

APPENDIX D

District/Local Water Management Strategy

Lots 11 & 74 Beenyup Road, Banjup

**DISTRICT WATER MANAGEMENT
STRATEGY**

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LOTS 11 & 74 BEENYUP ROAD, BANJUP

DISTRICT AND LOCAL WATER MANAGEMENT STRATEGY

2

16015/01

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EXECUTIVE SUMMARY

Ochre West Consulting Engineers (OWCE) has been commissioned by Aigle Royal Developments (ARD) to prepare a DWMS for the proposed future subdivision of Lots 11 & 74 Beenyup Road, Banjup.

The development will be completed in two stages, each stage will comprise of approximately 110 lots.

The key elements of the DWMS are summarised below.

Key DWMSElements	Design and Compliance to Objectives
Stormwater Management	<p>Structural and Non Structural BMP's will be used to improve water quality by reducing exposure to pollutants, encouraging infiltration and restricting water velocities within the development.</p> <p>Individual lots will have soakwells designed to capture and infiltrate Lot runoff up to 1 in 20 year (5 minute duration) ARI rainfall events.</p> <p>Lot runoff for larger than 1 in 20 up to 1 in 100 ARI rainfall event will be conveyed to the road reserve via overland flow and directed to the POS area.</p> <p>Pipe network will be sized to wholly contain the 1 in 5 year ARI rainfall event.</p> <p>Roads will be designed to convey up to the 1 in 100 year ARI rainfall event to the retention areas.</p> <p>Lot levels will be absolute minimum 0.5m above the 1 in 100 year ARI rainfall event flood level within the basin.</p> <p>Lot levels will be absolute minimum 0.3m above the 1 in 100 year ARI rainfall event flood level within road reserves.</p>
Groundwater Management	<p>Site will be filled to a minimum 2.0m separation to Controlled Groundwater Levels (CGL). Drainage system will utilise generally high site infiltration rates.</p> <p>Depth between the base of soakwells and CGLs is to be a minimum of 1.0m.</p>

Key DWMS Elements	Design and Compliance to Objectives
Water Quality Management	Best Management Practices (BMPs) will be maintained to improve water quality which apply to principals of Water Sensitive Urban Design (WSUD)
Vegetation and POS Management	Native plantings will be used in the POS and infiltration basin to reduce water and fertiliser requirements.
Subdivision Management	Management of subdivision works will ensure potential impacts to surrounding environment and conservation areas are minimised.
Monitoring	<p>Pre-development monitoring has been undertaken; analysis of samples includes physical parameters and nutrients which are provided in Appendix C and discussed in Section 3.</p> <p>Post-development monitoring will continue for not less than 3 years after construction if complete. Monitoring will include groundwater levels and water quality analysis.</p>
Implementation	Roles and responsibilities involved in the implementation of the LWMS & UWMP are identified in Section 8.

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1 INTRODUCTION

Aigle Royal Developments is seeking to develop portions of Lot 11 and Lot 74 Beenyup Road, Banjup for residential subdivision. Development will be pursued in two stages as outlined as follows:

Stage 1

Stage 1 relates to the western most portion of the site. This portion of the site is zoned “Urban Deferred” in the Metropolitan Region Scheme and “Development” in the local scheme.

Stage 2

Stage 2 adjoins the eastern boundary of Stage 1. The area of Stage 2 is currently zoned “Rural – Water Protection” in the Metropolitan Region Scheme and “Resource” in the local scheme.

Refer to **Figure 2** for the current District Context Plan.

Aigle Royal is seeking to amend the MRS to include the land in the “Urban” zone and the “Parks and Recreation” Reserve. Refer to **Figure 3** for proposed MRS rezoning plan.

A District Water Management Strategy (DWMS) provides guidance with regards to water management objectives and requirements for future precinct planning, subdivision and development of land, consistent with *State Planning Policy 2.9: Water Resources* (Government of WA, 2006).

This strategy seeks to address the requirements for water information as outlined in *Better Urban Water Management* (WAPC, 2008) wherever possible and is required to support the proposed rezoning of land to Urban within a region scheme area to demonstrate the land is capable of supporting urban development. The District Water Management Scheme is supporting the whole of site designated Stage 1 and Stage 2.

1.1 LOCATION

Lot 11 and 74 Beenyup Road are located south west of the Gibbs and Beenyup Road intersection bound by a residential development to the west, Woodland Park to the south west and private land holding to the south, approximately 23km south of the Perth CBD as shown in **Figure 1**.

1.2 PREVIOUS STUDIES AND POLICY FRAMEWORKS

This document takes due cognisance of the following documents:

- Better Urban Water Management (WAPC, 2008);
- Decision Process for Stormwater Management in Western Australia (DoW, 2009);
- Geotechnical Report on Lots 252 & 268 Beenyup Rd, Banjup (Bioscience, 2012).
- Liveable Neighbourhoods Edition 4 (WAPC, 2007);
- Planning Bulletin No. 64: Acid Sulphate Soils (WAPC, 2007);
- State Planning Policy 2.9 (WAPC, 2006);
- State Water Strategy (Government of WA, 2003);
- Statement of Planning Policy No. 3: Urban Growth and Settlement (WAPC, 2006); and
- Stormwater Management Manual for Western Australia (DoW, 2007).



1.3 OBJECTIVES

The objectives of this DWMS are based on the requirements of Better Urban Water Management (WAPC, 2008), the Department of Water, and the City of Cockburn.

This report incorporates the integrated water cycle management principles discussed in the BUWM guidelines for a **District Water Management Plan**:

- Considering water resources;
- Integrating water and land use planning;
- Using a whole catchment integration of natural resource use and management; and
- Promoting the sustainable and equitable use of all water sources and having consideration of the needs of all water users including the environment.



2 PROPOSED DEVELOPMENT

The site comprises of two lots Lot 11 (22.71 Ha) and Lot 74 (18.68 Ha) with a total area of approximately 41.39 hectares.

The proposed Metropolitan Region Scheme amendment seeks to rezone portions of the land to “urban” and “parks and recreation” reserve.

The proposed urban area is notated as Stage 1 and 2 as shown on **Figure 4**.

It is envisaged that Stage 1 and 2 will be developed for:

- I. Approximately 210-230 lots;
- II. Public open space, including drainage;
- III. and
- IV. 25m buffer to wetland

Once the land is rezoned a structure plan will be prepared the urban component which provides greater detail on the ultimate development of the site.

A DWMS is required to support the proposed amendment to the Metropolitan Region Scheme..



3 PRE-DEVELOPMENT ENVIRONMENT

3.1 CURRENT AND HISTORICAL LANDUSE

The western portion of the site, zoned “Urban deferred”, contains a single dwelling with surrounding grounds cleared for outbuildings, access & gardens, including grassed areas. The balance of the site contains remnant vegetation in various condition or state of disturbance.

The eastern third of the site has been historically cleared in the early 1980's for a native plant nursery. The clearing took place over the majority of the Resource Enhancement Wetland (REW) is located within Lot 74. The eastern portion of Lot 11 remains disturbed due to the presence of the nursery, with the plantations extending into as much as 50 m of the Conservation Category Wetland (CCW) (**Figure 9**). Clearing along the western portion of the site took place in the early 1990's which included wide tracks and a residence being built. In the early 2000's, extensive disturbance occurred within western portion of land through clearing for tracks.

3.2 TOPOGRAPHY

The western portion of the site and area identified as the *Study Area* is relatively steep with 80% of the *Study Area* with an average gradient of upto approximately 7% from west to east.

A small section of approximately 0.90 Ha grades to the north west of Lot 11 towards Gibbs Road.

The remainder of the site referred to as Rural – Water Protection area can be described a gently sloping and grade to the central CCW location.

