October 2015). The 100 year ARI allowable discharge rate is 4.5 L/s/ha for a 100 year event, or 88 L/s for the approximately 19.5 ha of catchment area.

As previously mentioned, the open secondary agricultural drain that traverses the site will be converted to a closed pipe. Both basins will have an outlet that connects to this pipe. The outlet from Basin 1 at the preliminary design stage is proposed to be set at 4.95m AHD and the outlet from Basin 2 has been set at 4.40 m AHD. As described in the drainage modelling and engineering summary report (Appendix 6) the maximum stormwater water discharge rate from the site is only 23 L/s during the 100 year ARI event. This complies with the Water Corporation requirements and provides opportunity to refine the drainage design and reduce POS inundation areas during subsequent detailed design.

The elevation of the outlets can be further refined during the detailed design stage following further consultation with the City of Rockingham. These will be controlled outlets to ensure the site complies with the Water Corporation flow requirements.

6.7 Tramway Reserve

The Tramway Reserve to the west of the site is underlain by sand with high permeability and thus there is expected to be minimal run-off onto the site. However, it is intended to include a subsoil drain along the road reserve that runs parallel to the Tramway Reserve which will drain any run-off from the Tramway Reserve from the regular 1 year ARI event. Any run-off generated from the larger events will be conveyed via the road drainage network to either the drainage basin in the POS or the drainage sump in the south-east.

6.8 Water Quality Treatment

The first 15 mm of run-off will be retained, treated and infiltrated on site in bio-filtration areas that will utilise vegetation and soil amendment to retain nutrients. This will ensure that the average annual TP target of 0.29 kg/ha/yr as identified by Kelsey et al. 2011 will be met. The Undo tool has been run and the results are included in Appendix 7. The site will also utilise other structure controls such as gross pollutant traps prior to stormwater outlets to the bio-retention area and non-structural controls such as street sweeping to assist in reaching the water quality targets.

6.8.1 Vegetation

Vegetation will be utilised in the stormwater drainage basin to provide treatment to stormwater prior to infiltration or leaving the site. Treatment will assist in erosion control, slow run-off flow rates, allow sediments to drop out of solution and remove soluble nutrients. Plant species will be selected based on their intended function, and native species will be used where practicable. Planting within the bio-retention basin will be equivalent to at least 2% of the connected impervious area. Bio-retention areas will be constructed in accordance with the *Adoption Guidelines for Stormwater Biofiltration Systems* (Payne et al. 2015).

6.8.2 Soil Amendment

The bio-filtration area of the detention basin will be designed according to FAWB (2009) and DoW (2011) guidelines for bio-filters. This will incorporate:

- 50 mm mulch layer
- minimum 300 mm filter layer
- at least 100 mm transition layer of fine gravel or crushed rock
- subsoil drainage layer.

7.0 GROUNDWATER MANAGEMENT

7.1 Groundwater Levels

As discussed in Section 2.6.2, pre-development groundwater levels across the site are relatively shallow in the south-eastern section of the site. This coupled with the expected increase in groundwater recharge rates associated with urban development require that the groundwater levels for some sections of the site need to be controlled. This will be achieved through fill to be brought onto the site and the installation of subsoil drains. However, the main driving factor for the finished earthwork levels is connection to the Water Corporation sewer network.

7.1.1 Subsoil Drainage Design

Minimum separation between finished lot levels for development and the MGL will be achieved by a combination of fill as well as the installation of subsoil drainage in the southern section of the site. Subsoil drainage is proposed to be located at approximately the MGL to provide a post-development Controlled Groundwater Level (CGL) to provide protection against any potential post development groundwater rise. All lots will have a minimum 1.6 m separation to the CGL. The subsoils will be installed in accordance with *Water resource considerations when controlling groundwater levels in urban development* (DoW 2013) and with consideration of the draft *Specifications separation distances for groundwater controlled urban development* (IPWEA 2016).

As well as installing subsoil drains in the road network of the southern section of the site, subsoil drains are also proposed to be installed at the edge of POS that will retain the stand of *Eucalyptus Rudis* to assist in infiltration (as per discussions with the CoR) and beneath the bio-retention area of the drainage basins to assist in infiltrating the increased run-off post-development. The indicative location of the subsoil drains is shown in Figure 10.

In the road reserve, the majority of the subsoil drainage will be located within the fill material, and will discharge into the bio-filtration area of the POS drainage basin. All subsoil drainage outlets into the bio-retention area will be a minimum of 100 mm above the base of the bio-retention area and be free draining. The separate subsoil drain to be installed under the bio-retention area to assist in infiltration will be constructed in a herringbone formation. There will be a minimum 0.5 m clearance from the invert of the bio-retention basins to the subsoil. The subsoils under the bio-retention area and at the edge of POS that retains the stand of *Eucalyptus Rudis* will discharge to the converted closed pipe before leaving the site via the culvert under Serpentine Road. The outlets will be free draining during normal conditions. The installation of subsoil drains at the edge of the section of POS that will retain the *Eucalyptus Rudis,* will be located a sufficient distance away from to avoid any detrimental impact to the vegetation and avoid the subsoil drains being blocked from tree roots.

Final finished lot levels and fill requirements are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP. Similarly, the subsoil design including the location, grade and invert of the subsoil system will be specified at the UWMP stage following detailed engineering design. However, subsoil elevation and clearance to groundwater is not a critical design criteria at this stage. RPS and the proponent will liaise with the City of Rockingham to finalise a preferred subsoil design during the detailed design stage and will be further documented in the UWMP.

7.2 Groundwater Quality

Many of the proposed stormwater measures will improve stormwater quality and subsequently groundwater quality through the following mechanisms:

- increased biological uptake of nutrients through the establishment of vegetation, in particular vegetation with nutrient stripping capabilities within the bio-retention area
- reducing water velocities by diverting water through drainage basins within the site
- minimising and controlling the amount of fertilisers and pesticides applied to the site through appropriate plant selection, and operation and maintenance procedures after development
- the use of soil amendment with the bio-retention area to encourage nutrient retention and condition the soil
- monitoring groundwater quality leaving the site to verify that pre-development values are being maintained or improved.

8.0 MONITORING REQUIREMENTS

8.1 Pre-development

Pre-development groundwater monitoring was undertaken to determine baseline conditions for the site and to allow for a direct comparison for during and post-development, as well as guiding the engineering drainage design and finished floor levels of the development. The pre-development groundwater monitoring program included monthly water level monitoring from September 2009 to February 2011, plus an additional three months of water level monitoring from September 2015 to November 2015. Groundwater quality monitoring was undertaken quarterly in April, July, October 2010 and January 2011. The results of the monitoring program have been detailed in Sections 2.6.2 and 2.6.3.

Due to the lack of permanent water in the Water Corporation drain that runs the length of the site, pre-development surface water quality monitoring was not undertaken.

8.2 Post-development

8.2.1 Groundwater Monitoring

An indicative post-development monitoring program of three years is proposed for the site following completion of the development. The aim of post-development monitoring is to demonstrate that potential impacts to groundwater have been avoided or minimised through the WSUD incorporated into the development, as well as ensuring that adequate clearance to groundwater will be maintained and there are no ongoing water management issues directly related to the urban development of the site.

It is currently proposed that seven bores will be monitored (MW11, MW15, MW17, MB1, MB2, MB3 and MB4). However, exact monitoring locations will be identified during the UWMP stage. Where bores have been destroyed or are no longer available for use, an alternate bore will be installed in a location as close as possible to ensure consistency in the monitoring program. The preliminary post-development monitoring program will include:

- monthly groundwater levels during the winter period from May to October and groundwater level monitoring in December and March each year
- quarterly monitoring (March, June, September and December) of field physio-chemical parameters including pH, EC, temperature and redox

- samples will be collected on a quarterly basis (March, June, September and December) for laboratory analysis for a suite of nutrients including TN, TKN, NH_3, NO_x, TP and PO_4

- samples will be collected annually for laboratory analysis for a suite of heavy metals including Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, and Ze, as well as major anions and cations including chloride, sulfate, alkalinity, calcium, magnesium, sodium, potassium and acidity.

RPS is proposing to monitor groundwater levels monthly during the winter period (May to October each year) and will also monitoring levels on a quarterly basis given levels in December and March during the quarterly quality sampling program. This will provide sufficient groundwater levels assessment throughout the year to make a determination on the performance of the drainage infrastructure as it will provide evidence of a winter high peaks and summer lows as requested by DoW.

The timing of commencement of the monitoring program for each individual subdivision area will be negotiated at UWMP stage with DoW and CoR.

8.2.2 Surface Water Monitoring

Opportunistic surface water sampling from the infiltration basin in the POS will be undertaken if sampling corresponds with rainfall events. Surface water sampling will be undertaken for water quality analysis for the suit of physico-chemical parameters and nutrients mentioned in Section 8.2.1.

Visual inspections of the stormwater management infrastructure will be undertaken during regular water monitoring events to ensure it is operating effectively and identify any potential issues. This is particularly important during and immediately after construction to ensure it is functioning as designed.

8.2.3 Trigger Values and Contingency Plans

The results from the groundwater quality monitoring will be compared to the pre-development baseline results obtained, with the trigger value being 20% above the average pre-development results, as well as the ANZECC (2000) freshwater guidelines for slightly to moderately disturbed lowland rivers in south-west Australia and the Peel Harvey WQIP target for TP. This is detailed in Table 10. As pre-development water quality data has not been obtained from bores MB1–MB4 these will be compared to the downstream values from MW17 as well as the ANZECC and Peel Harvey targets.

Table 10 Proposed Water Quality Monitoring Trigger Values

	TP (mg/L)	FRP (mg/L)	TN (mg/L)	NH_4-N (mg/L)	NO_x-N (mg/L)	TKN (mg/L)
ANZECC (2000)[1]	0.065	0.04	1.2	0.08	0.15	
Peel Harvey WQIP[2]	0.1					
Average Pre-development Results						
MW11*	5.9	0.78	14	4.5	0.56	13
MW15	0.76	0.35	2.61	0.15	0.46	2.13
MW16	1.64	0.19	3.23	0.07	0.79	2.47
MW17	0.18	0.02	2.45	0.02	0.19	2.31
Proposed Trigger (mg/L)						
MW11* (upstream)	7.08	0.94	16.8	5.4	0.67	15.6
MW15 (centre)	0.91	0.42	3.13	0.18	0.55	2.56
MW16 (upstream)	1.97	0.23	3.88	0.08	0.95	2.96
MW17 (downstream)	0.22	0.02	2.94	0.02	0.23	2.77

[1] Guidelines for slightly disturbed lowland rivers in south-west Australia (ANZECC 2000)
[2] Water quality objectives for nutrients in the Serpentine River (EPA 2008)
* There was only one sample taken for MW11

In the event where trigger values are exceeded by greater than 20% on two consecutive occasions, further investigation will be undertaken to determine the cause of these exceedances, and appropriate remedial actions will be taken.

Contingency plans may include:

- assess the spatial extent of the occurrence
- determine if it is due to residential development of other factors
- identification and removal of pollution source, if possible
- review operational and maintenance practices
- further soil amendment in infiltration areas (in relation to quality) or engineering to facilitate infiltration (in relation to levels)
- increased planting of nutrient stripping vegetation in infiltration areas
- reintroduce or increase the education and public awareness program
- confirm that the POS operating and maintenance strategy is being implemented.

Additional detail of the post-development monitoring plan, including triggers and contingencies will be provided in future UWMPs for the site.

8.2.4 Reporting

Results from the annual monitoring program will be summarised in a post-development monitoring report will be submitted to the DoW and the City of Rockingham annually at the completion of the monitoring period.

9.0 IMPLEMENTATION

9.1 Further Information to be Provided at the UWMP Stage

Consistent with processes defined in WAPC (2008), Urban Water Management Plans (UWMPs) will be developed and submitted to support subdivision applications for various stages of development within the site. UWMPs will address:

- demonstrated compliance with this LWMS criteria and objectives to the satisfaction of the DoW and CoR
- agreed/approved measures to achieve water conservation and efficiencies of water use
- management of groundwater levels including proposed finished lot levels, fill levels and subsoil drainage inverts (including calculations to justify subsoil spacing)
- landscaping plans and POS details
- detailed stormwater drainage design including the location and sizing of drainage infrastructure and required storage for the 1, 5 and 100 year ARI events as well as drainage control points, integrated major and minor flood management capability
- management of subdivisional works including development of a strategy for sediment control during construction as well as ASS and dewatering management
- specific post-development monitoring and reporting to be undertaken for each UWMP area consistent with the monitoring program defined in the LWMS
- finalised implementation plan including roles and responsibilities of all parties involved.
- contingency plans (where necessary).

More detail of POS and drainage integration will be provided during the development of the UWMP, including preparation of detailed landscaping plans (species selection and treatments), and detailed design drawings.

Preparation of the UWMP will be the proponent's responsibility.

9.2 Preliminary Implementation Plan

The proposed roles and responsibilities for the subsequent UWMPs and subdivision of the site as well as works associated with the LWMS are presented in Table 11. Monitoring outcomes will be used in a continual improvement capacity to review the implemented WSUD within the site and inform the planning and design approaches for subsequent stages of development.

Any modification required to the Implementation Plan would be identified through the review process and would require the agreement of all parties (DoW, CoR and developer). Details of the preliminary roles and responsibilities are shown in Table 11. These will be appropriately refined at UWMP Stage.

Table 11: Roles and Responsibilities

Principles	Role	Responsibility	Time-scale
UWMP	Preparation of UWMP	The proponent	When required as condition of subdivision approval
Post-development monitoring program	Groundwater	The proponent	Monthly for levels during the winter period (May to October), quarterly for nutrients, and annually for metals for three years after practical completion of the development
	Surface Water	The proponent	Opportunistic during winter for three years after practical completion of the development.
Public open space	Fertiliser application	The proponent	As required during revegetation and ongoing maintenance until handover to CoR.
	Plant establishment (via planting and irrigation regime)	The proponent	One to two years after planting or as agreed with the CoR.
	Irrigation scheduling	The proponent	As required following planting until handover to CoR
Drainage infrastructure	Maintenance of drainage infrastructure	The proponent	As required until three years after completion of the development until handover to the CoR. The extent of the maintenance commitment will be confirmed with the CoR at the UWMP stage of the development.
Subdivision management	Construction and site works management	The proponent	As required during construction until handover to CoR
	Erosion control	The proponent	As required during construction
	Waste and pollution management	The proponent	As required during construction until handover to CoR
Reporting	Report on monitoring results	The proponent	Annually, until three years after practical completion of the development

10.0 REFERENCES

ANZECC & ARMCANZ. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. ANZECC & ARMCANZ, Canberra, ACT.

City of Rockingham. 2014. Baldivis Tramway Master Plan June 2014. City of Rockingham, Western Australia.

Cooperative Research Centre Water Sensitive Cities (CRCWSC). 2015. Adoption guidelines for stormwater bio-filtration systems. Monash University. Clayton, Victoria.

Department of Aboriginal Affairs. 2015. Aboriginal Heritage Inquiry. Government of Western Australia. Accessed from: http://maps.dia.wa.gov.au/AHIS2/. Accessed 21 October 2015.

Department of Environment Regulation. 2015. Contaminated Sites Database. Government of Western Australia. Accessed from: https://secure.dec.wa.gov.au/idelve/css/. Accessed 19 October 2015.

Department of Water. 2004–2007. Stormwater Management Manual for Western Australia. Government of Western Australia. Perth, Western Australia.

Department of Water. 2008a. Interim: Developing a Local Water Management Strategy. Government of Western Australia, Perth, Western Australia.

Department of Water. 2008b. Rockingham-Stakehill groundwater management plan. Government of Western Australia, Perth, Western Australia.

Department of Water. 2011. Water Sensitive Urban Design, Biofilters. Government of Western Australia, Perth, Western Australia.

Department of Water. 2015a. Perth Groundwater Atlas. Government of Western Australia. Accessed from: http://atlases.water.wa.gov.au/idelve/gwa/. Accessed: 19 October 2015.

Department of Water. 2015b. Water Information Reporting. Government of Western Australia. Access from: http://wir.water.wa.gov.au/SitePages/SiteExplorer.aspx. Accessed: 19 October 2015.

Department of Water. 2015c. North-east Baldivis flood modelling and drainage study, Supporting the North-east Baldivis drainage and water management plan. Water Science Technical Series Report No. 73. Government of Western Australia, Perth, Western Australia.

ENV. 2007. Environmental Assessment – Heritage Park Estate Lots 986 and 993 Baldivis Road, Baldivis. ENV, Perth, Western Australia.

Environmental Protection Authority (EPA). 2008. Water quality improvement plan for the rivers and estuaries of the Peel-Harvey System – phosphorus management. Environmental Protection Authority, Perth, Western Australia.

FAWB. 2009. Adoption Guidelines for Stormwater Biofiltration Systems. Facility for Advancing Water Biofiltration, Monash University.

Government of Western Australia. 2007a. State Planning Policy 2.9: Water Resources. Government of Western Australia.

Government of Western Australia. 2007b. Western Australian State Water Plan. Government of Western Australia.

Gozzard, J.R. 1983. 1:50, 000 Environmental Geology Series – Rockingham part Sheets 2033 III and 2033 II. Geological Survey of Western Australia.

Greencap. 2015. Heritage Park Phase Two, District Water Management Strategy, Rockingham Park Pty Ltd. ENV, Perth, Western Australia.

Heddle, E. 1978. Darling System Vegetation. Forest Department. Perth, Western Australia

Heritage Council State Heritage Office. 2015. InHerit. Government of Western Australia. Accessed from: http://inherit.stateheritage.wa.gov.au/public. Accessed: 8 October 2015.

IPWEA. 2016. Specification separation distances for groundwater controlled urban development.

Kelsey, P., Hall J., Kretschmer, P., Quinton, B. and Shakya, D. 2011. Hydrological and nutrient modelling of the Peel-Harvey catchment. Water Science Technical Series. Department of Water, Perth, Western Australia.

Mayer, X.M., Ruprecht, J.K., Bari, M.A. 2005. Stream salinity status and trends in south-west Western Australia, Salinity and land use impact series, Report No. SLU138. Department of Environment, Government of Western Australia, Perth, Western Australia.

Monash University. 2014. Vegetation guidelines for stormwater biofilters in the south-west of Western Australia. Monash University. Clayton, Victoria.

Payne, E.G.I., Hatt, B.E., Deletic, A., Dobbie, M.F., McCarthy, D.T. and Chandrasena, G.I. 2015. Adoption Guidelines for Stormwater Biofiltration Systems. CRC for Water Sensitive Cities, Melbourne.

RPS. 2015. Local Water Management Strategy, Lots 460-463 Baldivis Road, Baldivis. RPS, Subiaco, Western Australia.

SKM. 2008a. Heritage Park Pump Station Baldivis, Geotechnical Plan. SKM, Perth, Western Australia.

SKM. 2008b. Heritage Park, Baldivis, Geotechnical Investigation and Assessment. SKM, Perth, Western Australia.

SKM. 2010. Serpentine River Floodplain Management Study, Floodplain Management Strategy. SKM, Perth, Western Australia.

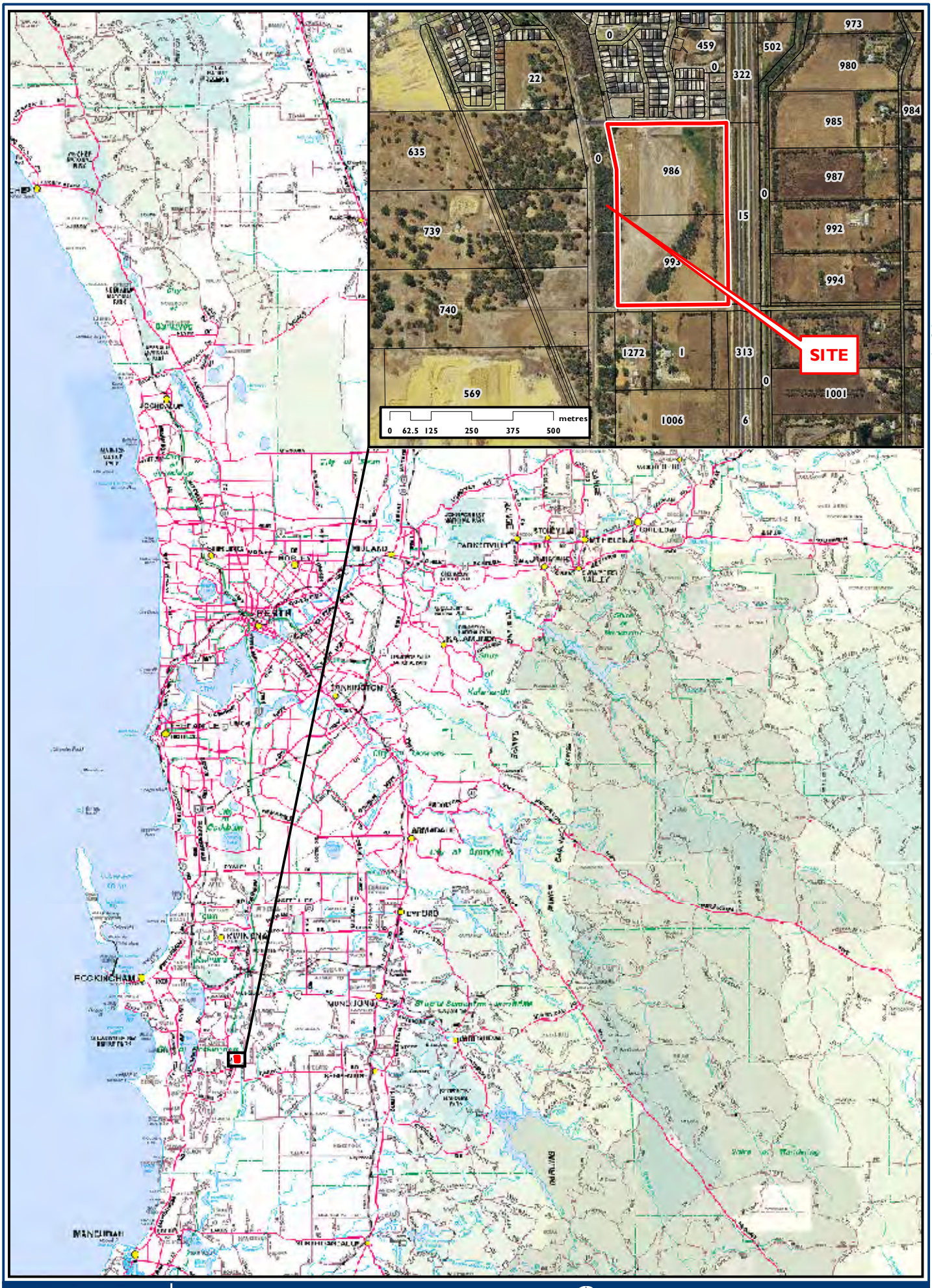
Swan River Trust. 2003. Developing Targets for the Swan-Canning Cleanup Program. Government of Western Australia, East Perth, Western Australia.

Water Corporation. (2000). Mundijong Drainage District Rural Drainage Criteria

Western Australian Planning Commission (WAPC). 2008. Better Urban Water Management. Government of Western Australia, Perth.

Western Australian Planning Commission (WAPC). 2015. Metropolitan Region Scheme Amendment 1288/57 (Minor Amendment), Lots 986 and 993 Baldivis Road, Baldivis Amendment Report. Government of Western Australia.

