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Integrated Science & Design

Local Water Management Strategy

SPIRES – KEROSENE LANE LOCAL STRUCTURE PLAN

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Executive Summary

Roberts Day, on behalf of Carcione Nominees Pty Ltd, has prepared a Local Structure Plan (LSP) for urban development. The LSP formally includes lots 55, 56, 294, 295 and 772 Kerosene Lane, Baldivis. This area is herein referred to collectively as "the site". The site is bound by Kerosene Lane to the north, Baldivis Road to the east, existing residential areas to the south, and undeveloped landholdings to the west.

This Local Water Management Strategy (LWMS) has been developed to support the Spires - Kerosene Lane Local Structure Plan (LSP) in consideration of the objectives and principles detailed in *'Better Urban Water Management*' (WAPC 2008a), *State Planning Policy 2.9 Water Resources* (WAPC 2006) and *Planning Bulletin 92 Urban Water Management* (WAPC 2008b). Water will be managed using an integrated water cycle approach, which has been developed using philosophies and design approaches described in the *Stormwater Management Manual for Western Australia* (DoW 2007).

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. In summary, the environmental investigations conducted to date indicate that:

- The site receives 754 mm annual rainfall (on average) with the majority of rainfall received in June and July.
- The site topography ranges between 10 and 42 m Australian height datum (AHD). The highest elevation is located in the north west portion of the site.
- The majority of the site is underlain by Tamala Limestone with an area of Sand derived from Tamala Limestone located in the eastern half of the site.
- Permeability of soils across the site range between 0.4 m/day and 13.1 m/day. On average, a permeability of 4.9 m/day was measured across the site and is considered to be moderate to high.
- Acid sulphate soil (ASS) risk mapping classifies the entire site as having 'no known risk of encountering ASS within 3 m of the natural surface'.
- Vegetation across the majority of the site is considered to be in a 'Completely Degraded' or 'Degraded' condition.
- There are no wetlands within the site. A multiple use wetland (MUW) is located to the east of the site.
- Surface water is largely retained and infiltrated within the site consistent with the moderate to high permeability of the underlying sands.
- The historical maximum groundwater level (MGL) recorded at a local Department of Water (DoW) bore in close proximity to the site is at 2 m AHD.
- Depth to groundwater ranges between 8 m and 40 m below ground level (BGL). Groundwater flows towards the Indian Ocean.
- The south west portion of the site was historically used for market gardening. The remainder of the site has not been developed.

The Spires – Kerosene Lane LSP is proposed to be developed for residential purposes. Once developed, Spires – Kerosene Lane will provide a range of housing choices with lot sizes ranging from approximately 350 m^2 to 544 m^2 and will include 5.16 ha of public open space (POS).

The overall objective for integrated water cycle management for the development is to mimic the existing hydrological regime of the site. The design objectives seek to deliver best practice outcomes using a Water Sensitive Urban Design (WSUD) approach, including management approaches for:

- Water conservation
- Stormwater quality management
- Flood mitigation.

The criteria proposed within this LWMS are based on the characteristics of the existing environment and a contemporary best-practice approach to integrated water cycle management.

The overall approach to water conservation is to reduce the amount of scheme water required within the development at both a lot and estate scale. Within the lot, potable water consumption will be reduced via the use of water efficient fixtures and appliances (WEFA) and water wise gardening (WWG) principles. On an estate scale, groundwater will be utilised for irrigation of landscaped areas within POS areas which will also utilise WWG principles.

The stormwater management strategy aims to mimic the existing hydrology of the site. Runoff from the 1% AEP (annual exceedance probability) rainfall event (major event) will be retained onsite as close to source as practicably possible. Lots will retain all runoff from the roof and rear (up to the major event – 1% AEP) within the lot boundary in soakwells and pervious garden areas, with runoff from front of lot directed downstream. Runoff from the front of lots and the road network will be conveyed to downstream bio-retention areas (BRAs) and flood storage areas (FSAs). BRAs will be sized to accommodate runoff from the small rainfall event (first 15 mm). FSAs will be sized to accommodate runoff in excess of the small event up to and including the major event (1% AEP).

Surface water quality will be addressed using a treatment train approach, which incorporates lot scale retention (via soak wells and pervious garden areas), vegetated BRAs within POS (for small events) and FSAs (for major events). Further non-structural measures will also be adopted and will be detailed in the future Urban Water Management Plan (UWMP).

There is significant clearance to groundwater across the site (8 – 40 m) therefore groundwater management focusses on maintaining or improving groundwater quality. This will be achieved by reducing total nutrient loads originating from the development, treating surface water runoff as close to source as possible and using high nutrient uptake soils and vegetation within drainage infrastructure. Measures to address groundwater quality are consistent with those proposed for surface water quality.

The design criteria and the manner in which they are proposed to be achieved are presented in **Table E1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management across the site have actually been achieved.

This LWMS demonstrates that by following the recommendations detailed in the report the site is capable of being developed.