Lot 11 has a high point of approximately RL 34m AHD in the north west, sloping to the south east low level of 27m AHD. Lot 74 has a high point level of RL 31m AHD in the north west corner grading east to a low level of RL 26m AHD before rising to 34m AHD at the southern boundary as shown in **Figure 5**.

3.3 GEOTECHNICAL INFORMATION

3.3.1 Soil Geology

Geological mapping indicates the site is comprised of predominately sandy soils of the Bassendean Sand surface geology type as shown in **Figure 6**.

A preliminary geotechnical investigation was undertaken by Bioscience in September 2011, the investigation included the drilling of twelve piezometers, and the laboratory testing of selected samples.

The investigation confirmed site profiles are as described in **Figure 6** consisting of sandy black topsoil overlaying a white/grey/brown, medium, sub-angular sand layer, down to a depth of 9 m below ground level. In some bores a dark brown, non-cemented coffee rock was observed.

The location of the monitoring bores are shown in **Figure 7** and a particle size distribution of the bore logs can be found in **Appendix A**.

The Stormwater Management Manual (DoW, 2007) specifies a permeability rate of 0.35mm/sec or more for Bassendean sands.

The Bioscience investigation included PSD testing on 16 selected samples from different bores and confirmed almost all the samples are in medium sand fraction range. PSD test results can provide a reliable indirect permeability value for the area. Generally medium sand fraction soils have a permeability value of 10⁻⁴ to 10⁻² (m/s). These soils will therefore be suitable for at-source retention of surface water runoff through soakwells, open drains, and infiltration basins provided there is adequate clearance to groundwater. The

Soils with higher infiltration rates tend to have lower Phosphorous Retention Index (PRI), the PRI of Bassendean sands is estimated 0 to 0.5 It is recommended that for areas to be used for drainage infiltration that imported fill with a PRI index greater than 10 be utilised to maximise retention of nutrients.

3.3.2 Acid Sulphate Management

Perth Groundwater Atlas mapping for Acid Sulphate Soils (ASS) classified the area subject to structure planning to be an area of Class 2 - Moderate to low risk of ASS occurring within depths of 3m from the surface, but high to moderate risk of ASS beyond 3m of natural soil surface (see **Figure 10**).

It is not considered that ASS will pose any risks to future development as any potential impacts are manageable through proper investigations and management plans in accordance with Department of Environment Regulation (DER) requirements.

3.4 ENVIRONMENTAL CHARACTERISTICS

360 Environmental have undertaken an Environmental Assessment Report of Lots 11 and 74. The 360 report titled "Lots 11 and 74 Beenyup Road, Banjup Environmental Assessment Report" dated February 2016 and is attached as **Appendix B**.

The summary of the 360 Environmental report is as follows.

3.4.1 Flora and Vegetation

360 Environmental undertook a 2km radial DPaW NatureMap and DotEE Protected Matters Search Tool (PMST). The NatureMap and PMST databased identified 23 conservation significant flora species as potentially occurring in the vicinity of the site. Of these nine are classed as Threatened, one as Priority 1, six as Priority 3 and seven as Priority 4 (360 Environmental 2016).

The likelihood assessment determined that of the 23 Conservation significant species (listed under the EPBC Act and the Wildlife Conservation Act) flora as potentially occurring in the vicinity of the survey area. Of this, there are 10 considered likely or possible to occur on the site (refer to Appendix B Table 10 (360 Environmental 2016)).

Despite some species being considered likely or possible to occur, the Level 2 Flora and Vegetation Survey did not identify any Priority species as listed by DPaW or Threatened Species as listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *Wildlife Conservation Act 1950* (WC Act). In addition, the DPaW database did not identify any conservation significant flora species within the site (360 Environmental 2016).

A vegetation survey completed by Bioscience in 2012 prior to the 360 Environmental study, found the majority of the site consisted of *Banksia*, *Melaleuca*, *Kunzea*, or *Eucalyptus* woodlands. Parts of the site are considered to be 'Completely Degraded' due to human disturbances such as tracks, a residence and a nursery. On account of the presence of Banksia Woodland, Aigle Royal Developments has referred the proposal to the Commonwealth Department of Environment of Energy for assessment of significance.

The remaining area in the site that has been left uncleared remains in 'Good' to 'Excellent' condition

3.4.2 Fauna

A DPaW NatureMap Fauna Search was undertaken by 360 Environmental with a 2 km and 5 km buffer of the site and a DotEE PMST search was undertaken with a 1 km buffer of the site and a likelihood assessment was undertaken (refer to Appendix B (Table 12)).

An assessment found that, potentially, a number of conservation significant fauna species occur within the site. However, this is based on a desktop assessment rather than a site survey. On account of the possible presence of black cockatoos, Aigle Royal Developments has referred the proposal to the Commonwealth Department of Environment of Energy for assessment of significance. Aigle Royal Group is currently negotiating an appropriate offset strategy with the Department. Negotiations are substantially progressed and are expected to be completed shortly.

3.4.3 Surface Water and Wetlands

A CCW exists in the central and eastern portion of the site (refer to **Figure 9**) and a REW exists in the south-eastern portion of the site, adjoining the CCW. A perennial lake subject to inundation all year round exists in the southern central portion of the site. A Wetland Management Plan will be prepared at subdivision stage to provide details of the revegetation and management proposed for the wetland. It is proposed to cede the CCW as a reserve at the subdivision stage for conservation in perpetuity. The management of surface water and groundwater has been addressed in the District and Local Water Management Strategy (D&LWMS) that will accompany the LSP submission. An Urban Water Management Plan that will be prepared at urban subdivision approval stage.

3.4.4 Potential Contamination:

A search of the Department of Environment Regulation (DER) Contaminated Sites Database did not identify any contaminated sites present within the site. The plant nursery in the east of the site is a potential contaminating land use. Prior to development of any special rural lots on the eastern part of the site, the potential for any historical or current contaminating activities associated with the nursery will be considered.

3.4.5 Groundwater

The western part of the site is classified as a 'Priority 3 Area' and the remainder of the site is classified as a 'Priority 2 Area' under the Jandakot Underground Water Pollution Control Area. The site contains shallow groundwater, with water ponding at the surface in the Conservation Category Wetland (CCW) in the southern central part of the site.

3.4.6 Acid Sulfate Soils (ASS)

The central portion of the site is classified as having a high to moderate risk ASS and the western and eastern parts of the site are classified as having a moderate to low risk of ASS. An ASS self-assessment form will be completed for the site once detailed engineering design has been undertaken. This will inform the risk of ASS and whether an investigation will be required.

3.5 SURFACE WATER

There are no known areas of inundation within the *Study Area*. The site topography proposes surface runoff will tend toward the existing wetland east of the *Study Area* but no existing drain or flow paths are observable.

All surface runoff within both lots 11 and 74 is contained within lot boundaries- but for a small section of the north west corner of Lot 11 which naturally grades toward the Gibbs Road/Beenyup Road Intersection. The natural terrain of the remainder of Lot 11 and 74 grades toward the CCW located centrally within the site.

Due to the high infiltration rate of soils in the *Study Area* it is unlikely any surface runoff will occur.

Urban development of the land will require the establishment of an improved drainage system and incorporating water management design principles and structures set out in the Department of Water's Better Urban Water Management (BUWM) guidelines.

The implementation of improvements to the drainage system according to the principles and methods set out in the BUWM guidelines will likely have a benefit to local and regional water quality.