FIGURES



RPS

Job Number: D1516601
Doc Number: 001
Date: 21.10.15
Scale: Map - 1:500,000 @ A4 Inset 1:15,000 @ A4
Created by: MR
Source: Landgate, 2015

Figure 1

Site Location

38 Station Steet, Subiaco | T +61 8 9211111 | F +61 8 9211122 | www.rpsgroup.com.au

38 Station Street, Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au

LEGEND

- Contour (mAHD)
- Site Boundary
- Existing Cadastre

Structure Plan

Zones

- Residential R25
- Residential R40
- Residential R60

Reserves

- Road Reserve
- Public Open Space (POS A, B)

R25 R40 R40 R25 R40 R25 R40 R40 R60 R25 R40 R25 R40 R25 R40 R25 R40 R60 R40 R25 R40 R25 POS A POS B

BALDIVIS RD

SERPENTINE RD

KWINANA FWY

Kwinana Fwy PSP

Job Number: D1516601
Doc Number: 002
Date: 29.02.16
Scale: 1:2,500 @ A3
Created by: MA
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Sept 2015, Structure Plan - CDP, dwg no RHPHP-2-002B (17.02.16)

RPS

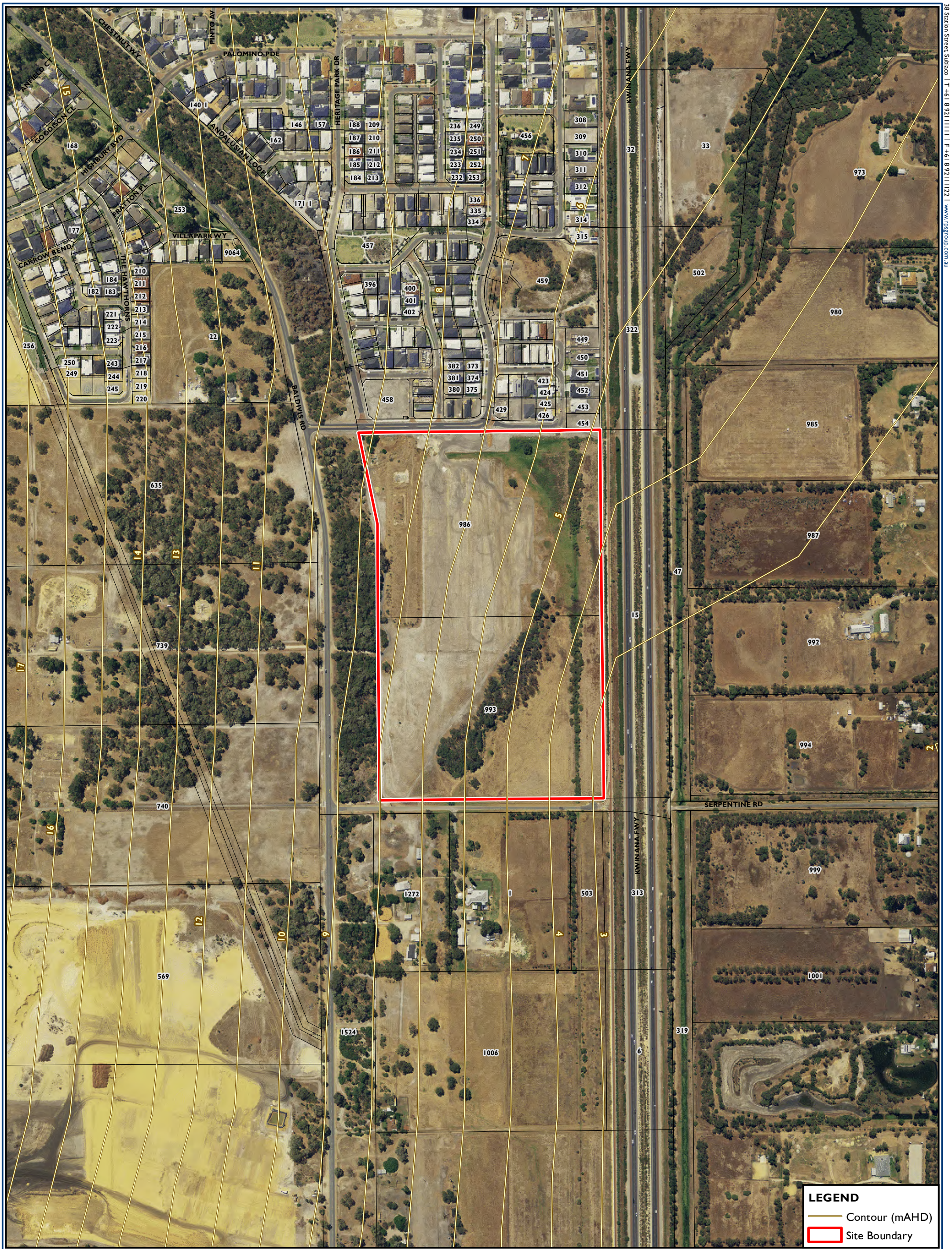
GDA 1994 MGA Zone 50

0 10 20 40 60 80 m

Figure 2

Structure Plan

38 Station Street, Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



LEGEND

Contour (mAHD)

Site Boundary

RPS

Job Number: D1516601
Doc Number: 003
Date: 21.10.15
Scale: 1:5,000 @ A3
Created by: MR
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

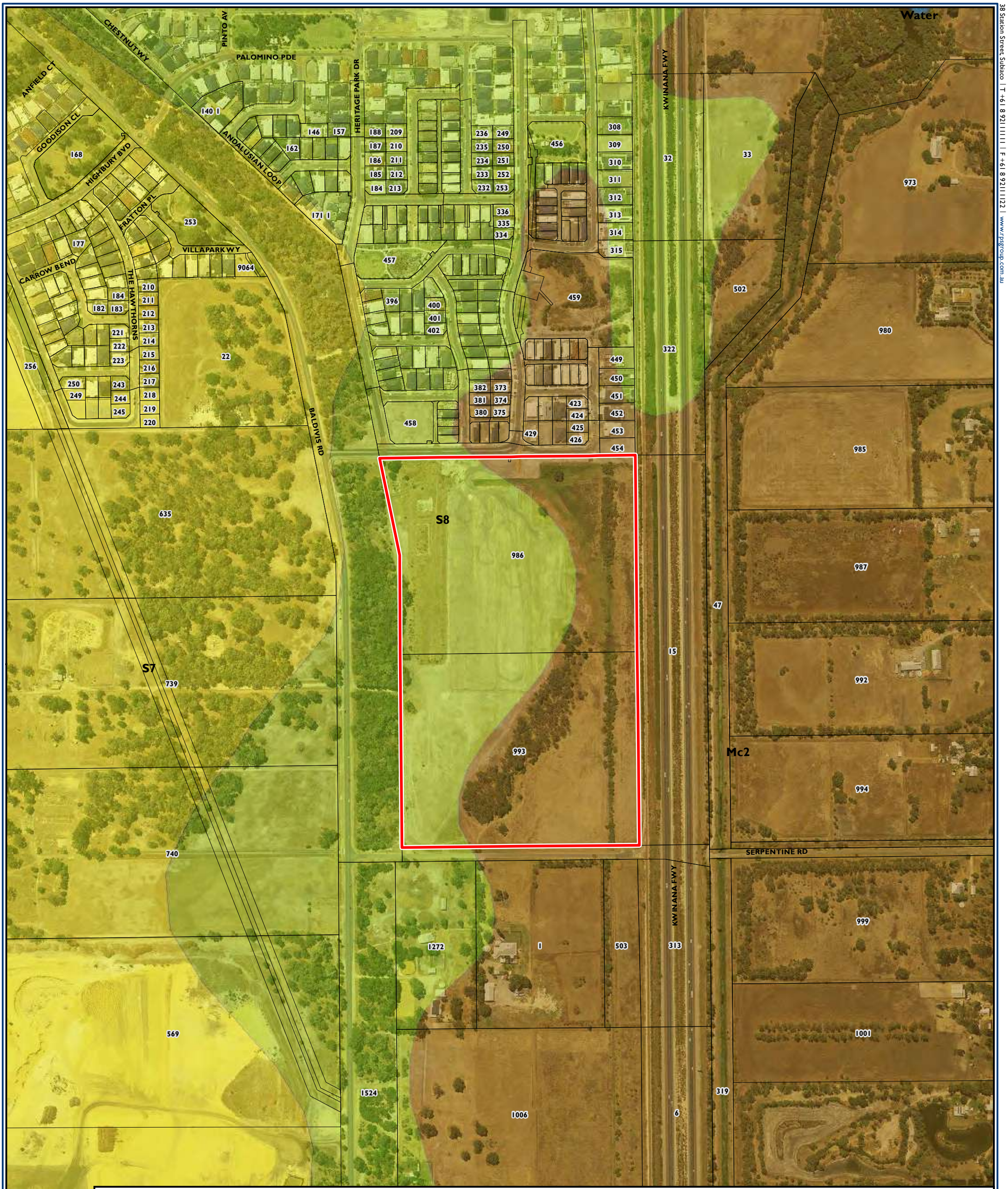
GDA 1994 MGA Zone 50

0 20 40 80 120 160 m

Figure 3

Topography

38 Station Street, Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



LEGEND

Geology

- Mc2 -- CLAYEY SILT - dark greyish brown, mottled in part, soft when wet, plastic in part, blocky, variable clay content, of alluvial origin
- S7 -- SAND - 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
- S8 -- SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin as relatively thin veneer over C2, M4 and Mc2
- Water -- Water
- Site Boundary

RPS

Job Number: D1516601
Doc Number: 004
Date: 22.10.15
Scale: 1:5,000 @ A3
Created by: MR
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

GDA 1994 MGA Zone 50

0 20 40 80 120 160 m

Figure 4

Geology

38 Station Street, Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au

CHESTNUT WY
PINTO AV
PALOMINO PDE
HERITAGE PARK DR
KWINANA FWY
ANFIELD CT
GOODISON CL
HIGHBURY BVD
FRATTON PL
ANDALUSIAN LOOP
CARROW BEND
THE HAWTHORNS
VILLA PARK WY
BALDIVIS RD
SERPENTINE RD
140 I
146
157
162
168
171 I
177
182
183
184
188
209
187
210
186
211
185
212
184
213
236
249
235
250
234
251
233
252
232
253
253
210
211
212
213
214
215
216
217
218
219
220
221
222
223
243
244
245
250
249
256
9064
22
635
739
740
569
1272
1524
I
503
313
319
6
1006
336
335
334
457
396
400
401
402
382
373
381
374
380
375
458
429
423
424
425
426
456
459
449
450
451
452
453
454
308
309
310
311
312
313
314
315
32
322
47
15
33
973
502
980
985
986
987
992
993
994
999
1001

LEGEND

Acid Sulfate Soil Risk Mapping

- High to Moderate Risk
- Moderate to Low Risk
- Site Boundary

RPS

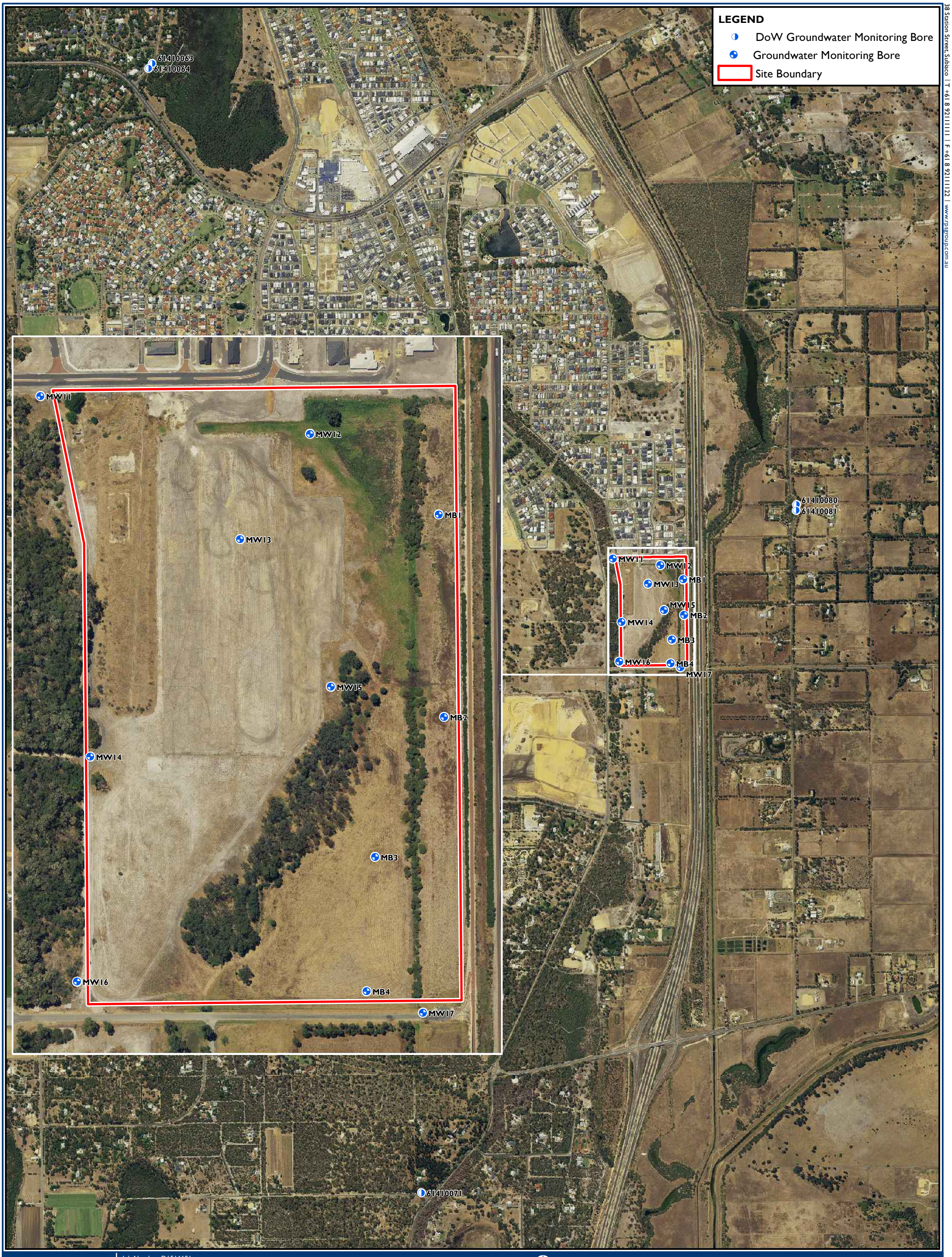
Job Number: D1516601
Doc Number: 005
Date: 22.10.15
Scale: 1:5,000 @ A3
Created by: MR
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

GDA 1994 MGA Zone 50

0 20 40 80 120 160 m

Figure 5

Acid Sulfate Soil Risk Mapping



38 Station Street, Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au

RPS

Job Number: D1516601
Doc Number: 006
Date: 27.01.16
Scale: 1:3,000 @ A3
Created by: MA
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

GDA 1994 MGA Zone 50

0 75 150 300 450 600 m

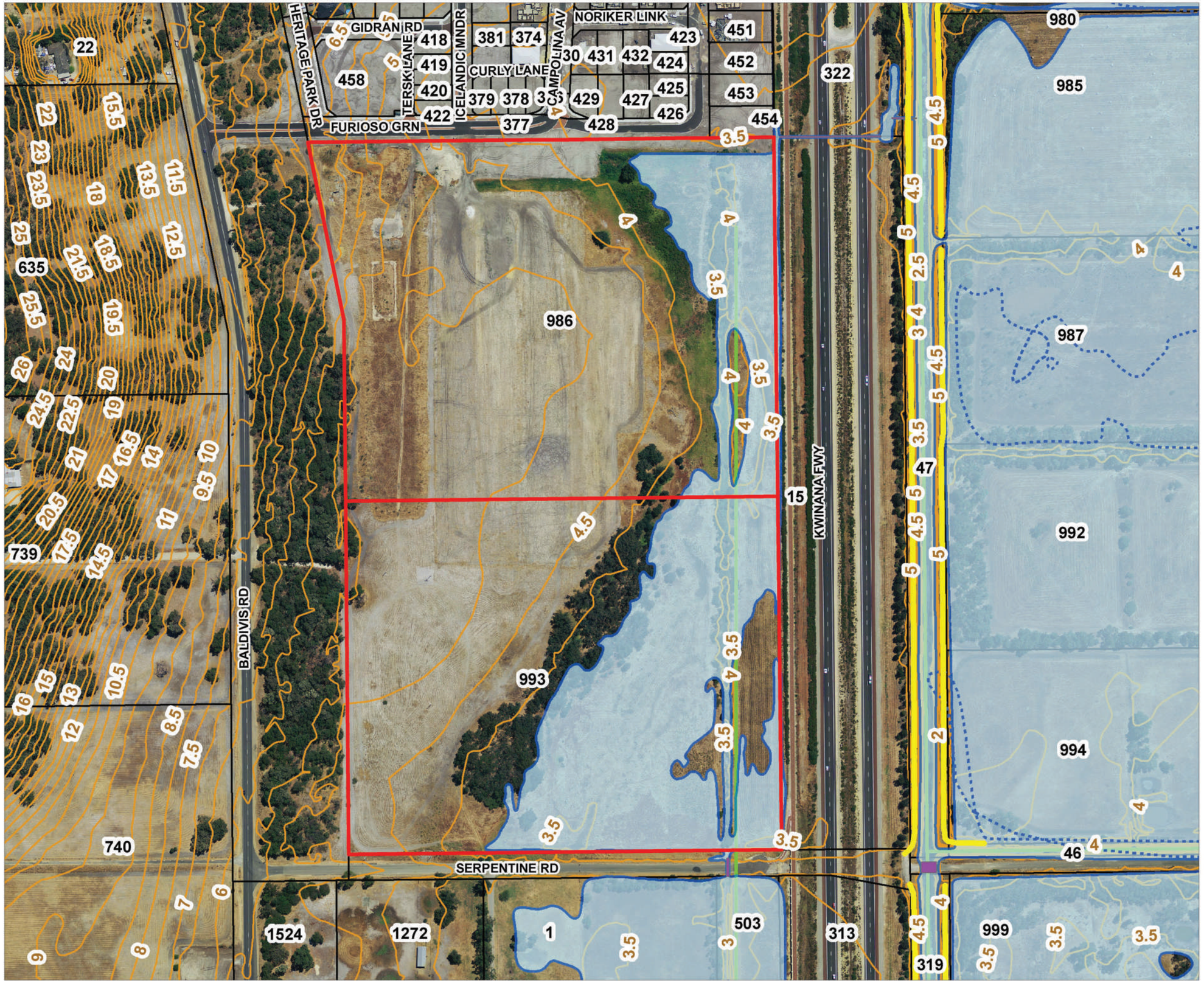
Figure 6

Groundwater Monitoring Bore Locations

38 Station Street, Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au

LEGEND

- Lot
- Cadastre
- 0.5m LiDAR Contours (m AHD)
- Water Corp Drains
- Levees
- Bridge/Culvert
- 1% AEP Floodplain
- 20% AEP Flood Extent



RPS

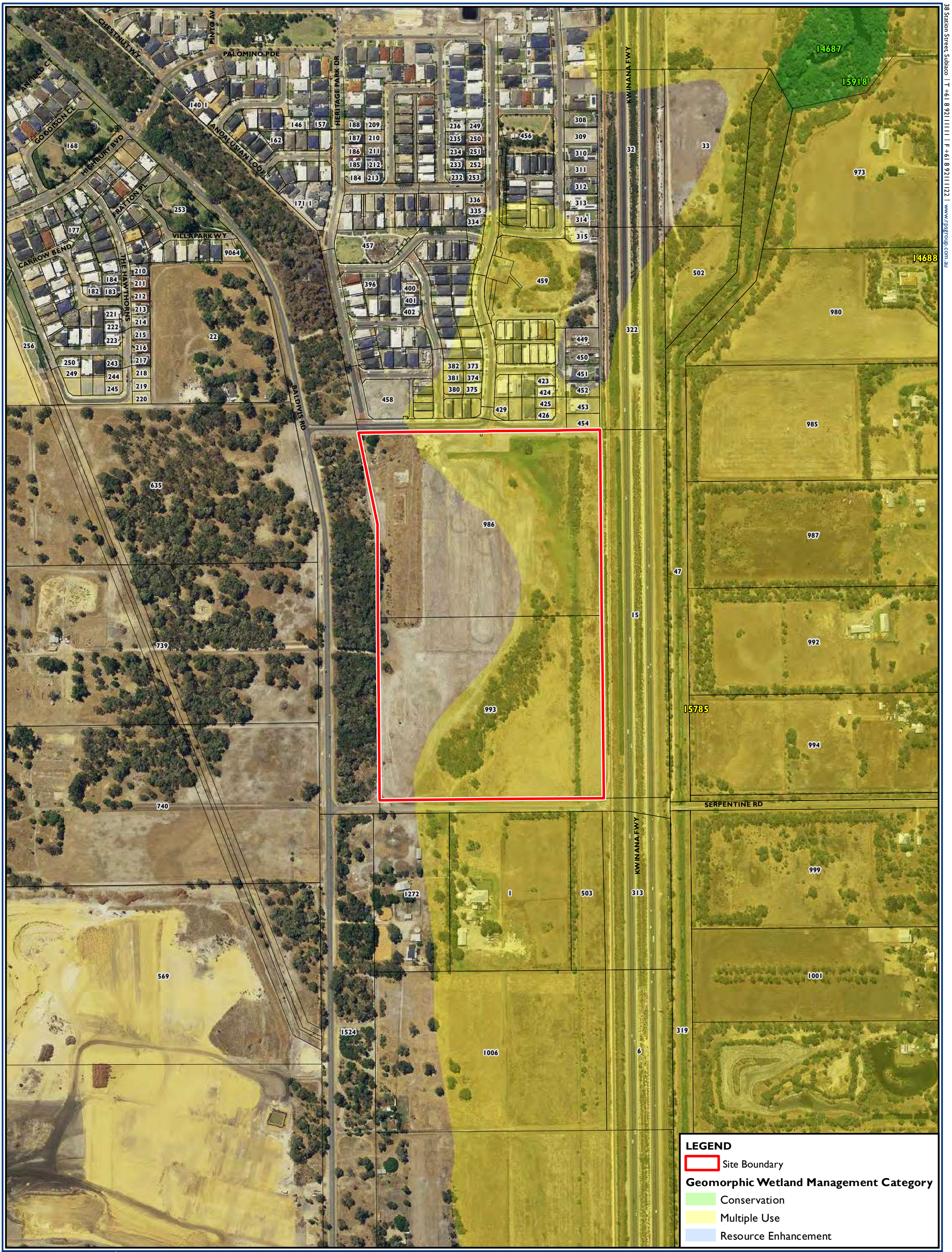
Job Number: D1516601
Doc Number: 007
Date: 21.01.16
Scale: NTS @ A3
Created by: MR
Source: DoW 2016

GDA 1994 MGA Zone 50

Figure 7

DoW Flood Plain Mapping

38 Station Street, Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



LEGEND

Site Boundary

Geomorphic Wetland Management Category

Conservation

Multiple Use

Resource Enhancement

RPS

Job Number: D1516601
Doc Number: 008
Date: 22.10.15
Scale: 1:5,000 @ A3
Created by: MR
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

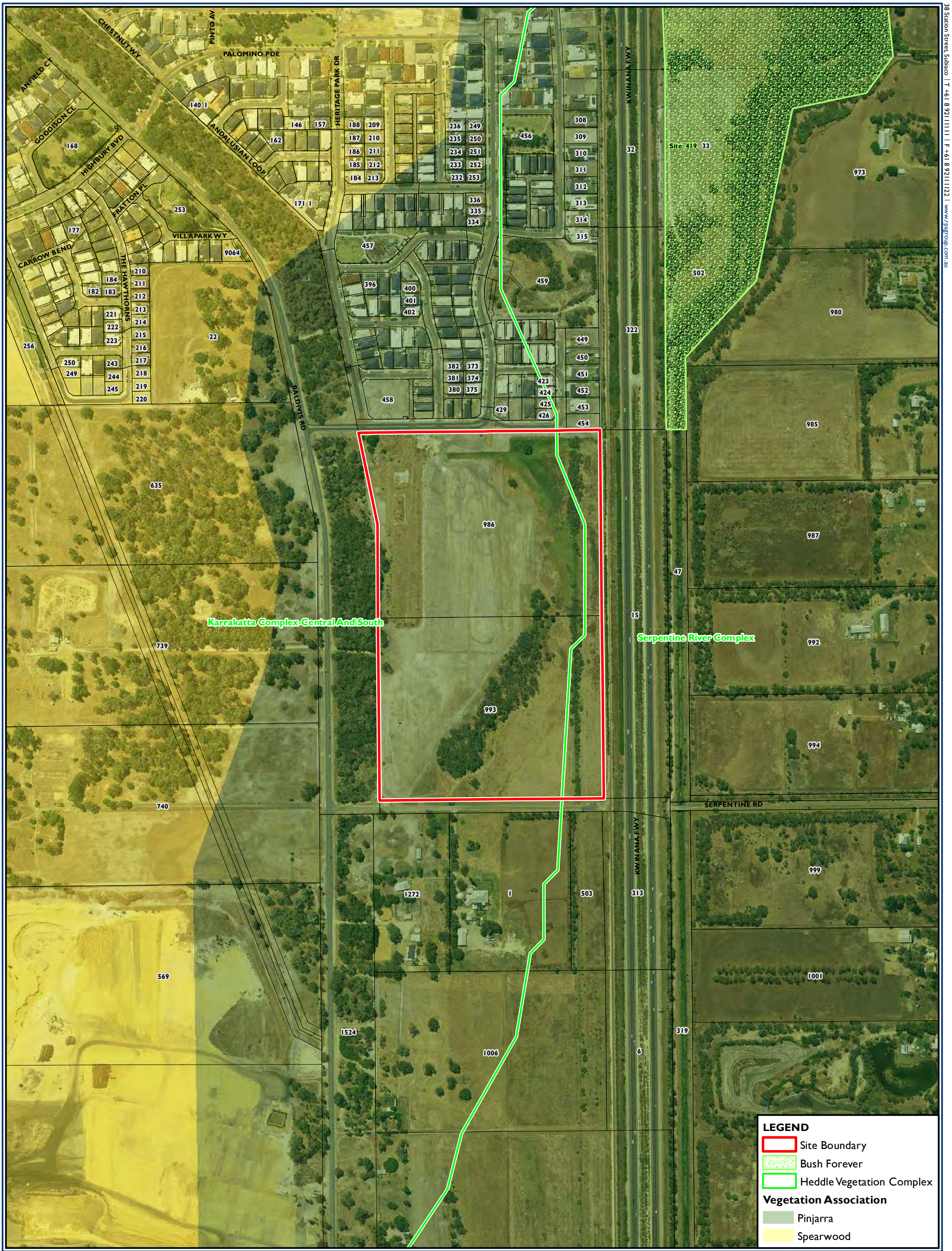
GDA 1994 MGA Zone 50

0 20 40 80 120 160 m

Figure 8

Geomorphic Wetland Mapping

38 Station Street Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



RPS

Job Number: D1516601
Doc Number: 009
Date: 22.10.15
Scale: 1:5,000 @ A3
Created by: MR
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2015

