

APPENDIX 7

LOCAL WATER MANAGEMENT STRATEGY

REPORT

**TERRANOVIS PTY LTD
LOTS 5, 6, 7 AND 8 KEROSENE LANE,
BALDIVIS**

LOCAL WATER MANAGEMENT STRATEGY

DECEMBER 2016



DEVELOPMENT
ENGINEERING
CONSULTANTS

Revision History:

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LOTS 5, 6, 7 AND 8 KEROSENE LANE, BALDIVIS

LOCAL WATER MANAGEMENT STRATEGY (LWMS)

Executive Summary

Estate Scale

- Swales will be constructed in discrete areas of POS to cater for the major and minor storms. Swale areas will be designed to ensure all events up to the major storm is infiltrated on site.
- Bio retention areas sized to 2% of the connected impervious area will be installed to permit a maximum depth of storage of 0.5m. Beyond this, the stormwater up to the 10 year storm will be retained within a lower tier basin which incorporates underground storage to minimise the drainage impact on POS areas.
- The 100 year storm will be contained within POS areas additional to the lower tier and below ground storage.
- Given the depth of the groundwater beneath the site, no future groundwater monitoring is proposed, although monitoring will be carried out as part of the UWMP to ascertain the quality of groundwater for irrigation purposes.
- Information Packages will be provided to all lot purchasers to: (a) Fully inform lot owners of the requirement to install the equivalent of two by 1500mm diameter by 1200 deep soakwells prior to an outflow connection to the drainage system; (b) To encourage the use of rainwater tanks; (c) To utilise water efficient devices & appliances throughout their homes; and (d) To maximise the use Water & Nutrient-wise plants, and minimise the use of lawns.

Access Street Scale

- All piped drainage systems will be designed to accommodate the 1 in 5 year ARI event.
- Where possible piped drainage will be excluded in preference of swale drains and overland flow.

Allotment Scale

- All lot owners will be encouraged to install rainwater tanks plumbed into their homes for household use in order to assist to contain the 1 year - 1 hour ARI event on-site in lieu of soakwells.
- All lots are required to install the equivalent of 2 by 1500mm by 1200mm deep soakwells which will hold a 1 in 5 year storm without outflow.

Public Open Space Areas

- All swale basins constructed within a POS area will be designed to infiltrate all storms up to and including the 100 year ARI.

1 Introduction

This LWMS report has been prepared as a stand-alone document to support the Local Structure Plan for Lots 5-8 Kerosene Lane, Baldivis and will be used to guide the design and construction of the proposed drainage solutions for subdivision within the area.

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

The site is located on the southern side of Kerosene Lane some 250m west of the intersection between Kerosene Lane and Mandurah Road.

1.1 Drainage / Water Management Principles and Design Objectives

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

- *Water Conservation & Water Efficiency*

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

Deliverable: All lot purchasers will be encouraged to install rain water tanks plumbed into their home; to use water efficient devices & appliances throughout their homes and to plant “Water-wise” & “Nutrient-wise” gardens.

Deliverable: All water will be infiltrated on site, mimicking the pre-development conditions.

- *Water Quantity Management and Protection of Property*

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

Deliverable: To ensure that post-development discharge is retained on site.

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

Deliverable: All allotments to be a minimum of 0.3m above the 1 in 100 year flood level.

Deliverable: Retention basins to be provided to ensure that 1 in 100 year storm is disposed on site via infiltration.

- *Water Quality Management*

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

Deliverable: Ensure that surface water is routed to swale basins and retained on site.

1.2 Planning Background

The subject land is currently zoned “Urban deferred” and is proposed to be amended to “Urban” under the Local Town Planning Scheme.

The proposed structure plan is detailed in Appendix A.

2 Proposed Development

2.1 Key Elements of the Local Structure Plan (LSP)

The site is located within the suburb of Baldvis within the City of Rockingham and covers an area of approximately 8.1ha of undeveloped land. The site is located south of Kerosene lane approximately 250m west where it intersects with Mandurah Road and west of the existing Spud Shed and “Paradiso” Development.

The development proposal consists of approximately 135 single residential allotments averaging around 350 square metres in area.

A large easement traverses the land holding to the east of the site within the “Paradiso” land. This easement contains the APA Dongara Gas pipeline and provision for a future pipeline for Alcoa. Although the easement is actually in the neighbouring land, the affected area is approximately 64m wide, which affects the eastern portion of this development and is proposed to be incorporated within POS.

2.2 Previous Land Use

The land is currently undeveloped and is generally uncleared, with existing Lots 5 and 7 having existing houses and sheds.

2.3 Finished Lot Levels

Finished Lot levels will be set using on the basis that they are a minimum of 0.5m above 100 year TWL of Drainage basins and that they are set such that major storm will flood into POS in lieu of flooding the lots.

Further criterion is that Lots are to be at least 1.2m above AAMGL, although the existing groundwater is well below surface levels.

3 Design Criteria

The drainage requirements for developments within this area are controlled by the requirements of the City of Rockingham, which are outlined below.

Item	Description	Requirement	Source / Comment
1	Water Quality	1 in 1 years 1 hour storm to be Retained on site	DoW requirements
2	ARI for pipe design	1 in 5 years	Standard Council requirement
3	ARI for compensating basin design	1 in 100 years without outflow from site	Standard Council requirement – No predevelopment flows currently exit the site.
4	Min. lot freeboard	0.5m above basin 1 in 100 year flood level 0.3m above 100 Year HGL in Road System	Standard Council requirement developments
5	Basin Criteria Side slopes – In POS	Max. 1 in 6	Standard Council requirement

Item	Description	Requirement	Source / Comment
6	Run-off coefficients	Road reserves $C_{100} - 0.72$ for Urban Residential Allotments $C_{100} - 0.15$ $C_{10} - 0.06$ 0. – Developed Rural Areas/POS	Per Council requirements – Based on 80% paved area in road reserve with Run –off Coefficient of 0.9. Lots as per Calculation in Appendix C.

4 Pre-development Environment

4.1 Topography and Landform

The site moderately rises from RL8.0mAHD on the south eastern side of the site to the north western corner of the site at RL22.0mAHD on Kerosene Lane as shown in Drawing L-03 in Appendix B. The average grade of the land is around 2%.

4.2 Soil Characteristics

The Perth Environmental Geology Mapping (Gozzard JR 1983 Rockingham Part Sheets 2033 II and 2133 III) ¹ indicates that part of the site area consists of two major soil types as outlined below:

- The majority of the area is “LS1”; being limestone, pale yellowish brown of eolian origin consisting of Tamala Limestone and Safety Bay sand.
- South Eastern Portion of Site - “S₇”, defined as sand derived from Tamala Limestone of residual origin. It is noted to be a good groundwater recharge area and the soils are recognized as having some ability to attenuate pollutants due to small clay content.

The various areas of the site as classified in the Environmental Geology Mapping have been superimposed on Drawing L-03 in Appendix B.

In essence the site is suitable for urbanisation, consisting of well graded sands of high permeability meaning that soakage will be effective on the site

The Western Australian Planning Commission Planning Bulletin 64 identifies the whole of the subject site as having Low to no risk of AASS and PASS occurring generally at depths of >3m no known risk of acid sulphate soils occurring.

4.3 Geotechnical

Given the homogeneous sand on the site and excavations in the peripheral areas to the site being consistent with the environmental mapping, no geotechnical investigations have been undertaken on the site to date.

It is proposed that further investigations will be undertaken as part of the Urban Water Management Plan for the area to confirm the soil profile of the area.

Development that has been carried out in adjacent land holdings has confirmed the soil profile in the area.

4.4 Groundwater Aspects

Groundwater flow directions are well documented from regional mapping data.

According to the 2004 Groundwater Atlas², which generally designates Average Annual Maximum Groundwater Levels (AAMGL) as measured from the relevant bores, the groundwater levels grade down from east to west from RL1.5 mAHD at the eastern boundary of the site to RL1.2 mAHD on the western side of the site. The measured levels on the adjoining Paradiso Development indicated that on average, the AAMGL was some 0.4m above the 2004 groundwater levels meaning that the AAMGL is likely to grade from say RL1.9m AHD on the eastern side of the site to RL1.6m AHD on the western side of the site.

The 1997 Groundwater Atlas³ indicates that the groundwater levels grade from say RL3.7m AHD on the eastern side of the site to RL3.2 mAHD on the western side of the site, although these would be representative of maximum likely groundwater levels (MGL) rather than AAMGL.

The lowest level of the site is located on the north western corner of the site and is at around RL8.0mAHD and is proposed to be filled to RL9.5mAHD to facilitate sewerage, meaning that at its shallowest; the maximum groundwater level would be at least 6.0m below the existing site levels. The 2004 Groundwater Atlas² levels are plotted in L-03 and L-04 in Appendix B.

Clearly, the groundwater levels are significantly lower than existing or proposed development levels and will have no effect on the development as such and therefore no further investigation is required for the purposes of drainage disposal and water management.

4.5 Surface Water Aspects

4.5.1 General

As shown in Appendix B, the current site is divided into three major catchments being west, central and eastern catchments, which have been split to facilitate the distribution of the drainage within the available areas of POS. The soil is very permeable and in the rare event that runoff occurs, each catchments will drain to suitable low areas and infiltrate.

4.5.2 Predevelopment Ground Water Monitoring

Given the significant depth between the site surface levels and the existing groundwater levels in addition to the low risk predevelopment land use, no predevelopment monitoring has been undertaken on the site or is required for the purposes of drainage disposal and water management.

It is noted that due to the upstream land uses of market gardening, it would be appropriate to undertake some testing to prove up groundwater quality for irrigation purposes and this will be undertaken as part of the Urban Water Management plan (UWMP).

4.6 Environmental Assets and Water-Dependent Ecosystems

There are two conservation category wetlands in the area, being Kerosene Lane Swamp to the north of the site, which is an existing Dampland some 300m north east of the site and Lake Coooloongup which is located some 300m west of the site on the Western Side of Mandurah Road.

The Kerosene Lane swamp is upstream of the hydraulic grade of the groundwater flow from the proposed development and is unlikely to be affected by the development. The depth to groundwater from the site together with the potential of the existing soils to attenuate nutrients means that provided the nutrient loading from any proposed development is managed to low levels, any development is unlikely to affect Lake Coongoolup.

There are also bush forever sites immediately north and west of the site, although they have potential environmental significance, due to the depth of groundwater and the proposal to dispose of all stormwater on this site via infiltration, there is unlikely to be any impact from this development.

4.7 Existing Infrastructure and Design Constraints

Sufficient capacity is available in the adjoining development to service the development of the subject land.

The whole of the site is proposed to be sewered into existing infrastructure to the east of the site, which will be extended through the “Paradiso” Development.

The primary constraint on the drainage of the site is the moderate terrain, which limits the use of soakage in isolated locations throughout the site, other than through the use of baseless manholes.

5 Water Sustainability Initiatives

5.1 General

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

This is proposed to be achieved by:

- Increased water efficiency in the household by encouraging the use of waterwise appliances through regulation and financial incentives.
- 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

5.2 Individual Lot Owner Initiatives

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

The information will also outline the case for all lot owners to use rainwater tanks plumbed into their homes to assist with the retention of the 1 in 1 year ARI event.

5.3 Estate Public Open Space (POS) Initiatives

5.3.1 Aims

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

- The maximum depth of water within drainage basins during a 100 year storm is limited to 1.2m.
- Inlets to basins will be directed to bio retention basins as requested by the City of Rockingham, which will facilitate infiltration and treatment of the low ARI storms prior to overflow to below ground storage, which will maximise the useability of POS.
- Flush kerbs may be constructed abutting POS areas with either direct run-off for infiltration in lower areas or with swales for infiltration/conveyance to drainage basin 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

5.3.2 General POS initiatives

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

Full landscape plans will be prepared at the time of subdivision in accordance with agreed requirements with the City of Rockingham which will address the objectives outlines in Section 5.3.1.