3.6 GROUND WATER

3.6.1 Groundwater Protection Area – Stage 2

Stage 2 is located within a designated "P2" groundwater protection area. Ordinarily, the Department of Water will not support urbanisation of such areas on account of potential risks to groundwater. Nevertheless, in some circumstances consideration can be given to reclassifying areas to P3. The Department's guidelines state:

“In specific instances, some areas that were previously P1 or P2 have been changed to P3 as a result of strategic-level planning assessments undertaken by the Western Australian Planning Commission, and subsequent planning scheme amendments, such as from rural to urban”

Grounds for supporting re-classification are outlined as follows:

The area of stage 2 is relatively small at approximately 5.5 hectares. Re-classification we simply represent a rounding out of existing urban development to the north and west.

Furthermore, the amendment submission prepared by Rowe Group indicates the land is strategically located for urban development. This is largely on account of proximity to the recently completed Aubin Grove train station and the Harvest Lakes Shopping Centre located approximately 900 metres west of the site. The land is also located near schools and public open space systems.

The MRS amendment also seeks to include a significant portion of the land in the Parks and Recreation Reserve thereby providing a long term sustainable management framework for subject land area. The area proposed to be reserved is approximately 21.07 ha and will represent a significant environmental dividend. Any potential impact from additional urbanisation will be substantially offset by the area proposed to be reserved.

3.6.2 Investigation

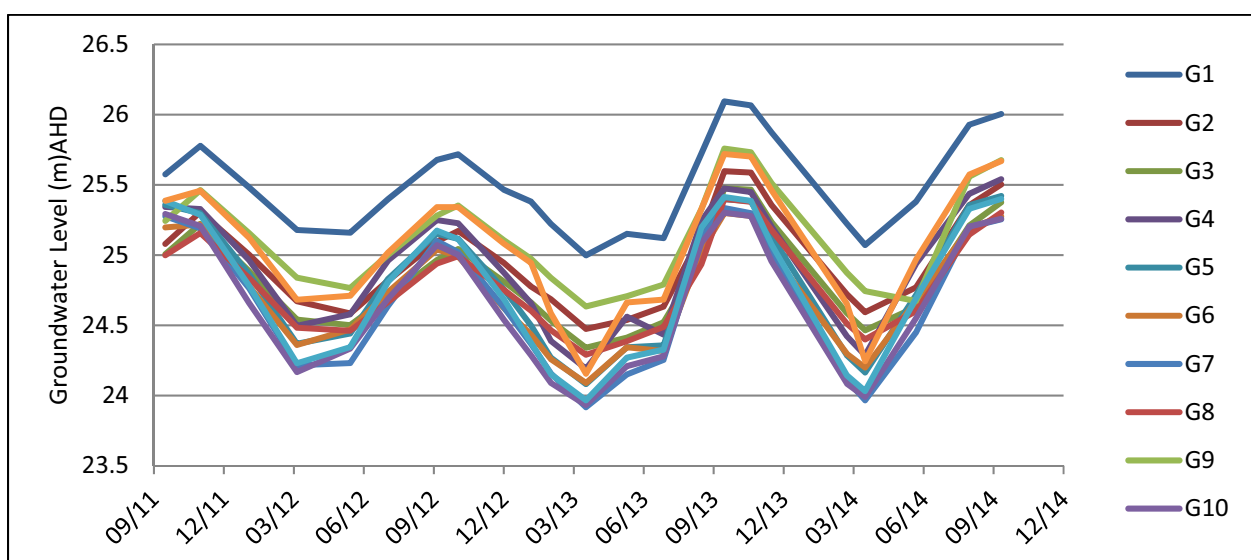
Initial desktop study of Perth Groundwater Atlas, indicates the groundwater levels range from 25.85m AHD at the north west of Lot 11 to 25.2 m AHD on the south west side of the project site near Beenyup road. The groundwater level for the *Study Area* is approximately 25.6m AHD.

12 monitoring bores were installed by Bioscience during the 2011 investigation at the locations shown in **Figure 7**. This data set captured three winter peaks and the bore monitoring results collated are detailed in **Appendix A**.

The *Study Area* is located within the Southern Suburbs District Structure Planning Area detailed within the Russell Road Arterial Drain Scheme, the remaining area of Lot 11 and 74 is outside the area of Controlled Groundwater Levels (CGL)

3.6.3 Groundwater Levels

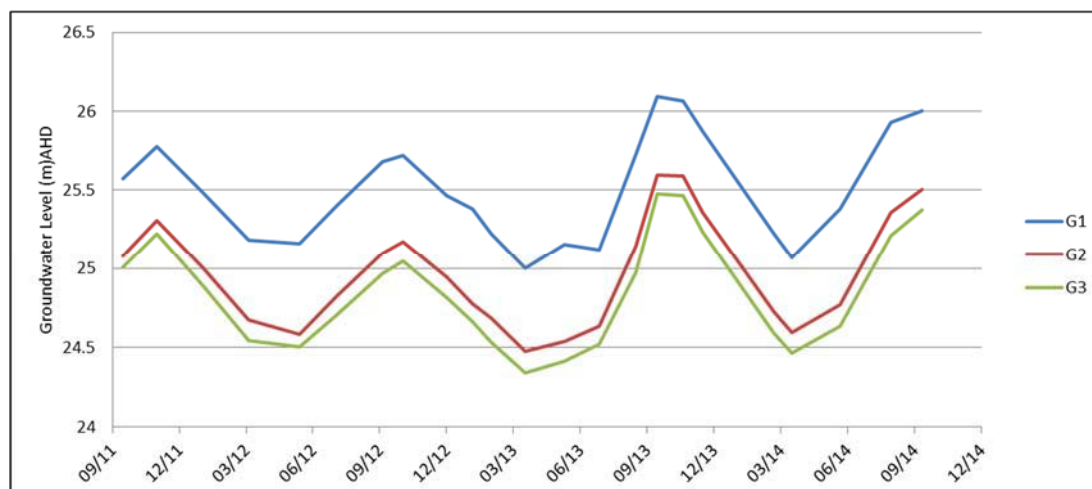
Groundwater levels from the 12 onsite monitoring bores varied from 26.0m AHD to 23.92m AHD. Representation of groundwater data collation is shown in Graph 1



Graph 1: Time Series Groundwater Level Data

There are 3 monitoring bores located within the *Study Area* Bores G1, G2 and G3.

Representation of the monitored groundwater levels for the 3 bores is shown in Graph 2



Graph 2: Time Series Groundwater Level Data Bores G1, G2 and G3

The *Study Area* is within the boundary of the Russell Road Arterial Drain Scheme (DWA, 2003) which has been adopted by the City of Cockburn. The Control Groundwater Levels (CGL) vary between 25.0m AHD and 25.25m AHD as displayed in **Figure 12**.

Groundwater level values taken from the on-site monitoring are comparable to those presented in the Russell Road Arterial Drain Scheme and are considered acceptable in accuracy.

As such, the CGL from the Russell Road Arterial Drain Scheme have been used as the basis of the design for this DWMS/LWMS. It is anticipated that the earthwork levels will also be predominately determined based on satisfying the 100 year flood water level requirement (Section 5.2.4) rather than the groundwater requirements (Section 4.5).

3.6.4 Groundwater Quality

Stage 1 of Lot 11 and 74 as identified in the Jandakot Groundwater Protection Policy, lies within a Priority 3 Underground Water Pollution Control Area, established under the Western Australian Metropolitan Water Supply, Sewerage and Drainage Act 1909.

The objective of Priority 3 Areas is to minimise the risk of pollution to water sources through the application of management controls, rather than by land use restrictions. Residential housing is a compatible land use in Priority 3 areas.

Groundwater quality sampling for physiochemical parameters and nutrient concentrations were conducted on a biannual basis for a period of 4 years (from September 2011 to September 2014) following installation of the monitoring bores (Bioscience 2012).