GDA 1994 MGA Zone 50

0 20 40 80 120 160 m

Figure 9

Vegetation Association

38 Station Street, Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au

LEGEND

- POS Subsoil Drainage
- Road Subsoil Drainage
- Flow Direction
- MGL Contours (m AHD)
- Drainage Basin
- Catchment 1
- Catchment 2
- Proposed Layout
- Site Boundary

BALDIVIS RD

KWINANA FWY

Kwinana Fwy PSP

SERPENTINE RD

Job Number: D1516601
Doc Number: 010
Date: 13.06.16
Scale: 1:2,000 @ A3
Created by: MA
Source: Cadastre - Landgate, 2015 Orthophoto - Landgate, Feb 2016, Structure Plan - CDP, dwg no RHPHP-2-002B (17.02.16)

GDA 1994 MGA Zone 50

0 10 20 40 60 80 m

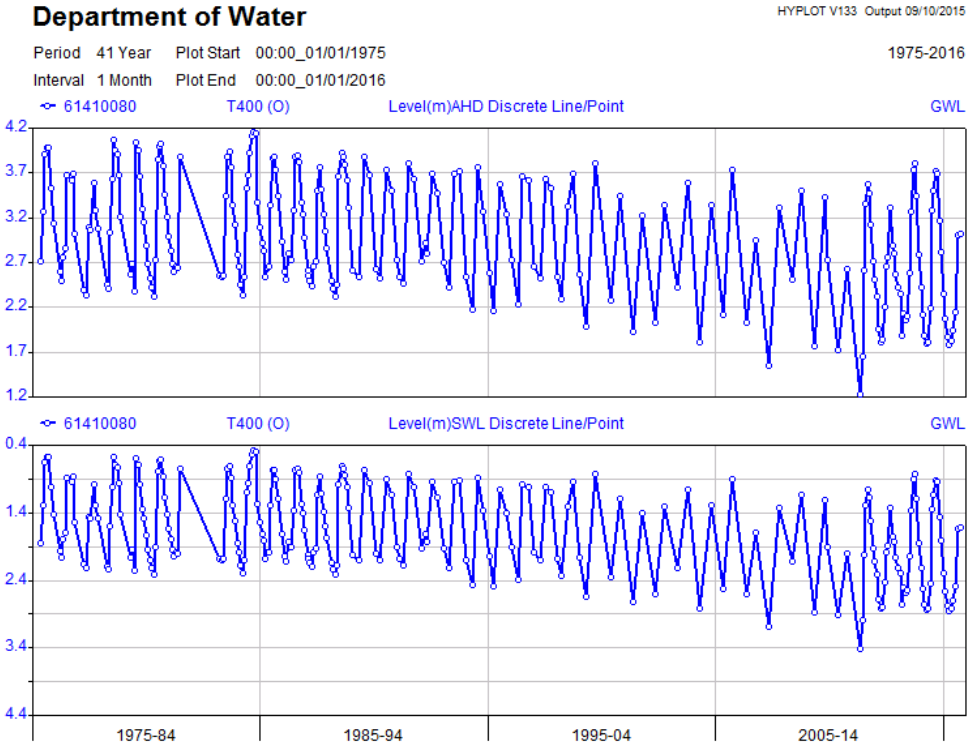
Figure 10

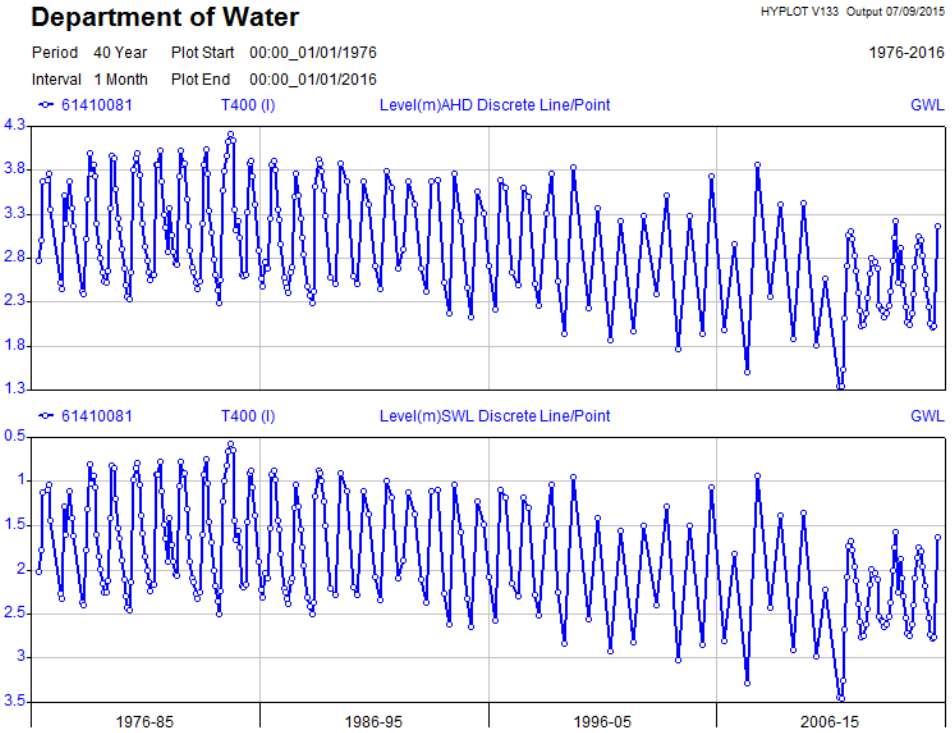
Post-development Catchment Plan

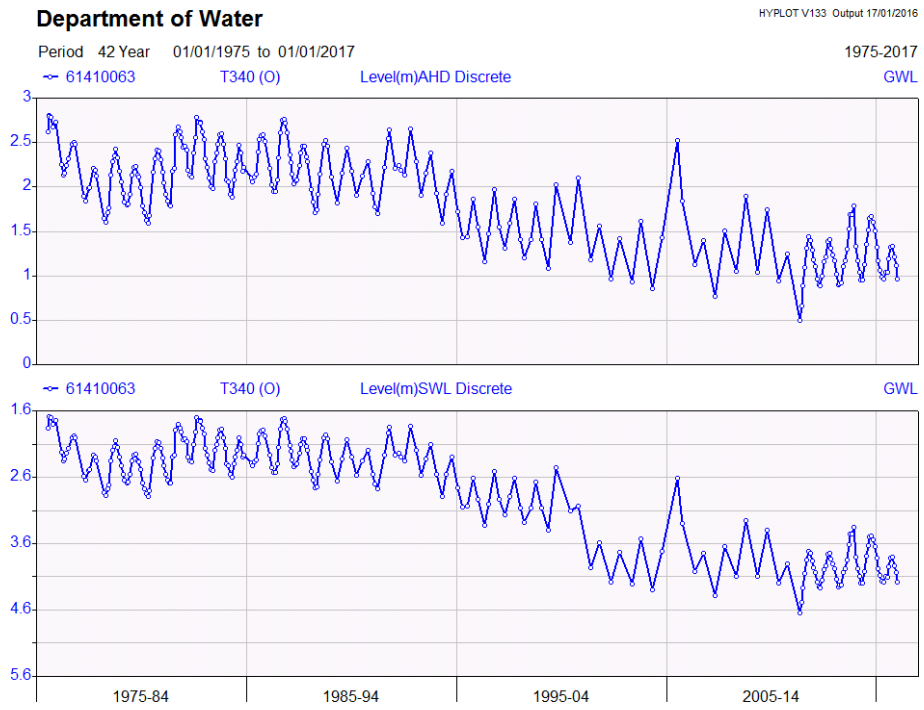
APPENDIX I

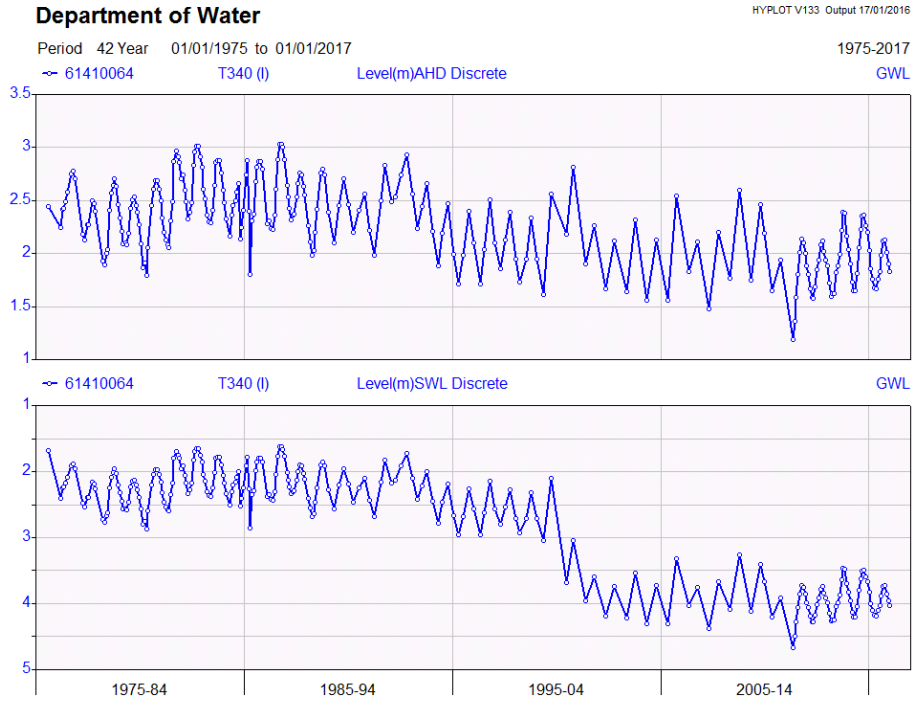
DoW Bore Hydrographs

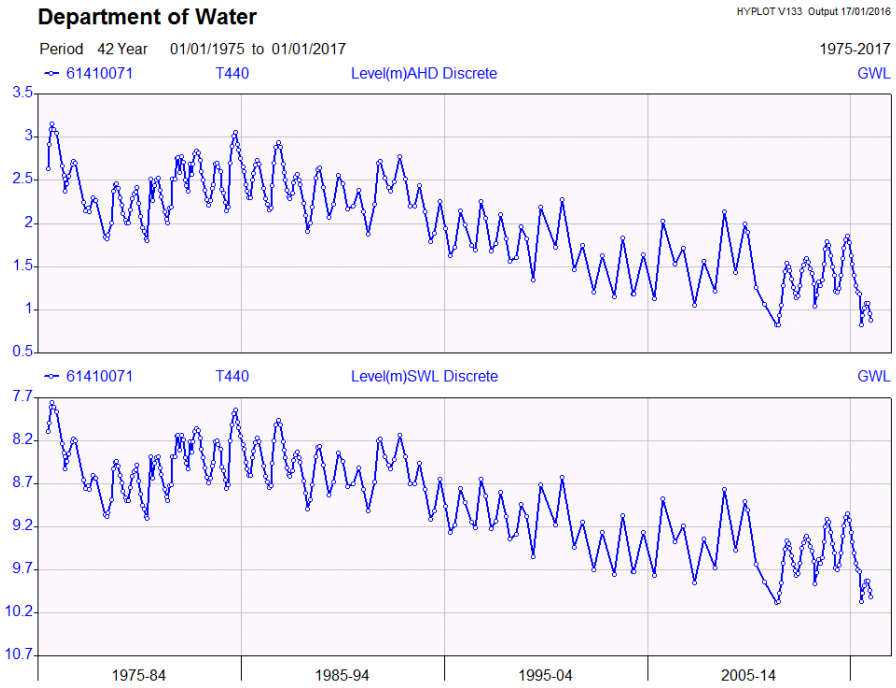
APPENDIX 1: DoW Bore Hydrographs






Department of Water
HYPLOT V133 Output 17/01/2016
Period 42 Year 01/01/1975 to 01/01/2017
1975-2017
61410063 T340 (O) Level(m)AHD Discrete GWL
3
2.5
2
1.5
1
0.5
0
61410063 T340 (O) Level(m)SWL Discrete GWL
1.6
2.6
3.6
4.6
5.6
1975-84
1985-94
1995-04
2005-14


Department of Water
HYPLOT V133 Output 17/01/2016
Period 42 Year 01/01/1975 to 01/01/2017
1975-2017
61410064 T340 (I) Level(m)AHD Discrete GWL
3.5
3
2.5
2
1.5
1
61410064 T340 (I) Level(m)SWL Discrete GWL
1
2
3
4
5
1975-84
1985-94
1995-04
2005-14


Department of Water
HYPLOT V133 Output 17/01/2016
Period 42 Year 01/01/1975 to 01/01/2017
1975-2017
61410071 T440 Level(m)AHD Discrete GWL
3.5
3
2.5
2
1.5
1
0.5
61410071 T440 Level(m)SWL Discrete GWL
7.7
8.2
8.7
9.2
9.7
10.2
10.7
1975-84
1985-94
1995-04
2005-14

APPENDIX 2

Groundwater Monitoring Bore Logs

Client:	Rockingham Park	**Project:**	Heritage Park
Logged By:	ES	**Job No:**	09.086
Drilled By:	E Drill	**Date Logged:**	17/09/09
Monitoring Bore No:	MW11	**Installation Method:**	Rotary Auger

389896E/6420119N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$, VOC)
			0-0.25	TOPSOIL - SAND, grey		
			0.25-1.5	SAND, grey/brown		
1.0						
			1.5-3.0	SAND, orange/brown		
2.0						
3.0						
			3.0-4.0	SAND, orange		
4.0						
			4.0-5.0	SAND, dark brown, saturated		
5.0						
			5.0-5.5	COFFEE ROCK		Hole abandoned due to lack of water at completion
				EoH @ 5.5 mbgl		
6.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:	Rockingham Park	**Project:**	Heritage Park
Logged By:	ES	**Job No:**	09.086
Drilled By:	E Drill	**Date Logged:**	18/09/09
Monitoring Bore No:	MW11	**Installation Method:**	Rotary Auger

389896E/6420119N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)
			0-0.25	TOPSOIL - SAND, grey		
			0.25-1.0	SAND, grey/brown, saturated		Groundwater
1.0						
			1.5-3.0	SAND, orange/brown		
2.0						
3.0						
			3.0-4.0	SAND, orange		
						After completion:
						Depth to water: 4.05 mbgl TOC
						Total depth: 6.0 mbgl TOC
4.0						
			4.0-5.0	SAND, dark brown, saturated		
5.0						
			5.0-5.4	COFFEE ROCK		
				EoH @ 5.4 mbgl		
						This hole was drilled 2 m apart from 11.1 a day later
6.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

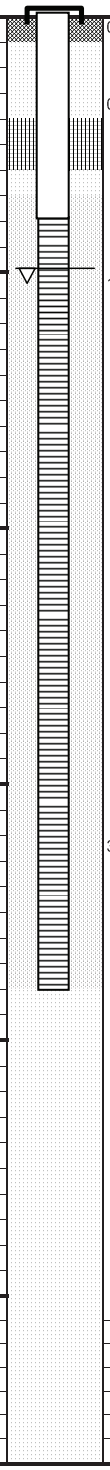
Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: Rockingham Park
Logged By: HL
Drilled By: E Drill
Monitoring Bore No: MW12

Project: Heritage Park
Job No: 09.086
Date Logged: 18/09/09
Installation Method: Rotary Auger

390139E/6420085N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
			0-0.25	TOPSOIL		
			0.25-1.0	SAND, grey/brown, saturated		
1.0			1.0-3.25	SAND, grey, medium grained		Groundwater at 1.0 mbgl
2.0						
3.0			3.25-3.75	SAND, dark grey, coarse grained		
						After completion:
						Depth to water: 0.9 mbgl TOC
						Total depth: 4.20 mbgl TOC
				EoH @ 3.75 mbgl		
4.0						
						3 m screen
5.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

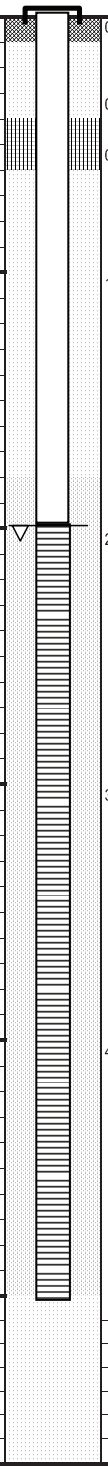
Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: Rockingham Park
Logged By: HL
Drilled By: E Drill
Monitoring Bore No: MW13

Project: Heritage Park
Job No: 09.086
Date Logged: 18/09/09
Installation Method: Rotary Auger

390076E/6919990N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
			0-0.25	TOPSOIL		
			0.25-0.5	SAND, grey/brown		
			0.5-1.0	SAND, brown		
1.0			1.0-2.0	SAND, light brown		
2.0			2.0-3.0	SAND, cream/light brown		Groundwater at 2.0 mbgl
3.0			3.0-4.0	SAND, light brown		After completion:
						Depth to water: 1.76 mbgl TOC
						Total depth: ca. 5 mbgl TOC
4.0			4.0-5.0	SAND, drak brown, some coffee rock		(lots of sediment)
						3 m screen
5.0				EoH @ 5.0 mbgl		

NOTE:
- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:	Rockingham Park	**Project:**	Heritage Park
Logged By:	HL	**Job No:**	09.086
Drilled By:	E Drill	**Date Logged:**	18/09/09
Monitoring Bore No:	MW14	**Installation Method:**	Rotary Auger

389941E/6419794N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)
			0-0.25	TOPSOIL		
			0.25-1.0	SAND, black, damp		
1.0						
			1.0-2.0	SAND, dark grey, damp, saturated at depth		
2.0						
		▽	2.0-3.5	SAND, slightly clayey, dark grey/brown		Groundwater at 2.0 mbgl
3.0						
			3.5-5.0	SAND, slightly clayey, yellow/brown, some grey patches		After completion:
						Depth to water: 2.27 mbgl TOC
						Total depth: 5.75 mbgl TOC
4.0						
						3 m screen
5.0						
				EoH @ 5.15 mbgl		
6.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

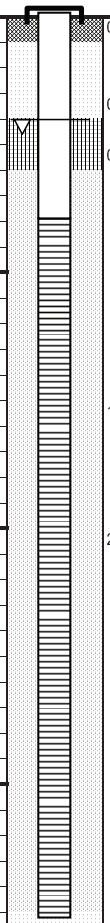
Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: Rockingham Park
Logged By: HL
Drilled By: E Drill
Monitoring Bore No: MW15

Project: Heritage Park
Job No: 09.086
Date Logged: 18/09/09
Installation Method: Rotary Auger

390158E/6419857N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
			0-0.25	TOPSOIL		
			0.25-0.5	SAND, dark grey, medium grained, damp		
						Groundwater at 0.5 mbgl
			0.5-1.5	SAND, grey, medium grained		
1.0						
			1.5-2.0	SAND, grey, cream patches, medium grained		
2.0			2.0-3.5	SAND, light brown/grey, medium grained		
3.0						
				EoH @ 3.5 mbgl		After completion:
						Depth to water: 1.06 mbgl TOC
						Total depth: 4.0 mbgl TOC
4.0						
						3 m screen
5.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

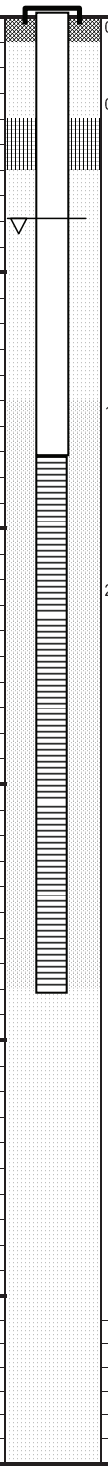
Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: Rockingham Park
Logged By: ES
Drilled By: E Drill
Monitoring Bore No: MW16

Project: Heritage Park
Job No: 09.086
Date Logged: 17/09/09
Installation Method: Rotary Auger

389929E/6419591N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
			0-0.25	TOPSOIL - SAND, dark brown		
			0.25-1.5	SAND, yellow/light grey		
						Groundwater at 0.75 mbgl
1.0						
			1.5-2.25	SAND, light grey		
2.0						
			2.25-3.75	SAND, dark brown, with hard layer of coffe rock		
3.0						
						After completion:
						Depth to water: 1.75 mbgl TOC
						Total depth: 3.9 mbgl TOC
				EoH @ 3.75 mbgl		
4.0						
						3 m screen
5.0						

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

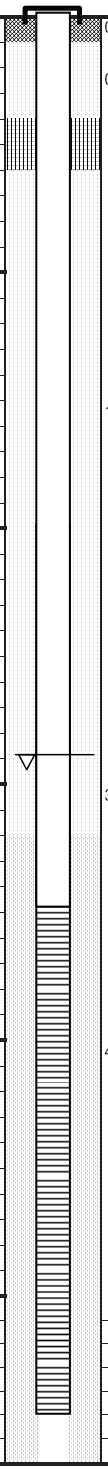
Initial water table at time drilling

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: Rockingham Park
Logged By: ES
Drilled By: E Drill
Monitoring Bore No: MW16

Project: Heritage Park
Job No: 09.086
Date Logged: 17/09/09
Installation Method: Rotary Auger

390241E/6419563N

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
			0-0.2	TOPSOIL and limestone	FILL	
			0.2-1.5	SAND, clayey, brown		
1.0						
			1.5-3.0	CLAY, sandy, dark brown, dry, wet at depth		
2.0						
						Groundwater at 2.7-3.0 mbgl
3.0			3.0-4.0	CLAY, grey/green, very sticky		
						After completion:
						Depth to water: 1.89 mbgl TOC
						Total depth: 5.5 mbgl TOC
4.0			4.0-5.5	CLAY, green and beige mottled		
						3 m screen
5.0						
				EoH at 5.5 mbgl		

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

Initial water table at time drilling ▽

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: D1516602				WEATHER: Fine	
BOREHOLE ID: MB-1				DRILLING METHOD: Hollow Stemmed Auger	
SITE: Heritage Park		LOCATION:		TOTAL DEPTH: 4 m	
EAST:	390253	NORTH:	6420016	TOP of COLLAR RL: mAHD	
DATE BEGUN:	21/09/2015	DATE COMPLETED:	21/09/2015	STATIC WATER LEVEL:	
SCIENTIST: SH				CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: DPP				LOCKABLE BORE: Yes	
DRILLER: Luke Webster				SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

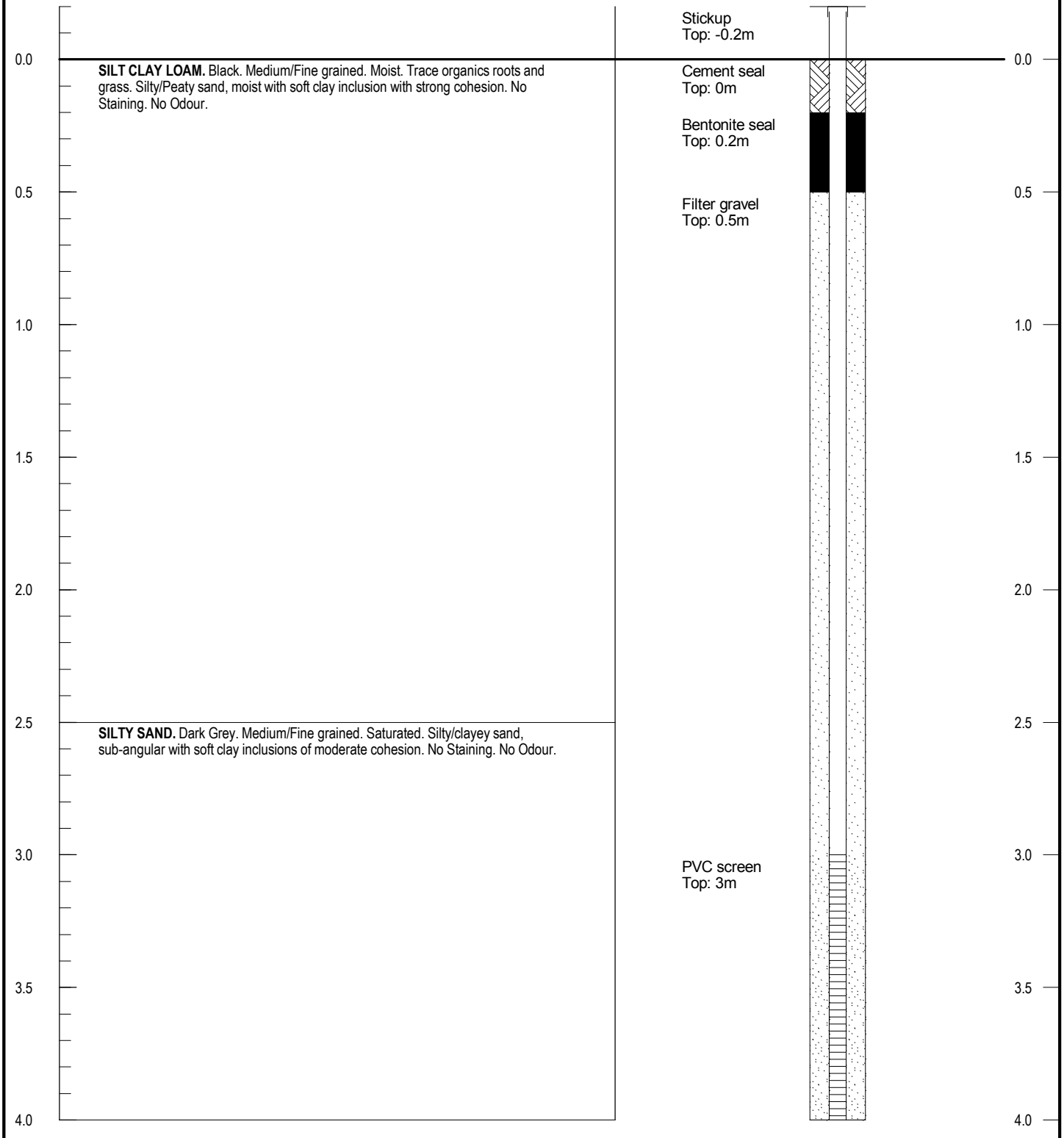
0.0

SILT CLAY LOAM. Black. Medium/Fine grained. Moist. Trace organics roots and grass. Silty/Peaty sand, moist with soft clay inclusion with strong cohesion. No Staining. No Odour.