Table E1 Water management criteria and compliance summary

Management Aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	When implemented
Water conservation	WC 1	Utilise fit for purpose water sources throughout the development.	Potable water through integrated water supply scheme (IWSS).	Proponent	Detailed design
			Use of groundwater for POS irrigation.	Proponent	Detailed design
	WC 2	Consumption target of 7,500 kL/ha/year for POS areas.	WWG practices in POS.	Proponent	Landscape implementation
			Retain native vegetation where possible.	Proponent	Landscape implementation
	WC 3	Consumption target of 100 kL/person/year for residential areas with no more than 40-60 kL/person/year of scheme water.	Use of WWG practices.	Lot owner	Ongoing
			Use water efficient appliances.	Lot owner	Ongoing
			Use of water efficient fittings.	Lot owner	Lot construction
Stormwater management	SW1	Retain runoff from the major event on site.	Lots will retain major event (1% AEP) runoff from the roof and rear within soakwells and pervious garden areas. Runoff from front of lots will directed downstream and retained in BRAs and FSAs.	Lot owner	Lot construction
			Runoff from road reserves will be retained within BRAs (small event) and FSAs (greater than small event and up to the major event).	Proponent	Detailed design
	SW2	Maintain 500 mm clearance between habitable floor levels and the major event top water level (TWL) within onsite storage areas (BRAs and FSAs).	The indicative Landscape sections (provided in Appendix H of The Spires—Kerosene Lane LSP) and the earthworks (provided in **Appendix F**) show that finished floor levels of lots will maintain a minimum clearance to the major event TWL within onsite storage areas (BRAs and FSAs) of at least 500 mm.	Proponent	Detailed design
	SW3	Minor roads must remain passable in the minor rainfall event.	The stormwater pipe network will be designed to ensure that minor roads remain passable in the minor (20% AEP) rainfall event.	Proponent	Detailed drainage design

Management Aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	When implemented
	SW4	Retain and treat the small event as close to source as possible.	Lots will retain rainfall from the major event from the roof and rear within soakwells and pervious garden areas.	Lot owner	Lot construction
			Small event runoff from front of lots and road reserves will be retained within BRAs.		
			BRAs will be vegetated with species known for their nutrient uptake capabilities.	Proponent	Detailed design
			BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal.	Proponent	Detailed design
	SW5	Treatment areas to be sized to 2% of the total connected impervious area.	The total combined size of the BRAs is 3.7 % of the total connected impervious area (road pavement).	Proponent	Detailed design
	SW6	Utilise appropriate non-structural measures to reduce nutrient loads.	WWG practices.	Proponent	Landscape design / ongoing
			Maintenance of POS and drainage areas.	Proponent / CoR	Proponent for first two years then CoR
			Street sweeping.	Proponent / CoR	Proponent for first two years then CoR
Groundwater management	GW1	Maintain groundwater quality beneath the site.	Direct small event runoff to vegetated BRAs for treatment prior to infiltration.	Proponent	Detailed drainage design
			BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal.	Proponent	Landscape implementation
			Minimise fertiliser use in POS and road verges.	Proponent	Landscape implementation
			Use roll-on, drought tolerant turf species.	Proponent	Landscape implementation

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1 Introduction

1.1 Background

Roberts Day, on behalf of Carcione Nominees Pty Ltd, has prepared a Local Structure Plan (LSP) for the proposed urban development of a number of land parcels in the locality of Baldivis, within the City of Rockingham (CoR). The site is approximately 53.5 hectares (ha), situated 38 km south of the Perth Central Business District (CBD), as shown in **Figure 1**.

The LSP formally includes lots 55, 56, 294, 295 and 772 Kerosene Lane. This area is herein referred to collectively as "the site". The site is bound by Kerosene Lane to the north, Baldivis Road to the east, existing residential areas to the south, and undeveloped landholdings to the west, as shown in **Figure 2**. Lot 1212 Kerosene Lane and lots 1210 and 1211 Baldivis Road do not form part of the LSP but have been indicatively included in the extent of the LSP layout, as shown in **Appendix A**.

The LSP has been prepared for the site to support urban development, in accordance with CoR's Baldivis (North) District Structure Plan (DSP). Carcione Nominees Pty Ltd has coordinated the preparation of the LSP on behalf of the owners of lots 55, 56, 294, 295 and 772 Kerosene Lane.

1.2 Town planning context

The majority of the site is zoned "Urban" under the Metropolitan Region Scheme (MRS) (WAPC 2014) with the north-eastern portion zoned "Urban Deferred", and "Development" under the CoR Town Planning Scheme (TPS) No. 2) (CoR 2004).

1.3 Purpose of this report

It is important that the manner in which stormwater runoff from urban zoned areas is to be managed to avoid flooding and protect the environment is clearly documented early in the planning process. This approach provides the framework for actions and measures to achieve the desired outcomes at subdivision and development stages. This Local Water Management Strategy (LWMS) details the water management approach to support the Spires – Kerosene Lane LSP and is intended to satisfy the requirement to prepare a LWMS in accordance with *Better Urban Water Management* (WAPC 2008a).