A total of 12 monitoring bores have been located throughout Lot 11 and 74. Three bores G1, G2 and G3 are located within the *Study Area*, data tabled refer specifically to these monitoring bores specifically. The groundwater quality data is given in **Appendix C**.

Table 1 below provides that results of the pre-development monitored physico-chemical parameters and the results of predevelopment measurement for nutrients as well as the ANZECC water quality guidelines for wetlands as indicative comparison for the, *Study Area*.

Table 1: Pre-development Physical and Nutrient Parameters

Bore Number	G1	G2	G3	Average	ANZECC Guidelines
pH	5.85	4.3	3.7	4.63	7.0-8.5
EC (mS/cm)	0.473	0.444	0.519	0.45	0.3-1.5
Fe (mg/L)	0.069	0.244	0.226	.217	N/A
NH ₄ ⁺ (mg/L)	0.008	0.565	0.0325	0.024	0.04
NO ₂ (mg/L)	<0.01	<0.01	<0.01	0.02	NA
NO _x (mg/L)	1.06	0.017	10.75	0.55	0.1
TN (mg/L)	0.085	0.107	0.026	0.086	1.5
FRP (mg/L)	0.020	0.0115	<0.01	0.015	0.03
TP (mg/L)	0.051	0.052	0.063	0.057	0.06

Analysis of the monitored physical parameters indicates that the groundwater is fresh, acidic with low level of oxygen. This result was expected due to the nature of the soils on site.

Analysis of the monitored water quality parameter indicates that TN is mainly in the organic form. This result was expected due to the extent of native vegetation on both Lot 11 and 74. Comparison of on-site nutrient levels with ANZECC guidelines reveals that nutrient levels are below the ANZECC guidelines within the *Study Area* for bores G1, G2 and G3.

This result was expected as it reflects the anthropogenic elevated nutrient conditions under native vegetation on Bassendean Sands.

4 WATER SUSTAINABILITY INITIATIVES

4.1 WATER CONSERVATION OBJECTIVES

The proposed development will significantly increase the demand for water as there will be an increase in the number of residents. Water conservation management is therefore needed to make sure that use of water is minimised. The objectives for water conservation management are to minimise the net use of water by maximising surface infiltration/recharge in addition to minimising the irrigation water requirements for establishing and maintaining gardens and public open spaces by utilising waterwise principles such as low water requirement plants and species.

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

The State government identified demand reduction for potable water use and consideration include the use of alternative, fit-for-purpose and water supplies in new residential developments. The initiatives include:

- The BCA 5 Star Plus initiative, by Government of Western Australia, requires that new homes will have water efficient hot water systems, showerheads, taps and toilets; stage 2 of the initiative require alternative water supply for flushing toilets and for washing machines where single dwellings are located on larger lots.
- The Water Corporation's waterwise Rebate Program which include swimming pool covers, rain sensors, subsurface irrigation system, grey water re-use, rainwater tanks, and garden bores.
- The DoW has developed a waterwise Communities Toolkit that provides access to information on wise water use, availability of sources for recycling.
- Encouragement of the use of rainwater tanks to supplement scheme water for irrigation.
- The use of low water requirement plants and minimizing turf areas for gardens and POS areas.

4.2 LOT OWNERS

4.2.1 Design Criteria

- The criteria of water efficiency initiatives for households include:
- Consumption target of water of 100kL/per/year including not more than 40-60kL/person/year of scheme water.
- Meeting 5 Star Plus provisions for all new dwellings.
- Use of rainwater tanks to be promoted to achieve water consumption targets.
- Use alternative water resources for irrigation.

4.2.2 Management Measures

All requirements for the purchaser will be outlined in their purchase contract and associated information handouts.

At the development stage, water conservation could be achieved by implementation of the following management measures:

- Encouraging at-source surface recharge where possible using soakwells, vegetated retention basins and swales,
- Retention of native trees within POS where possible to reduce demand for water during POS area establishment.
- Use of non-potable groundwater for irrigation of POS areas.
- Manage irrigation within POS areas to minimise losses to evaporation.

It will be the responsibility of the local Council to ensure that the building licence applicant details how they expect to manage stormwater with the view to conserving water and to maximise the reuse of this water.

4.3 ESTATE PUBLIC OPEN SPACE

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

A Public Open Space Management Plan (POSMP) will be prepared in accordance the Department of Water's (DoW) and City of Cockburn requirements which will address the objectives outlines in Section 4.3.1.

4.3.1 Design Criteria

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

- The maximum depth of water within drainage basins during a 100 year storm is limited to 1.2m.
- Bio Retention areas will be provided on site to ensure for low ARI rainfall events the water will be contained and maximise the useability of the adjacent POS areas.

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

- Minimising irrigation & fertiliser demands via appropriate species selection
- Managing fertiliser application to minimise impacts on water quality.
- Weed Management
- Fauna Protection

4.3.2 Irrigation

For the POS irrigation the overall water use is limited to a maximum of 7500kl per hectare per annum in accord with the Department of Water requirements. Given that the total area to be irrigated over the total development is approximately 0.940 ha requiring an annual bore yield of some 7270kL per annum.

There is an existing bore license in place sufficient to cover the irrigation requirement.

The requirement for construction groundwater is unknown at present and will vary depending on the time of year the works are done, the required staging, the existing cadastral boundaries and if water is sourced from a hydrant or from a bore. This will be resolved at the time of preparation of the UWMP. Water use for construction purposes will be mainly used for dust control and compaction, meaning that the water will be infiltrated and there will be minimal implications on the water balance.

4.4 WATER AND WASTEWATER

Water Corporation has confirmed the development will be able to be connected to existing water reticulation and sewer reticulation mains for Gibbs Road and Prosperity Loop.

4.5 GROUNDWATER MANAGEMENT

The design objectives for groundwater management are:

- Minimise changes to the underlying groundwater levels as a result of development;
- Maintain a 2m separation between lot levels and CGL;
- Minimise the risk of nutrient enrichment of downstream receiving surface water bodies from groundwater sources;
- Implement strategies to reduce the nutrient transport into the groundwater; and
- Protect wetlands that are dependent on the underlying groundwater.

4.6 SURFACE WATER MANAGEMENT

WSUD and BMP's for stormwater and nutrient management will be incorporated into the site's drainage design to ensure there will be no unacceptable impacts on the hydrological regime and water quality in the region.

4.6.1 Stormwater Quantity

The proposed stormwater management design criteria are:

- Retain catchment runoff up to the 1 in 100 year ARI rainfall event within the development site;
- Convey the 1 in 5 year ARI rainfall event within the pipe network;
- Contain flows within individual lots within property soakwells sized for storage and infiltration of the 1 in 20 year (5 minute) ARI rainfall event.
- Ensure that the 1 in 100 year ARI rainfall event can be conveyed and contained within road reserves;
- The floor levels of all habitual buildings are a minimum of 300mm above the 1 in 100 year ARI rainfall event flood level within road reserves;
- The floor levels of all habitable buildings are a minimum of 500mm above the 1 in 100 year ARI rainfall event flood levels within storage areas (basin).

4.7 STORMWATER QUALITY

The design objectives for stormwater quality are:

- Maintain or improve the nutrient concentrations of the groundwater compared to pre-development levels;
- Use of imported fill and/or amended soils with a minimum PRI of 10 within POS and drainage areas;
- Retain the 1 in 1 year – 1 hour duration ARI rainfall event onsite as close to source as practical; and
- Vegetated bio-retention areas to be sized at 2% of the connected impervious area.