2.5

SILTY SAND. Dark Grey. Medium/Fine grained. Saturated. Silty/clayey sand, sub-angular with soft clay inclusions of moderate cohesion. No Staining. No Odour.

4.0



BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: D1516602				WEATHER: Fine	
BOREHOLE ID: MB-2				DRILLING METHOD: Hollow Stemmed Auger	
SITE: Heritage Park		LOCATION:		TOTAL DEPTH: 4 m	
EAST:	390259	NORTH:	6419829	TOP of COLLAR RL: mAHD	
DATE BEGUN:	21/09/2015	DATE COMPLETED:	21/09/2015	STATIC WATER LEVEL:	
SCIENTIST: SH				CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: DPP				LOCKABLE BORE: Yes	
DRILLER: Luke Webster				SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

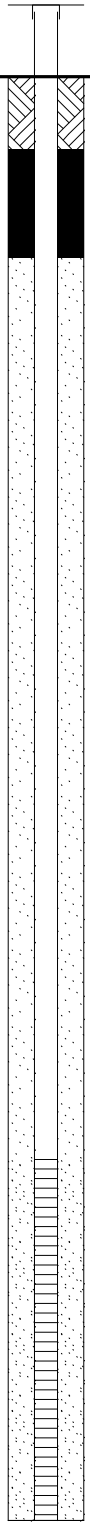
0.0 — **SILT CLAY LOAM.** Black. Medium/Fine grained. Moist. Silty/clay sand, soft to medium firmness with strong cohesion. No Staining. No Odour.

0.5 — **SANDY CLAY.** Black. Medium/Fine grained. Moist. Sandy clay, soft to medium firmness with strong cohesion. No Staining. No Odour.

2.0 — **CLAYEY SAND.** Brown. Medium/Fine grained. Moist. Sand with very high clay content, sub-rounded, soft to moderate cohesion.. No Staining. No Odour.

3.0 — **CLAYEY SAND.** Grey. Medium/Fine grained. Saturated. Sand with very high clay content, sub-rounded, soft to moderate cohesion.. No Staining. No Odour.

4.0

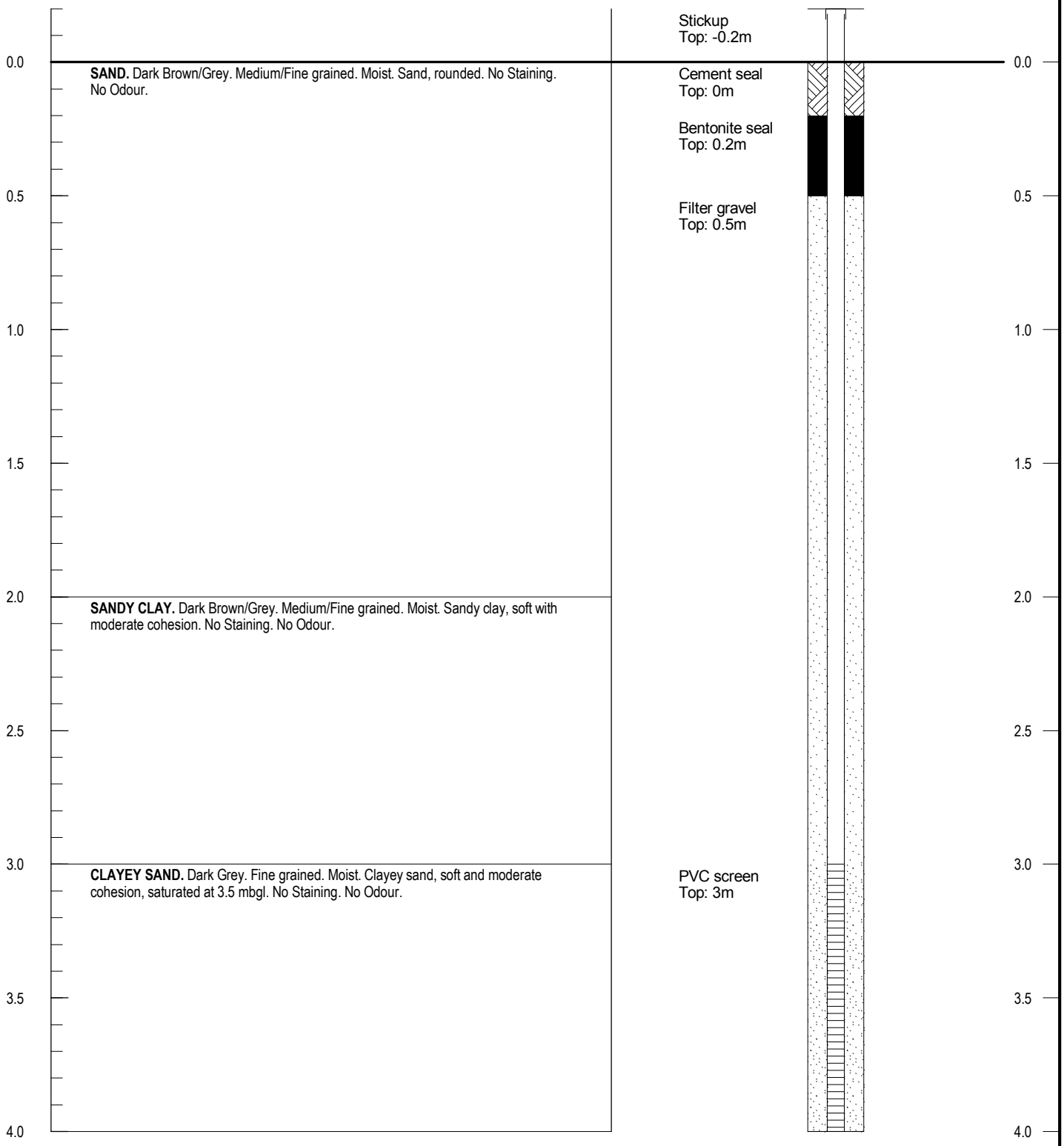


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: D1516602				WEATHER: Fine	
BOREHOLE ID: MB-3				DRILLING METHOD: Hollow Stemmed Auger	
SITE: Heritage Park		LOCATION:		TOTAL DEPTH: 4 m	
EAST:	390200	NORTH:	6419703	TOP of COLLAR RL: mAHD	
DATE BEGUN:	21/09/2015	DATE COMPLETED:	21/09/2015	STATIC WATER LEVEL:	
SCIENTIST: SH				CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: DPP				LOCKABLE BORE: Yes	
DRILLER: Luke Webster				SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION



SAND. Dark Brown/Grey. Medium/Fine grained. Moist. Sand, rounded. No Staining. No Odour.

SANDY CLAY. Dark Brown/Grey. Medium/Fine grained. Moist. Sandy clay, soft with moderate cohesion. No Staining. No Odour.

CLAYEY SAND. Dark Grey. Fine grained. Moist. Clayey sand, soft and moderate cohesion, saturated at 3.5 mbgl. No Staining. No Odour.

BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: D1516602				WEATHER: Fine	
BOREHOLE ID: MB-4				DRILLING METHOD: Hollow Stemmed Auger	
SITE: Heritage Park		LOCATION:		TOTAL DEPTH: 6 m	
EAST:	390184	NORTH:	6419586	TOP of COLLAR RL: mAHD	
DATE BEGUN:	21/09/2015	DATE COMPLETED:	21/09/2015	STATIC WATER LEVEL:	
SCIENTIST: SH				CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: DPP				LOCKABLE BORE: Yes	
DRILLER: Luke Webster				SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

0.0 – 0.5 **CLAY.** Dark Brown. Medium/Fine grained. Moist. Trace organics roots and grass. Platey, medium firm, moderate cohesion. No Staining. No Odour.

0.5 – 1.0 **SANDY CLAY.** Brown. Medium/Fine grained. Moist. Sandy/platey clay, soft/medium firm, weak moderate cohesion and trace laterite gravel. No Staining. No Odour.

1.0 – 2.0 **SANDY CLAY.** Dark Brown. Medium/Fine grained. Moist. Sandy/platey clay, soft/medium firm, weak moderate cohesion and trace laterite gravel. No Staining. No Odour.

2.0 – 2.5 **SANDY CLAY.** Brown. Medium/Fine grained. Moist. Brown sandy clay, moderate cohesion. No Staining. No Odour.

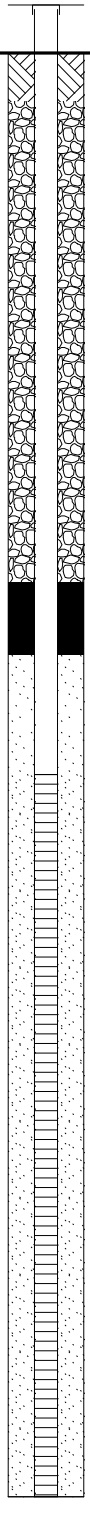
2.5 – 3.0 **CLAY.** Brown/Grey. Medium/Fine grained. Moist. Brown/grey/green sandy clay, moderate firm, moderate cohesion. No Staining. No Odour.

3.0 – 4.5 **CLAY.** Green/Brown. Medium/Fine grained. Moist. Sandy clay, moderate firm, moderate cohesion. No Staining. No Odour.

4.5 – 5.0 **CLAYEY SAND.** Grey. Medium/Fine grained. Saturated. Clayey sand, sub-rounded, saturate. No Staining. No Odour.

5.0 – 6.0

BORE INSTALLATION



APPENDIX 3

Pre-development Groundwater Levels and Groundwater Quality Laboratory Results

Bore ID	Date	DTW (mbtoc)	DTW (mbgl)	GWL btoc(m AHD)	Elevation	Temp	pH	EC (µS/cm)	Redox (mV)	DO (ppm)	Comments
MB-1	25/09/2015	0.84	0.19	3.408		15.7	6.7	572			
	15/10/2015	0.945	0.295	3.303		16.2	6.35	352	-50	0.72	
	27/11/2015	1.27	0.62	2.978		18.7	6.02	332	-135	0.03	
	average					**16.87**	**6.36**	**419**	**-93**	**0.38**	
MB-2	25/09/2015	1.49	0.8	2.746		16.6	6.67	566			
	15/10/2015	1.582	0.892	2.654		16.9	6.4	307	-67	0.7	
	27/11/2015	2.07	1.38	2.166		18.7	6.23	301	-175	0.55	
	average					**17.4**	**6.43**	**391**	**-121**	**0.63**	
MB-3	25/09/2015	1.39	0.65	3.018		16.9	6.02	165.1			
	15/10/2015	1.648	0.908	2.76		17.6	5.82	144	19	4.09	
	27/11/2015	2.262	1.522	2.146		19.1	5.61	159	62	0.96	
	average					**17.87**	**5.82**	**156**	**41**	**2.53**	
MB-4	25/09/2015	1.885	1.145			17.6	6.98	2260			
	15/10/2015	2.035	1.295			17.1	6.84	1911	21	0.79	
	27/11/2015	2.458	1.718			17.6	5.99	4630	42	0.44	
	average					**17.43**	**6.60**	**2934**	**32**	**0.62**	
MW-11	25/09/2015	4.212	3.612			19.8	6.73	447			
	15/10/2015	4.269	3.669			19.8	6.42	353	49	1.95	
	27/11/2015	4.418	3.818			21.2	6.24	434	55	0.49	
	average					**20.27**	**6.46**	**411**	**52**	**1.22**	
MW-12	15/05/2015	1.687	1.087	1.087		17.9	6.06	279	-53.6	7.06	
	9/07/2015	1.322	0.722	0.722		15.6	6.02	267	-50.6	4.1	
	25/09/2015										Could not find. Concelled by tall grass.
	15/10/2015	1.136	0.536	0.536		15.6	6.45	396	31.7	4.45	
	average					**16.37**	**6.18**	**314**	**-24**	**5.20**	
MW-13	15/05/2015	3.859	3.259	3.259		22.7	5.46	349	1337	2.1	
	9/07/2015	3.617	3.017	3.017		20	5.57	435	42	3.67	
	25/09/2015	3.15	2.55	2.55		18.5	6.26	378			
	15/10/2015	3.254	2.654	2.654		18.7	6.03	291	33	1.94	
	15/10/2015	3.252	2.652	2.652		18.8	5.68	355	45.2	3.61	
	27/11/2015	3.472	2.872	2.872		21.2	6.24	399	103	0.93	
	average					**19.98**	**5.87**	**368**	**312**	**2.45**	
MW-14	25/09/2015										Damaged by fire
MW-15	25/09/2015	1.47	0.87	0.87							
	15/10/2015	1.54	0.94	0.94							
MW-16	25/09/2015	2.15									
MW-17	15/05/2015	3.79	3.19	3.19		20.4	6.36	1300	101.4	3.14	
	9/07/2015	3.458	2.858	2.858		18.8	7.25	1300	45.1	4.44	
	24/09/2015	2.42	1.82	1.82		16.7	7.26	1343			
	15/10/2015	2.508	1.908	1.908		17.4	6.92	1156	116	2.13	
	15/10/2015	2.552	1.952	1.952		17.4	7.34	1620	57.9	3.78	
	27/11/2015	2.921	2.321	2.321		18.8	7.31	1482	-54	0.48	
	average					**18.25**	**7.07**	**1367**	**53**	**2.79**	

Depth to groundwater (below top of casing)																							
	Ground Level	Top of Casing	Depth to Water from Top of Casing (m)																				
Sample ID	(mAHD)	(mAHD)	17/06/2009	23/07/2009	25/08/2009	17/09/2009	15/10/2009	18/11/2009	3/12/2009	28/01/2010	16/03/2010	31/03/2010	29/04/2010	27/05/2010	24/06/2010	28/07/2010	27/08/2010	29/09/2010	28/10/2010	24/11/2010	16/12/2010	27/01/2011	9/02/2011
MW11	7.406	8.006				4.050	4.11	4.224	4.307	4.552	4.738		4.287	4.422	4.345	3.972	4.093	4.296	3.628	3.984	3.995	4.321	4.489
MW12	4.249	4.849				0.900	0.98	1.094	1.241	1.582	1.751	1.666	1.097	0.969	0.972	0.913	0.944	1.089	0.624	0.983	1.293	1.598	1.636
MW13	5.282	5.882				1.760	1.95	2.133	2.189	2.514	2.764	2.814	2.66	2.521	2.404	2.085	2.06	2.189	1.836	2.005	2.396	2.730	2.852
MW14	5.544	6.144				2.270	2.43	2.618	2.699	2.998	3.319	3.380	3.433	3.336	3.173	2.738	2.669	2.797	2.642	2.68	2.991	3.386	3.449
MW15	4.313	4.913				1.060	1.20	1.327	1.414		1.920	1.934	1.934	1.717	1.538	1.319	1.321	1.472	1.376	1.678	1.907	Dry	Dry
MW16	4.866	5.466				1.750	1.89	2.071	2.133	2.481	2.729	2.785	2.867	2.798	2.65	2.261	2.183	2.301	2.448	2.756	3.083	Dry	Dry
MW17	4.174	4.774				1.890	2.11	2.508	2.634	3.331	3.705	3.846	3.759	3.485	3.16	2.462	2.477	2.773	2.984	3.374	3.484	3.827	3.894
RP2A	4.570	4.800	0.411	0.289	0.29	0.260	0.43	0.419	0.693	1.111	0.921	0.993	0.24	1.387	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
RP3A	4.400	4.900	0.739	0.573	0.399	0.398	0.60	0.721	0.827	dry	dry			0.646	under water	under water	0.526	0.788	0.953	1.087	1.107	1.213	1.289
Replacement MW3																			0.995	1.072	1.169	1.361	1.455
Replacement RP2A																			1.162	1.209	1.371	1.407	1.477
SW1							dry	dry	dry		dry			dry	dry	dry			Dry	Dry	Dry	Dry	Dry
DoW Bore 3042 / T400(0)	4.180	4.636	1.283	0.840	0.944	0.930	0.95	1.571	1.699	2.278	2.740	2.918			locked	1.609		1.657	1.745	2.197	2.586	2.785	2.836
Dow Bore 3043 / T400 (I)	4.080	4.787	2.452	2.319	1.72	1.470	1.77	1.681	1.831	2.541	2.932					1.829		1.898	1.942	2.304	2.76	2.963	3.038

	Ground Level	Top of Casing	Groundwater Level (m AHD)																				
Sample ID	(mAHD)	(mAHD)	17/06/2009	23/07/2009	25/08/2009	17/09/2009	15/10/2009	18/11/2009	3/12/2009	28/01/2010	16/03/2010	31/03/2010	29/04/2010	27/05/2010	24/06/2010	28/07/2010	27/08/2010	29/09/2010	28/10/2010	24/11/2010	16/12/2010	27/01/2011	9/02/2011
MW11	7.406	8.006				3.956	3.892	3.782	3.699	3.454	3.268		3.719	3.584	3.661	4.034	3.913	3.71	4.378	4.022	4.011	3.685	3.517
MW12	4.249	4.849				3.949	3.874	3.755	3.608	3.267	3.098	3.183	3.752	3.88	3.877	3.936	3.905	3.76	4.225	3.866	3.556	3.251	3.213
MW13	5.282	5.882				4.122	3.934	3.749	3.693	3.368	3.118	3.068	3.222	3.361	3.478	3.797	3.822	3.693	4.046	3.877	3.486	3.152	3.03
MW14	5.544	6.144				3.874	3.718	3.526	3.445	3.146	2.825	2.764	2.711	2.808	2.971	3.406	3.475	3.347	3.502	3.464	3.153	2.758	2.695
MW15	4.313	4.913				3.853	3.717	3.586	3.499		2.993	2.979	2.979	3.196	3.375	3.594	3.592	3.441	3.537	3.235	3.006		
MW16	4.866	5.466				3.716	3.58	3.395	3.333	2.985	2.737	2.681	2.599	2.668	2.816	3.205	3.283	3.165	3.018	2.71	2.383		
MW17	4.174	4.774				2.884	2.663	2.266	2.14	1.443	1.069	0.928	1.015	1.289	1.614	2.312	2.297	2.001	1.79	1.4	1.29	0.947	0.88
RP2A	4.570	4.800	4.39	4.51	4.51	4.54	4.37	4.381	4.107	3.689	3.879	3.807	4.56	3.413									
RP3A	4.400	4.900	4.16	4.33	4.5	4.5	4.302	4.179	4.073			4.9	4.9	4.254			4.374	4.112	3.947	3.813	3.793	3.687	3.611
SW1							3.426	0.256						1.726				2.6					
DoW Bore 3042 / T400(0)	4.180	4.636	3.35	3.8	3.69	3.71	3.682	3.065	2.937	2.358	1.896	1.718				3.027		2.979	2.891	2.439	2.05	1.851	1.8
Dow Bore 3043 / T400 (I)	4.080	4.787	2.34	2.47	3.07	3.32	3.017	3.106	2.956	2.246	1.855					2.958		2.889	2.845	2.483	2.027	1.824	1.749

	Ground Level	Top of Casing	Depth to Water Below Ground Level (m)																				
Sample ID	(mAHD)	(mAHD)	17/06/2009	23/07/2009	25/08/2009	17/09/2009	15/10/2009	18/11/2009	3/12/2009	28/01/2010	16/03/2010	31/03/2010	29/04/2010	27/05/2010	24/06/2010	28/07/2010	27/08/2010	29/09/2010	28/10/2010	24/11/2010	16/12/2010	27/01/2011	9/02/2011
MW11	7.406	8.006				3.45	3.51	3.62	3.71	3.95	4.14		3.69	3.82	3.75	3.37	3.49	3.7	3.03	3.38	3.4	3.72	3.89
MW12	4.249	4.849				0.3	0.38	0.49	0.64	0.98	1.15	1.07	0.5	0.37	0.37	0.31	0.34	0.49	0.02	0.38	0.69	1	1.04
MW13	5.282	5.882				1.16	1.35	1.53	1.59	1.91	2.16	2.21	2.06	1.92	1.8	1.49	1.46	1.59	1.24	1.41	1.8	2.13	2.25
MW14	5.544	6.144				1.67	1.83	2.02	2.1	2.4	2.72	2.78	2.83	2.74	2.57	2.14	2.07	2.2	2.04	2.08	2.39	2.79	2.85
MW15	4.313	4.913				0.46	0.6	0.73	0.81		1.32	1.33	1.33	1.12	0.94	0.72	0.72	0.87	0.78	1.08	1.31		
MW16	4.866	5.466				1.15	1.29	1.47	1.53	1.88	2.13	2.19	2.27	2.2	2.05	1.66	1.58	1.7	1.85	2.16	2.48		
MW17	4.174	4.774				1.29	1.51	1.91	2.03	2.73	3.11	3.25	3.16	2.89	2.56	1.86	1.88	2.17	2.38	2.77	2.88	3.23	3.29
RP2A	4.570	4.800	0.18	0.06	0.06	0.03	0.2	0.19	0.46	0.88	0.69	0.76	0.01	1.16									
RP3A	4.400	4.900	0.24	0.07	-0.1	-0.1	0.1	0.22	0.33			-0.5	-0.5	0.15			0.03	0.29	0.45	0.59	0.61	0.71	0.79
DoW Bore 3042 / T400(0)	4.180	4.636	0.83	0.38	0.49	0.47	0.5	1.12	1.24	1.82	2.28	2.46				1.15		1.2	1.29	1.74	2.13	2.33	2.38
Dow Bore 3043 / T400 (1)	4.080	4.787	1.75	1.61	1.01	0.76	1.06	0.97	1.12	1.83	2.23					1.12		1.19	1.24	1.6	2.05	2.26	2.33