5.3.3 Irrigation

1) Water Sources and required Allocations:

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. The total area to be irrigated over the total development is approximately 0.711ha which will require an annual bore yield of some 5330kL per annum. An application for this allocation has been made and approved and a copy of the approval is included in Appendix E.

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

It is noted that arrangements have been made with the adjoining Paradiso Estate to make up the shortfall of POS, some 0.153ha, but this area will be irrigated from the Paradiso Estate groundwater allocation.

Although street trees are typically not included in the allocation, these will be irrigated using hand watering or from an individual's internal irrigation system.

2) Programming and Irrigation Minimisation.

Establishment irrigation for trees and native POS planting areas is expected to be used for a period of between 2 and 3 years after planting then disconnected.

Typically, watering will start with 10mm three times / day for initial establishment over a period of around 1 month, depending on the weather and the time of the year. This should then be reduced to 10mm once/day for a period of around 2 months - dependent on the time of year. The watering is then reduced to 10mm applied 2 to 3 times a week.

Irrigation should be programmed and maintained to minimise the water used across the site, with the following mechanisms to minimise water use.

- The system should be checked regularly to detect faults and ensure water is being used effectively and efficiently.
- In general the system should be checked at a frequency of
 - November to April - Once per fortnight.
 - May to October - Once a month.
- All sprinklers should be checked to fully pop-up and retract, bubblers and that nozzles are free of blockages and sprinklers are providing adequate coverage. Particular attention should be paid to irrigation of transplanted mature trees and street trees to ensure they are receiving adequate water.
- The watering regime for planted areas should reflect the plants needs in accordance with the plant type and natural rainfall, in accordance with the Water Corporation's "Water-wise" guidelines. Watering should be monitored throughout the year and adjusted accordingly to ensure appropriate watering. Watering should only take place within the hours stipulated by the Water Corporation (Currently 6.00pm to 9.00am).

The Irrigation Schedule is expected to be as follows (based on landscape hydrozones):

- Turf should be separated from shrubbery and turf and shrubbery should be supplied by different stations of irrigation and scheduled separately.
- Areas of turf subject to lower wear in sheltered environments &/or are not in visually prominent positions should be scheduled to receive a lesser amount of irrigation than areas of turf that are subject to high levels of wear, in exposed environments &/or in visually prominent locations;
- Low Water use plants should be scheduled to receive a lesser amount of water than areas of higher water use; and,
- Irrigation should be progressively withdrawn from areas of native shrubbery.

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

6 Stormwater Management Strategy

6.1 Pre-Development Hydrology

As outlined in Section 4, the site consists of sand with excellent soakage characteristics and is moderately steep with most portions of the site grading at around 5%.

Based on the fact that little or no run-off occurs from the site and all rainfall is infiltrated, it has been assumed that there is no predevelopment flow from the site. A plan detailing the predevelopment catchment boundaries is shown in L-03 in Appendix B.

The majority of the area, being the western two thirds of the land grade to a low point to the south of the site in the southern land holding at around RL6.0mAHD.

The remaining eastern third of the land grades to a low point in the “Paradiso land”, which in turn grades north of Kerosene lane to the Kerosene Lane at around RL3.0mAHD.

As outlined above, despite the topography indicating these flow paths, the permeability of the surface means that infiltration occurs at a greater rate than run-off meaning that little or no runoff leaves the site. In the unlikely event that runoff reached the isolated low points, the water infiltrates in that area.

6.2 Pre- & Post- Development Hydrology

The drainage strategy is proposed to infiltrate all stormwater on site as close to the source as possible. The underlying soils, consisting of a deep limestone layer are deemed to be appropriate for uptake of nutrients meaning that the soakage of the water will provide sufficient opportunities for nutrient uptake.

The site is proposed to be divided into three major catchments to suit the distribution of Public Open Space. A plan detailing the catchment boundaries and proposed drainage basins is shown in Appendix B.

Due to the moderately steep slopes on the site, the benefit and logistics of installing small retention basins across the site are marginal and difficult. Soakage at source will be employed for all allotments without outflow for all storms up to the 5 year storm. Beyond that, water will surcharge and run overland to the street drainage system and be conveyed to the drainage basins.

Planning of the site has utilised lineal open space, particularly abutting the service easement and in various other locations on the site which lends itself to use of flush kerbing which allows road water to run off and infiltrate. This can be either used in conjunction with swales or simply allowing run-off into POS areas where they are lower than roadways and lots, but this will be resolved as part of the approval process in detailed design.

Infiltration has been conservatively calculated on the assumption that the permeability of the insitu soils is 1.1m/day and this will need to be reaffirmed at the time of the UWMP.

Basins will generally be constructed as swales within POS areas. The basin arrangements are generally constructed as a two or three tiered arrangement as follows:

- Where bio-retention areas are provided, water will drain into a bio-retention area surrounded by a retaining wall around 0.5m high.
- For areas where a bio-retention area is not provided water will flow direct into below ground storage, which in conjunction with some additional depth in the basin will contain the 10 year storm. For those areas for which the bio-retention area has been provided, the water will surcharge to the below ground storage after the 1 year 1 hour storm.
- Beyond the 10 year, the water will further surcharge into a grassed swale which will contain the 100 year ARI storm.

GPT's will be constructed at entry to the POS soakage areas to ensure that all litter and sediment is contained for easy cleaning.

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

Table 6.1 – Drainage Basin Areas/Catchments and Areas affected by Drainage

Basin Description	Catchment 5(Eastern)	Effective Volume in the Paradise Site – Catchment 5²	Catchment 6/7(Central)	Catchment 8 (Western)	TOTAL
Impervious Catchment (Ha) (C₁₀₀)	0.54	0.83	1.58	0.96	3.91
Storage provided (100Yr)	229	463	645	615	2012
Storage provided (5Yr)¹	229	0	389	338	956
Storage provided (1Yr)	229	0	343	180	752
Site Area Required (100Yr)(m²)	120	726	533	650	2,330
Site Area Required (5Yr) (m²)	120	0	176	0	296
Site Area Required (1Yr) (m²)	120	0	0	0	120
TWL₁₀₀ (mAHD)	8.5	8.7	9.8	13.36	
Critical Tc (1 Year ARI) (hours)	32	16	16	16	
Critical Tc (5 Year ARI) (hours)	32	32	16	16	
Critical Tc (100 Year ARI) (hours)	32	32	32	32	

Notes:

1. After the 1 in 1 year 1 hour storm has been exceeded and the water overflows the bio retention areas, the stormwater flows into below ground storage which then provides capacity for up to the 5 year storm for Catchment 5 and the 10 year storm for Basin 8.

Water flows directly into the below ground storage for Catchments 6/7 and 8.

2. Excess water for the 100 year storm from the combined catchments has been allocated within the lineal POS for the neighboring Paradiso Development – the impacted area inclusive of the Paradiso Development is included. Refer Calculation Catchment D Paradiso in Appendix C.

6.3 1 in 1 year ARI event

6.3.1 General

The 1 in 1 year event is typically seen as the storm where most nutrients and particulate matter is generated from.

The separation distance between all of the development and the groundwater is greater than 5.0m and generally no groundwater control measures are required. The greater separation distance between the surface and groundwater levels together with the greater distance of potentially affected receiving environments means that this area does not require bio-retention in higher areas of the catchment.

It is proposed that the 1 in 1 year ARI 1 hour storm will be retained on site without outflow in accordance with DoW requirements. This is proposed to be undertaken at the various levels as outlined in the following sections.

6.3.2 Lots:

Lots will either retain water on site in rainwater tanks in conjunction with soakwells or install soakwells to infiltrate water to ensure no outflow into the street drainage system. All Lots are required be fitted with the equivalent 2 by 1500 diameter by 1.2m deep soakwells to achieve full retention of all storms up to the 1 in 5 year storm without outflow.

Beyond this storm, stormwater will surcharge from the soakwells and run overland to the street drainage system and some infiltration will occur, particularly in back yards.

6.3.3 Streets:

The 1 in 1 year 1 hour storm for roadways, will be contained within swales in POS and in the end of line swales/soakage basins and below ground storage.

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

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

The remainder of the 1 in 1 year 1 hour event will be contained within the soakage basin without overflow to any surrounding POS areas.

Where required, the 1 in 1 year bio-retention area will be defined using retaining walls, thereby ensuring that stormwater will be constricted to cause minimal inundation for lower ARI rainfall events, thereby maximizing the usability of the POS area and associated swales. Bio-retention areas will be installed in accordance with the *Adoption Guidelines for Stormwater Biofiltration Systems (CRCWSC, 2015)*.

A GPT will be installed prior to any inflow from the piped drainage system into the drainage basin to limit the siltation of the basin.

6.3.4 Detention Basins

Beyond the measures employed in baseless pits and lineal swales, the remainder of the 1 in 1 year 1 hour storm will be retained within the retention basin areas. The drainage basins will retain the water until it infiltrates.

Details of the proposed retention basins are included in Appendix D.

6.3.5 Non structural measures

Non structural measures will also be employed to reduce the sources of nutrients. These measures involve providing advice to lot purchasers and stakeholders to reduce nutrient sources from the application of garden fertilisers and eroded particulate matter particularly from the new urban areas during the housing construction phase and in establishment of gardens.

Minimisation of nutrient loading can obviously be achieved through:

- Education of local residents and Council maintenance personnel; and
- By implementing frequent street and storm water maintenance programs – particularly during housing construction.
- By planting and using appropriate native species.

6.4 1 in 5 year ARI event

All piped drainage systems will be designed to accommodate the 1 in 5 year ARI event, without any inundation of roadways.

6.5 1 in 100 year ARI event

For the major event, lot drainage flows in excess of the 5 year storm will surcharge and run overland. All roads within the estate will be designed to accommodate and direct extreme event flows towards each POS and compensating basin. The land will be divided into the same catchment areas as detailed in the post development plan as Appendix B.

6.6 Finished Lot Levels (Relative to the 1 in 100 year flood levels)

As outlined in Section 2.3, the land is proposed to be filled a minimum of 500mm above the top water level of drainage basins. In all cases, lots will be set to ensure conveyance for major storms will be along the roadways without flooding homes.

6.7 POS Credits

As outlined in the LSP document all POS credit calculations have been based upon current “Liveable Neighbourhood” policy guidelines - where 100% of the area covered by the 1 in 1 year event of each compensating basin is typically not included as a “usable” POS area. The 1 in 5 Year event is designated as a restricted area normally attracting a 100% credit for the area between the 1 Year and the 5 year ARI levels provided this comprises less than 20% of the total POS allocation.

The affected areas of the drainage basins are detailed in Table 6.1.

6.8 Best Management Practices Water Quality Targets

The DoW’s Stormwater Manual provides guidelines and information on best management practices that may be applied at land development and construction sites to improve stormwater management and environmental performance.

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

The major source of pollutants from construction activities in this instance will potentially be from:

- Eroded materials in the interim period between opening up the surface of the site and implementing the drainage management measures.
- Litter & waste storage areas- that allow materials to be blown by wind or washed away by rainfall into existing stormwater systems.
- Wash-down areas– poor practices can allow materials to enter stormwater systems.
- Placement & storage of delivered products- particularly sand and soil stockpiles where such materials may be tracked by vehicles onto roads, or blown, or washed on to roads which then get into existing stormwater systems.
- Dewatering activities– which can cause sedimentation of downstream water bodies.

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

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

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

The Best Management measures proposed for this area are proposed to be:

- Non Structural Measures to be implemented reduce applied nutrient loading.

- On Site Retention of 1 in 1 year 1 hour ARI Storm.