5 STORMWATER MANAGEMENT STRATEGY

5.1 DEVELOPMENT STAGING

A stormwater management strategy will be completed when a structure plan is prepared for either Stage 1 and/or Stage 2 and will occur upon completion of rezoning to “Urban” in the Metropolitan Region Scheme. Development of the SMS will be guided by the following objectives:

- Maintaining or improving the surface and groundwater quality within the development relative to predevelopment conditions;
- Maintaining the total water cycle balance within the development relative to the pre- development conditions;
- Maximising the reuse of stormwater;
- Retaining natural drainage systems and protecting ecosystem health;
- Implementing stormwater management systems which are economically viable in the long term;
- Maintain the surface water and groundwater quality and quantity within the development areas to predevelopment conditions;
- Utilising onsite infiltration to groundwater where possible;
- Protect existing wetlands from reductions in underlying groundwater levels;
- Integrate stormwater treatment into the landscape by incorporating swales/basins that enhance the visual and recreational amenity of developments.
- Maintain or improve surface and groundwater quality at or above pre-development levels;
- Manage catchment runoff up to the 1 in 100 year ARI event in the development area;
- Prevent adverse impacts to natural environments that may be sensitive to changes in the natural hydrological cycle (Liveable Neighborhoods);
- Minimise the public risk of injury or loss of life, and protect the built environment from flooding; and
- Ensure best practice stormwater management is delivered through planning and development of high quality developed areas, that are consistent with sustainability and ensuring the long term viability of the stormwater management systems.

5.2 STORMWATER DRAINAGE

Surface water runoff needs to be managed at both lot level and development scale. To manage the stormwater runoff at the post development stage, a preliminary drainage system is proposed to manage minor and major events up to the 1 in 100 ARI event based on maintaining existing hydrology by infiltrating surface water as close to the source as possible.

The principle drainage system of the development will be based on the Better Urban Water Management (BUWM) guideline and also local government subdivision development guidelines as directed by the City of Cockburn, and the DoW.

The principle design allows for all run off at post development stage to be contained within both lots and drainage basins up to 1 in 100 ARI event.

The stormwater management system will include the following design concepts:

Lot Level

- Retain catchment runoff up to the 1 in 100 ARI rainfall event within the development site;
- Convey the 1 in 5 ARI rainfall event within the pipe network;
- Contain flows within individual lots within property soakwells sized for storage and infiltration of the 1 in 20 (5 minute) ARI rainfall event;
- Ensure that the 1 in 100 ARI rainfall event can be conveyed and contained within road reserves;
- The floor levels of all habitual buildings are a minimum of 300mm above the 1 in 100 ARI rainfall event flood level within road reserves;
- The floor levels of all habitual buildings are a minimum of 500mm above the 1 in 100 ARI rainfall event flood levels within storage areas (basin).

Road Reserve

- To ensure the water balance for both pre and post development, where practical, stormwater is to be conveyed to the infiltration basin within the POS of the subdivision boundaries.
- Road Reserve drainage will be via a conventional piped system sized to capture, manage and convey up to the 1 in 5 ARI event wholly within system for road reserve catchment direct to the POS infiltration basin.
- Pits will have drainage weepholes and raised pipe inverts above the base for source infiltration for minor short duration events.
- For events in excess of the 1 in 5 ARI event up to the 1 in 100 ARI event, road reserve runoff in addition to lot runoff for events exceeding the 1 in 20 ARI will be conveyed to the POS via overland flow within the road carriageway.
- Bubble-up pit for inlet of flows into the drainage basin to promote flow and velocity control upon entry to basin.
- Gross Pollutant Trap (GPT) to be installed prior to discharge of street drainage system into Basin within the POS area.

Flood Mitigation & Infiltration Basin

- The Infiltration basin within Public Open Space (POS) is sized to cater for 1 in 5 ARI stormwater event, with outflow of water from basin through infiltration...
- Use of imported fill and/or amended soils with a minimum PRI of 10 within POS and drainage areas;
- Retain the 1 in 1 ARI – 1 hour duration ARI rainfall event onsite as close to source as practical; and
- Vegetated bio-retention areas to be sized at 2% of the connected impervious area.
- Basin area designed to ensure it empties within 72 hours maximum.
- Basin to have 1 in 7 batter slopes to ensure accessibility for maintenance purposes.
- For larger event of 1 in 100 ARI event, water will be allowed to flood the POS with freeboard of 300mm to prevent overflow into residential lots.
- Minimum Lot levels will be 500mm above 1 in 100 ARI flood level in the POS.

5.3 ASSESSMENT OF STORMWATER STRATEGY

A summary of management design is outlined in the sections below.

5.3.1 1 in 1 ARI Event

The future development drainage plan will cater for the minor event runoff without exporting pollutants in surface water from the site. The 1 in 1 ARI will be retained as high in the catchment as practical, this will be achieved by combination of the following:

- Roof and lot runoff from each property will be detained in the property soakwells.
- POS drainage basin is designed to ensure that for a 1 in 1 ARI event, the maximum water depth does not exceed 0.5m.
- Use of amended soils with PRI>10 in basins

5.3.2 1 in 5 ARI Event

A pipe drainage system shall collect runoff from road hardstand areas to discharge to a series of interconnected landscaped infiltration swales with sufficient capacity for storage of the 1 in 5 ARI event. The landscape swales will form a focal asset for the development as well as an important stormwater treatment as detailed in Appendix D Landscape Masterplan.

The stormwater runoff within the area will enter the pipe system through side entry pits; to be conveyed to the POS infiltration basin, via Gross Pollutant Trap (GPT) where required

POS drainage basin has been sized to store a 1 in 5 ARI event and to empty via infiltration within 72 hours.

5.3.3 1 in 20 year ARI Event

Individual lots will contain flows within property soakwells sized for storage and infiltration of the 1 in 20 ARI (5 minute duration) event. Larger events, lot runoff will be directed into the road reserve for conveyance via overland flow in the road carriageway to the POS major flood area.



5.3.4 1 in 100 year ARI Event

For events exceeding the 1 in 5 ARI event from the road reserve catchment and exceeding the 1 in 20 ARI event from lot runoff, stormwater will be conveyed through both the pipe system and overland flow within the road pavement carriageway into the infiltration basin and POS Area

5.4 STORMWATER CALCULATION METHODOLOGY

Assessment of detailed stormwater capacity will be undertaken once structure planning has been completed. It is anticipated that assessment will require computer analysis using XP-SWMM software or similar to model post-development conditions for the 1 year, 5 year and 100 year ARI design events.

The proposed system is likely to be modeled using a conservative infiltration rate of 5 m/day and well below the infiltration rate recommended in the Bioscience site investigation report of between 9 and >200m/day.

5.5 SURFACE WATER QUALITY

To achieve water conservation and efficiency, the project will need to ensure that the use of Best Management Practices (BMP's) will be adapted so as to manage the stormwater at the pre-development conditions, as well as nutrient and sediment management of the stormwater. The primary strategy is utilise devices to maintain and/or improve the water quality for minor 1 in 1 ARI event runoff.

This will be implemented where possible through the use of unconnected property soakwells, however the ability to do so for road reserve runoff is restricted in this case by soil types and steep grades of the natural surface of the site. The implementation of vegetated bioretention basins within POS areas strategically located throughout the development structure plan is proposed to meet the quality objectives and setout by the Stormwater Management Manual of Western Australia regarding bioretention system areas and non-structural measures. The bioretention/detention basin areas are to be vegetated with local native species selected for their ability to take up nutrients. A detailed list of species will be provided in the UWMP phase of the planning process.

Where the presence of limestone is an issue the implementation of soakage pits into the road piped system will aid the infiltration at source for road reserve runoff for minor events.

Implementation of at source measures and any potential constraints will be investigated during the UWMP phase when geotechnical and other details are known such as the presence and clearance to limestone.