Pre-development Groundwater Quality Laboratory Results

Definitions: LOR (Limits of reporting), FWG (Freshwater Guidelines) for slightly - moderately disturbed lowland river systems (Table 3.3.6 ANZECC 2000), SSCP -Swan Canning Cleanup Program (SRT 2003), LIWG (Long Term Irrigation Water Guidelines) (Table 4.1.10 ANZECC 2000) , NG denotes no guideline.
If no guideline then the laboratory limit of reporting is recognised as exceeding the guideline trigger value

Sample ID	Date	Trigger	Field Parameters		Nutrients (mg/L)						Heavy metals (mg/L)							
			pH	EC	Total P	Total N	Phosphate	TKN	NH_4-N	NOx-N	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
		FWG	6.5-8	NG	0.065	1.2	NG	NG	0.08	0.15	0.024	0.0002	NG	0.0014	0.0034	0.0006	0.011	0.008
		SCCP short-term	NG	NG	0.2	2	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
		SCCP long-term	NG	NG	0.10	1.00	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
		LIWG	NG	NG	NG	NG		NG	NG	NG	0.10	0.01	0.1	0.2	2	0.002	0.2	2
MW11	28/07/2010		5.8	390	5.9	14	0.78	13	4.5	0.56	<0.001	<0.0001	<0.1	0.012	<0.001	<0.0001	0.001	<0.2
Average			**5.8**	**390**	**5.9**	**14**	**0.78**	**13**	**4.5**	**0.56**	-	-	-	**0.012**	-	-	**0.001**	-
MW15	29/04/2010		4.6	430	1.1	0.63	0.04	0.2	0.059	0.43	0.001	<0.0001	<0.001	0.004	<0.001	<0.0001	<0.001	0.31
	28/07/2010		5.6	190	0.85	4.7	0.76	4.4	0.11	0.28	<0.001	<0.0001	<0.005	0.005	<0.001	<0.0001	0.003	0.02
	28/10/2010		7	410	0.33	2.5	0.25	1.8	0.28	0.67	0.01	<0.002	<0.005	0.007	<0.001	<0.0001	<0.005	<0.01
Average			**5.73**	**343**	**0.76**	**2.61**	**0.35**	**2.13**	**0.15**	**0.46**	**0.006**	-	-	**0.005**	-	-	**0.003**	**0.165**
MW16	29/04/2010		5.6	110	1.1	4	0.53	3.5	0.1	0.5	0.001	<0.0001	<0.001	0.004	0.001	<0.0001	0.002	0.035
	28/07/2010		4.4	150	3.6	3.9	0.01	2.6	0.039	1.3	<0.001	<0.0001	<0.005	0.006	<0.001	<0.0001	0.008	<0.01
	28/10/2010		5.6	60	0.23	1.8	0.04	1.3	0.06	0.57	0.016	<0.002	0.051	0.12	0.069	0.0015	0.0016	0.02
Average			**5.20**	**107**	**1.64**	**3.23**	**0.19**	**2.47**	**0.07**	**0.79**	**0.009**	-	**0.051**	**0.043**	**0.035**	**0.0015**	**0.004**	**0.028**
MW17	29/04/2010		7.6	1500	0.23	1.8	0.03	1.7	0.021	0.12	0.012	<0.0001	<0.001	0.004	<0.001	<0.0001	0.003	0.029
	28/07/2010		7.2	1700	0.13	6.6	0.03	6.2	0.021	0.39	0.004	<0.0001	<0.005	0.009	<0.001	<0.0001	0.012	<0.01
	28/10/2010		8	1700	0.094	0.79	0.01	0.72	0.01	0.065	0.09	<0.002	0.033	0.038	0.012	<0.0001	0.023	0.08
	27/01/2011		8.1	1300	0.26	0.61		0.6	<0.01	<0.05	0.015	<0.0002	0.003	0.004	<0.001	<0.0001	0.001	<0.001
Average			**7.73**	**1550**	**0.18**	**2.45**	**0.02**	**2.31**	**0.02**	**0.19**	**0.030**	-	**0.018**	**0.014**	**0.012**	-	**0.010**	**0.055**

APPENDIX 4

Groundwater Licence

PH /HD

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Your ref: GWL164680(8)
Our ref: RF7311-03
Enquiries: Alana Patterson
Tel: 95504236

Rockingham Park Pty Ltd
PO Box 907
CLAREMONT WA 6910

Dear Mr David Simpson

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*
Property*: Parkland Heights and Heritage Park*

Please find enclosed the following:

- Your licence to take water *(GWL164680(8)*
- Brochure *Your licence to take water*
- Brochure *Metering your water use*
- Meter Water Use Card & example card can be downloaded from the department's website: http://www.water.wa.gov.au/licensing/water-licensing/metering or refer to Water Online information below

Please take time to read these documents as they contain important information about your rights and responsibilities.

You may apply to the State Administrative Tribunal (SAT) for a review of our decision. You will need to contact the SAT office directly, within 28 days.

In person	State Administrative Tribunal Level 6, 565 Hay Street PERTH WA 6000
In writing:	State Administrative Tribunal GPO Box U1991 PERTH WA 6845
By telephone:	Metro: (08) 9219 3111 Regional: 1300 306 017 (for the cost of a local call)
By fax:	(08) 9325 5099

For more information about the SAT please visit their website www.sat.justice.wa.gov.au.

Kwinana Peel Region
107 Breakwater Parade Mandurah Ocean Marina Mandurah Western Australia 6210
PO Box 332 Mandurah Western Australia 6210
Telephone (08) 9550 4222 Facsimile (08) 9581 4560
www.water.wa.gov.au

You can now use online services to manage all of your licensing and metering needs. Water Online provides the easiest, fastest and most efficient way to:

- Apply for a new licence or permit
- Apply to amend, renew or transfer an existing licence
- Submit meter readings in accordance with a licence; and
- Manage your account details.

Register for Water Online at www.water.wa.gov.au by clicking on the Water Online Login icon.

The instructions for registering, checking your details and updating them where required can be found by selecting the Quick Reference Guides link on the water online home page.

Please check your details to ensure that they are correct. If they are not correct please contact the department's online business support unit on 1800 508 885 (select option 2).

If you have any queries about this or any other water licensing matter please contact Alana Patterson on telephone 95504236.

Yours sincerely,

Alana Patterson
Natural Resource Management Officer
Peel Region
6 September 2016

cc. Iza Griffin

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Rockingham Park Pty Ltd		
Description of Water Resource	Stakehill Perth - Superficial Swan	**Annual Water Entitlement**	83030 kL
Location of Water Source	Lot 459 On Plan 76557 - Volume/Folio Lr3163/607 - Lot 459 - Heritage Park Development - Pos 5 Lot 792 On Plan 77078 - Volume/Folio Lr3163/658 - Lot 792 - Furnival Pde Pos - Parkland Heights		

Authorised Activities

Taking of water for	Location of Activity
Irrigation of up to 0.2 ha of public open space	- Portion Of Road Reserve - Heritage Park Development
Irrigation of up to 2.2 ha of public open space	Lot 459 On Plan 76557 - Volume/Folio Lr3163/607 - Lot 459 - Heritage Park Development - Pos 5
Dust suppression for earthworks and construction purposes	Lot 9009 On Plan 406823 - Volume/Folio 2891/11 - Lot 9009 - Parkland Heights
Irrigation of up to 2 ha of public open space	Lot 993 On Plan 202758 - Volume/Folio 2125/382 - Lot 993 Baldivis Rd Baldivis - Heritage Park Development - Pos 7
Dust suppression for earthworks and construction purposes	Lot 986 On Plan 202758 - Volume/Folio 2128/381 - Lot 986 Baldivis Rd Baldivis - Heritage Park Development Lot 993 On Plan 202758 - Volume/Folio 2125/382 - Lot 993 Baldivis Rd Baldivis - Heritage Park Development - Pos 7
Irrigation of up to 2 ha of public open space	Lot 792 On Plan 77078 - Volume/Folio Lr3163/658 - Lot 792 - Furnival Pde Pos - Parkland Heights Lot 793 On Plan 400283 - Volume/Folio Lr3164/85 - Lot 793 - Parkland Heights

Duration of Licence	From 6 September 2016 to 4 February 2024

This Licence is subject to the following terms, conditions and restrictions:

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

This Licence is subject to the following terms, conditions and restrictions:

1 The licensee shall not use water for public open space between 9 am and 6 pm except for the establishment of newly planted areas. For newly planted areas water may be used within these hours for a period of up to 28 consecutive days, commencing from the date of planting.

2 Between 1 June and 31 August in any year, the licence-holder must not water a lawn, garden, or grass-covered area ("turf") by reticulation, provided always that this restriction shall not apply to watering with a hand held hose; or watering, by way of reticulation: newly planted areas for a period of up to 28 days from the date of planting; for renovating turf; or for maintenance of reticulation systems.

3 The annual water year for water taken under this licence is defined as 1st January to 31st December twelve months later.

4 The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.

5 The licensee must install an approved meter to each water draw-point through which water is taken under this licence.

6 The licensee must take and record the reading from each meter required under this licence at the beginning and another at the end of the water year defined on this licence.

7 The licensee must take and record the reading from each meter required under this licence, at the end of each month.

8 The licensee must notify the Department of Water in writing of any water meter malfunction within seven days of the malfunction being noticed.

9 The licensee must obtain authorisation from the Department of Water before removing, replacing or interfering with any meter required under this licence.

10 The licensee must submit to the Department of Water the recorded meter readings and the volume of water taken within the water year, every 12 month(s) commencing 14/01/2017.

End of terms, conditions and restrictions

APPENDIX 5

Landscaping Master Plan

PHASE 2 LANDSCAPE MASTER PLAN

LEGEND

- BOUNDARY
- BALDIVIS TRAMWAY RESERVE
- KWINANA FWY
- INTERNAL ROADS
- LOTS
- CONCRETE PATHS:
  - TRAMWAY TREATMENT/TRAIL - DUP - 2.5m
  - POS FOOTPATH - DUP - 2.5m
  - POS INTERNAL FOOTPATH - 2.1m
- LIMESTONE PATHS:
  - TRAMWAY TREATMENT/TRAIL - 2.0m + 0.5m SHOULDER
  - POS INTERNAL FOOTPATH - 1.5m
- PLAYGROUND
- TURF
- GARDEN BED
- MULCH ONLY
- PROPOSED TREES
- EXISTING EUCALYPTUS RUDIS STAND

POS - DRAINAGE BASIN1 AREAS:

- Q1 - 1,221m²
- Q5 - 3,193m²
- Q10 - 4,826m²
- Q100 - 9,841m²

DRAINAGE BASIN2 AREAS:

- Q1 - 372m²
- Q5 - 473m²
- Q10 - 499m²
- Q100 - 606m²

SCALE 0m 10m

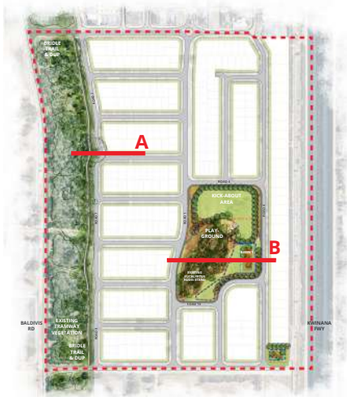
LD TOTAL
LEADERS IN LANDSCAPING
172 BURSWOOD ROAD, BURSWOOD, WA, 6100
T +61 8 6436 1111
F +61 8 9367 2034

MORTONS urbansolutions
Civil Engineering | Town Planning | Project Coordination

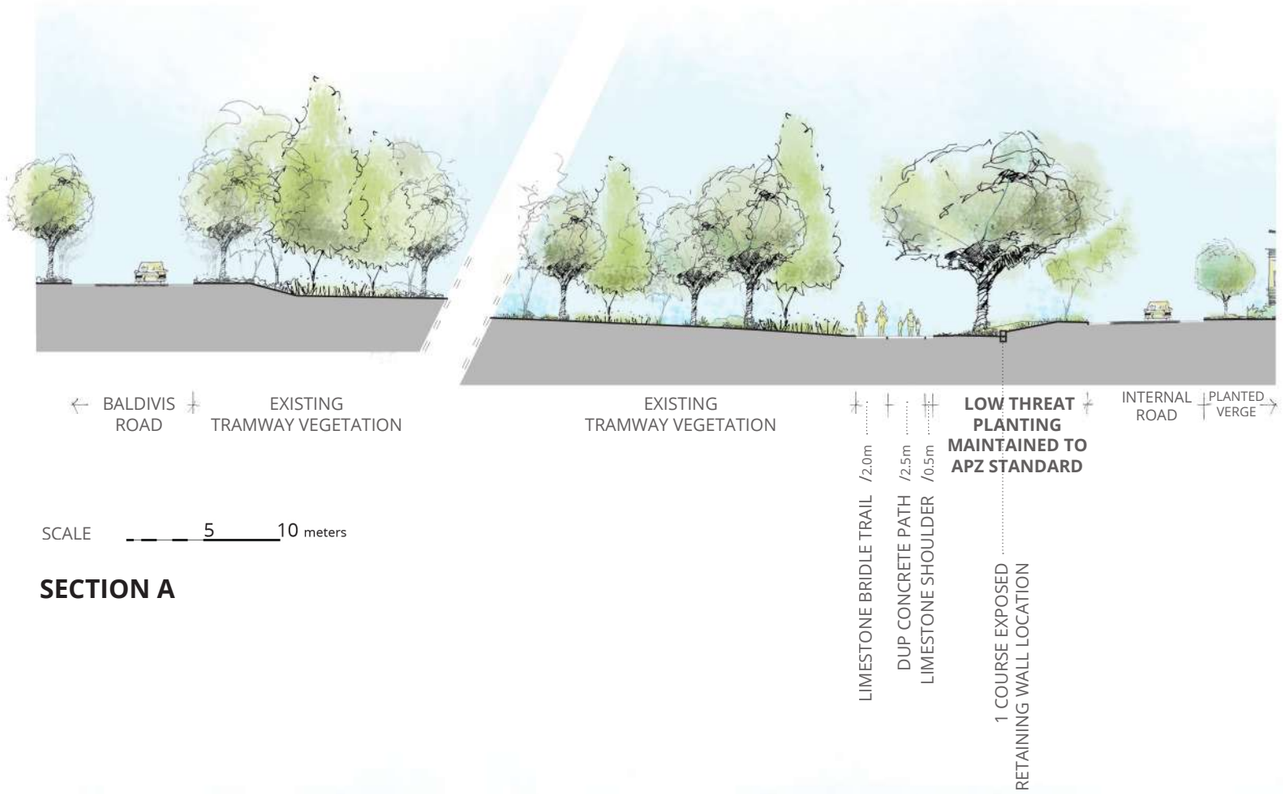
Heritage Park Phase 2

2ND MAY 2017 - REV C

PHASE 2 SECTIONS



KEY PLAN



SCALE 5 10 meters

SECTION A

SECTION A/ PLANTING TO BATTER:
LOW THREAT PLANTING MAINTAINED TO APZ STANDARD, as defined in the Guidelines for Planning in Bushfire Prone Areas (WAPC et al. 2015).
This will adhere to a low threat standard in accordance with AS 3959.

SCALE 5 10 meters

SECTION B

LD TOTAL
LEADERS IN LANDSCAPING
172 BURSWOOD ROAD,
BURSWOOD, WA, 6100
T +61 8 6436 1111
F +61 8 9367 2034

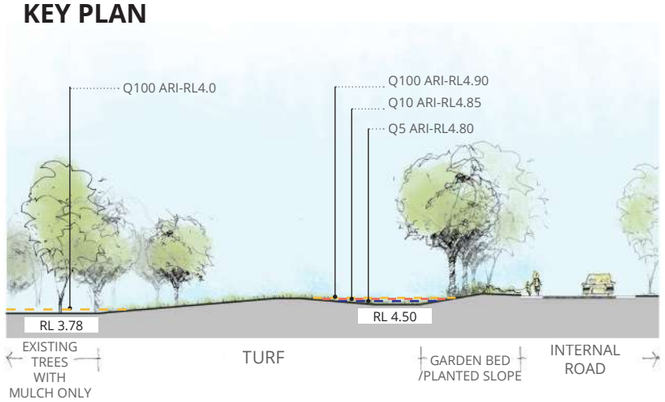
MORTONS urbansolutions
Civil Engineering | Town Planning | Project Coordination

Heritage Park Phase 2

2ND MAY 2017 - REV C

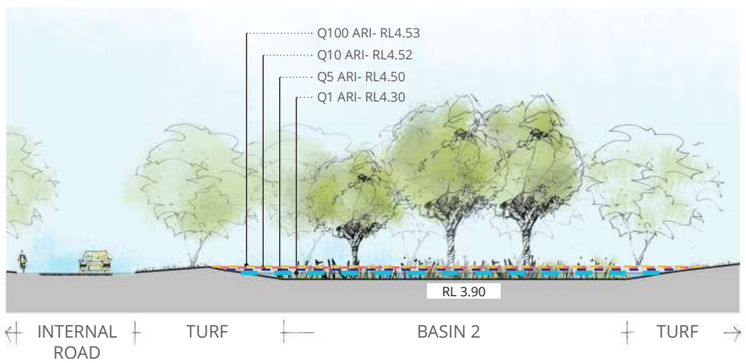
PHASE 2 SECTIONS

KEY PLAN



SCALE 5 10 meters

SECTION C



SCALE 5 10 meters

SECTION D

PHASE 2 LANDSCAPE MASTER PLAN - POS

- INTERNAL ROAD
- GARDEN BED
- CONCRETE PATH - DUP /2.5m
- CONCRETE PATH /2.1m
- TURF
- PROPOSED TREES
- GARDEN BED
- PLAYGROUND
- CONCRETE PATH /2.1m
- GARDEN BED
- CONCRETE KERB
- MULCH ONLY
- PLANTED BASIN
- LIMESTONE PATH /1.5m
- EXISTING TREES WITH MULCH ONLY
- PROPOSED TREES AND GARDEN BED
- CONCRETE PATH - DUP /2.5m

DRAINAGE BASIN1 LEVELS:

Q1 ARI-RL 4.30	- 1,221m²
Q5 ARI-RL 4.50	- 3,193m²
Q10 ARI-RL 4.52	- 4,826m²
Q100 ARI-RL 4.53	- 9,841m²

LD TOTAL
LEADERS IN LANDSCAPING
172 BURSWOOD ROAD,
BURSWOOD, WA, 6100
T +61 8 6436 1111
F +61 8 9367 2034

MORTONS urbansolutions
Civil Engineering | Town Planning | Project Coordination

Heritage Park Phase 2

2ND MAY 2017 - REV C

APPENDIX 6

Engineering Drawings

From: DUARTE Paola [Paola.DUARTE@water.wa.gov.au]
Sent: Wednesday, 28 October 2015 4:21 PM
To: Shane McSweeney
Subject: RE: Floodplain Management Advice - Lots 986 993 Baldivis Road BALDIVIS

Hi Shane,
I have extracted the information for you. I haven't done it for quite a while so I had to double check with my peers. My original advice regarding storage volumes being extracted at the peak of the peaks is not right. The way we calculate it is at the peak of the 100yr 24hr storm event at a particular location, in this case at your lots. So, the pre development storage at the peak (~2.5hr) of the event for both of your lots is 4.5ML.
Let me know if you require additional calculations.
Regards
Paola

Paola Duarte
A/Senior Engineer
Urban Water Planning| Department of Water
Ph: 6364 7208| PO Box K822, Perth WA 6842
www.water.wa.gov.au

From: Shane McSweeney [mailto:Shane.McSweeney@rpsgroup.com.au]
Sent: Tuesday, 27 October 2015 11:32 AM
To: DUARTE Paola
Cc: Daniel Williams
Subject: RE: Floodplain Management Advice - Lots 986 993 Baldivis Road BALDIVIS

Hi Paola,

I was just wondering if you had any further thoughts or feedback on my previous email from last week.

I have a design meeting with the civil engineers on Thursday and was hoping to get some clarity on this issue before detailed design is commenced.

Regards,

Shane

Shane McSweeney
Managing Scientist/Team Leader
Environment - Land & Infrastructure
RPS Australia Asia Pacific
38 Station Street, Subiaco, WA , Australia, 6008
PO Box 465, Subiaco WA 6904
Dir: +61 8 9288 0884
Tel: +61 8 9211 1111
Fax: +61 8 9211 1122
Email: Shane.McSweeney@rpsgroup.com.au
www: http://rpsgroup.com.au

UDIA Awards Logo

- The Primary at Coolbellup – Residential Development under 250 lots

UDIA 2014 AWARDS FOR EXCELLENCE WINNERS

- Frasers Landing – National Environmental Excellence
- Eliza Ponds – Rising Star Award

UDIA 2013 AWARDS FOR EXCELLENCE WINNERS

- Frasers Landing – Environmental Excellence
- Port Coogee – Urban Water Excellence
- Austin Lakes – National Environmental Excellence

From: Shane McSweeney
Sent: Wednesday, 21 October 2015 12:29 PM
To: 'DUARTE Paola'
Cc: Daniel Williams
Subject: RE: Floodplain Management Advice - Lots 986 993 Baldivis Road BALDIVIS

Hi Paola,

Thanks for your email.

I have a couple of queries and a possible request.

The NE Baldivis Flood Study with was released in August 2015 discusses some of the flood modelling undertaken in the area. RPS understand that the model is a 1D/2D model with the Peel Main Drain, Serpentine Drain and Birega Main Drain modelled in 1D and the rest of the catchment modelled in 2D with a 10m grid size. The 2D grid resolution is not sufficient to pick up the rural drains but the model DTM (2D topo grid) was manually modified to lower individual cell elevations to represent the invert of some the larger rural drains. It is unclear whether the Heritage Park drain (lot 986 and 993) was included in the model in this way (by adjusting the DTM to simulate the drain in the 2D domain). From your email you seem to indicate that this drain was not modelled.

However, Figure 5.6 (screenshot attached) shows the structures included in the model which indicates that the culvert at the southern end of the Lot 993 is included in the model. Is this the case? But it is not clear whether all of the stormwater drains shown in this figure were modelled. Figure 5.1 (screenshot attached) shows the model DTM but it is not detailed enough to tell if the drain in question is included in the modified DTM.

Runoff from lots 986 and 993 is modelled by rain-on-grid in the 2D domain. However it is unclear how the model simulates flows from the site entering the Peel Main Drain. The attached figure 5.6 shows that the hydraulic model boundary intercepts the Lot 986 & 993 drain south of the site. Therefore, it is not known how the model deals with flows discharging from the Heritage Park site via the drain. Does the model just remove these flows at the model boundary?

Paola, you indicated that you could provide a storage volume for the site, but we are not sure what this would present or how it would be determined given the uncertainties on the modelling of the drain and also how the model deals with flow discharging from the site (as the model boundary appears to intercept the drain south of the site). Can you expand on how you would do this and how precise you could be given the unknowns?

Perhaps it would be most appropriate to provide us with the modelled flow rate in the culvert or at southern end discharge of Lot 993. We could then use this as a maximum allowable flow rate from the proposed development site (lots 986 & 993)?

Regards,

Shane

RPS

Shane McSweeney
Managing Scientist/Team Leader
Environment - Land & Infrastructure
RPS Australia Asia Pacific
38 Station Street, Subiaco, WA , Australia, 6008
PO Box 465, Subiaco WA 6904
Dir: +61 8 9288 0884
Tel: +61 8 9211 1111
Fax: +61 8 9211 1122
Email: Shane.McSweeney@rpsgroup.com.au
www: http://rpsgroup.com.au

From: DUARTE Paola [mailto:Paola.DUARTE@water.wa.gov.au]
Sent: Monday, 19 October 2015 4:47 PM
To: Shane McSweeney
Subject: RE: Floodplain Management Advice - Lots 986 996 Baldivis Road BALDIVIS

Hi Shane,
Following up on Damon's email, I have had a look at our model at Lot 993. The model that we developed for the NE Baldivis area is a coarse, catchment scale model and at this particular location (Lot 993) unfortunately we did not explicitly model the drains nor the culvert. The 2D model does not register discharge rates at the boundary of the lot so I'm guessing the discharge through the culvert must be very nominal.
What I could be able to provide you with is a water level (at the outlet) and additionally a storage volume for the whole of your area (i.e. Lot 986 + 993) if you wish. Please let me know if you require this information.
Regards
Paola

Paola Duarte
A/Senior Engineer
Urban Water Planning| Department of Water
Ph: 6364 7208| PO Box K822, Perth WA 6842
www.water.wa.gov.au

From: GRACE Damon
Sent: Monday, 19 October 2015 4:23 PM
To: Shane.McSweeney@rpsgroup.com.au
Cc: DUARTE Paola
Subject: Floodplain Management Advice - Lots 986 996 Baldivis Road BALDIVIS

Hi Shane

The Department of Water in carrying out its role in floodplain management provides advice and recommends guidelines for development on floodplains with the object of minimising flood risk and damage.