1.4 Policy framework

There are a number of State and local Government policies of relevance to the site. These policies include:

- *State Water Strategy* (Government of WA 2003a)
- *State Water Plan* (Government of WA 2007)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Liveable Neighbourhoods Edition 4* (WAPC 2007)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009)
- *Bush Forever* (Government of WA 2000)

- *Planning Policy 3.4.1 Public Open Space* (CoR 2011)
- *Planning Procedure 1.8 Water Sensitive Urban Design* (CoR 2010).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water management approach that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

- *Better Urban Water Management* (WAPC 2008a)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Australian Rainfall and Runoff* (Engineers Australia 1987*)*
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017)
- *Stormwater Management Manual for Western Australia* (DoW 2007)
- *National Water Quality Management Strategy* (ANZECC 2000).

The guidance documents listed indicate a need for accurate baseline data prior to urban development. This will ensure that any future development is able to fulfil the stormwater management requirements of the Department of Water (DoW) and engineering standards specified by the CoR, but will also ensure that realistic water management criteria that are practically achievable are adopted.

1.5 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in *Better Urban Water Management* (WAPC 2008a). The LWMS is intended to support the Spires – Kerosene Lane LSP, and is further based on the following major objectives:

- Provide a broad level stormwater management framework to support future urban development.
- Incorporate appropriate best management practices (BMPs) into the drainage system that address the environmental and stormwater management issues identified.
- Minimise development construction costs, which will result in reduced land costs for future home owners.
- Minimise ongoing operation and maintenance costs for the land owners and CoR.
- Develop a water supply and conservation strategy for the site that will aim to meet water use targets.
- Gain support from DoW and CoR for the proposed method to manage stormwater within the site and potential impacts on downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

The Spires – Kerosene Lane LSP covers 53.5 ha and is proposed to be developed for residential purposes. Once developed, Spires – Kerosene Lane will provide a range of housing choices with lot sizes ranging from approximately 350 m^2 to 544 m^2 and will include 5.16 ha of public open space (POS). The Spires – Kerosene Lane LSP is shown in **Appendix A**.

Drainage is proposed to be integrated within POS areas incorporating a dual purpose of function and public amenity. Landscape concept plans are provided in Appendix H of The Spires—Kerosene Lane LSP.

3 Pre-development Environment

3.1 Sources of information

The following sources of information were used to provide a broad regional environmental context to the site:

- *National Water Quality Management Strategy* (NWQMS) (ANZECC 2000)
- *Rockingham 1:50 000 Environmental Geology Series* (Gozzard 1983)
- *WA Atlas* (Landgate 2015)
- *Water Register* (DoW 2015a)
- *Perth Groundwater Atlas* (DoW 2015b)
- *Water Information Reporting Tool* (DoW 2015c)
- *Weather and Climate Statistics data* (Bureau of Meteorology 2015).

In addition to the above information, site-specific investigations have been conducted. These have aimed at providing more detail to the existing regional information. These site-specific investigations include:

- *Environmental assessment and management strategy* (Emerge Associates 2015a)
- *Preliminary flora and vegetation survey* (Emerge Associates 2015b)
- *Geotechnical investigation report* (Structerre 2015).

The above studies have been reviewed to determine any existing hydrological constraints. This is important, as it can have implications for the stormwater management measures and the extent of earthworks that may be required to facilitate subdivision.

3.2 Climate

The site experiences a Mediterranean climate of hot dry summers and cool wet winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall, receiving 754 mm on average annually (Bureau of Meteorology 2015) with the majority of rainfall received in June and July. The region experiences rainfall for 90 days annually (on average).

3.3 Geotechnical conditions

3.3.1 Topography

The topography of the site is dominated by a high point occurring within the north west of the site at 42 m Australian height datum (AHD). The slope grades with a westerly and easterly aspect away from the high point and reaches a low point on the eastern boundary of 10 m AHD. Topographic contours of the site are shown in **Figure 3**.

3.3.2 Soils

The Rockingham sheet of the 1:50,000 scale *Environmental Geology series* map (Gozzard 1983) indicates that the area is largely underlain with Tamala Limestone (LS_1). Areas of Sand derived from Tamala Limestone (S_7) are located within the eastern half of the site. Geological mapping for the site is shown in **Figure 4**.

Results of geotechnical investigations (Structerre 2015) are consistent with regional mapping and indicate the site consists of sand overlying Tamala Limestone.

The site experiences variable permeability ranging between 0.4 m/day and 13.1 m/day with the lower permeability attributed to the presence of limestone or sand with a higher fines content (Structerre 2015). On average, a permeability of 4.9 m/day was measured across the site and is considered to be moderate to high (Structerre 2015).

Test pit and permeability test locations are shown in **Figure 4**.

3.3.3 Acid sulfate soils

The *WA Atlas* (Landgate 2015) acid sulfate soil (ASS) risk mapping classifies the entire site as having 'no known risk of ASS occurring within 3 m of natural soil surface'.

3.4 Flora and vegetation

A preliminary flora and vegetation survey (Emerge Associates 2015b) found that there are no Threatened or Priority Flora species within the site, nor are any considered likely to occur due to the high level of historical disturbance and widespread weed invasion which has resulted in the removal of almost all native understorey species.