5.6 STRUCTURAL BEST MANAGEMENT PRACTICES (BMPS)

The key structural BMP's implemented as part of this development, are summarised in Table 3 below.

Table 2 – Key Structural BMP's

Scale	Ownership & Maintenance	BMP
Lot	Lot Owner	Infiltration System: <ul style="list-style-type: none">• Reduced impervious areas• Soakwells, Water Efficiency Devices
Street	Local Authority	Conveyance System: <ul style="list-style-type: none">• Gravity piped drainage system designed for the 1 in 5 ARI event or and equally designed open trench drainage system. Pollutant Control System: <ul style="list-style-type: none">• Vegetated sedimentation basins and Gross Water Pollutant Traps
Precinct	Local Authority	Infiltration System: <ul style="list-style-type: none">• Vegetated detention basin designed to cater for the 1 in 100 ARI event.

Requirements for the Lot owners will be required to be enforced at the building stage as part of building application.

5.6.1 Separation System

The street drainage system is designed to cater for the 1 in 5 ARI event, within a suitable system. All drainage networks are proposed to be directed to a separation system such as sedimentation basin.

Up to 1 in 5 ARI events will discharge into the piped drainage system which direct the flow into the detention swales/ infiltration control basins or other approved structures. Overland flows higher than 1 in 5 ARI event ARI which will have a higher quality of water will be allowed to bypass the designated pollution control systems flowing directly into the detention basin.

Incorporating a sediment and pollution control component within the system provides additional water quality treatment for water sensitive urban design purposes.

5.7 NON-STRUCTURAL BMP'S

Non-structural BMP's are recommended with the view to provide additional stormwater quality management and can include; public awareness, community education, establishing operation, maintenance activities and management of land use.

The following are considered most relevant to the development:

- Implementation of sediment and erosion control measures at construction phase.
- Ensure all structural BMP's are maintained according to relevant maintenance plans.
- Maintenance shall include regular vegetation trimming and removal to promote growth and nutrient take-up, as well as removal of sedimentation.
- Sweeping to capture pollutants such as litter, organic matter and other sediments so that they are not collected by the drainage system.

6 GROUNDWATER MANAGEMENT STRATEGY

6.1 GROUNDWATER LEVEL MANAGEMENT

The Russel Road Arterial Drainage Scheme (RRDS) (DWA, 2003) proposes to control the rise of groundwater and protect infrastructure by ensuring 3.0 metres clearance to the nominated site CGL. The use of subsoil drains was proposed for areas where separation to the proposed CGL is less than 3m (DWA, 2003).

The RRDS is not seen as being consistent with current WSUD principles that could be applied at Banjup, which will promote retention of stormwater within the catchment, maximisation of groundwater recharge and minimisation of off-site transport of water that will cause a net change to the overall water balance at the site.

On this basis, subsoil drains are not seen keeping with the guidelines set out in the *Stormwater Management Manual for Western Australia* (DoW, 2007) and the *Decision Process for Stormwater Management in WA* (DoW, 2009), it is proposed that the 3 metre clearance to the CGL is too conservative and that a clearance of 2.0 metres is proposed as being more suitable to the Banjup area.

Detention basins shall not intersect groundwater and emptying of the basins within 72 hours is likely.

Infiltration both at source and from the POS/Drainage areas will ensure groundwater levels should be maintained close to predevelopment levels.

6.2 GROUNDWATER QUALITY MEASURES

The lot areas typically have high permeability sand, which allows high amount of soakage from the post development flows, to infiltrate into the ground. Sediment and gross pollution control systems have been included in this design, thus preventing pollutants from entering the aquifers and therefore improving the water quality of the stormwater before infiltration at the detention basin takes place.

6.2.1 Detention Swale Basins

Detention swale basins will also be vegetated with local species to encourage stripping of nutrients before being infiltrated into the ground, thus increasing the water quality before being recharged into the ground.

It is also possible to combine all measurements to control the sediment and gross pollution movements with one arrangement, i.e. a vegetated bio-retention basin.

7 LOCAL AND URBAN WATER MANAGEMENT PLAN

A Local Water Management Plan (LWMP) and Urban Water Management Plans (UWMP) containing a more detailed water management strategy will be required to be submitted as a condition of subdivision;

the areas to be investigated Post-DWMA includes not limited to the following:

- Completion of Geotechnical Investigation
- Design of water management strategy which demonstrate compliance to the satisfaction of the City of Cockburn and Department of Water design criteria and this document.
- Detailed methodology for implementation of water conservation strategies.
- Hydrogeological Investigation to determine depth of groundwater and infiltration capacity of soil;
- Detailed earthworks design and stormwater drainage management design;
- Computer stormwater modelling to determine drainage strategy and flood storage requirements;
- Detailed Monitoring of Surface and Groundwater targets for water quality, flows and levels;
- Landscape design ensuring that the concept promotes the water conservation strategy and stormwater management.
- Completion of Contaminated Site Investigation
- Construction management of subdivisional works to ensure minimum disturbance to environment.
- Maintenance strategy including roles and responsibilities of each stakeholder.
- Implementation of UWMP including roles, responsibilities, funding, and maintenance arrangements.

7.1 GEOTECHNICAL INVESTIGATION

A detailed Geotechnical site investigation should be completed prior to finalisation of the UWMP. The geotechnical investigation will confirm infiltration rates for proposed basin locations and will include investigation for ASS and contamination investigations. However, the investigation is unlikely to impact on the proposed stormwater management strategy.

7.2 ACID SULFATE SOILS OR CONTAMINATION

Perth Groundwater Atlas mapping of ASS indicates the Subject Site Area is Class 2 (Moderate to Low risk of ASS occurring within 3m of natural soil surface).

There are potentially areas where excavation from current natural surface levels to design levels may exceed 3.0m during service installation.

During the final UWMP an assessment of the 100 cum trigger point identified in the Department of Environment Regulation (DER) self-assessment form should be completed and if exceeded a comprehensive ASS management plan can be prepared and approved by the DER prior to commencing construction.

7.3 STORMWATER CONTROL, DUST AND SEDIMENT MANAGEMENT

Prior to commencement of construction works, the contractor shall prepare a dust management plan, as well as implement measures for sediment and stormwater control during construction to ensure minimised effects to the surrounding environment.

Dust control measures will include:

- Wet areas of exposed soils to limit dust levels;
- Limit operations in high winds;
- Cover truck loads transporting fill to site;
- Clearing only to proceed once clearing perimeters have been identified, setout and checked; and
- Stabilisation of disturbed areas through mulching.
- Sediment and stormwater control shall consist of:
 - Designated and clearly identified transport routes within site to minimise disturbance to soils and vegetation;
 - Regular clean out of sediment trapped by fences and drains;
 - Sweep sediment from roadways; and



- Stabilisation of berms/channels and repair where needed in a timely manner.

7.4 MAINTENANCE OF BMP'S

The maintenance of BMPs during construction is required to ensure function is retained during subsequent operations.

The following are procedures required during construction:

- Adherence to geotechnical/engineering specifications to prevent damage during construction, in particular
- compaction;
- Install temporary sediment fences/controls to protect stormwater infrastructure, during construction; and
- Inspection and clean out of sediment and litter from stormwater devices upon completion of construction works, and prior to council handover.

8 MONITORING PROGRAM

Monitoring requirements in this section is in accordance with DoW's Draft "Water monitoring guidelines for better urban water management strategies/plans".

8.1 PRE-DEVELOPMENT MONITORING

Bioscience have set up 3 monitoring bores within the *Study Area* for the pre-development monitoring within the subject land.

The groundwater monitoring data collected to 2012 is detailed in Appendix C.