The Draft North East Baldivis Flood and Drainage Study shows that the two Lots are likely to be affected by flooding from major flood events with the 1 in 100 (1%) Annual Exceedance Probability (AEP) flood level estimated to be between 3.95 and 3.75 m AHD (see attached plan). The north of Lot 986 has the higher flood levels (3.95 m AHD, draining north to south) and the south of Lot 993 has the lower flood levels (3.75 m AHD, draining north to south and under Serpentine Road via the culvert). The Lots in question have a stormwater drain near the eastern side which drains water from north to south. Based on our floodplain management strategy for the area:

- Proposed development (i.e. filling, building, etc) that is located outside of the floodplain is considered acceptable with respect to major flooding. However, a minimum habitable floor level of 4.25 – 4.45 m AHD is recommended to ensure adequate flood protection (i.e. 500 mm freeboard).

- Proposed development (i.e. filling, building, etc) that is located within the floodplain will be assessed on its merits on a case-by-case basis.

The 1 in 5 (20%) AEP flood is not expected to cross to the western side of the Kwinana Freeway and hence no major flooding is expected within the Lots from the Peel Main Drain.

Please note that a failure to properly adhere to these recommendations will result in a greater exposure to risks of flood damage. This advice is related to major flooding only and other planning issues, such as environmental and ecological considerations, may also need to be addressed. It should be noted that this advice does not take into account local stormwater drainage. Additionally, any increase in stormwater and runoff generated by the proposed development will need to be managed appropriately so as not to increase neighboring flood levels. If these lots are to be developed in tandem, the flood management approach should also be assessed in tandem.

Advice regarding the allowable discharge from the site to the Water Corp drain will come from Paola from the Urban Water Section. Estimates of the required storage for a potential detention basin can also be given if required.

Kind regards,

Damon Grace
Department of Water
Surface Water Engineer (MIEAust CPEng)
+61 8 6364 6608

Damon.Grace@water.wa.gov.au

168 St Georges Tce, Perth WA 6000
PO Box K822, Perth WA 6842
www.water.wa.gov.au

Hi Damon,

A couple of queries for you.

Floodplain Management Advice:

Can you please provide me with the 1 in 100 AEP flood level and extent as well as the 1 in 5 ARP flood level and extent for lots 986 and 993 Baldivis Road, Baldivis (Heritage Park)? See attached figure.

Allowable Discharge to Water Corp Drain Advice:

RPS understands (based on advice from Water Corp) that DoW have now completed a more refined 2D modelling and updated the allowable flow rates and required regional flood storage for the rural drain which runs from north to south across this landholding in Baldivis (see attached figure).

Can you please provide RPS with the maximum allowable flow rate that can be discharged from this site via the existing Water Corp agricultural drain?

James Wegner and Kanex Kanagaratnam from Water Corp have pointed us in your direction for the more up to date data.

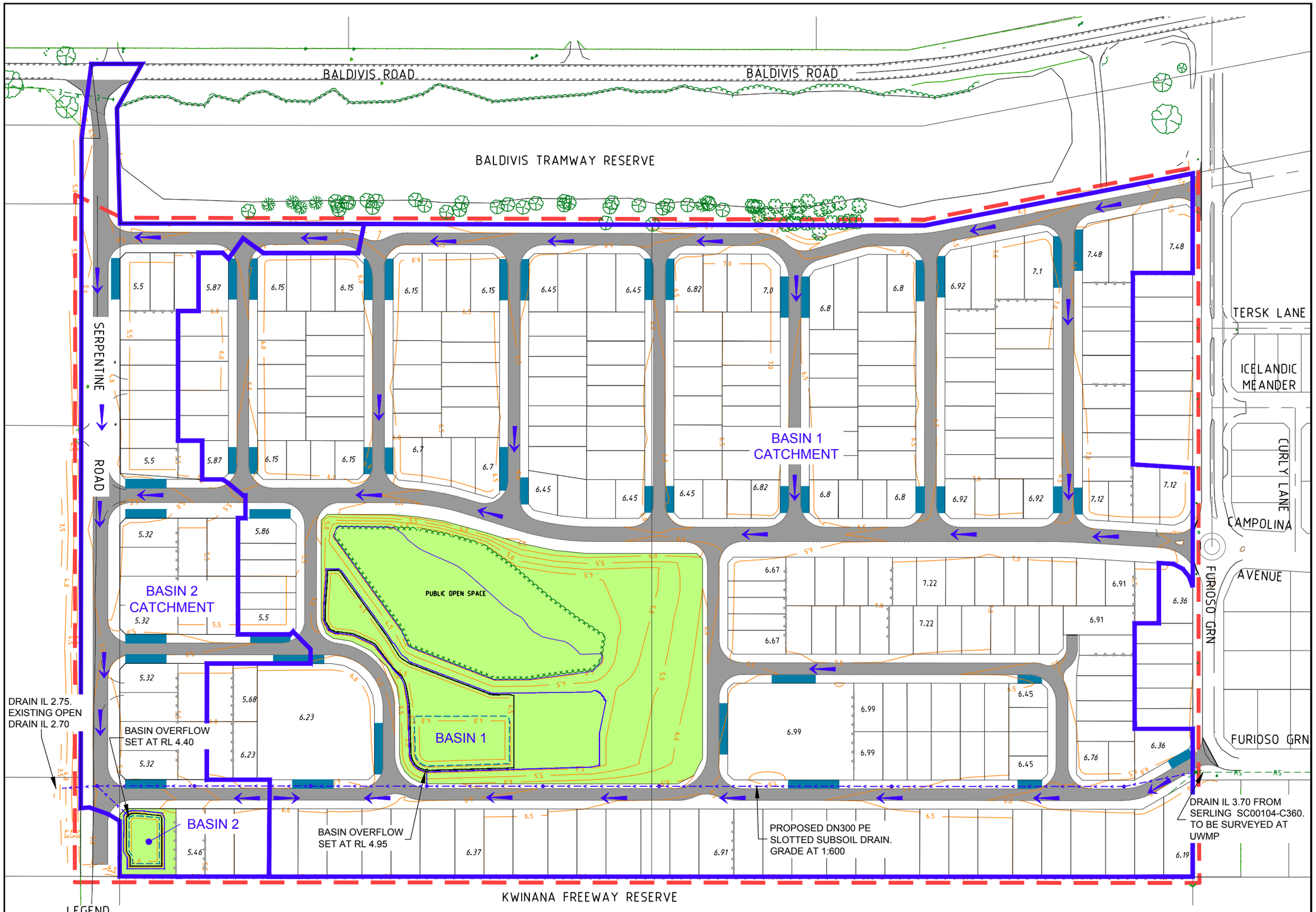
Regards,

Shane

RPS

Shane McSweeney
Managing Scientist/Team Leader
Environment - Land & Infrastructure
RPS Australia Asia Pacific
38 Station Street, Subiaco, WA , Australia, 6008
PO Box 465, Subiaco WA 6904
Dir: +61 8 9288 0884
Tel: +61 8 9211 1111
Fax: +61 8 9211 1122
Email: Shane.McSweeney@rpsgroup.com.au
www: http://rpsgroup.com.au

Disclaimer:
This e-mail is confidential to the addressee and is the view of the writer, not necessarily that of the Department of Water, which accepts no responsibility for the contents. If you are not the addressee, please notify the Department by return e-mail and delete the message from your system; you must not disclose or use the information contained in this email in any way. No warranty is made that this material is free from computer viruses.



LEGEND

- SITE BOUNDARY
- POST DEVELOPMENT CATCHMENT BOUNDARY / PROPOSED FINISHED CONTOURS
- EXISTING TREELINE TO BE RETAINED / PROPOSED PUBLIC OPEN SPACE
- POTENTIAL RAIN GARDEN AREA, TO BE INVESTIGATED AT UWMP
- 6.45 PROPOSED LOT LEVELS

NOTE

FOR SUBSOIL DRAINAGE CONCEPT AND STRATEGY , REFER TO RPS FIGURE 10

BASIN 1 LAND USE

LAND USE	CATCHMENT AREA	PERCENTAGE OF EFFECTIVE IMPERVIOUS AREA	IMPERVIOUS AREA	PERVIOUS AREA
ROAD RESERVE	4.5317	80%	3.625	0.906
LOT > 300m2	9.5856	40%	3.834	5.751
LOT < 300m2	0.7925	80%	0.634	0.158
POS	1.9818	10%	0.1982	1.783

BASIN 2 LAND USE

LAND USE	CATCHMENT AREA	PERCENTAGE OF EFFECTIVE IMPERVIOUS AREA	IMPERVIOUS AREA	PERVIOUS AREA
ROAD RESERVE	1.545	80%	1.1716	0.769
LOT > 300m2	1.183	40%	0.473	0.709
LOT < 300m2	0.025	80%	0.0199	0.0049
POS	0.0998	10%	0.0099	0.089

LOSS MODEL	INITIAL LOSS	CONTINUING LOSS
IMPERVIOUS AREA	1.5mm	NIL
PERVIOUS AREA	15mm	3m PER DAY

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

DIAL1100 BEFORE YOU DIG

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE	
TENDER		
COUNCIL		
WATER CORPORATION		
CONSTRUCTION		

PRE	DATE	AMENDMENT
A	07-04-17	INITIAL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

POST DEVELOPMENT CATCHMENT PLAN

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As
Mortons-Urban Solutions
ABN 39 116 375 065

Perth Office
Unit 4
100 Railway Rd.
Subiaco WA 6008

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

DESIGNED	RCB	DRAWN	SM
APPROVED		DATE	29-03-17

DRAWING NUMBER	AMEND.
28602-LWMS-100	A

FEATURE LEGEND

EXISTING PROPERTY LINE

RETAINING WALL (WITH FOOTINGS)

DESIGN CONTOURS

NATURAL SURFACE BEFORE EARTHWORKS

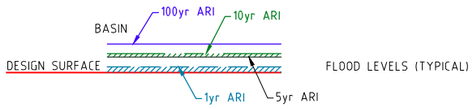
SERVICES LEGEND

PROPOSED STORMWATER

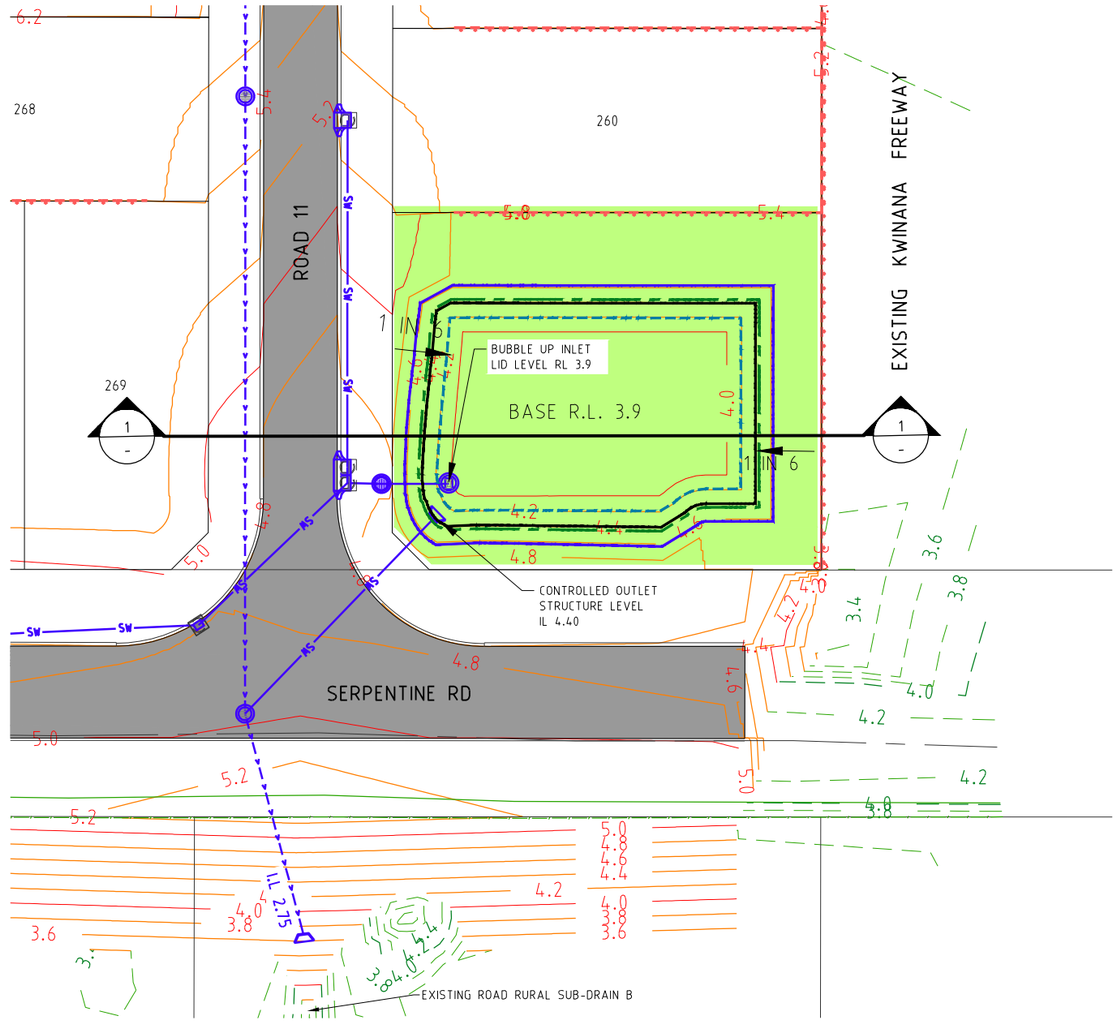
PROPOSED RD RURAL SUB-DRAIN B

NOTE

FOR SUBSOIL DRAINAGE CONCEPT AND STRATEGY , REFER TO RPS FIGURE 10

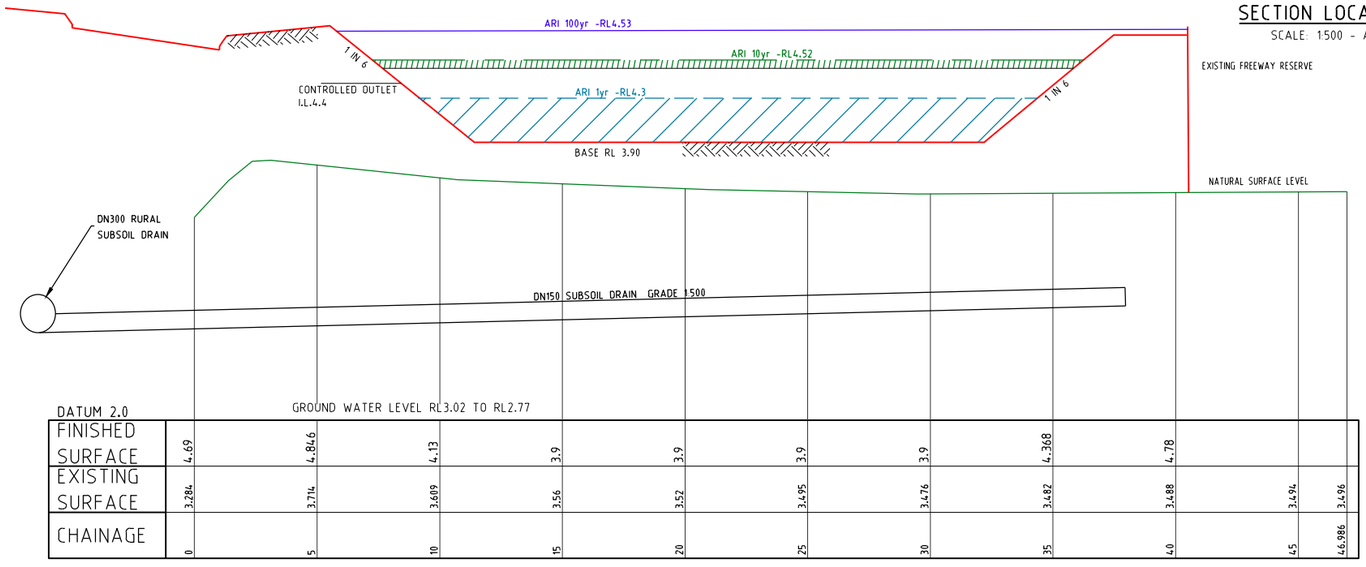


BASIN 2 CATCHMENT							
ARI (yr)	CATCHMENT AREA (ha)	WATER AREA (m2)	WATER VOLUME (m3)	TOP WATER LEVEL (RL)	DEPTH (m)	CRITICAL STORM (minutes)	OUTFLOW (LITRES/SEC)
-	1.21	126	129	4.296	0.396	360	6
5	2.65	546	229	4.505	0.505	360	22
10	2.65	560	236	4.517	0.517	360	23
100	2.65	560	311	4.527	0.627	60	23



SECTION LOCATION PLAN

SCALE: 1:500 - A1 (1:1000 - A3)



DATUM 2.0

FINISHED SURFACE	4.69		4.846	4.13	3.9	3.9	3.9	3.9	4.368	4.78	
EXISTING SURFACE	3.284		3.714	3.609	3.56	3.52	3.495	3.476	3.482	3.488	3.494	3.496
CHAINAGE	0	5		10	15	20	25	30	35	40	45	46.986

LONGITUDINAL SECTION 1

Horizontal scale 1:125

Vertical scale 1:20

0 1.25 1.5 3.75 5 6.25m

Scale 1:125 - A1 (1:250 - A3)

0 0.2 0.4 0.6 0.8 1.0m

Scale 1:20 - A1 (1:40 - A3)

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m

Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	21-04-17
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	21-04-17	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

BASIN 2
PLAN & SECTIONS

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065

Perth Office
Unit 4,
100 Railway Rd,
Subalco WA 6008

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

DESIGNED	RB	DRAWN	BL
APPROVED		DATE	21-04-17

DRAWING NUMBER: 28602-LWMS-101

AMEND.: A

FEATURE LEGEND

EXISTING PROPERTY LINE

RETAINING WALL (WITH FOOTINGS)

DESIGN CONTOURS

NATURAL SURFACE BEFORE EARTHWORKS

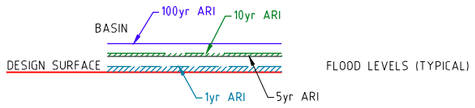
SERVICES LEGEND

PROPOSED STORMWATER

PROPOSED RD RURAL SUB-DRAIN B

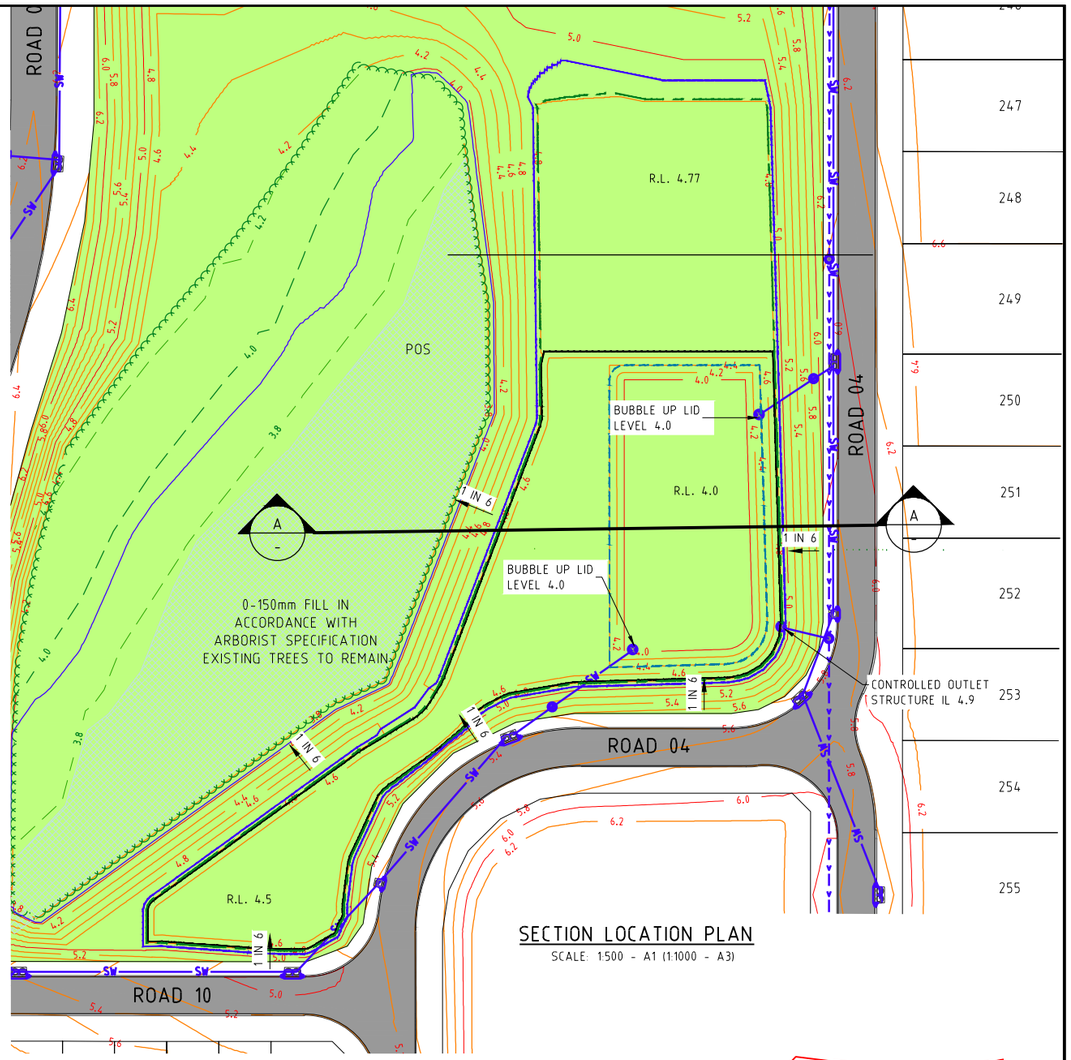
NOTE

FOR SUBSOIL DRAINAGE CONCEPT AND STRATEGY , REFER TO RPS FIGURE 10



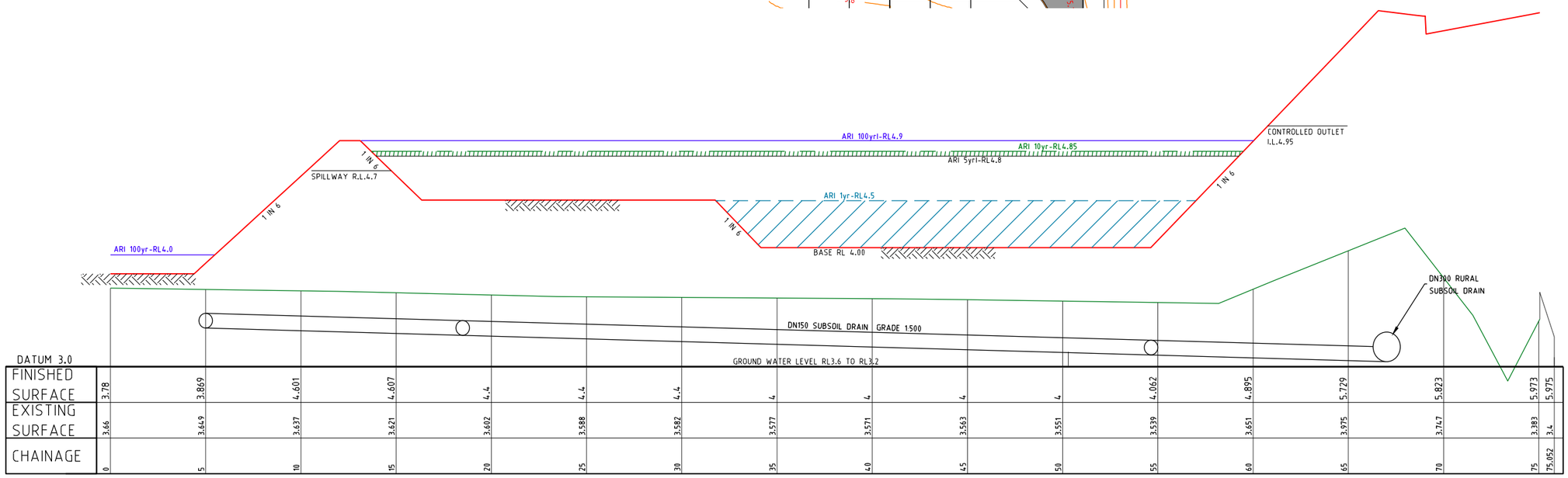
FLOOD LEVELS (TYPICAL)