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

7 Groundwater Management Strategy

7.1 Groundwater Level Management

Groundwater levels for the site location are plotted on the site plan in Appendix B. In general the levels are many metres below the site levels with the exception of the eastern side of the site. Development levels in that location are set at around RL9.50 minimum which is well above the maximum likely groundwater level of around RL3.0mAHD.

There is no further need for controls of groundwater levels and all drainage pipework will be laid well above the controlled groundwater levels.

7.2 Actions to Address Acid Sulphate Soils or Contamination

The ASS mapping for the area indicates that there is no known of ASS soils occurring within 3.0m of natural soil surface (or deeper).

Therefore there is little or no risk of the development proposal encountering any ASS soils.

8 The next stage – Subdivisions and Urban Water management Plans

The structure plan area is under the ownership of four separate land owners which are not professional developers, which depending on the ultimate agreements forged in regard to a development strategy, may mean that the full drainage strategy as proposed cannot be implemented immediately. As a result, the staging of the development and any temporary facilities as required will be addressed in the Urban Water Management Plan (UWMP) which will be required for the subdivision proposal. It is anticipated that the ultimate drainage strategy will generally fit within the framework of this Local Water Management Strategy.

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

- Further detail in the design of the detention basins.
- Detailed geotechnical investigations including testing of the PRI and permeability of the existing soils both at the surface and at the depth of drainage cells.
- Further detail in landscape proposals.
- Testing of groundwater quality for irrigation purposes.

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

- Finalise the design of the swales in the POS.
- Detail the Drainage basins including the various inlet configurations and edge treatments to ensure the overall functional and aesthetic outcomes are satisfactory.
- Review the drainage calculations relative to final planning proposals for the site to ensure that the land use assumptions within the drainage calculations herein are consistent.

9 Monitoring

9.1 General

Given the height of the site above the water table, empirical information indicating the benefits of infiltration of stormwater through Safety Bay sand to ameliorate nutrient levels and the significant distance of the site from any environmental assets of any note it is not proposed to undertake further monitoring.

10 Implementation

10.1 Commitments

The developers are committed to

- 1) Physical Outcomes – To be undertaken at the time of construction.
 - Ensuring that all storm water drainage from the estate is infiltrated on site.
- 2) Non Structural – To be undertaken as part of sales documentation, by providing Information Packages to all lot purchasers to:
 - Fully inform lot owners of the requirement to install the equivalent of two 1500mm diameter by 1200mm deep soakwell prior to outflow into the drainage system in the event a rainwater tank is not installed or reduced storage equivalent to the storage of a rainwater tank in the event that one is used.
 - To encourage the use of rainwater tanks (plumbed into their homes); and
 - To utilise water efficient devices & appliances throughout their homes, and to encourage all purchasers to install Water & Nutrient-wise plants.
- 3) Further investigation and reporting:
 - Prepare Urban Water Management plans to support further detailed subdivision planning.
 - Undertake geotechnical investigations.

10.2 Maintenance Schedules (Incl. Roles & Responsibilities)

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

Table 10.1 – Proposed Maintenance Programme for the development

#	Drainage Element:	Possible Maintenance and Inspection Frequency:	Responsibility:
---	-------------------	--	-----------------

#	Drainage Element:	Possible Maintenance and Inspection Frequency:	Responsibility:
1	Rainwater tank(s); trapped underground soakage / connection pit(s)	Annually inspection & clean-out (as necessary) – just prior to winter rains	Lot Owner
2	Swale Areas, table drains and detention basins	<p><u>During developer maintenance period</u> (2 year in conjunction with Landscaping)</p> <p>Inspect, clean-out & maintain plants ~fortnightly intervals (depending on loading) – as part of POS maintenance works</p> <p><u>After developer maintenance period:</u></p> <p>Inspect, clean-out & maintain plants (as required) as part of standard Council POS maintenance program</p>	Developer Council
3	Drainage culverts, standard table drains, pipes and pits	<p><u>During developer maintenance period:</u> (12 month Defects liability period)</p> <p>Inspect, clean-out & maintain structures annually – just prior to winter (& then again in Aug / Sept if necessary)</p> <p><u>After developer maintenance period:</u></p> <p>Inspect, clean-out & maintain structures at least annually – just prior to winter – but inspection frequency will need to be higher during home construction phase</p>	Developer Council
4	Trapped Pits, Underground Storage and GPT's	<p><u>During developer maintenance period:</u> (12 month Defects liability period)</p> <p>Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / July & again in Oct / Nov for the first two years</p> <p><u>After developer maintenance period:</u></p> <p>Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / Aug – but inspection frequency will need to be higher during home construction phase.</p>	Developer
5	Base of compensating basins	Initial formal inspection & assessment of performance of bases (say) at around year 3 & then every 5 – 10 years.	Council

10.3 Funding

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

10.4 Review

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

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

11 References:

1. Environmental Geology Mapping - Part Sheets 2033 II and 2133 III, Gozzard JR 1983
2. Australian Rainfall and Run-off A Guide to Flood Estimation Volume 1, Institute of Engineers, 1987

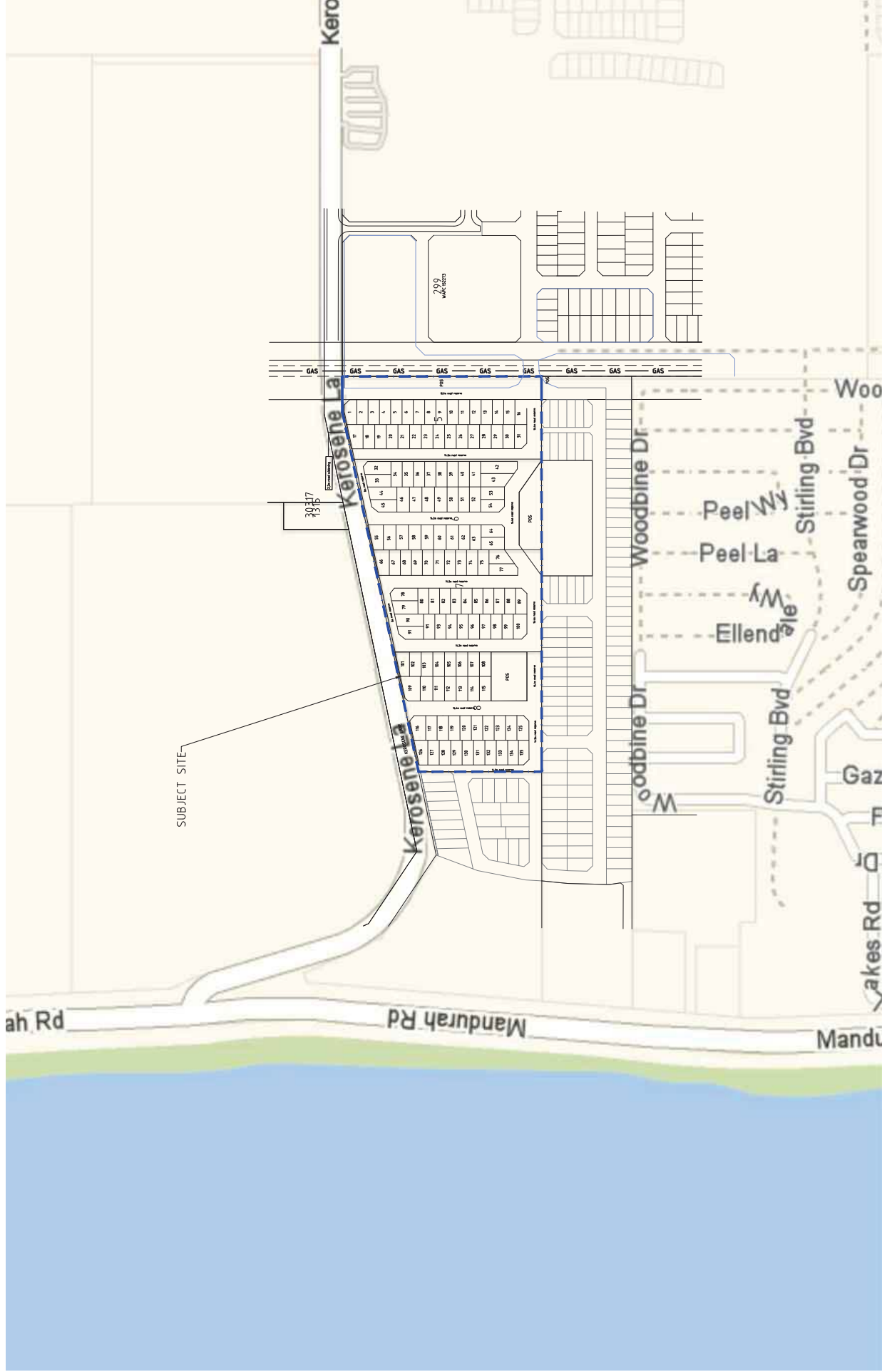
3. Perth Groundwater Atlas, Waters and Rivers Commission, October 1997.
4. Perth Groundwater Atlas (Edition 4), Department of Environment, 2004

APPENDIX A –

- L- 01 Locality Plan**
- L- 02 Aerial Photo with Development Superimposed
Thereon**
- Whelans Subdivision/Structure Plan Concept Plan**

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PROJECT
LOTS 5, 6, 7 & 8
KEROSENE LANE
BALDIVIS
W.A.P.C. No. -

DRAWING
LOCAL WATER MANAGEMENT STRATEGY
LOCALITY PLAN
LAD DRAWING NO. INT. MANUALLY A.1/24

SCALE	DATE	PROJECT NUMBER	DRAWING NUMBER
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PROJECT
LOTS 5, 6, 7 & 8
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**SUBDIVISION CONCEPT PLAN
LOTS 5 - 8 KEROSENE LANE
BALDIVIS**

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DRAWN BY: CHAL
CHECKED BY: JP
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V: 1.0
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 - Dwelling Orientation
 - Structure Plan Boundary
 - Pipeline
 - Existing parent lot boundary
 - Pipeline 32m setback