Further predevelopment groundwater quality monitoring of following parameters is also to be undertaken prior to the next phase of development:

- In-situ pH, electrical conductivity, turbidity, dissolved oxygen, and oxidation reduction potential
- Laboratory
 - Heavy metals: aluminium, arsenic, cadmium, chromium, copper, iron, lead mercury, nickel, zinc
 - Total suspended solids
 - Nutrients: ammonia, nitrate and nitrite, total nitrogen and total phosphorous
 - Total titratable acidity, and total alkalinity
 - Major cations (calcium, magnesium, sodium, and potassium) and anions (chloride and sulphate)
- Potential ASS effects and contaminants to the subsoil drainage system and groundwater conveyance.

The design and requirements of the final UWMP will be updated based on the results of the monitoring programme.

8.2 POST DEVELOPMENT MONITORING

The location of the current groundwater monitoring bores are indicated in **Figure 7**. For post development monitoring, bores located in private land (i.e new lots) pose access and bore management issues. Upon completion of the detailed design and confirmation of development final layout, the location of the monitoring bores with respect to the lots will be assessed and detailed in the UWMP. Should additional bores be required for the post development monitoring, these will be implemented and clarified in the UWMP at the subdivision stage.

The implementation and funding for the post development monitoring programme and reporting are the responsibility of the developer Mainlake Holdings Pty Ltd for a period of 36 months post construction of the subdivision.

A post development monitoring program will be implemented with activities pertaining to the following:

- biannual water quality monitoring for nutrients, total suspended solids and other physical parameters at the outlet of the stormwater treatment swale. This will be opportunistic based on flow.
- Nutrients should be measured on a quarterly basis with some initial first flush monitoring for heavy metals and pesticides. Groundwater levels and field parameters should be measured every two months.

8.2.1 Groundwater Quantity

Groundwater level measurements will continue for 36 months after completion of the development and should be undertaken on a quarterly basis.



Monitoring will continue at the same borehole locations used for predevelopment monitoring to allow for consistent and direct comparison of pre to post development.

8.2.2 Groundwater Quality

Groundwater quality monitoring is to be undertaken within the project site, nutrients are to be measured on a quarterly basis. Groundwater parameters, such as salinity, pH, alkalinity, calcium and sulphate concentrations, will be measured every two months. Monitoring will continue until subdivision is handed over to City of Cockburn.

An annual report will be provided to Department of Water and City of Cockburn.

8.2.3 Surface Water Monitoring

Surface water flows should be monitored at drainage controls (Basin inlets) on a quarterly basis and on the first flush.

The following parameters are to be analysed for:

- In-situ pH, electrical conductivity, turbidity, dissolved oxygen, and oxidation reduction potential
- Laboratory
- Heavy metals: aluminium, arsenic, cadmium, chromium, copper, iron, lead mercury, nickel, zinc
- Total suspended solids
- Nutrients: ammonia, nitrate and nitrite, total nitrogen and total phosphorous
- Total titratable acidity, and total alkalinity
- Major cations (calcium, magnesium, sodium, and potassium) and anions (chloride and sulphate)

8.3 CONTINGENCY RESPONSE

Minimum Trigger values will be identified as part of LWMS and trigger values for each stage of the development will be provided in the UWMP.

If results are greater than 20% above the trigger values for consecutive sampling events, contingency actions will be required.

The contingency actions will be identified within the LWMS and UWMP but are likely to include the following:

- Determination of whether the breach:
 - is genuine, outside natural variability of the parameter and signifies a real decline;
 - may have caused by external events;
 - caused by failure of structural BMP's provided during sub-division works; and
 - Caused an impact on local or downstream receiving environment.
- Contingency measures, in consultation with relevant authority, will address majority of physical deteriorations that may occur, they are as follow:
 - identify the source of water quality deterioration and remove/replace as appropriate;
 - prevent continuing deterioration with temporary controls; and
 - if required, remove/replace/repair existing structural control, provide/construct additional controls or modify controls/procedures to prevent further deterioration in water quality.
- If measures above has been done and breaches still occur, the following are advised:
 - construction/operation management and maintenance plans and practices should be revised and modified if required; and
 - revision of trigger values may be sought with consultation with City of Cockburn, and Department of Water in consideration of all data collected and actions taken.

9 NEXT STAGE- FUTURE PLANNING

This District Water Management Strategy provides guidance on water management in the study area. The objectives and strategies contained in this document should be implemented as part of the preparation of subsequent water management documents including the Local Water Management Strategy and Urban Water Management Plan consistent with the requirements of Better Urban Water Management (WAPC, 2008) (Figure 11).

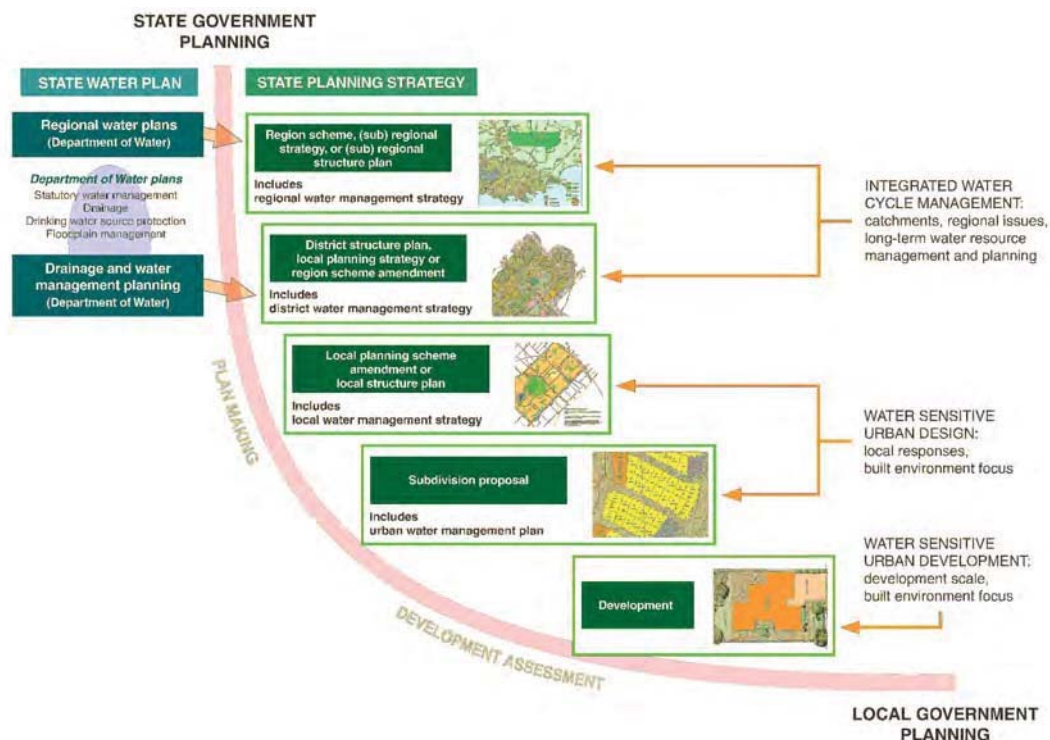


Figure 11: Integrating water planning into the land use planning system (Source: WAPC, 2008)

9.1 LOCAL STRUCTURE PLANNING

Local Structure Planning (LSP) effectively guide subdivision and development of an area. LSPs provide the planning context of the development area including regional and neighbourhood structure, in particular residential areas, open space, school sites, commercial uses and community uses, mixed use, industrial and mixed business uses; and the proposed indicative lot pattern. LSPs also outline constraints and opportunities associated with the site, along with solutions to deliver the identified outcomes.