BASIN 1 CATCHMENT						
ARI (yr)	CATCHMENT AREA (ha)	WATER AREA (m2)	WATER VOLUME (m3)	TOP WATER LEVEL (RL)	DEPTH (m)	CRITICAL STORM (minutes)
1	7.55	2582	693	4.498	0.498	720
5	16.89	3282	1577	4.789	0.789	360
10	16.89	4813	1808	4.838	0.838	360
100	16.89	8705	3041	4.904	0.904	360



SECTION LOCATION PLAN

SCALE: 1:500 - A1 (1:1000 - A3)



LONGITUDINAL SECTION A

Horizontal scale 1:125

Vertical scale 1:20

Scale 1:125 - A1 (1:250 - A3)

Scale 1:20 - A1 (1:40 - A3)

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m

Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	21-04-17
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
B	28-04-17	BASIN DETAIL AMENDED
A	21-04-17	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

BASIN 1
PLAN & SECTIONS

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As
Mortons-Urban Solutions
ABN 39 116 375 065

Perth Office
Unit 4
100 Railway Rd.
Subiaco WA 6008

Email: mortons@urbansolutions.net.au
Website: www.urbansolutions.net.au
Tel 08 9380 9700

DESIGNED	RB	DRAWN	BL
APPROVED		DATE	21-04-17

DRAWING NUMBER: 28602-LWMS-102

AMEND.: B

NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS.
2. THE CONSTRUCTION OF WORKS SHALL BE TO THE APPROVAL OF THE LOCAL AUTHORITY FOR ALL INTERNAL ROADS.
3. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.
4. ALL LEVELS SHALL BE DETERMINED FROM BENCHMARKS ESTABLISHED BY THE PROJECT'S SURVEYOR.
5. DRAINAGE PIPE SHALL BE RC CLASS 2 UNLESS OTHERWISE NOTED.
6. ALL TRENCHING, PIPE BEDDING AND BACKFILLING SHALL BE IN ACCORDANCE WITH AS3725.
7. CENTERLINES OF DRAINAGE MANHOLES SHALL BE ALIGNED 3.0m FROM THE ROAD RESERVE BOUNDARY UNLESS SHOWN OTHERWISE.
8. ALL JUNCTION PITS AND SIDE ENTRY GULLY PITS SHALL BE LOCATED AS SHOWN IRRESPECTIVE OF PIPE LENGTHS SHOWN ON THE DRAWINGS.
9. AT LOW POINTS THE ENTRY PITS SHALL BE LOCATED AT THE LOW POINT OF THE ROAD PAVEMENT.
10. THE JUNCTION PIT AND ENTRY PIT LIDS SHALL BE SET TO SUIT TOP VERGE SLOPE, NOMINALLY 2% UPWARDS FROM THE TOP OF BACK OF KERB.
11. WHERE THE SEWER LINE INTERSECTS WITH STORMWATER DRAINAGE LINE AND THE SEWER PASSES OVER THE DRAIN THEN THE SEWER SHALL HAVE A TIMBER PILE AND KEEL PROVIDED FOR THE FULL EXTENT NECESSARY TO SUPPORT THE SEWER DURING EXCAVATION FOR THE DRAIN.
12. THE CONTRACTOR SHALL LOCATE EXPOSE AND CONFIRM LEVELS OF EXISTING DRAINAGE AT THE CONNECTION POINTS PRIOR TO COMMENCEMENT OF WORKS.
13. THE CONTRACTOR SHALL IMMEDIATELY REPORT ANY DISCREPANCY OR CLASH WITH OTHER SERVICES TO THE SUPERINTENDENT.
14. NO TREES SHALL BE REMOVED WITHOUT THE SUPERINTENDENT'S WRITTEN INSTRUCTIONS. REFER TO SPECIFICATIONS.
15. IRRIGATION DUCTS TO BE DETERMINED ON SITE WITH SUPERINTENDENT.
16. ALL KERBS SHALL BE MOUNTABLE KERBS U.N.O.
17. GROSS POLLUTANT TRAP SHALL BE HUMES OR SIMILAR APPROVED.
18. 225mm AND 100mm DIA uPVC IRRIGATION DUCTS ENSURE ENDS MIN 600mm CLEAR OF ROADWAY AND PATH. DEPTH SHALL BE 600mm BELOW FINISHED ROAD LEVEL.

FEATURE LEGEND

- RETAINING WALL (WITH FOOTINGS)
- PROPERTY LINE
- FACE OF KERB, FOOTPATHS
- LIP AND BACK OF KERB
- CONTROL LINE / CENTER OF ROAD
- EXISTING PROPERTY LINE
- EXISTING KERB
- EXISTING EDGE OF BITUMEN
- SITE BOUNDARY
- LIMIT OF WORKS BOUNDARY
- EXISTING CONTOURS
- DESIGN CONTOURS

SERVICES LEGEND

- SW — PROPOSED STORMWATER
- RM — EXISTING RISING MAIN
- S — EXISTING SEWER
- SW — EXISTING STORMWATER

SYMBOLS

- PROPOSED GULLY PIT
- PROPOSED SIDE ENTRY PIT
- PROPOSED DOUBLE SIDE ENTRY PIT SAG
- PROPOSED MANHOLE
- PROPOSED HEADWALL
- PROPOSED ENDCAP
- 10-001 PROPOSED STORMWATER PIT & LINE NO.
- FLOW DIRECTION
- LOT CONNECTION

- FUTURE GULLY PIT
- FUTURE SIDE ENTRY PIT
- FUTURE DOUBLE SIDE ENTRY PIT SAG
- FUTURE MANHOLE
- FUTURE HEADWALL
- 10-001 FUTURE STORMWATER PIT & LINE NO.

- EXISTING JUNCTION PIT
- EXISTING SIDE ENTRY PIT
- EXISTING COMBINED SIDE ENTRY/GULLY PIT
- EXISTING GULLY PIT
- EXISTING GROSS POLLUTANT TRAP SMARTSTREAM ECO-BITE
- EXISTING BUBBLE UP PIT WITH SCOUR PROTECTION
- EXISTING / FUTURE DRAINAGE INLET PIT
- 10-001 EXISTING STORMWATER PIT & LINE NO.

SHEET LAYOUT

28602-ALL-103 SHEET 03	28602-ALL-106 SHEET 06
28602-ALL-102 SHEET 02	28602-ALL-105 SHEET 05
28602-ALL-101 SHEET 01	28602-ALL-104 SHEET 04

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

WARNING
IF WORKING IN THE VICINITY OF EXISTING OVERHEAD DISTRIBUTION OR TRANSMISSION LINES CONTRACTOR TO COMPLY WITH "WORKSAFE" CLEARANCES DURING CONSTRUCTION

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 20 40 60 80 100m
Scale 1:2000 - A1 (1:4000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE
SITE PLAN
NOTES & LEGEND

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER	AMEND.
28602-ALL-100	A

ADJOINS SHEET 02

ROAD 08

ROAD 09

ROAD 10

ROAD 01

ROAD 08

BALDIVIS RD

BALDIVIS TRAMWAY RESERVE

LIMIT WORKS

MATCH NEATLY TO EXISTING AC

SAWCUT & REMOVE OFF SITE EXISTING KERB

SERPENTINE RD

ADJOINS SHEET 04

LOT 1272

LOT 1

f:\autocad client\286 - rockingham\02 - heritage\Overall\engineering drawings\Current\28602-ALL-100.dwg, PLAN-SHEET 01, 7/04/2016 7:23:15 AM

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE PLAN
SHEET 01

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065

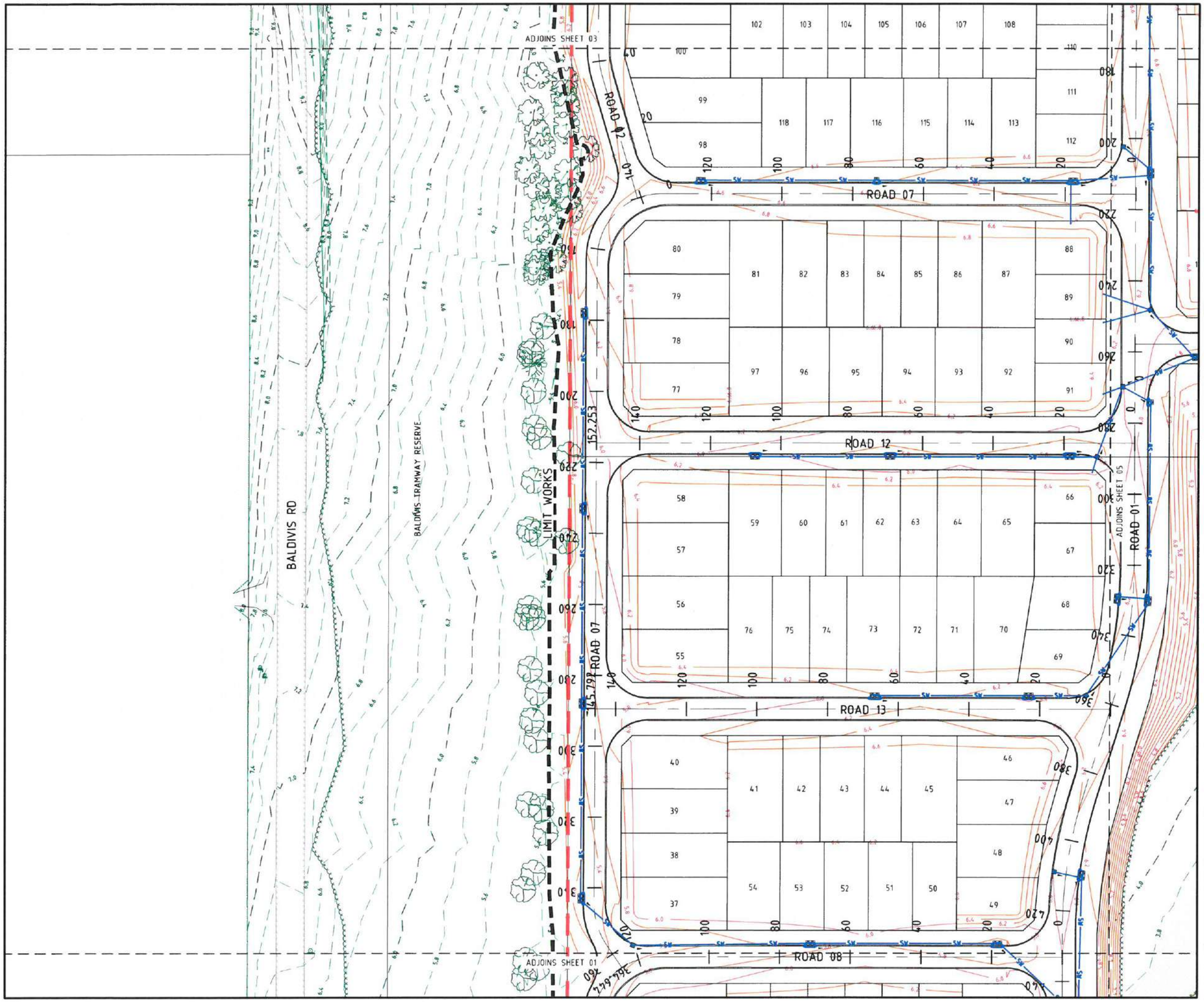
Postal Address
42A Salvado Road
Wembley WA 6014

Email: mortons@urbansolutions.net.au
Website: www.urbansolutions.net.au
Tel 08 9380 9780

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER	AMEND.
28602-ALL-101	A



PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1500 - A1 (1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE
PLAN
SHEET 02

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER 28602-ALL-102

AMEND. A

GIDRAN RD

HERITAGE PARK BR

TERSK LA

EXISTING SUBDIVISION

ICELANDIC MEANDER

CURLY LA

CAMPOLINA AV

MATCH NEATLY TO EXISTING AC & KERB

SAWCUT & REMOVE OFF SITE EXISTING KERB

FURIOSO GRN

LIMIT WORKS

ROAD 02

ROAD 14

ROAD 03

ROAD 01

BALDIVIS RD

BALDIVIS TRAMWAY RESERVE

ADJOINS SHEET 02

ADJOINS SHEET 06

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE PLAN
SHEET 03

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065

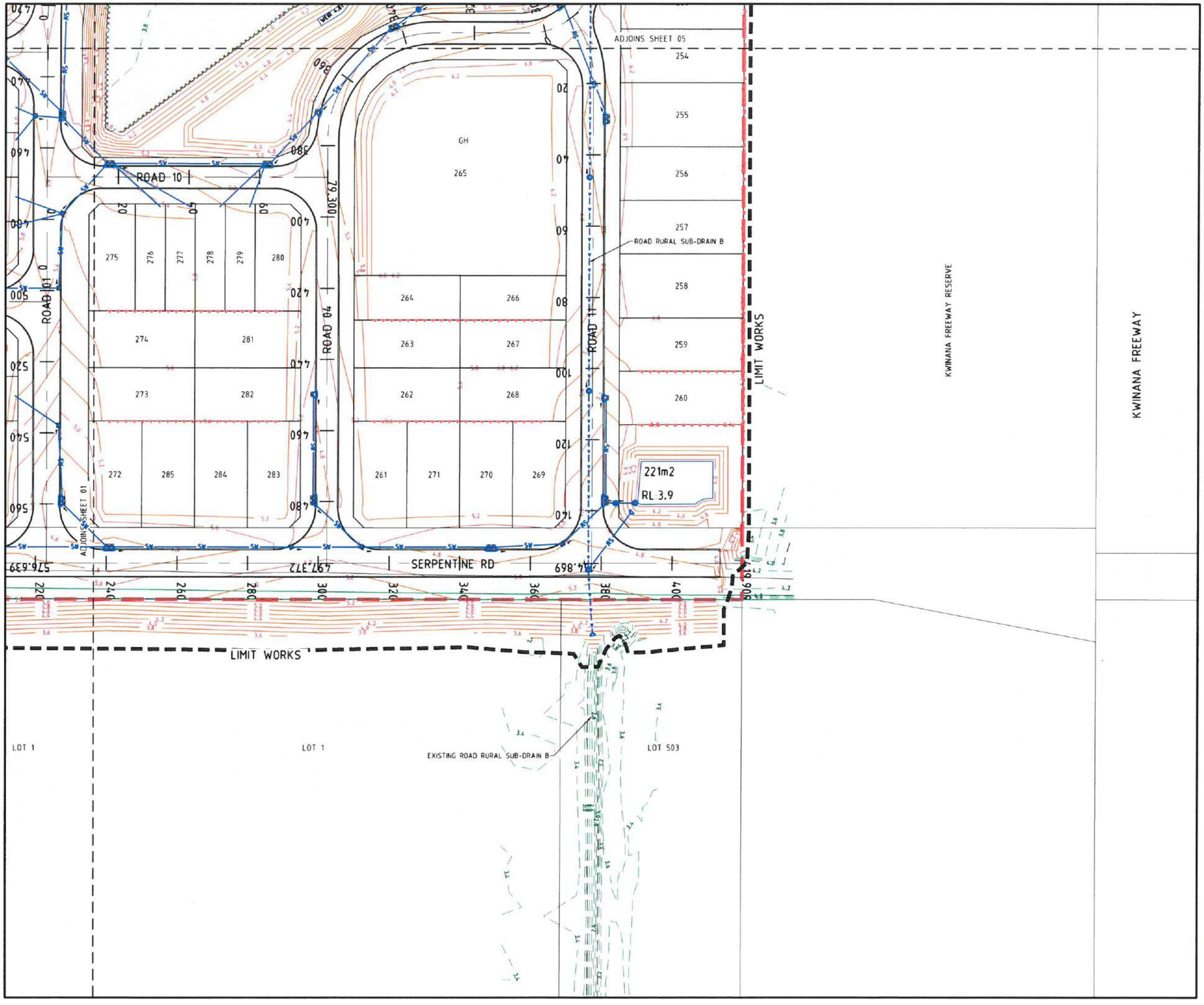
Postal Address
42A Salvado Road
Wembley WA 6014

Email: mortons@urbansolutions.net.au
Website: www.urbansolutions.net.au
Tel: 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER	AMEND.
28602-ALL-103	A



PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE	
TENDER		
COUNCIL	01-04-16	
WATER CORPORATION		
CONSTRUCTION		

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE PLAN
SHEET 04

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As
Mortons-Urban Solutions
ABN 39 116 375 065

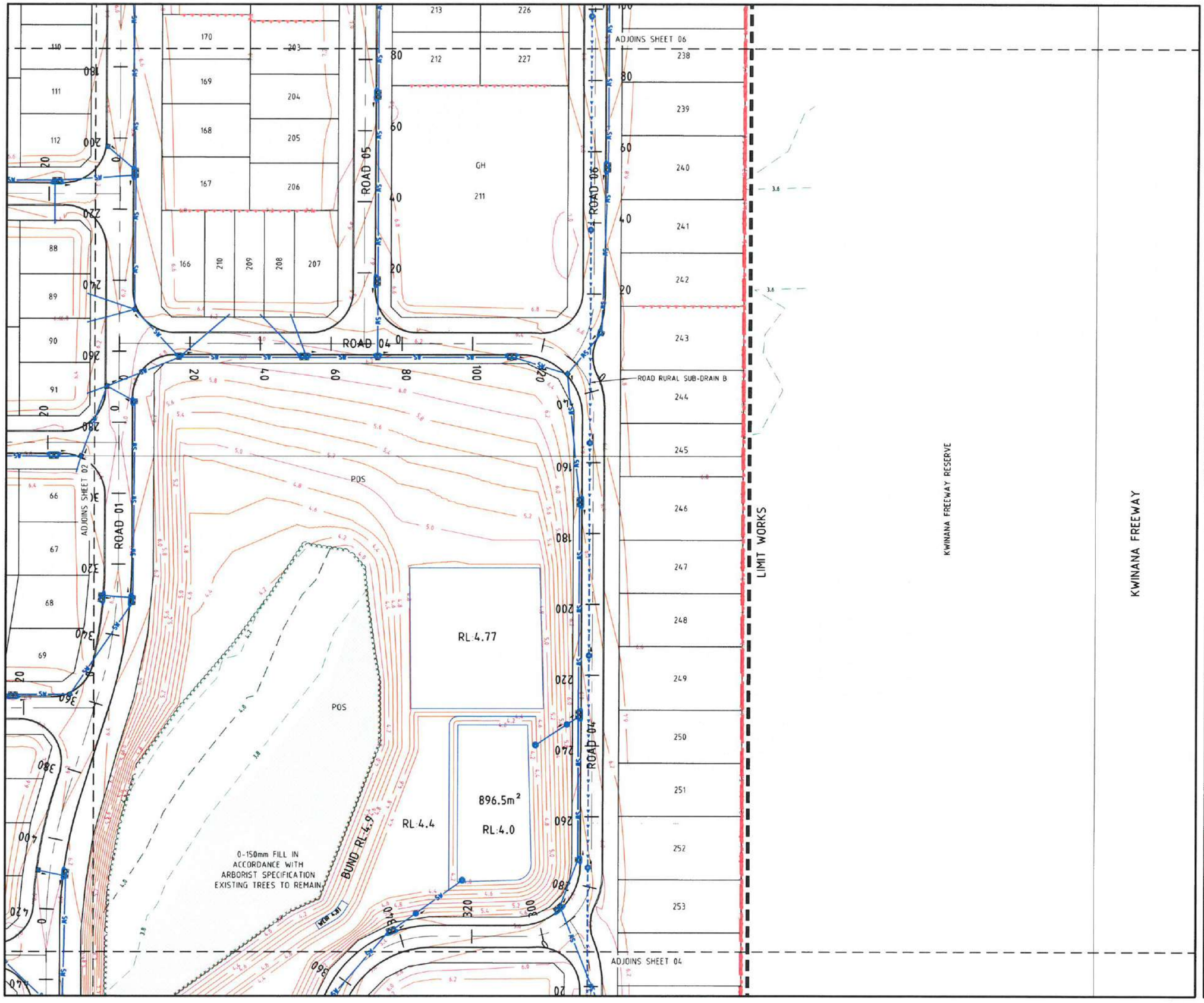
Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER	AMEND.
28602-ALL-104	A



PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE PLAN
SHEET 05

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As
Mortons-Urban Solutions
ABN 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email: mortons@urbansolutions.net.au
Website: www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED RB	DRAWN EP
APPROVED	DATE 07-12-15

DRAWING NUMBER	AMEND.
28602-ALL-105	A

NORIKER LA

CAMPOLINA AV

LY LA

EXISTING SUBDIVISION

FURIOSO GRN

FURIOSO GRN
LIMIT WORKS

SAWCUT & REMOVE OFF SITE EXISTING KERB

MATCH NEATLY TO EXISTING AC & KERB

REMOVE OFF SITE EXISTING BOND BEAMS AND RED BRICK PAVING

RELOCATE EXISTING LIGHT POLE

MATCH NEATLY TO EXISTING AC & KERB

SAWCUT & REMOVE OFF SITE EXISTING KERB

MATCH NEATLY TO EXISTING AC & KERB

BLANK OFF AND DEMOLISH AND REMOVE EXISTING STORMWATER LINE

BREAK INTO EXISTING STORMWATER MANHOLE AND MAKE GOOD CONNECTION

ADJOINS SHEET 03

ADJOINS SHEET 05

ROAD 01

ROAD 05

ROAD 06

ROAD 07

ROAD RURAL SUB-DRAIN B

KWINANA FREEWAY RESERVE

LIMIT WORKS

KWINANA FREEWAY

154 155 156 157 131 132 133 134 109 110 111

180 179 178 177 176 175 174 173 172 171 170 169

182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203

229 230 231 232 233 234 235 236 237

218 219 220 221 217 222 216 223 215 224 214 225 213 226 212 227

25.227

238.107

PROJECT NAME

HERITAGE PARK

PHASE 2
PRELIMINARY ENGINEERING

CLIENT

Rockingham Park Pty Ltd

NORTH

0 5 10 15 20 25m
Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
WATER CORPORATION	
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

WAPC 152391

ASSOCIATED CONSULTANTS

DRAWING TITLE

ROADWORKS AND DRAINAGE
PLAN
SHEET 06

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email: mortons@urbansolutions.net.au
Website: www.urbansolutions.net.au
Tel: 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RB	DRAWN	EP
APPROVED		DATE	07-12-15

DRAWING NUMBER: 28602-ALL-106

AMEND.: A

FEATURE LEGEND

- PROPERTY LINE
- EXISTING PROPERTY LINE
- CONTROL LINE / CENTER OF ROAD
- EXISTING CONTOURS
- SITE BOUNDARY
- LIMIT OF WORKS BOUNDARY
- EDGE OF SEAL
- EXISTING FENCE
- EXISTING TRACK
- EXISTING BANK (BOTTOM)
- EXISTING BANK (TOP)
- EXISTING STORMWATER SWALE
- EXISTING VEGETATION
- EXISTING BOREHOLE
- EXISTING SIGN
- EXISTING TELSTRA PIT
- EXISTING ELECTRICITY POLE
- EXISTING WATER PIT
- EXISTING STORMWATER MANHOLE
- EXISTING STORMWATER HEADWALL
- EXISTING TREE
- EXISTING EDGE OF BUILDING

SERVICES LEGEND

- EXISTING SEWER
- EXISTING WATER
- EXISTING STORMWATER
- EXISTING ELECTRICAL (OVERHEAD)

PROJECT NAME

HERITAGE PARK

PHASE 2
BULK EARTHWORKS

CLIENT

Rockingham Park Pty Ltd

NORTH

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

ASSOCIATED CONSULTANTS

DRAWING TITLE

EXISTING SURFACE
PLAN
SHEET 01

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RCB	DRAWN	BL
APPROVED		DATE	23-11-15

DRAWING NUMBER	AMEND.
28602-BE-020	A

f:\autocad client\286 - rockingham\02 - heritage\Overall\engineering drawings\change of level of land\Current\28602-BE-020.dwg, EXISTING SURFACE PLAN-SHEET 01, 7/04/2016 7:34:10 AM

FEATURE LEGEND

- PROPERTY LINE
- EXISTING PROPERTY LINE
- CONTROL LINE / CENTER OF ROAD
- EXISTING CONTOURS
- SITE BOUNDARY
- LIMIT OF WORKS BOUNDARY
- EDGE OF SEAL
- EXISTING FENCE
- EXISTING TRACK
- EXISTING BANK (BOTTOM)
- EXISTING BANK (TOP)
- EXISTING VEGETATION
- EXISTING BOREHOLE
- EXISTING SIGN
- EXISTING TELSTRA PIT
- EXISTING ELECTRICITY POLE
- EXISTING WATER PIT
- EXISTING STORMWATER MANHOLE
- EXISTING STORMWATER HEADWALL
- EXISTING TREE
- EXISTING EDGE OF BUILDING

SERVICES LEGEND

- EXISTING STORMWATER
- EXISTING WATER
- EXISTING ELECTRICAL (OVERHEAD)

PROJECT NAME

HERITAGE PARK

PHASE 2
BULK EARTHWORKS

CLIENT

Rockingham Park Pty Ltd

NORTH

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
CONSTRUCTION	

A	01-04-16	COUNCIL ISSUE
PRE	DATE	AMENDMENT

ASSOCIATED CONSULTANTS

DRAWING TITLE

EXISTING SURFACE
PLAN
SHEET 02

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065

Postal Address
42A Salvado Road
Wembley WA 6014

Email: mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RCB	DRAWN	BL
APPROVED		DATE	23-11-15

DRAWING NUMBER 28602-BE-021 | AMEND. A

f:\autocad client\286 - rockingham\02 - heritage\Overall\engineering drawings\change of level of land\Current\28602-BE-020.dwg, EXISTING SURFACE PLANSHEET 02, 7/04/2016 7:34:11 AM

NOTES:

1. DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DRAWINGS AND SPECIFICATION.
2. PRIOR TO CUTTING OR FILLING, THE SITE AREAS SHALL BE CLEARED, AND TOPSOIL STOCKPILED AS SPECIFIED.
3. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.
4. SOIL STABILISATION TO BE AS PER THE SPECIFICATION.
5. DUST CONTROL SHALL BE THE RESPONSIBILITY OF THE APPOINTED CONTRACTOR.
6. WHERE LIMESTONE IS ENCOUNTERED THE ROCK IS TO BE OVER EXCAVATED 1.2m AND FILLED TO THE FINISHED SURFACE LEVEL WITH CLEAN SAND.