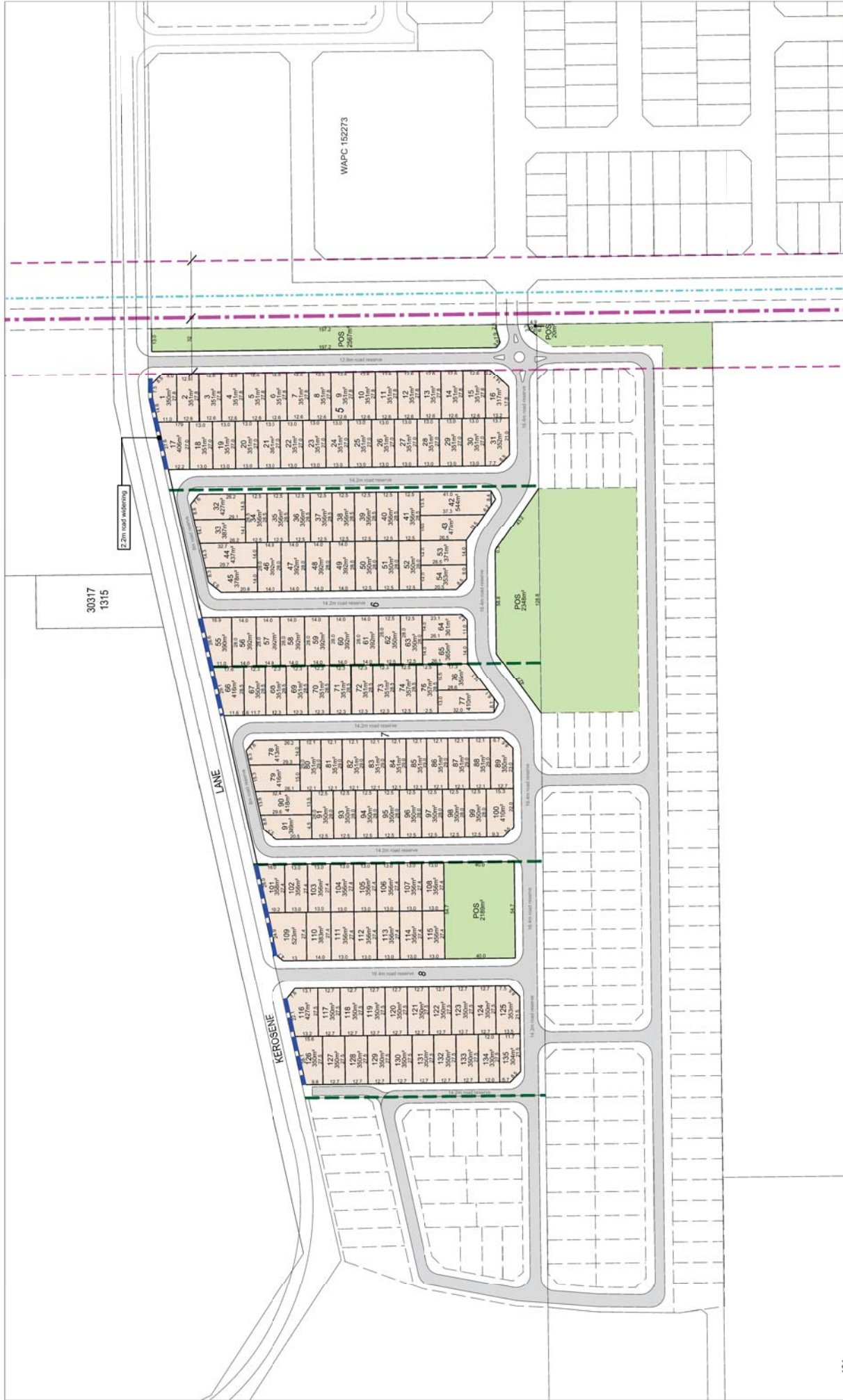
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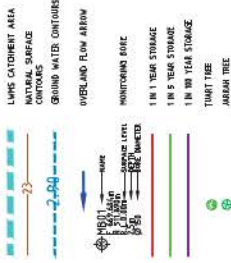
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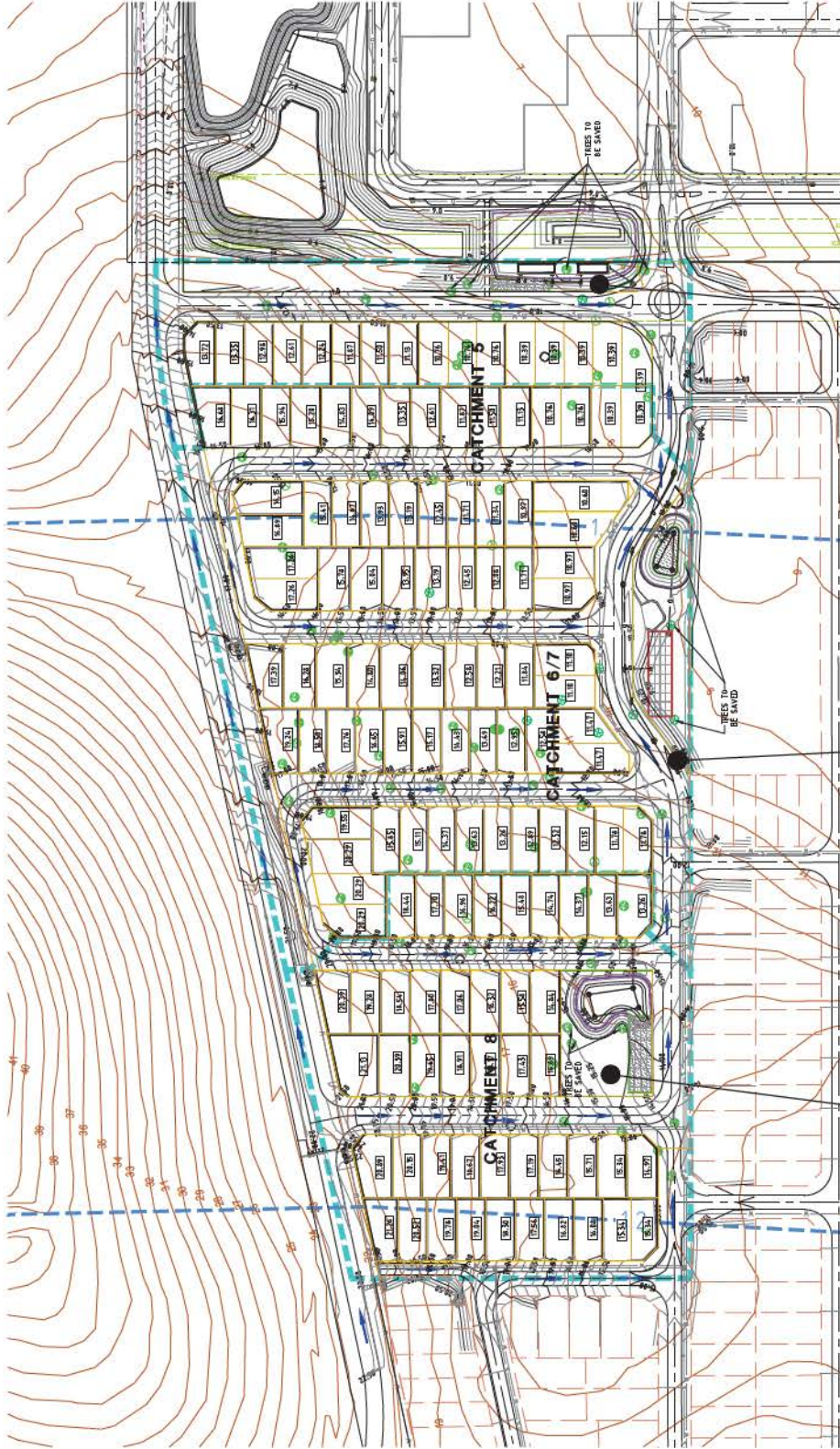


APPENDIX B – DRAINAGE CATCHMENT PLANS

- L- 03 - Pre-development catchment plan**
- L- 04 - Post development catchment plan with flow directions and proposed drainage basins**



CATCHMENT	CATCHMENT DATA			
	TOTAL AREA (in ²)	LOT AREA (in ²)	ROAD RESERVE AREA (in ²)	POK AREA (in ²)
5	19321	5542	5327	2511
6 / 7	4,5239	27848	15350	2349
8.	264928	117558	8940	2980



BASIN DETAILS - CATCHMENT 6/7	
TOTAL INFLOWING AREA (H2OYR)	15240
100% STORAGE REQUIRED	4154
AREA AT T.W. (100yrs)	5334
RL (T.M.) (100yrs)	9.60m AHD
5yr STORAGE REQUIRED	3494
AREA AT T.W. (5yr)	7164
RL (T.M.) (5yr)	9.05m AHD
1yr STORAGE REQUIRED	3424
AREA AT T.W. (1yr)	84
RL (T.M.) (1yr)	4.35m AHD
PEAK OVERTOP (100yrs)	n.a. 1.24

BASIN DETAILS - CATCHMENT 5	
TOTAL INTERFLOWS AREA (100%)	2,200
100% STORAGE LOTS 5-8	220
100% STORAGE PARADOX	440
AREA AT TML 100% TOTAL	100
AREA AT TML 100% LOTS 5-8	300
AREA AT TML 100% PARADOX	720
RL TML 100%	8,790
5% STORAGE REQUIRED	160
AREA AT TML 5%	950
RL TML 5%	100
10% STORAGE REQUIRED	160
AREA AT TML 10%	950
RL TML 10%	100
20% STORAGE REQUIRED	160
AREA AT TML 20%	850
RL TML 20%	100

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PROJECT: **LOTS 5, 6, 7 & 8
KEROSENE LANE
BALDIVIS**

**LOCAL WATER MANAGEMENT STRATEGY
POST-DEVELOPMENT
CATCHMENT PLAN**

BDVTER30 L04

APPENDIX C – DRAINAGE CALCULATIONS

- End of Line Drainage Basin size calculations**
- At Lot calculation to Establish Run-off**

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldvivi

LWMS Calcs

Location: Catchment 5

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	0.45
Required BioRetention Area (2%) (m ²)	100
Required Storage(1 in 1Yr 1 Hr)(m ³)	69
Available Storage(m ³)	229
Soakage Outflow(l/s/m ²)	0.013



Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Sub Total Catchment Area	Add Effective Area from Catchment 6/7	Deduct Effective Area to Paradiso	Total
Gross Catchment Area	0.52	0	0.5582	0.1769	0.0800	1.3321			1.33
Run-Off Co-efficient(C ₁₀)	0.80	0.45	0.06	0	1.00				
ARI Multiplier	0.90	1.22	2.50	1.41	1.00				
Run-Off Co-efficient(C _y)	0.72	0.55	0.15	0.00	1.00				
Impervious Area(Ha)	0.37	0.00	0.08	0.00	0.08	0.54	0.58	-0.83	0.29

0.40 Effective C

Data From A,R & R Volume 2

Location	Baldvivi WA	Road Catchment Area:	RR Width(m)	Length(m)	Area (Total)
Map 1	20.6		20	0	-
Map 2	4.5		18	0	-
Map 3	1.3		40	0	-
Map 4	35.5		16	0	-
Map 5	7		15	0	-
Map 6	2.1		14	0	-
Map 7	0.68		13	0	-
Map 8	4.82		6	0	-
Map 9	17				5,170

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	78	94	0.25	3.03	3,63168	90	8.6	0	0.0
30	0.50	75.22	60	108	0.25	3.03	5,44752	102	9.9	0	0.0
45	0.75	56.30	45	121	0.25	3.03	8,17128	113	11.1	0	0.0
60	1.00	45.44	36	130	0.25	3.03	10,89504	119	11.9	0	0.0
120	2.00	28.82	23	165	0.25	3.03	21,79008	143	15.1	0	0.0
240	4.00	18.07	14	207	0.25	3.03	43,58016	163	19.0	0	0.0
480	8.00	11.32	9	259	0.25	3.03	87,16032	172	23.8	0	0.0
960	16.00	7.21	6	330	0.25	3.03	174,32064	156	30.3	0	0.0

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldivis

LWMS Calcs

Location: Catchment 5

2880	48.00	3.53	3	484	0.25	3.03	522.96192	-39	0	0.0
4320	72.00	2.62	2	540	0.25	3.03	784.44288	-244	0	0.0



Calculation of Storage in Above Ground Basin

Lower Tier Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)

0 30 4

RL(Base)

TWL(mAHD)	Height(m)	A(TWL)	Total Wetted		Average Area	Vol(m ³)	Treatment		Storage for
			Area	Area			Storage above	The Designated Height allows	
8	0	120	120	480	0	0	LWL	Static Water Level	
8.5	0.5	120	120	480	60	60	60	1 in 1 year 1 hour	

TOTAL STORAGE TO TOP OF LOWER TIER 60 m³

Volume and Dimensions of below Ground Storage Based on Humes Storm Trap

Width (Inside)	2350 mm	2.35 m	
Height	1500 mm	1.5 m	
Storage Required	143.00 m ³	Width Provided	4.70 m
Length Required	40.57 m	Length Provided	20.28 m
		Length provided (4.0m Increments)	24.00 m
Area of Storage	95.33	Storage Provided	169.20 m ³
TOTAL STORAGE LOWER TIER AND STORMTRAP	229	m ³	100 Year Storage