9.1.1 Local Water Management Strategy

Detailed information relating to water use, wastewater servicing, surface water and groundwater management is to be included in the local structure plan in the form of a LWMS. This DWMS provides information and guidance to be used in the preparation of the future LWMS. The environmental information and monitoring data will be used to select the most appropriate WSUD BMP for local conditions. Each LWMS will need to be prepared in accordance with Better Urban Water Management.

9.1.2 Urban Water Management Plans

Preparation of an Urban Water Management Plan (UWMP) will be required as a condition of subdivision approval following acceptance of this DWMS/LWMS. The UWMP will build on this DWMS/LWMS, providing further details on the concepts outlined herein and clarifying details which have not yet been provided. The main areas that will require further clarification.

The areas to be investigated Post-DWMA includes not limited to the following:

- Completion of Geotechnical Investigation
- Design of water management strategy which demonstrate compliance to the satisfaction of the City of Cockburn and Department of Water design criteria and this document.
- Detailed methodology for implementation of water conservation strategies.
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- Landscape design ensuring that the concept promotes the water conservation strategy and stormwater management.
- Completion of Contaminated Site Investigation
- Construction management of subdivisional works to ensure minimum disturbance to environment.
- Maintenance strategy including roles and responsibilities of each stakeholder.
- Implementation of UWMP including roles, responsibilities, funding, and maintenance arrangements.
- Detailed subdivision development design;
- Construction period management strategy;
- Completion of geotechnical investigation;
- Completion of ASSMP, if required;
- Details and proposed implementation processes of water conservation strategies;
- Non-structural water quality improvement measures to be implemented;
- Clarification of monitoring bore locations for post development monitoring;
- Updated monitoring program including requirements, trigger values and duration; and
- Implementation process including roles, responsibilities, funding, and maintenance arrangements.

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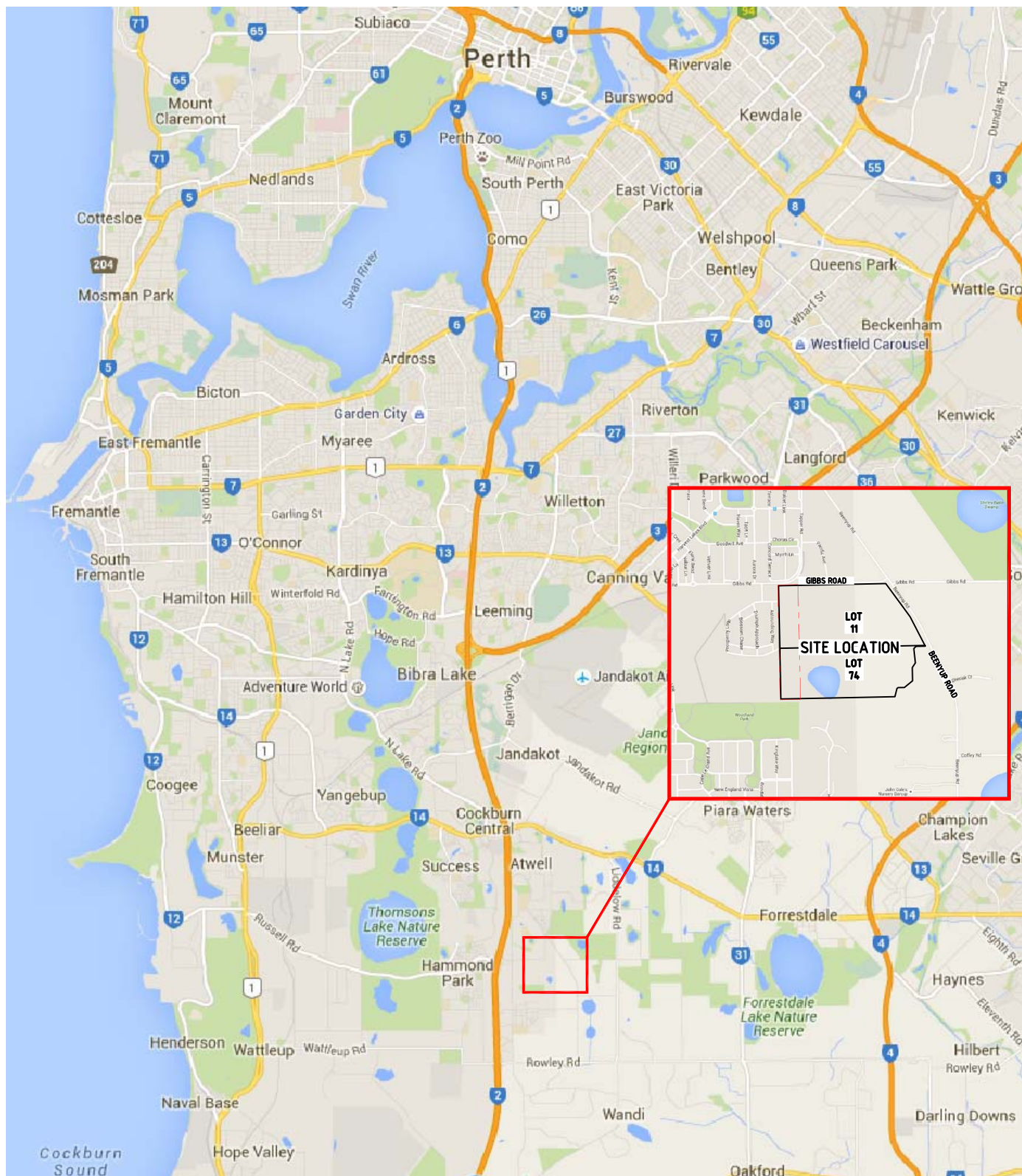
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REFERENCES

- 360 Environmental, 2015, Lots 11 and 74 Beenyup Road Banjup Environmental Assessment Report
- Bioscience, 2012, Geotechnical Report: Lots 252 & 268 Beenyup Road Banjup
- City of Cockburn, 2013, Guidelines and Standards for the Design, Construction and Handover of Subdivision within the Municipality
- City of Cockburn, 2002, Town Planning Scheme No 3
- Cozzard JR, 1983, Perth metropolitan region, Environmental Geology Series, geological Survey of Western Australia. Environmental Geology mapping Fremantle Environmental Geology Mapping (Part Sheets 2033I and 2033 IV)
- David Wills and Associates, 2002, Russell Road Arterial Drainage Scheme
- Department of Water, 2004, Perth Groundwater Atlas, 2nd Edition
- Department of Water, 2007, Stormwater Management Manual for Western Australia
- Department of Water, 2007, Urban Water Management Conditions
- Department of Water, 2008, Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions
- Department of Water, 2009, Decision Process for Stormwater Management in Western Australia
- Department of Water, 2009, Southern River Integrated Land and Water Management Plan
- Government of Western Australia, 2003, State Water Strategy
- Government of Western Australia, 2007, State Water Plan
- Water Corporation, 2003, Domestic Water Use Study - In Perth, Western Australia 1998-2001
- Water and Rivers Commission, 1998, A Manual for Managing Urban Stormwater Quality in Western Australia
- Western Australian Planning Commission (WAPC), 2008, Better Urban Water Management
- Western Australian Planning Commission (WAPC), 2008, Liveable Neighbourhoods: A Western Australian Government Sustainable Cities Initiative
- Western Australian Planning Commission (WAPC), 2008, Planning Bulletin 64: Acid Sulphate Soils





PROJECT **DWMS LOTS 11 & 74 BEENYUP ROAD, BANJUP.**

FIGURE **FIGURE 1**

TITLE **LOCALITY PLAN**

CLIENT **AIGLE ROYAL DISCRETIONARY TRUST**



NOT TO SCALE

DRAWING No 16015-FG-01	REV B	ORIGINAL A3	DATE 11/5/2018
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