The majority of the site is considered to be in a 'Completely Degraded' or 'Degraded' condition owing to clearing and extensive grazing that has resulted in the removal of most native flora species. The 'Completely Degraded' areas of the site include some areas containing scattered or isolated native trees such as *E. gomphocephala*, *C. calophylla* and *E. marginata* or planted non-native trees. The patches in 'Degraded' condition tended to contain an intact overstorey layer over an understorey dominated by weeds, with no or few remaining native shrub and forb species.

Vegetation condition mapping is shown in **Figure 5**.

3.5 Wetlands

The *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DPaW 2014) indicates that there are no wetlands within the site. A multiple use wetland (MUW) is located approximately 150 m to the east of the site (UFI 15785). The proposed development of the site will not impact on the wetland. The location of the MUW is shown in **Figure 6**.

3.6 Hydrology

3.6.1 Surface water quantity

No surface water bodies or channels are observed within the site. Surface water infiltrates freely across the site due to the moderate to high permeability of the underlying soils, as discussed in **Section 3.3.2**.

3.6.2 Surface water quality

Given that there are no defined surface water bodies or channels, no surface water quality data is available for the site.

3.6.3 Groundwater levels

The *Perth Groundwater Atlas* (DoW 2015b) historical maximum groundwater level (MGL) contours do not extend across the site.

Historical groundwater level monitoring data since 2004 from a nearby DoW monitoring bore (61410073) indicates that MGL reached 1.99 m AHD (14 October 2009) (DoW 2015c). Depth to groundwater is therefore assumed to range between 8 m and 40 m across the site.

The location of the DoW monitoring bore 61410073 is shown on **Figure 3** with the historical record provided in **Appendix B**.

3.6.4 Groundwater quality

No groundwater quality data has been obtained for the site due to the significant clearance to groundwater (8 – 40 m).

3.7 Current and historical land uses

Based on a review of historic aerial photography the site was largely vegetated with some small areas used for agricultural purposes (i.e. grazing) prior to 1953. Native vegetation in the south-west of the site was cleared between 1977 and 1979 to allow for other agriculture which ceased operations circa 2006. The remainder of the site has remained undeveloped.

3.8 Summary of existing environment

In summary, the environmental investigations conducted to date indicate that:

- The site receives 754 mm annual rainfall (on average) with the majority of rainfall received in June and July.
- The site topography ranges between 10 and 42 m AHD. The highest elevation is located in the north west portion of the site.
- The majority of the site is underlain by Tamala Limestone with an area of Sand derived from Tamala Limestone located in the eastern half of the site.
- Permeability of soils across the site range between 0.4 m/day and 13.1 m/day. On average, a permeability of 4.9 m/day was measured across the site and is considered to be moderate to high.
- ASS risk mapping classifies the entire site as having ‘no known risk of encountering ASS within 3 m of the natural surface’.
- Vegetation across the majority of the site is considered to be in a ‘Completely Degraded’ or ‘Degraded’ condition.
- There are no wetlands within the site. A MUW is located to the east of the site.
- Surface water is largely retained and infiltrated within the site consistent with the moderate to high permeability of the underlying sands.
- The historical MGL recorded at a local Department of Water (DoW) bore in close proximity to the site is at 2 m AHD.
- Depth to groundwater ranges between 8 m and 40 m BGL. Groundwater flows towards the Indian Ocean.
- The south west portion of the site has historically been used for market gardening. The remainder of the site has remained undeveloped.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future management plans must achieve. The water management strategy covers water consumption, groundwater management and stormwater management.

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003b) endorses the promotion of integrated water cycle management and application of Water Sensitive Urban Design (WSUD) principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater and groundwater
- Integrating water and land use planning
- Allocating and using water sustainably and equitably
- Integrating water use with natural water processes
- Adopting a whole of catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Stormwater management design objectives should therefore seek to deliver best practice outcomes in terms of:

- Potable water supply and consumption
- Flood mitigation
- Groundwater management.

The first step in applying integrated water cycle management in residential catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines and site specific studies undertaken in and around the site development. These were detailed in **Sections 1.4** and **3.1**.

The design criteria discussed in the following sections are based on the assessment of the existing environment within the site, with the aim of achieving the integrated water cycle outcomes discussed above.

4.2 Water conservation

This LWMS proposes the following water conservation criteria:

Criteria WC 1 Utilise fit for purpose water sources throughout the development.

Criteria WC 2 Consumption target of 7,500 kL/ha/year for POS areas.

Criteria WC 3 Consumption target of 100 kL/person/year for residential areas with no more than 40-60 kL/person/year of scheme water.

The manner in which these objectives will be achieved is further detailed in **Section 5**.

4.3 Surface water management

The principle behind surface water management at the site is to mimic the pre-development hydrological conditions, as described in **Section 3.6**. This principle and the guidance documents discussed in **Section 3** have guided the surface water management criteria.

This LWMS proposes the following stormwater design criteria:

Criteria SW1 Retain runoff from the major event on site.