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldivis

LWMS Calcs

Location: Catchment 6 and 7

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	1.16
Required BioRetention Area (2%) (m ²)	300
Required Storage(1 in 1Yr 1 Hr)(m ³)	179
Available Storage(m ³)	645
Soakage Outflow(l/s/m ²)	0.013



Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Sub Total Catchment Area	Deduct effective Area to Catchment 5/Paradiso	Total
Gross Catchment Area	1.51	0	2.784	0.1549	0.0800	4.5239		4.52
Run-Off Co-efficient(C ₁₀)	0.80	0.45	0.06	0	1.00			
ARI Multiplier	0.90	1.22	2.50	1.41	1.00			
Run-Off Co-efficient(C _y)	0.72	0.55	0.15	0.00	1.00			
Impervious Area(Ha)	1.08	0.00	0.42	0.00	0.08	1.58	-0.58	1.00

0.35 Effective C

Data From A,R & R Volume 2

Location	Baldivis WA	Road Catchment Area: RR Width(m)	Length(m)	Area (Total)
Map 1	20.6	20	0	-
Map 2		18	0	-
Map 3	1.3	40	0	-
Map 4	35.5	16	0	-
Map 5	7	15	0	-
Map 6	2.1	14	0	-
Map 7	0.68	13	0	-
Map 8	4.82	6	0	-
Map 9	17			15,050

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	275	330	1.00	10.01	12,014,854,63	318	9.1	0	0.0
30	0.50	75.22	209	377	1.00	10.01	18,022,281,95	359	10.4	0	0.0
45	0.75	56.30	157	423	1.00	10.01	27,033,422,92	396	11.7	0	0.0
60	1.00	45.44	126	455	1.00	10.01	36,044,563,9	419	12.6	0	0.0
120	2.00	28.82	80	577	1.00	10.01	72,089,127,8	505	16.0	0	0.0
240	4.00	18.07	50	724	1.00	10.01	144,178,255,6	579	20.1	0	0.0
480	8.00	11.32	31	907	1.00	10.01	288,356,511,2	619	25.2	0	0.0
960	16.00	7.21	20	1155	1.00	10.01	576,713,022,4	578	32.0	0	0.0
2880	48.00	3.53	10	1695	1.00	10.01	1730,139,067	-35	47.0	0	0.0
4320	72.00	2.62	7	1892	1.00	10.01	2595,208,601	-703	52.5	0	0.0

Calculation of Storage in Above Ground Basin



Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldivis
LWMS Calcs
Location: Catchment 6 and 7

Volume and Dimensions of below Ground Storage
Based on Humes Storm Trap

Width (Inside)	2350 mm	2.35 m
Height	1500 mm	1.5 m
Storage Required	340.00 m ³	Width Provided 7.05 m
Length Required	96.45 m	Length Provided 32.15 m
		Length provided (4.0m Increments) 36.00 m

Area of Storage	226.67	Storage Provided	381 m ³	380.70 m ³
TOTAL STORAGE LOWER TIER AND STORMTRAP				
RL(Base)	7			5 Year Storage

TWL(mAHD)	Height(m)	A(TWL)	Vol(m ³)	Storage for
7	0	254	0	Static Water Level
7.44	0.44	254	112	1 in 1 year 1 Hour
8.35	1.35	254	343	1 in 1 year
8.5	1.50	254	381	Top of Underground Storage

Upper Tier Drainage Basin Dimensions:

Side Slopes 1:	Length(m)	Breadth(m)
6	22.5	7.00

RL(Base)	9			
TWL(mAHD)	Height(m)	A(TWL)	Total Wetted Area	Total Storage above LWL
9	0	158	158	0
9.05	0.05	176	176	0
9.54	0.54	391	391	0
9.8	0.8	533	533	0

The Designated Height allows Storage for			
Bottom of Soakage Area			
1 in 5 year			
1 in 10 year			
1 in 100 year			

TOTAL STORAGE TO TOP OF UPPER TIER 645 m³

Development Engineering Consultants - Drainage Basin Spreadsheet



Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldvis

LWMS Calcs

Location: Catchment 8

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	0.73
Required BioRetention Area (2%) (m ²)	200
Required Storage(1 in 1Yr 1 Hr)(m ³)	112
Available Storage(m ³)	615
Soakage Outflow(l/s/m ²)	0.013

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Sub Total Catchment Area	Total
Gross Catchment Area	0.90	0	1.5758	0.1390	0.0800	2.6928	2.69
Run-Off Co-efficient(C ₁₀)	0.80	0.45	0.06	0	1.00		
ARI Multiplier	0.90	1.22	2.50	1.41	1.00		
Run-Off Co-efficient(C _y)	0.72	0.55	0.15	0.00	1.00		
Impervious Area(Ha)	0.65	0.00	0.24	0.00	0.08	0.96	0.96

0.36 Effective C

Data From A, R & R Volume 2

Location	Baldvis WA	Road Catchment Area: RR Width(m)	Length(m)	Area (Total)
Map 1	20.6	20	0	-
Map 2	4.5	18	0	-
Map 3	1.3	40	0	-
Map 4	35.5	16	0	-
Map 5	7	15	0	-
Map 6	2.1	14	0	-
Map 7	0.68	13	0	-
Map 8	4.82	6	0	-
Map 9	17			8,980

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water In Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	264	317	0.25	9.00	10.79451259	306	9.8	0	0.0
30	0.50	75.22	201	362	0.25	9.00	16.19176889	346	11.2	0	0.0
45	0.75	56.30	151	407	0.25	9.00	24.28765334	382	12.6	0	0.0
60	1.00	45.44	122	438	0.25	9.00	32.38353778	405	13.5	0	0.0
120	2.00	28.82	77	555	0.25	9.00	64.76707557	490	17.1	0	0.0
240	4.00	18.07	48	696	0.25	9.00	129.5341511	566	21.5	0	0.0
480	8.00	11.32	30	872	0.25	9.00	259.0683023	613	26.9	0	0.0
960	16.00	7.21	19	1111	0.25	9.00	518.1366046	593	34.3	0	0.0
2880	48.00	3.53	9	1630	0.25	9.00	1554.409814	76	50.3	0	0.0
4320	72.00	2.62	7	1819	0.25	9.00	2331.61472	-512	56.2	0	0.0

Project: Lots 5, 6, 7 and 8 Kerosene Lane Baldivis

LWMS Calcs

Location: Catchment 8



Volume and Dimensions of below Ground Storage
Based on Humes Storm Trap

Width (Inside)	2350 mm	2.35 m	
Height	1500 mm	1.5 m	
Storage Required	300.00 m ³	Width Provided	7.05 m
Length Required	85.11 m	Length Provided	28.37 m
		Length provided (4.0m Increments)	32.00 m
Area of Storage	200.00	Storage Provided	338.40 m ³

TOTAL STORAGE LOWER TIER AND STORMTRAP 338 m³ 10 Year Storage

RL(Base)	TWL(mAHD)	Height(m)	A(TWL)	Vol(m ³)	Storage for
10.3	0	226	0	0	Static Water Level
10.75	0.45	226	102	102	1 in 1 year 1 Hour
11.1	0.8	226	180	180	1 in 1 year
11.8	1.5	226	338	338	1 in 5 year
11.8	1.50	226	338	338	Top of Underground Storage

Upper Tier Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)

6 17.6 20.00

RL(Base) 12.8

Total Wetted			Total Storage				
TWL (mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Volume in Dip	above LWL	The Designated Height allows Storage for
12.8	0	352	1408	0	0	338	Bottom of Upper Tier
12.81	0.01	357	1417	4	0	342	1 in 10 year
13.36	0.56	650	1959	276	0	615	1 in 100 year

TOTAL STORAGE TO TOP OF UPPER TIER 615 m³

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 5, 6, 7 and 8 Kerosene Lane, Baldivis

Location: At Lot Detention Calculations to Establish Run-off Coefficient

Lots Unconnected > 300m² in Area - 350m² Ave

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	0.022

Required Storage(1 in 1Yr 1 Hr)(m³) 3.396

Catchment Details	Paved Area	Upaved area	Total
Lot Area (SQM)			350.00
Proportion Paved	70%	30%	100%
Area Paved (Ha)	0.025	0.011	0.035
Run-Off Co-efficient(C10)	0.90	0.00	
ARI Multiplier	1.00	1.20	
Run-Off Co-efficient(Cy)	0.90	0.00	
Impervious Area(Ha)	0.022	0.000	0.022

0.63 Effective C

Volume and Dimensions of Available Storage

NOTE: All water is retained in Soakwells to 5 ARI without surcharge. For Greater ARI storms water will surcharge and soak over an area of 30 Square metres to a maximum depth of 20mm

Area above Ground inundated to 0.03m Deep (Back Yard and Front Yard)	30.00	0.02
Storage provided manholes and pipe	-	
Number of Soakwells	2.00	
Diameter of Soakwells	1.50	
Depth of Each Soakwell	1.20	
Storage Provided Soakwells	4.24	
Total Storage Provided	4.84	
Soakage Rate (l/s/m2)	0.02	

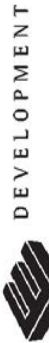


Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 5, 6, 7 and 8 Kerosene Lane, Baldvins

Location: At Lot Detention Calculations to Establish Run-off Coefficient
Data From A, R & R Volume 2

Location	Perth WA
Map 1	2 _{I₁} 22.6
Map 2	2 _{I₁₂} 4.9
Map 3	2 _{I₇₂} 1.5
Map 4	50 _{I₁} 37.5
Map 5	50 _{I₁₂} 7.8
Map 6	50 _{I₇₂} 2.5
Map 7	G 0.68
Map 8	F2 4.85
Map 9	F50 17



Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Q out (Soakage)(l/s)	V out	Net Storage Required	Vout (Required)	Q out(l/s)	Effective Run-off C
10	0.167	152.26	9.33	5.595553704	0.90	0.538128303	5.0574254	0.22	0.36	0.02
20	0.333	101.28	6.20	7.443743327	0.90	1.076256607	6.36748672	1.53	1.27	0.13
30	0.500	77.57	4.75	8.551792527	0.90	1.61438491	6.937407617	2.10	1.16	0.15
60	1.000	47.33	2.90	10.43611421	0.90	3.228769821	7.207344391	2.37	0.66	0.14
120	2.000	30.65	1.88	13.51710928	0.90	6.457539642	7.059569636	2.22	0.31	0.10
240	4.000	19.63	1.20	17.31523396	0.90	12.91507928	4.400154674	-	0.00	0.00
480	8.000	12.57	0.77	22.17335383	0.90	25.83015857	-3.65680474	-	0.00	0.00
960	16.000	8.19	0.50	28.88956675	0.90	51.66031713	-22.77075038	-	0.00	0.00
1440	24.000	6.44	0.39	34.06399351	0.90	77.4904757	-43.42648219	-	0.00	0.00
2880	48.000	4.18	0.26	44.19550366	0.90	154.9809514	-110.7854477	-	0.00	0.00
4320	72.000	3.16	0.19	50.17568102	0.90	232.4714271	-182.2957461	-	0.00	0.00

Development Engineering Consultants - Drainage Basin Spreadsheet



Project: Lots 14, 9010, 299 Kerosene Lane, Baldivis
Paradiso Estate Development
Location: Western Catchment - Catchment D

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	0.41
Required Storage(1 in 1Yr 1 Hr)(m ³)	63
Available Storage(m ³)	721
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	Commercial Lots (Unconnected)	POS/School*	Basin Area	Add Extra Area Lots 5-8	Total
Gross Catchment Area	0.54	0	0.45	0	0.21	0.03		1.23
Run-Off Co-efficient(C ₁₀)	0.78	0.32	0.05	0.01	0	1.00		
ARI Multiplier	0.90	1.20	2.40	29.00	1.41	1.00		
Run-Off Co-efficient(Cy)	0.70	0.38	0.12	0.29	0.00	1.00		
Impervious Area(Ha)	0.38	0.00	0.05	0.00	0.00	0.03	0.83	1.29