PROPERTY LINE
EXISTING PROPERTY LINE
CONTROL LINE / CENTER OF ROAD
EXISTING CONTOURS
BULK EARTHWORKS CONTOURS
SITE BOUNDARY
LIMIT OF WORKS BOUNDARY
PROPOSED DUST FENCING
EDGE OF SEAL
EXISTING FENCE
EXISTING TRACK
EXISTING BANK (BOTTOM)
EXISTING BANK (TOP)
EXISTING VEGETATION
EXISTING BOREHOLE
EXISTING SIGN
EXISTING TELSTRA PIT
EXISTING ELECTRICITY POLE
EXISTING WATER PIT
EXISTING STORMWATER MANHOLE
EXISTING STORMWATER HEADWALL
EXISTING TREE
EXISTING EDGE OF BUILDING

SERVICES LEGEND

EXISTING STORMWATER
EXISTING WATER
EXISTING ELECTRICAL (OVERHEAD)

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

WARNING
BEWARE OF UNDERGROUND SERVICES
The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.
DIAL 1100 BEFORE YOU DIG

PROJECT NAME

HERITAGE PARK

PHASE 2
BULK EARTHWORKS

CLIENT

Rockingham Park Pty Ltd

NORTH

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

ASSOCIATED CONSULTANTS

DRAWING TITLE

BULK EARTHWORKS
PLAN
SHEET 01

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As
Mortons-Urban Solutions
ABN 39 116 375 865

Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RCB	DRAWN	BL
APPROVED		DATE	23-11-15

DRAWING NUMBER	AMEND.
28602-BE-030	A

FEATURE LEGEND

- PROPERTY LINE
- EXISTING PROPERTY LINE
- CONTROL LINE / CENTER OF ROAD
- EXISTING CONTOURS
- BULK EARTHWORKS CONTOURS
- SITE BOUNDARY
- LIMIT OF WORKS BOUNDARY
- EDGE OF SEAL
- EXISTING FENCE
- EXISTING TRACK
- EXISTING BANK (BOTTOM)
- EXISTING BANK (TOP)
- EXISTING VEGETATION
- EXISTING BOREHOLE
- EXISTING SIGN
- EXISTING TELSTRA PIT
- EXISTING ELECTRICITY POLE
- EXISTING WATER PIT
- EXISTING STORMWATER MANHOLE
- EXISTING STORMWATER HEADWALL
- EXISTING TREE
- EXISTING EDGE OF BUILDING

SERVICES LEGEND

- EXISTING STORMWATER
- EXISTING WATER
- EXISTING ELECTRICAL (OVERHEAD)

DIAL1100 BEFORE YOU DIG

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

PROJECT NAME

HERITAGE PARK

PHASE 2
BULK EARTHWORKS

CLIENT

Rockingham Park Pty Ltd

NORTH

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	01-04-16
CONSTRUCTION	

PRE	DATE	AMENDMENT
A	01-04-16	COUNCIL ISSUE

ASSOCIATED CONSULTANTS

DRAWING TITLE

BULK EARTHWORKS
PLAN
SHEET 02

MORTONS urbansolutions
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 865

Postal Address
42A Salvado Road
Wembley WA 6014

Email mortons@urbansolutions.net.au
Website www.urbansolutions.net.au
Tel 08 9380 9700

Perth Office
42A Salvado Road
Wembley WA 6014

DESIGNED	RCB	DRAWN	BL
APPROVED		DATE	23-11-15

DRAWING NUMBER 28602-BE-031

AMEND. A

f:\autocad client\286 - rockingham\02 - heritage\Overall\engineering drawings\change of level of land\Current\28602-BE-030.dwg, BULK EARTHWORKS PLAN-SHEET 02, 7/04/2016 7:34:26 AM

MORTONS
urbansolutions

Civil Engineering
Project Coordination
Urban & Regional Planning

mortons@urbansolutions.net.au
www.urbansolutions.net.au

MUS Pty Ltd t/as:
Mortons - Urban Solutions
ABN: 39 116 375 065

Our Reference: 286-02 HP Phase 2

21 April 2017

PO Box 2142
Rockingham DC WA 6967

Attention: Damien Slack

Dear Damien,

Re: Heritage Park Phase 2 – LWMS Hydrologic and Hydraulic Modelling Engineering Summary

Hydrologic and hydraulic modelling has been undertaken to determine the peak flow rates and detention requirements of the proposed drainage system at Heritage Park Phase 2.

Modelling of the system has been undertaken using 12D hydrological and hydraulic modelling tool for an urban catchment, which utilises a variant of ILSAX hydrological modelling, a storage routing model.

This engineering summary report outlines the assumptions made and the results of the hydrologic and hydraulic modelling.

1. IFD:

Using the principals of AR&R 1987, a site-specific IFD table was generated in 12D for modelling of Heritage Park Phase 2 post development. The Rainfall IFD data utilised in our model are presented below:

DURATION	1 year	2 year	5 year	10 year	20 year	50 year	100 year
5Mins	59.5	78.6	104	122	146	183	215
30Mins	24.5	31.8	40	45.7	53.7	65.3	75.1
1Hr	16	20.7	25.6	29	33.8	40.7	46.5
6Hrs	5.04	6.45	7.84	8.76	10.1	12	13.6
12Hrs	3.24	4.14	5.01	5.6	6.46	7.67	8.67
24Hrs	2.1	2.67	3.24	3.62	4.18	4.96	5.61
48Hrs	1.33	1.7	2.07	2.32	2.68	3.19	3.61
72Hrs	0.99	1.27	1.55	1.73	2.01	2.39	2.71

Table 1: Heritage Park Phase 2 IFD

2. RUNOFF:

To convert this region rainfall pattern and the above rainfall intensity into a runoff hydrograph for proposed post development catchments, the following assumptions were made.

The runoff models were determined based on the assumption of 80% effective impervious of Road Reserve areas for all storm events. As for Lot areas, 40% effective impervious was assumed for Lots that are greater than 300m^2, and 80% effective impervious for Lots that are 300m^2 or less due to these smaller cottage Lots having a direct connection to the street stormwater pits and pipes system. A 10% effective impervious was assumed for POS areas, to allow for hard stands and saturated areas during the storm event.

For Lots greater than 300m^2, we recognised that the Lot impervious area could also be up to 80% under the current R-Codes building envelope plus the provisions for outdoor living areas, impervious paving, and the potential for a swimming pool. However, it can be assumed that the impervious area will be connected to soakwells and other pervious areas, hence ultimately providing an overall effective impervious percentage of no more than 40% during the major storm events when overflows from Lot area occur.

A summary of the land-use and the portions of impervious and pervious areas are presented in Table 2 below, and the catchment boundaries are shown on drawing *28602-LWMS-100-Rev A*.

Post Development Land-Use	Catchment Area (ha)	Percentage of Effective Impervious Area	Impervious Area (ha)	Pervious Area (ha)
Road Reserve	5.7468	80%	4.5974	1.1494
Lot > 300m2	10.8664	40%	4.3466	6.5198
Lot < 300m2	0.8175	80%	0.654	0.1635
POS	2.0859	10%	0.2086	1.8773

Table 2: Land-use and assumed percentage of Effective Impervious Area

The following Loss Model was applied to all Effective Impervious Area and Pervious Area, it should be noted that with ILSAX routing method the continuing loss decreases exponentially with time (asymptotic to a constant loss rate). The use of 3m/day continuing loss is based on permeability test results for the sandy fill materials that will be sourced from Parkland Heights. In 2009, geotechnical testing undertaken by SKM found the sandy material at Parkland Heights to have an infiltration rate from 4.3m/day to 5.8m/day. Furthermore, these sandy materials have recently been placed over the Guildford Formation at North Baldivis development and initial infiltration tests carried out over North Baldivis Bulk Earthwork areas have shown an average infiltration rate of 5m/day prior to installation of subsoil drainage. Mortons Urban Solution (MUS) believes 3m/day continuing loss is conservative and suitable for this development with the consideration for clogging over time.

Loss Model	Initial Loss	Continuing Loss
Impervious Area	1.5mm	Nil.
Pervious Area	16mm	3m per day

Table 3: Loss model assumptions

The modelled catchment areas and sub-catchment areas were determined based on a preliminary earthwork design in 12D and preliminary stormwater pits and pipes design as shown on MUS' engineering drawings *28602-BE-060 and 061 Rev A*, and *28602-ALL-101 to*

106 Rev A. Heritage Park Phase 2 consist of 2 major catchment areas, Catchment 1 with a total area of 14.9ha will discharge directly into Basin 1 within the Central POS, and Catchment 2 with a total area of 2.55 ha will discharge to Basin 2 within the Southern POS. Each catchment was broken down to a number sub-catchments based the location of the proposed Side Entry Pits (SEP). This has allowed MUS to check the Hydraulic function of the drainage design in detail, which will be discussed further in Section 3.

It should be noted that the potential rain garden areas as indicated on drawing 28602-LWMS-100 are indicative only and have not been considered in the LWMS calculations and modelling. The incorporation of these rain gardens will be investigated at UWMP Phase with aim to minimize the 1 Year 1 Hour inundation areas within POS.

3. HYDRAULICS:

The existing open drain which runs parallel to the Freeway will be replicated by the construction of a DN300 subsoil drain, with aim to maintain the predevelopment perched groundwater condition and an outlet for the subsoil drainage system of Heritage Park Phase 1 POS 5. During major storm events, overflow from Basin 1 and 2 will also be connected to the DN300 subsoil drain, which will discharge into the existing open drain south of Serpentine Road.

Stormwater will enter the POS detention basins via bubble-up pits, therefore, preliminary stormwater pits and pipes systems were designed and modelled using 12D to ensure that there is adequate separation between the system Hydraulic Grade Line (HGL) and pavement level (300mm separation for critical 1 in 5-year ARI storm event).

Infiltration within the detention basins and overflow areas within the POS will be assisted by subsoil drainage network. Refer to RPS' Figure 10 of the LWMS for the concept subsoil drainage strategy. As loamy sand will be placed under the bio-retention basins, it was assumed that the soil permeability for these basins will be 1.75m/day, half the infiltration rate at Lot level. The volume of infiltration was modelled by using Time-Area method, and the estimated emptying time is presented in Table 4.

Critical ARI Storm Event	Basin 1 Emptying Time (hours)	Basin 2 Emptying Time (hours)
1 Year	7	6
5 Year	11	9
10 Year	12	9
100 year	13	9

Table 4: Basins Emptying Time (Using Time-Area Method)

In accordance with City of Rockingham Planning Policy 3.4.1 – Public Open Space, MUS preliminary design, and modelling have ensured compliance with the following conditions:

- A maximum of 25% site area of any parcel of POS may be covered by any body of water a frequency of inundation of 1 in 10 years.
  23.7% of the central POS will be inundated with water during the critical 10 Year 6-Hour ARI storm event.
- The base of detention basin be a minimum of 0.5m above the post development groundwater level.
  Basins 1 and 2 will have a separation of 0.5m and 0.8m from the maximum groundwater level.
- Flood depth of 1.2m maximum for Storm up to the critical 100-Year event.

We estimate the maximum depth of water within POS 1 & 2 will be 0.9m and 0.65m, respectively.

As discuss in Section 2.7.1 of the LWMS, the 100-Year ARI level could reach up to 3.75m AHD at the south-east corner of the site. Therefore, the controlled outlet for Basin 1 & 2 has been set at 4.95m AHD and 4.4m AHD, respectively, to ensure there is adequate hydraulic head in the overflow system and that it remains functional during the critical 100-Year storm event.

With this preliminary design and model, the maximum discharge rate from the development will be 23 L/s during the critical 100-Year 1-Hour storm event (excluding base flow), under the allowable 88 L/s (4.5L/s/ha). This design will be refined at UWMP phase, with the incorporation of rain gardens in the drainage model, refining of the basin size and controlled outlet structure to increase discharge from site and minimise inundation areas within the POS. The low discharge rate is attributed by the Central POS being able to detain the 100-year storm event onsite, whereby during the major storm events, water would overflow into the existing vegetated area. This vegetated area would provide an additional 3,400 m^2 of storage/infiltration space, reaching a maximum water depth of 200mm during the critical 100-Year storm event. Infiltration within the existing vegetated area would also be assisted by subsoil drainage along the eastern perimeter.

Based on the Time-Area method and the soil permeability rate of 1.75m/day, the maximum infiltration rate (subsoil flow) could reach up to 66 L/s. However, at the subsoil discharge location, the critical time of concentration would be significantly delayed in comparison to the surface runoff.

Refer to sketch 28602-LWMS-101A and 102A for MUS' modelling results.

4. Conclusions

Following the City of Rockingham comments dated 22 February 2017, MUS have updated our assumptions in relation to the Runoff model, which is detailed in Section 2 of this summary report. As requested by the City possible locations for rain garden within verge area have been highlighted on drawing 28602-LWMS-100A, the possibility and design of these rain garden will be investigated at UWMP phase and the resultant bio-retention swale sizes within the POS will be updated.

We recognised that the current Hydraulic design and modelling have not achieved the optimum allowable discharge rate of 88 L/s, however, this represents the worst case scenario yet still achieving all other design criteria and planning policy. Furthermore, when considering the combined subsoil drainage flow and surface runoff flow, then the maximum storm water discharge rate from this development is much closer to the allowable target flow.

Yours faithfully,

Christopher Le
Development Manager - Engineering
Mortons Urban Solutions

RPS

APPENDIX 7

UNDO Report

Government of Western Australia
Department of Water

Project:	Heritage Park LWMS	Date:	20/12/2016
		Version:	Version 1.1.0.16333

Subregion name: Subregion 1

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	61	10.34	242.87	71.15
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	12	2.03	106.62	30.92
Road reserve	27	4.58	76.87	7.69

Total area	Total percent (%)
16.95	90

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
30.39	6.63

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.94	0.32

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	10.34	242.87	71.15
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area	Total percent (%)
10.33767	61

Nitrogen input (kg)	Phosphorus input (kg)
242.87	71.15

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	5	0.10
Non-native gardens	63	1.28
Not fertilised	0	0.00
Nature	30	0.61
Sport	0	0.00
Recreation	2	0.04
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area	Total percent (%)
2.03	12

Nitrogen input (kg)	Phosphorus input (kg)
106.62	30.92

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	70	3.20
Road reserve - impervious	0	0.00
Road reserve - native garden	20	0.92
Road reserve - non-native garden	0	0.00
Road reserve - turf	10	0.46
Road reserve - not fertilised	0	0.00

Total area	Total percent (%)
4.57569	27

Nitrogen input (kg)	Phosphorus input (kg)
76.87	76.87

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Bassendean**	Type of fill imported	**Yellow sand (Spearwood)**
Depth to groundwater (m)	**1.5**	Fill depth (m)	**2**
Groundwater slope (%)	**0.69**	Approximate PRI of imported fill	**11**
Soil PRI	**11.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Subregion 2

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	50	0.94	22.12	6.48
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	4	0.08	3.95	0.94
Road reserve	46	0.87	14.55	1.46

Total area	Total percent (%)
1.88	10

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
26.80	4.86

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
9.05	1.25

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	0.94	22.12	6.48
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area	Total percent (%)
0.9415	50

Nitrogen input (kg)	Phosphorus input (kg)
22.12	6.48

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	50	0.04
Non-native gardens	50	0.04
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area	Total percent (%)
0.08	4

Nitrogen input (kg)	Phosphorus input (kg)
3.95	0.94

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	70	0.61
Road reserve - impervious	0	0.00
Road reserve - native garden	20	0.17
Road reserve - non-native garden	0	0.00
Road reserve - turf	10	0.09
Road reserve - not fertilised	0	0.00

Total area	Total percent (%)
0.86618	46

Nitrogen input (kg)	Phosphorus input (kg)
14.55	14.55

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Pinjarra**	Type of fill imported	**Yellow sand (Spearwood)**
Depth to groundwater (m)	**0.2**	Fill depth (m)	**2.5**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**11**
Soil PRI	**11.0**	**Does subregion contain onsite sewage diposal system?**	**No**

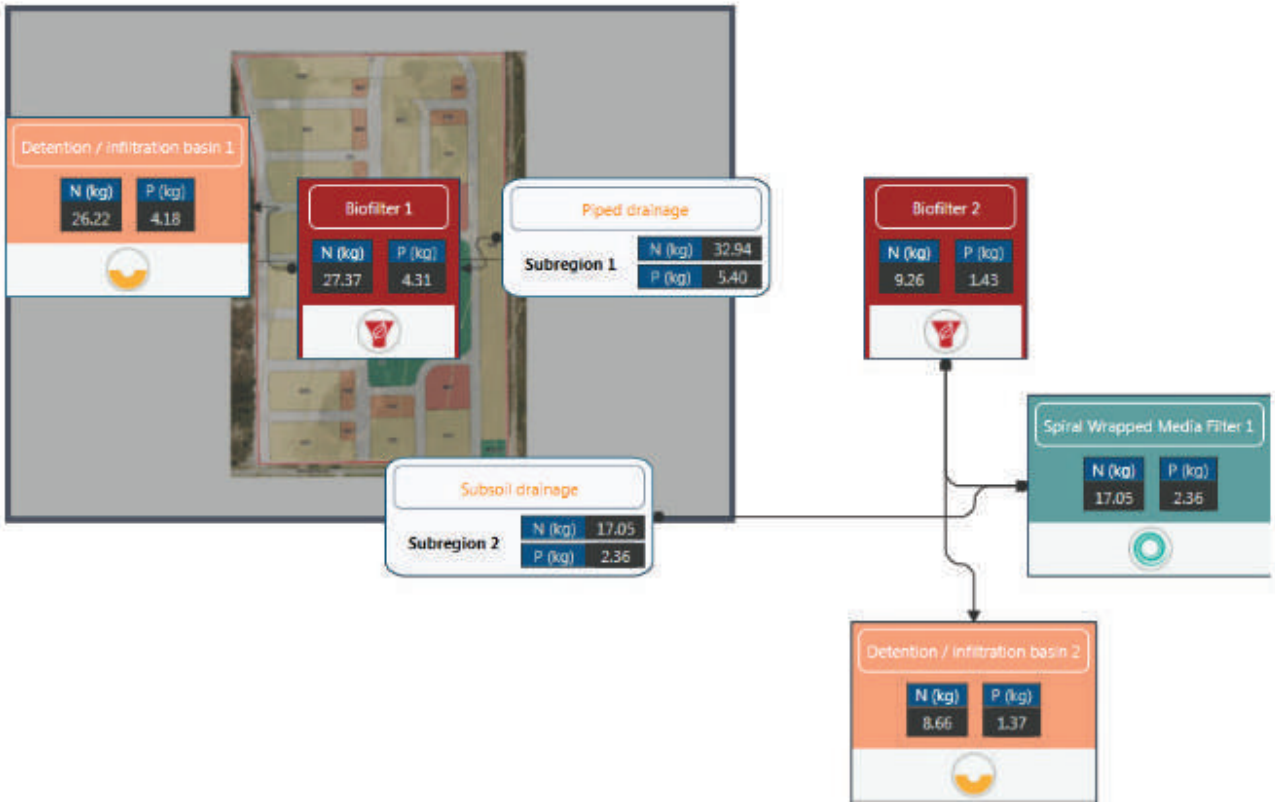
Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices						
Treatment	**Name**	**Size (m²)**	**Treated area (ha)**	**Treating**	**N removed (kg/ha/yr)**	**P removed (kg/ha/yr)**
Biofilter	Biofilter 1	896.30	16.95	Sandy soils – Runoff only (infiltration on lots)	0.33	0.06
Detention / infiltration basin	Detention / infiltration basin 1	9841.00	16.95	Sandy soils – Runoff only (infiltration on lots)	0.07	0.01
Biofilter	Biofilter 2	221.00	1.88	Sandy soils – Runoff and subsoil drains	4.14	0.50
Detention / infiltration basin	Detention / infiltration basin 2	606.00	1.88	Sandy soils – Runoff and subsoil drains	0.31	0.03
Spiral Wrapped Media Filter	Spiral Wrapped Media Filter 1	0.00	1.88		0.00	0.00
Load removed					**0.80**	**0.12**
Net export					**1.85**	**0.29**

Summary: Nutrient load exports			
Region	**Area (ha)**	**P export (kg/ha/yr)**	**N export (kg/ha/yr)**
Subregion 1	16.95	0.32	1.94
Subregion 2	1.88	1.25	9.05

PRE-TREATMENT LOAD (kg/ha/yr)		LOAD REMOVED (kg/ha/yr)		NET LOAD EXPORT (kg/ha/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
2.65	**0.41**	**0.80**	**0.12**	**1.85**	**0.29**

Treatment diagram



APPENDIX 8

LWMS Submission Checklist

Government of Western Australia
Department of Water

Looking after all our water needs

DISTRICT/LOCAL WATER MANAGEMENT STRATEGY DOCUMENT SUBMISSION CHECKLIST

Document title: Local Water Management Strategy, Heritage Park, Phase Two, Baldivis	
Version number: Rev 2	Document ref: D1516601
Development stage: 2	Number of stages: 2
Associated developments (if relevant):	
Structure plan reference: Figure 2	*Include structure plan as an appendix*
Lot/s number & street address:	Lots 986 & 993 Baldivis Road, Baldivis
Suburb: Baldivis	Number of proposed lots:
Local Government Authority: City of Rockingham	

REQUIRED	**CHECK BOX**
1 x Hardcopy	✓ ☐
1 x Electronic copy (CD preferably affixed within CD slip to inside back cover of hard copy)	✓ ☐
Revised document to include cover letter identifying amendments in relation to comments)	**NA**☐
Provide and comply with LWMS Guidelines checklist	✓ ☐
Referred to Local Government Authority	✓ ☐
Referred to Department of Parks and Wildlife (if relevant)	**NA**☐
Other relevant referrals (list)	**NA** ☐

i.e. Swan River Trust, Water Corporation, Dept. Environment & Regulation etc.

Compiled by (Consultancy): RPS	
Contact person: Shane McSweeney	Email: Shane.McSweeney@rpsgroup.com.au
Contact number: 9288 0884	Postal address: PO Box 465, Subiaco WA 6904
Compiled on behalf of (Developer)	Rockingham Parks Pty Ltd
Contact person: Jane Charters	Email: janec@urbansolutions.net.au
Contact number: 9380 9700	Postal address: 42A Salvado Road, Wembley WA 6014