Criteria SW2 Maintain 500 mm clearance between habitable floor levels and the major event top water levels (TWLs) within onsite storage areas (bio-retention areas (BRAs) and flood storage areas (FSAs)).

Criteria SW3 Minor roads must remain passable in the minor (20% AEP) rainfall event.

Criteria SW4 Retain and treat the small event as close to source as possible.

Criteria SW5 Treatment areas to be sized to 2% of the total connected impervious area.

Criteria SW6 Utilise appropriate non-structural measures to reduce nutrient loads.

The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.4 Groundwater management

Clearance to groundwater is significant across the site as discussed in **Section 3.6.3** and hence no groundwater level criteria are proposed. This LWMS therefore proposes the following groundwater management quality criteria:

Criteria GW1 Maintain groundwater quality beneath the site.

The manner in which these objectives will be achieved is further detailed in **Section 7**. Additional criteria to achieve groundwater quality aims are consistent with those proposed for surface water. In order to reduce unnecessary duplication these are not proposed as groundwater criteria.

5 Water Source Allocation, Infrastructure and Fit-For-Purpose

5.1 Fit for purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose principles have been utilised in the water conservation strategy for the site.

5.1.1 Scheme water

The site is located within and will connect to the Water Corporation (WC) integrated water supply scheme (IWSS) network. Scheme water is proposed to be used for all in-house potable uses, and where external house uses cannot be serviced by other supplies or approaches, it would also satisfy external house requirements.

5.1.2 Groundwater

The *Water Register* (DoW 2015a) indicates the site is located within the Stakehill groundwater area and the Tamworth Swamp groundwater subarea. Groundwater beneath the site is a multi-layered system comprised of the following:

- Perth - Superficial (unconfined) aquifer
- Perth - Leederville (confined) aquifer
- Perth - Yarragadee North (confined) aquifer.

The Superficial aquifer is considered to be the primary aquifer of interest in relation to this LWMS as this is the aquifer most likely impacted by water management practices within the site, and also most likely accessed for local use.

Groundwater is proposed to be used for irrigation of POS areas. Emerge Associates have prepared an irrigation schedule which details the water use requirements for both establishment and long term usage for all POS areas. The peak ongoing groundwater usage is estimated to be 12,350 kL/year as indicated in Appendix H of The Spires—Kerosene Lane LSP. Refer to **Section 5.4** for further details regarding estate scale irrigation requirements.

A groundwater licence (GWL180812(1)) has been secured and includes an annual water entitlement of 113,325 kL to meet the temporary dust suppression requirements and ongoing POS irrigation requirements. A copy of the licence is provided in **Appendix C**.

5.2 Water conservation measures

The Spires – Kerosene Lane development will utilise groundwater for POS irrigation, active POS irrigation management, waterwise gardening (WWG) principles for lot scale gardens and within estate landscaping and water efficient fixtures and appliances (WEFA) to ensure that the development minimises the use of water. Details of these measures are further discussed in the following sections.

5.2.1 Water efficient fixtures and appliances

Significant reduction in in-house water uses will be achieved with the use of water efficient fixtures and appliances. The Spires – Kerosene Lane LSP water conservation strategy assumes that all dwellings will use water efficient fixtures and that approximately 35% of homes will install water efficient appliances (ABS 2013b).

The uptake of water efficient fixtures will be mandated through the building licence, while the uptake of water efficient appliances will be encouraged by State and Local Government rebates. Typical water use rates (Australian Government 2011, Melbourne Water 2008) have been incorporated in the water balance analysis.

5.2.2 Waterwise gardens

Reductions in water use for irrigation by employing water efficiency measures can significantly reduce the total water usage (WC 2003). The development will undertake a variety of waterwise garden (WWG) measures to limit water use into the future within POS and the private residential landscape works under the control of the proponent. A variety of methods and approaches will be considered including any or all of the following:

- The adoption of water wise species, with a mix of local native and exotic water wise species.
- Where required, existing site soil may be improved with soil conditioner certified to Australian Standard AS 4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- The irrigation system is proposed to be designed and installed in accordance CoR irrigation specifications including consideration of hydro zone design solutions.
- The amount of turfed areas will be minimised to that which is functional only in meeting CoR and community needs.
- The design will cater for efficient water requirements during POS maintenance. This will be achieved by implementing an appropriate management and maintenance program for POS areas that will be further detailed at the Urban Water Management Plan (UWMP) stage.

The proponent will be providing front of lot landscaping packages which will utilise WWG principles. In relation to the lot and estate water balances discussed in **Sections 5.3** and **5.4** respectively, WWG principles will be utilised in all POS areas and within 75% of private lots (as informed by ABS studies (ABS 2013a, ABS 2013b)).

The use of WWG and water efficient fixtures and appliances will assist in achieving **Criteria WC1**, **WC2** and **WC3**.

5.3 Lot water balance

A water balance analysis has been undertaken to demonstrate the effectiveness of the water conservation strategy proposed. The analysis considers realistic uptakes of non-mandatory water conservation measures including WEFA, RWTs and WWG. Uptake rate and population assumptions are calculated using data from the ABS (ABS 2013a, b).