1.05 Effective C

* Includes School Sites

Data From A,R & R Volume 2

Location	Perth WA	Road Catchment Area:			Area (Total)
Map 1	20.6	RR Width(m)	Length(m)		-
Map 2	4.5	20	0		-
Map 3	1.3	18	0		-
Map 4	35.5	16	0		-
Map 5	7	15	0		-
Map 6	2.1	14	0		-
Map 7	0.68	12.5	0		-
Map 8	4.82	10	0		-
Map 9	17	6	0		-
					5,400

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	354.66	426	0.60	18.77	22.52093466	403	6.3	0	0

Development Engineering Consultants - Drainage Basin Spreadsheet



Project: Lots 14, 9010, 299 Kerosene Lane, Baldivis
Paradiso Estate Development

Location: Western Catchment - Catchment D

30	0.50	75.22	270.17	486	0.60	18.77	33.78140199	453	7.2	0	0
45	0.75	56.30	202.21	546	0.60	18.77	50.67210298	495	8.1	0	0
60	1.00	45.44	163.21	588	0.60	18.77	67.56280397	520	8.7	0	0
120	2.00	31.59	113.47	817	0.60	18.77	135.1256079	682	12.1	0	0
240	4.00	19.11	68.66	989	0.60	18.77	270.2512159	718	14.6	0	0
480	8.00	11.56	41.53	1196	0.60	18.77	540.5024318	656	17.7	0	0
960	16.00	8.08	29.01	1671	0.60	18.77	1081.004864	590	24.7	0	0
2880	48.00	3.65	13.10	2263	0.60	18.77	3243.014591	-980	33.5	0	0
4320	72.00	2.62	9.43	2443	0.60	18.77	4864.521886	-2421	36.2	0	0

Lower Tier Drainage Basin Dimensions:

Side Slopes 1: Length(m)	6	33	Breadth(m)	3.6
RL(Base)	7.7			

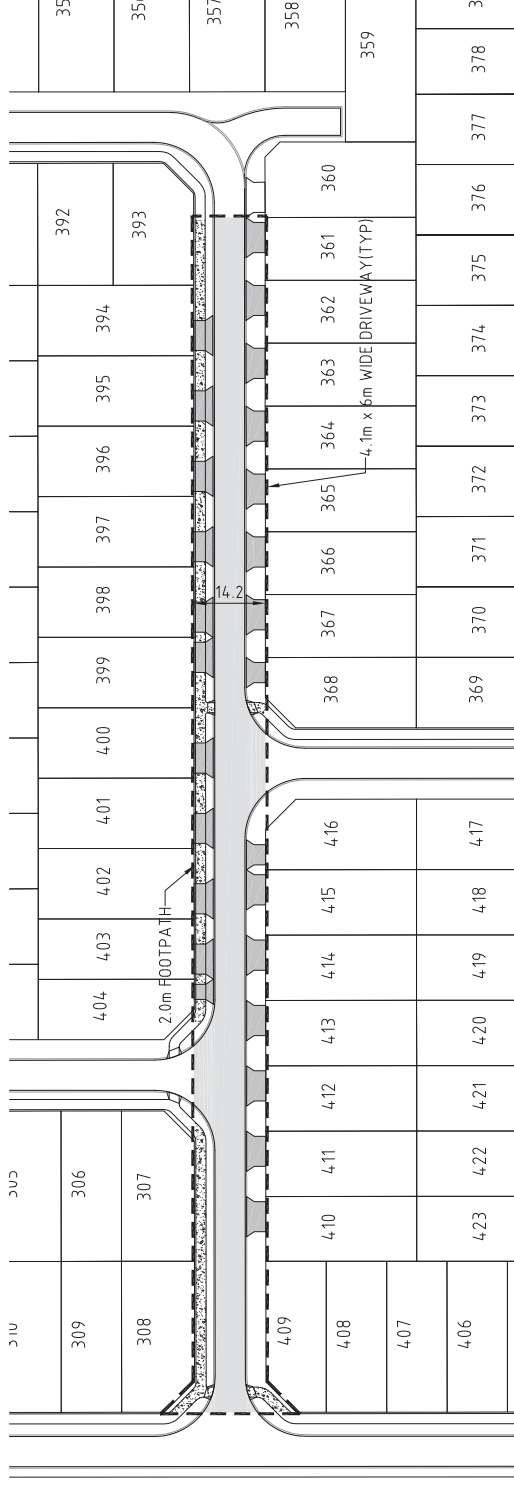
TWL(mAHD)	Height(m)	A(TWL)	Equip Fenced Site		Average Area	Vol(m ³)	The Designated Height allows Storage for
			Area	Area			
7.7	0	119	196	475	0	Static Water Level	
7.88	0.18	203	288	638	29	1 in 1 year 1 Hour	
8.15	0.45	346	444	900	102	1 in 1 year	
8.4	0.7	497	608	1161	207	5 Year Storage	
8.5	0.8	562	678	1270	260	10 Year Storage	

TOTAL STORAGE TO TOP OF LOWER TIER

Upper Tier Drainage Basin Dimensions:

Side Slopes 1: Length(m)	6	60	Breadth(m)	24
RL(Base)	8.5			

TWL(mAHD)	Height(m)	A(TWL)	Equip Fenced Site		Average Area	Vol(m ³)	Total Volume(m ³)	The Designated Height allows Storage for
			Area	Area				
8.79	0.29	1744	1930		6357	461	721	100 Year Storage
Allocation to Lots 6-8		1120					463	



CALCULATION OF "COEFFICIENT" OF RUN-OFF FOR TYPICAL ROAD RESERVE

RESERVE WIDTH = 14.2m, LENGTH 237m

OVER 237m LENGTH, PAVED AREA IS:-

- 26 x DRIVEWAYS (6.0m WIDE-TYP) =605m²
- 2.0m FOOTPATH & CROSSINGS =34.7m²
- 6.0m WIDE ROAD (INC. KERB) =1713m²

THEREFORE TOTAL PAVED AREA = 2665m²

TOTAL RESERVE AREA = 3410m²

THEREFORE
PROPORTION OF RESERVE AS PAVED AREA = 0.781

APPLYING 0.9 RUN-OFF COEFFICIENT

EFFECTIVE "C" OFF TYPICAL ROAD = 0.702

THEREFORE SAY 0.70 APPLIES

Copyright This drawing is the property of Galati Nominees Pty Ltd. It is to be used for the purposes of the project only and is not to be reproduced or used in any way without the written consent of Galati Nominees Pty Ltd.	DATE 26/11/16	BY A	INITIAL DPH	ISSUE 01	REVISION	CLIENT GALATI NOMINEES PTY LTD	DEVELOPMENT ENGINEERING CONSULTANTS	SUITE 3, 1234 COLIN ST. ST. LOUIS WESTERN AUSTRALIA Ph: (08) 9441 1900 Fax: (08) 9441 1700	PROJECT LOTS 14, 9010, 299 KEROSENE LANE, BALDIVIS NEIGHBOURHOOD CENTRE	W.A.P.C. No. - 151237, 151235 & 141467	DRAWING CO-EFFICIENT CALCULATION TYPICAL ROAD RESERVE AREA	SCALE DATE 26/11/16	DRAWN BY DESIGNED DPH	CHECKED BY APPROVED SA	REV. No. A

BDVTER15 K18

5: SUBMITTAL DRAWING 15.11.16

5: SUBMITTAL DRAWING 15.11.16

5: SUBMITTAL DRAWING 15.11.16

5: SUBMITTAL DRAWING 15.11.16

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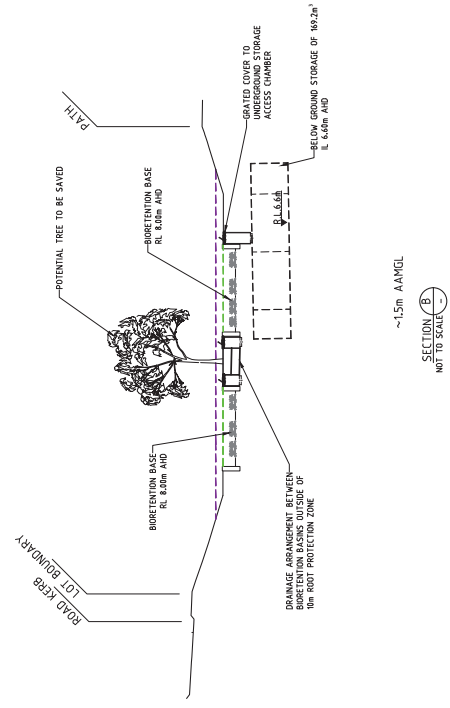
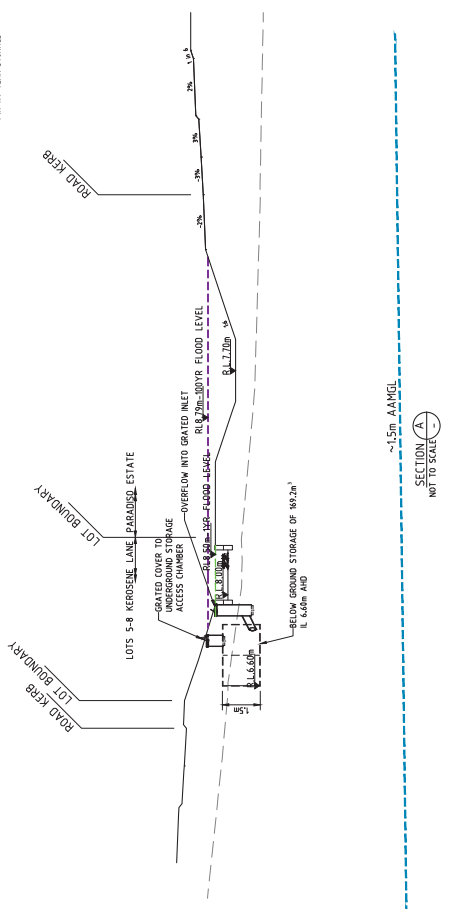
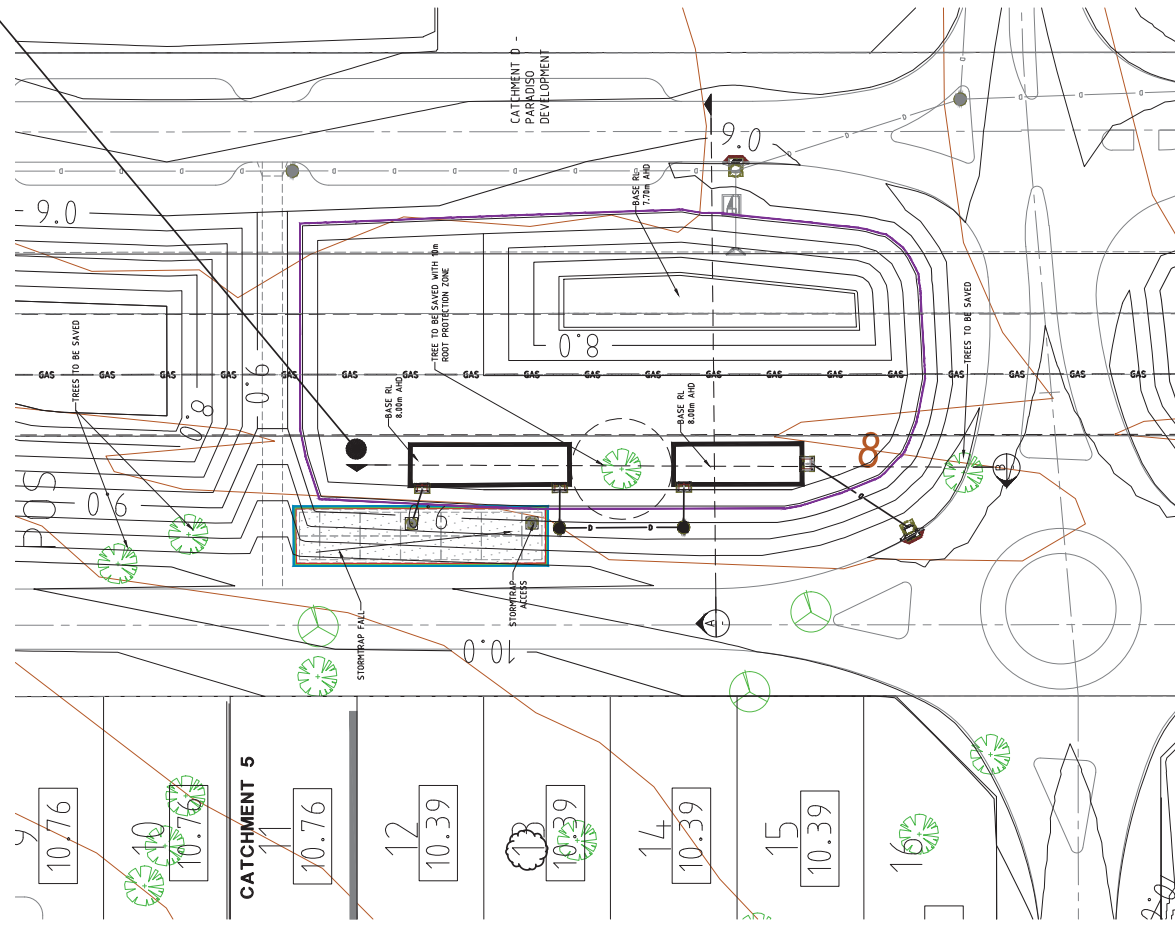
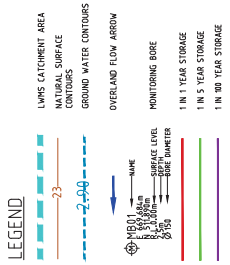
5: SUBMITTAL DRAWING 15.11.16

5: SUBMITTAL DRAWING 15.11.16

APPENDIX D – DETAILS OF DRAINAGE BASINS

- L- 05 – Catchment 5 – Basin details**
- L- 06 – Catchment 6 – Basin details**
- L- 07 – Catchment 7 – Basin details**
- Landscape Concept Plans**

BASIN DETAILS - CATCHMENT 5	
TOTAL IMPERVIOUS AREA (100yr)	8.27ha
100yr STORAGE (PARADISO)	227m ³
AREA AT T.M. (100yr)	453m ²
AREA AT T.M. (100yr) PARADISO	103m ²
AREA AT T.M. (100yr) LOTS 5-8	350m ²
AREA AT T.M. (100yr) PARADISO	776m ²
RL (T.M.) (100yr)	8.77m AHD
5yr STORAGE REQUIRED	19m ³
AREA AT T.M. (5yr)	19m ²
RL (T.M.) (5yr)	8.52m AHD
1yr STORAGE REQUIRED	95m ³
AREA AT T.M. (1yr)	95m ²
RL (T.M.) (1yr)	8.52m AHD
PEAK OUTFLOW (100yr)	8.1 L/s



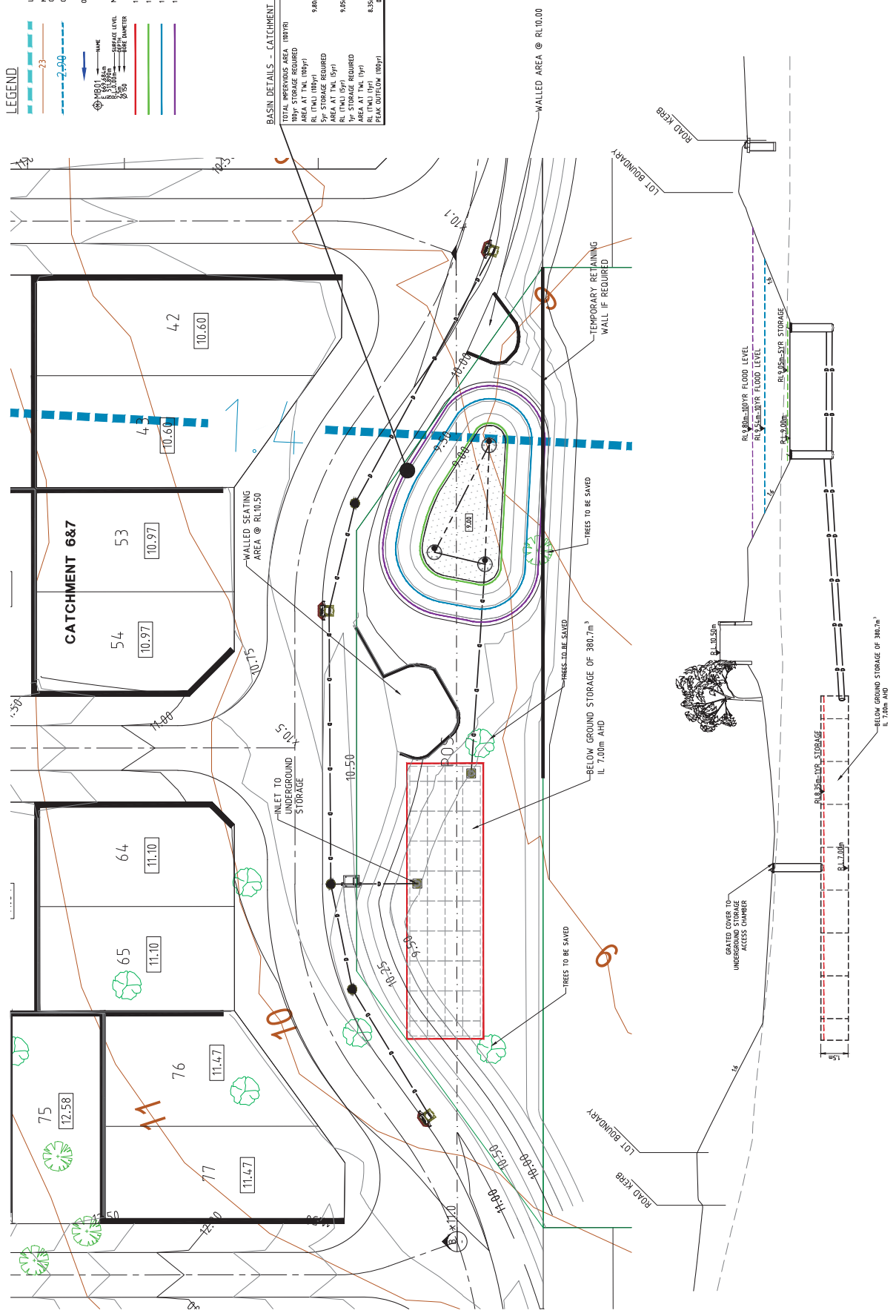
TERRANOVIS PTY LTD DEVELOPMENT ENGINEERING CONSULTANTS	LOTS 5, 6, 7 & 8 KERSENE LANE BALDVIS W.A.P.C. No. -	LOCAL WATER MANAGEMENT STRATEGY CATCHMENT 5 BASIN DETAILS LOCAL WATER MANAGEMENT STRATEGY	SCALE: 1:250 DATE: 12/11/15 PROJECT NUMBER:	DRAWN: JG CHECKED: JG APPROVED: JG	REF: No. G SHEET: 1 OF 1 DRAWING NUMBER:
			BDVTER30 L05 SUBMITTED FOR REVIEW AND APPROVAL		

LEGEND

- LWS CATCHMENT AREA
- NATURAL SURFACE
- GROUND WATER CONTOURS
- OVERLAND FLOW ARROW
- MONITORING BORE
- 1 IN 1 YEAR STORAGE
- 1 IN 5 YEAR STORAGE
- 1 IN 10 YEAR STORAGE
- 1 IN 100 YEAR STORAGE

BASIN DETAILS - CATCHMENT 6/7

TOTAL INTERVISED AREA (100YR)	1.39ha
100YR STORAGE REQUIRED	645m ³
AREA AT TNL (100Yr)	53m ²
100YR STORAGE REQUIRED	9.25m ³
AREA AT TNL (5Yr)	38m ²
5Yr STORAGE REQUIRED	17m ³
AREA AT TNL (1Yr)	9.25m ²
1Yr STORAGE REQUIRED	3.3m ³
AREA AT TNL (1Yr)	8.25m ²
PEAK OUTFLOW (100Yr)	8.0 L/s

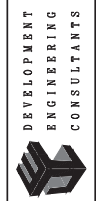


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SECTION B

N.T.S.