The water balance analysis has been based on the rates and calculation methodology presented in the Water Corporation Spreadsheet *AltWaterSupply_Water_Use_Model.xls* (WC 2011). The water balance analysis assumes an average of 2.6 people per lot. This spreadsheet has been adapted to

model the effects of using RWT, WWG and WEFA. Values are calculated from data provided by the ABS for new housing developments in Perth (ABS 2013a).

The results of the water balance indicate that on average, if households in the development adopt the proposed water conservation measures at typical uptake rates, they will use 49.6 kL/year/person. This achieves the state water consumption target of no more than 100 kL/year/person and the *Better Urban Water Management* (WAPC 2008a) aspirational goal of 40-60 kL/year/person, and satisfies **Criteria WC1** and **WC3**.

5.4 Estate scale water usage

Water usage at an estate scale has been determined by the amount of POS provided and any additional areas which will require irrigation. The Spires - Kerosene Lane LSP provides 5.16 ha of POS with a mixture of planting, turf and hard stand areas provided. Approximately 1.65 ha of POS will be permanently irrigated which, based on an average irrigation rate of 7,500 kL/ha/annum, the equates to 12,350 kL/annum. A concept irrigation schedule is provided in the landscape masterplan report provided in Appendix H of The Spires—Kerosene Lane LSP.

As discussed in **Section 5.1.2**, a groundwater licence (GWL180812(1)) has been secured and includes an annual water entitlement of 113,325 kL to meet the temporary dust suppression requirements and ongoing POS irrigation requirements. A copy of the licence is provided in **Appendix C**.

The above measures will assist in achieving **Criteria WC1** and **WC2**.

5.5 Wastewater management

The site will be connected to Water Corporation's deep sewer network.

5.6 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria, and how these are addressed within the Spires – Kerosene Lane development, is provided in **Table 1**.

Table 1 Water conservation criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
WC 1	Utilise fit for purpose water sources throughout the development.	Scheme water for use in lot.
		Use of groundwater for POS irrigation.
WC 2	Consumption target of 7,500 kL/ha/year for POS areas.	WWG practices in POS.
		Retain native vegetation where possible.
WC 3	Consumption target of 100 kL/person/year for residential areas with no more than 40-60 kL/person/year of scheme water.	Use of WWG practices in lot.
		Use of water efficient fittings.
		Use water efficient appliances.
		Use of WWG in POS.

6 Stormwater Management Strategy

The principle behind the stormwater management strategy for the Spires – Kerosene Lane development is to retain surface flows from up to the major event and infiltrate stormwater runoff as close to source as possible.

The utilisation of various WSUD strategies within the development drainage system will achieve the design criteria stated in **Section 4.3**.

WSUD techniques utilised in the stormwater management strategy are further discussed in the subsequent sections and include:

- Soakwells
- Raingardens
- BRAs
- FSAs.

Roadside swales and bottomless side entry pits are not included in the stormwater management strategy as the majority of runoff from within the site will be retained and infiltrated higher in the catchment. This approach mimics the pre-development hydrology of the site and increases public usability and amenity of downstream POS. Where required, flows will be piped under lots or within adjacent road reserve to downstream drainage infrastructure. Indicative piped flows are shown in **Figure 7**.

6.1 Stormwater management approach

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.3**. Surface runoff modelling undertaken using XPSWMM has been used to inform the design of stormwater infrastructure as detailed below. Modelling assumptions are provided in **Appendix D**. The post-development catchments across the Spires – Kerosene Lane development are shown in **Figure 7**.

6.1.1 Lot drainage

As discussed in **Sections 3.3.2** and **3.6.3**, the moderate to high permeability of underlying soils and the significant clearance to groundwater (> 8 m) are suitable conditions for localised infiltration. Therefore, lot roof and backyard areas (comprising 80% of total lot areas) will retain runoff from up to the major event within the lot in soakwells and pervious garden areas. Runoff generated from front of lot garden areas will infiltrate at source in the small event, with any excess runoff from front of lot directed to downstream storage areas. Lots will therefore retain 90% of runoff in the small event on lot.. Lot retention is the responsibility of the lot owner and will be required to be confirmed at building design.

The use of soakwells will assist in achieving **Criteria SW1** and **SW4**.

6.1.2 Development drainage

6.1.2.1 Rain gardens

Rain gardens will considered within in verges adjacent to rear loaded lots or where double frontage to lots is provided and other services and cross-overs allow adequate space to install them. The design of rain gardens will be generally consistent with that shown in **Plate 1**, and developed in consultation with CoR as part of the detailed civil and landscape design process.

Plate 1 Example rain garden

The specific location and capacity of raingardens will be determined at detailed design stage and documented in the future UWMP.

6.1.2.2 Bio-retention areas

Small event runoff from the road network and front of lot impervious areas will be retained within BRAs located within POS. BRAs will be co-located within FSAs, therefore rainfall events greater than the small event will overflow into the enveloping FSA (detailed in **Section 6.1.2.3**).

BRAs have been assumed to have a maximum depth of 500 mm, side slopes of 1:6 and will be underlain with a 300 mm layer of soil suitable for nutrient removal. The soil can be comprised of naturally found soils with a sufficient phosphorus retention index (PRI) (i.e. PRI >10). BRAs will also be vegetated with plant species known for their nutrient uptake capabilities. Indicative locations of BRAs are provided within **Figure 7** with storage details presented in **Table 2**. Inundation areas for the small event are shown in **Figure 8**.

Table 2 Small event retention storage

Basin	Catchment	Depth (mm)	TWL surface area (m^2)	Volume (m^3)
Basin A	Ct A	500	880	355
Basin B	Ct B, Kerosene Lane East	500	1,075	445
Basin C	Ct C, Ct E, Kerosene Lane West.	500	1,295	545
Basin D	Ct D	500	515	195
Total			*3,765*	*1,540*

The total combined area of the BRAs is 3.7% of the connected impervious area (impervious road reserve areas and impervious front of lot areas), which achieves **Criteria SW5**.

The use of BRAs will assist in achieving **Criteria SW1**, **SW4**, and **SW5**.

6.1.2.3 Flood storage areas

FSAs will be utilised to retain up to the major event runoff within the site. The size of the FSAs will be minimised due to the retention of lot runoff (80% of major event runoff retained on lot) higher in the catchment. Indicative locations of FSAs are provided within **Figure 7** with inundation for the minor events (10% and 20% AEP events) and major event shown in **Figure 9**, **Figure 10** and **Figure 11** respectively. Storage details of FSAs are presented in **Table 3**.

FSAs have been assumed to have 1:6 side slopes and a cumulative maximum depth (inclusive of BRA depth) of 1.2 m. FSAs will be designed to ensure a minimum 500 mm clearance is maintained between habitable floor levels and the major event TWL. A concept earthworks/finished floor level plan is provided in **Appendix E** with indicative FSA designs provided in Appendix H of The Spires—Kerosene Lane LSP.

The maximum infiltration time within the FSAs and BRAs following an extreme rainfall event (major event) is 14 hours. Infiltration calculations have been based on Darcy's law with an assumed hydraulic conductivity of 2.16 m/day (consistent with the fine-medium grained sands seen across the site detailed in **Section 3.3.2** and an assumed 50% clogging factor for design purposes).

The use of FSAs will assist in achieving **Criteria SW1, SW4** and **SW5**.

The configuration of BRAs and FSAs can be modified at detailed design stage, provided the assumed storages detailed in **Table 2** and **Table 3** are maintained. The Landscape Masterplan, provided in **Appendix H of The Spires—Kerosene Lane LSP**, shows how the development is intended to be landscaped. Note that the FSA characteristics are nominal, and will need to be confirmed/revised following outcomes of any geotechnical investigation, the development of the detailed earthworks strategy and detailed civil designs.

Table 3 Minor and major event storage

Basin	Catchment	20% AEP			10% AEP			1% AEP		
		Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)
Basin A	Ct A	0.68	2,712	821	0.89	2,976	1,407	1.2	3,405	2,410
Basin B	Ct B, Kerosene Lane East	0.64	2,056	728	0.76	2,183	973	1.2	2,710	2,050
Basin C	Ct C, Ct E, Kerosene Lane West	0.70	3,637	1,225	0.82	3,817	1,683	1.2	4,410	3,255
Basin D	Ct D	0.77	1,285	506	0.87	1376	644	1.2	1,690	1,150
Total			*,9690*	*3,280*		*10,352*	*4,707*		*12,215*	*8,865*

Note that basins are co-located, therefore values are cumulative and are inclusive of BRA storage.

6.2 Surface water criteria compliance summary

A summary of the proposed surface water design criteria and how these are addressed within the Spires – Kerosene Lane development is provided in **Table 4**.

Table 4 Surface water management criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Retain runoff from the major event on site.	Lots will retain runoff from the majority of lot areas (80%) up to the major event within soakwells and pervious garden areas. Runoff in excess of lot scale storage will be retained within downstream BRAs and FSAs.
		Runoff from road reserves will be retained within BRAs (small event) and within FSAs (greater than small event and up to the major event).
SW2	Maintain 500 mm clearance between habitable floor levels and the major event top water level (TWL) within onsite storage areas (BRAs and FSAs).	The indicative Landscape sections (provided in Appendix H of The Spires—Kerosene Lane LSP) and the earthworks (provided in Appendix E) show that finished floor levels of lots will maintain a minimum clearance to the major event TWL within onsite storage areas (BRAs and FSAs) of at least 500 mm.
SW3	Minor roads must remain passable in the minor rainfall event.	The stormwater pipe network will be designed to ensure that minor roads remain passable in the minor (20% AEP) rainfall event.
SW4	Retain and treat the small event as close to source as possible.	Lots will retain runoff from the majority of lot areas (90%) in the small event within soakwells and pervious garden areas.
		Small event runoff from road reserves and front of lot areas will be retained within BRAs.
		BRAs will be vegetated with species known for their nutrient uptake capabilities.
		BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal.
SW5	Treatment areas to be sized to 2% of the total connected impervious area.	The total combined area of BRAs is 3.7 % of the connected impervious area (impervious road reserve areas and impervious front of lot areas).
SW6	Utilise appropriate non-structural measures to reduce nutrient loads.	WWG practices.
		Maintenance of POS and drainage areas.
		Street sweeping.