TERRANOVIS PTY LTD



DEVELOPMENT
ENGINEERING
CONSULTANTS

LOTS 5, 6, 7 & 8
KEROSENE LANE
BALDVIS

LOCAL WATER MANAGEMENT STRATEGY
CATCHMENT 6/7
BASIN DETAILS

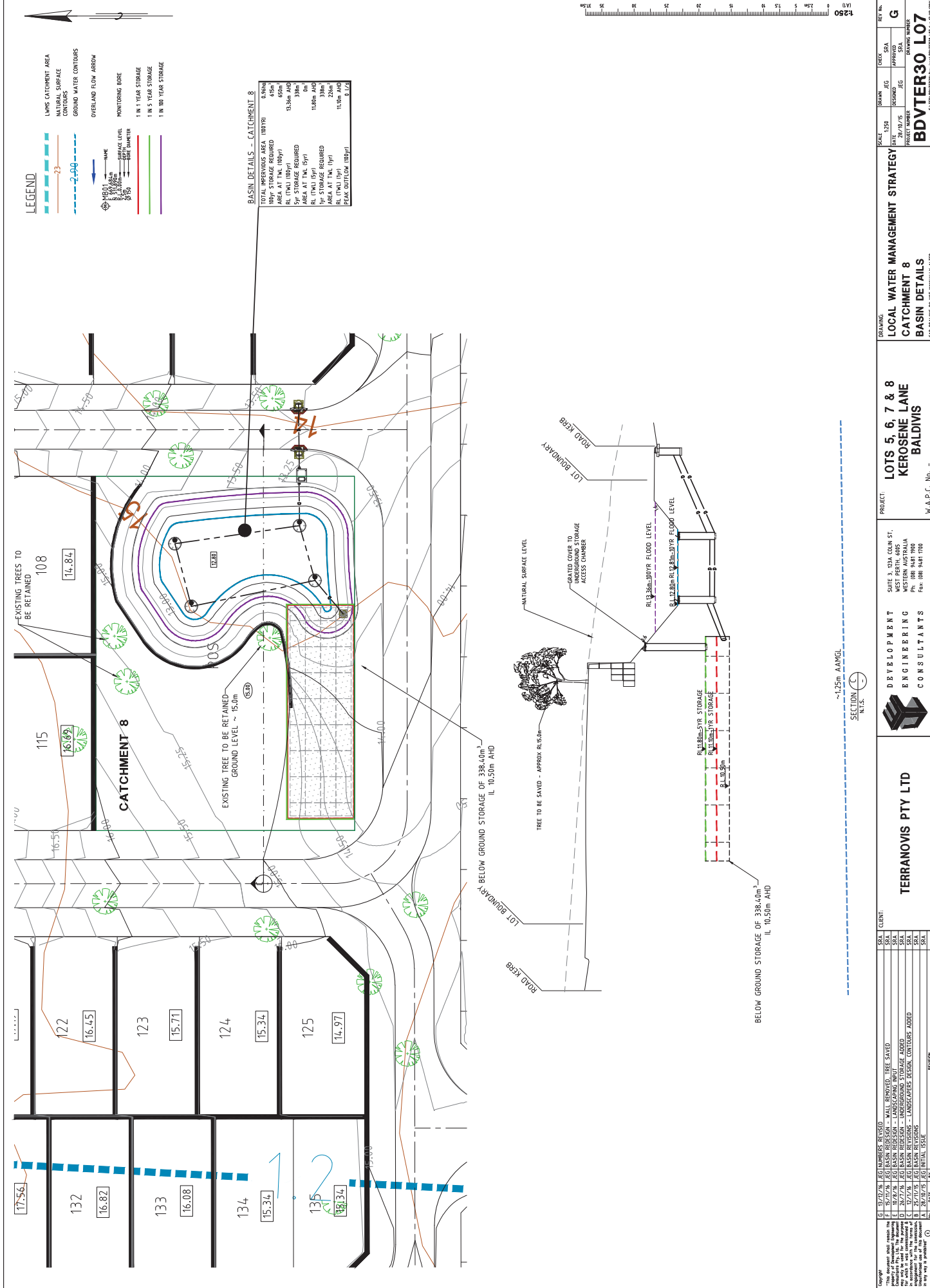
BDVTER30 L06

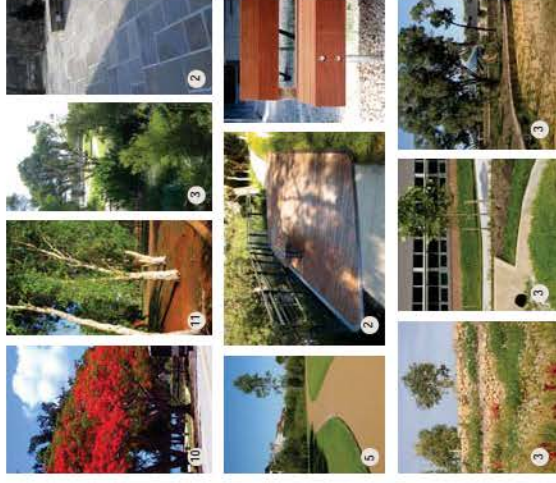
REV	DATE	BY	CHKD	DESCRIPTION
1	15/11/24	JES	REE	TREE TO BE SAVED NOTED
2	15/11/24	JES	REE	BASIN REVISION - WALL REMOVED, TREE SAVED
3	15/11/24	JES	REE	BASIN REVISION - UNDERGROUND STORAGE ADDED
4	15/11/24	JES	REE	BASIN REVISIONS - LANDSCAPERS DESIGN
5	15/11/24	JES	REE	BASIN REVISIONS
6	15/11/24	JES	REE	NUMBERS REVISED

SCALE	DATE	BY	CHKD	DESCRIPTION
1:250	15/11/24	JES	REE	TREE TO BE SAVED NOTED
1:250	15/11/24	JES	REE	BASIN REVISION - WALL REMOVED, TREE SAVED
1:250	15/11/24	JES	REE	BASIN REVISION - UNDERGROUND STORAGE ADDED
1:250	15/11/24	JES	REE	BASIN REVISIONS - LANDSCAPERS DESIGN
1:250	15/11/24	JES	REE	BASIN REVISIONS
1:250	15/11/24	JES	REE	NUMBERS REVISED

LOCAL WATER MANAGEMENT STRATEGY
CATCHMENT 6/7
BASIN DETAILS

BDVTER30 L06

[illegible]



LEGEND

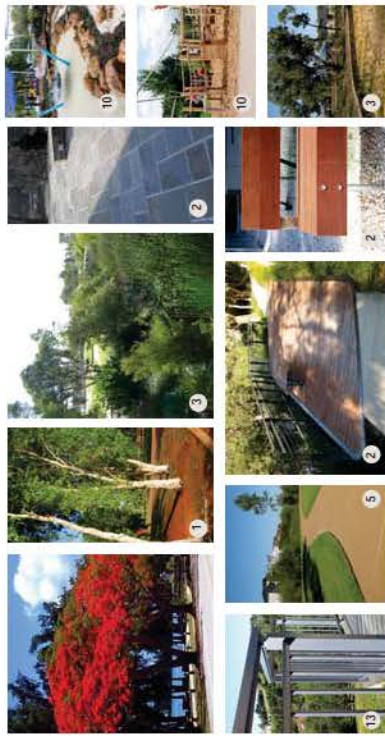
- 1 Ulmus parvifolia street trees to main road.
 - 2 Feature paved seating area overlooking basin / POS.
 - 3 Native reeds & sedges tubestock planting to drainage basin.
 - 4 Turf grassing to verge with evergreen street trees.
 - 5 Path connections to the adjacent POS network.
 - 6 Estate Entry sign
 - 7 1:100 year event overflow to open turf area.
 - 8 Make good to existing lawn / garden bed areas
 - 9 Existing high pressure gas line
 - 10 Feature deciduous shade tree to entry. E.g. Erythrina indica
 - 11 POS planted with groups of local, native trees. E.g. Eucalyptus gomphocephala
 - 12 Stormtrap underground storage.
 - e Significant existing trees to be retained & protected. Jarrah (Eucalyptus marginata) / Tuart (Eucalyptus gomphocephala)
 - p POS will provide attractive areas as hillside areas to walk, ride, sit and relax.
- Existing significant trees may be retained in verges and POS depending upon cut and fill requirements. These will be identified following finalised civil design works.
- Final drawings to be completed as part of subdivision stage.



12 TYPICAL DETAIL
RETAINING WALL & FENCE SURROUNDING SEATING AREAS
1:30 @ A1

LEGEND

- 1 Avenue of large native trees
E.g. Eucalyptus rudis or Melaleuca leucadendra
 - 2 Feature paved seating area overlooking basin with balustrade.
 - 3 Native reeds & sedges tubestock planting to drainage basin.
 - 4 Turf grassing to batter (max 1:5 slope)
 - 5 2m Wide in situ concrete path.
 - 6 Ulmus parvifolia street trees to main road.
 - 7 Underground storage tanks.
 - 8 RL 9.80-100yr Flood level.
 - 9 Feature paved picnic seating area with shade trees & feature garden bed planting.
 - 10 Feature deciduous shade trees E.g. Erythrina indica
 - 11 Drainage basin planted with native tree species.
E.g. Eucalyptus rudis & Melaleuca preissiana.
 - 12 Balustrade to retaining wall surrounding picnic area.
 - 13 Low native shrub & groundcover planting.
 - 14 Open lawn recreation area.
 - e Significant existing trees to be retained & protected.
Jarrah (Eucalyptus marginata) / Tuart (Eucalyptus gomphocephala)
 - p POS will provide attractive areas hillside area to walk, ride, sit and relax.
Existing significant trees may be retained in verges and POS depending upon cut and fill requirements. These will be identified following finalised civil design works.
- Final drawings to be completed as part of subdivision stage.



LEGEND

- 1 Avenue of native trees
E.g. Melaleuca leucadendra
 - 2 Feature paved seating area overlooking basin.
 - 3 Native reeds & sedges tubestock planting to drainage basin.
 - 4 Turf grassing to verge with Ulmus parrifolia street trees.
 - 5 2m Wide In situ concrete dual-use path.
 - 6 1:100 year flood level
 - 7 1:21 sloped walkway.
 - 8 Latentite block seating height retaining wall (TW 15.8)
 - 9 Feature paved picnic seating area with bin, overlooking playground.
 - 10 Mulched nature play playground area with climbing log and boulders.
 - 11 Feature deciduous shade trees E.g. Erythrina indica
 - 12 Drainage basin planted with native tree species.
E.g. Eucalyptus rudis or Melaleuca preissiana.
 - 13 Balustrade to top of wall.
 - 14 Underground storage tanks.
 - 15 Significant existing trees to be retained & protected.
Jarrah (Eucalyptus marginata) / Tuart (Eucalyptus gomphocephala)
 - 16 POS will provide attractive areas hillside areas to walk, ride, sit and relax.
 - 17 Existing significant trees may be retained in verges and POS depending upon cut and fill requirements. These will be identified following finalised civil design works.
- Final drawings to be completed as part of subdivision stage.



APPENDIX E – Approved Groundwater Licence for POS Irrigation



Your ref: CAW182356 & GWL182358

Our ref: RF14147

Enquiries: Alana Patterson

Tel: 95504236

Bortolo Morzenti
C/- Terranovis
PO Box 1320
CANNINGBRIDGE APPLECROSS WA 6153

Dear Licensee

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*
Property: Lot 8 Keroscene Lane Baldivis

Please find enclosed the following:

- Your licence to take water (GWL182358)
- 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
- Your licence to construct or alter a well (CAW182356)
- Form 2 "Information to be provided on completion of a non-artesian well"
- Brochure *Your licence to construct a well*

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.

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

A handwritten signature in blue ink, appearing to read 'Alana Patterson', is written over a faint, light blue circular official stamp.

Alana Patterson
A/ Snr Natural Resource Management Officer
Peel Region

30 May 2016



LICENCE TO TAKE WATER

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

Licensee(s)	Morzenti, Bortolo Nicola		
Description of Water Resource	Stakehill Perth - Superficial Swan	Annual Water Entitlement	5330 kL
Location of Water Source	Lot 8 On Diagram 31197 - Volume/Folio 1907/259 - Lot 8 Kerosene Lane Baldivis		
Authorised Activities	Taking of water for	Location of Activity	
	Irrigation of up to 0.711 ha of public open space	Lot 8 On Diagram 31197 - Volume/Folio 1907/259 - Lot 8 Kerosene Lane Baldivis	
Duration of Licence	From 24 May 2016 to 24 May 2026		

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 licensee must install an approved meter to each water draw-point through which water is taken under this licence.
- 4 The annual water year for water taken under this licence is defined as 1 July to 30 June.
- 5 The licensee must not, in any water year, take more water than the annual water entitlement specified in 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 Unless otherwise approved, all meter readings must be recorded on the 'Meter Water Use Card' available from the Department of Water.
- 9 The completed Meter Water Use Card must be submitted to the Department of Water every 12 month(s) commencing 14/07/2017.
- 10 The licensee must ensure the installed meter(s) accuracy is maintained to within plus or minus 5% of the volume metered, in field conditions.
- 11 The licensee must notify the Department of Water in writing of any water meter malfunction within seven days of the malfunction being noticed.

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:

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

End of terms, conditions and restrictions

**LICENCE TO CONSTRUCT OR ALTER WELL**

Granted by the Minister under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Morzenti, Bortolo Nicola	
Description of Water Resource	Stakehill Perth - Superficial Swan	
Location of Well(s)	Lot 8 On Diagram 31197 - Volume/Folio 1907/259 - Lot 8 Kerosene Lane Baldivis	
Authorised Activities	Activity	Location of Activity
	Construct 1 non-artesian well(s).	Lot 8 On Diagram 31197 - Volume/Folio 1907/259 - Lot 8 Kerosene Lane Baldivis
Duration of Licence	From 24 May 2016 to 24 May 2017	

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

- 1 The well must be constructed by a driller having a current class 1 water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or equivalent certification recognised nationally by the Australian Drilling Industry Association.
- 2 The licensee must install an approved meter to each well, and provide evidence of the installation to the Department of Water within 30 days of completion of the well.
- 3 The licensee shall provide to the Department of Water within 30 days of drilling, the results of down-hole lithological logging of the bore hole drill cuttings. The results must contain a strata description and their corresponding depth intervals.
- 4 The licensee shall construct the well using materials and methods for single aquifer systems described in "Minimum construction requirements for water bores in Australia, 3rd edition, National Uniform Drillers Licensing Committee (2012)".

End of terms, limitations and conditions