7 Groundwater Management Strategy

Clearance to groundwater is significant across the site as discussed in **Section 3.6.3**. Groundwater management for the site therefore focusses on groundwater quality.

7.1 Groundwater quality

The main objective of the management of groundwater is to maintain the existing groundwater quality. This can be achieved by reducing the total nutrient load to groundwater from sources within the development and by improving the groundwater via treatment of surface runoff prior to infiltrating to groundwater.

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.4** and detailed in **Section 6**.The reduction of nutrient loads to groundwater will be achieved by the following measures:

- Direct stormwater to vegetated BRAs.
- BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal. The soil can be comprised of naturally occurring soils with a high PRI (i.e. PRI >10). If parent soils are found to have sufficient PRI then additional imported soils/media will not be required.
- Minimising fertiliser use to establish and maintain vegetation within POS areas and road verges.
- Utilising drought tolerant turf species that require minimal water and nutrients.
- Roll-on turf will be used within POS areas to prevent the high nutrient input requirement during establishment of turf.
- The change in land use from market gardening and agriculture (as discussed in **Section 3.7**) to residential will also substantially reduce nutrient loading and improve groundwater quality.

The above measures will improve the quality of the water prior to it infiltrating into the underlying groundwater, and will assist in achieving **Criteria GW1**.

7.2 Groundwater criteria compliance summary

A summary of the proposed groundwater quantity design criteria and how these are addressed within the Spires – Kerosene Lane development is provided in **Table 5**.

Table 5 Groundwater management criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Maintain groundwater quality beneath the site.	Direct small event runoff to vegetated BRAs for treatment prior to infiltration.
		BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal.
		Minimise fertiliser use in POS and road verges.
		Use roll-on, drought tolerant turf species.

8 Matters to be addressed in the UWMP

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future subdivision designs and supportive UWMPs will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs include:

- Detailed drainage design
- Soil specifications and requirements
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction period management strategy.

These are further detailed in the following sections. Post-development groundwater monitoring is not proposed due to the significant depth to groundwater (>8 m) as discussed in **Section 3.6.3**.

8.1 Detailed drainage design

While the Spires – Kerosene Lane development area drainage catchments have been defined based on the earthworks model presented in **Appendix E**, it is possible that these could undergo some change to accommodate stakeholder feedback prior to final subdivision design. It is also expected that the civil drainage designs will be progressed to a level that provides detailed cross-sections, sizes of storage areas, pipe sizes, inverts, etc. The ultimate aim of revising the hydrological model will be to confirm that the post-development runoff volumes are able to meet the performance criteria proposed in **Section 4** of this LWMS. The design of the drainage system to date has been undertaken at an appropriate level for the LSP and runoff-routing computer modelling of the stormwater drainage system will be reviewed once detailed drainage design has commenced for the area. The exact location and shape of the stormwater management infrastructure will still need to be specified and presented within the future UWMP.

The exception to the requirement to revise the surface runoff modelling is if the catchment details and basin designs are consistent with the assumptions made in this LWMS. If this were the case it would be acceptable to provide design calculations for the concrete pipe network and retention areas to demonstrate compliance with the LWMS.

8.2 Soil specifications

As discussed previously, BRAs will be underlain with a 300 mm layer of soil suitable for nutrient removal. The soil can be comprised of naturally occurring soils with a high PRI (i.e. PRI >10). The exact soil to be used will be confirmed at UWMP stage.

The permeability of soil should be confirmed to be consistent with the permeability of soils underlying BRAs as specified in the modelling assumptions report (provided in **Appendix D**). Alternatively, the permeability of the soil to be used is to be reflected in future detailed modelling at the UWMP stage.

8.3 Implementation of water conservation strategies

A number of potential measures to conserve water have been presented within this LWMS. These water conservation strategies will be incorporated into the design and the ongoing maintenance of all POS areas. Landscape design measures that will be incorporated into the water conservation strategy will be further detailed within the future UWMPs.

8.4 Non-structural water quality improvement measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). Some measures will be more appropriately implemented at a Local Government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the subdivision and the POS areas. The future UWMP will provide reference to measures such as public education (through measures such as signage that may be implemented to raise awareness).

8.5 Management and maintenance requirements

The management measures to be implemented to address surface water quality, such as the use of vegetation within BRAs and FSAs will require ongoing maintenance. Therefore, the future UWMP will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the CoR and DoW will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.6 Construction period management strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed in the future UWMP.

9 Implementation

This LWMS is a key supportive document for the Spires – Kerosene Lane LSP. The development of this LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the site and to guide the development of the future UWMPs.

9.1 Roles and responsibility

This LWMS provides a framework that the developer can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State policies and have been endorsed by the CoR. The responsibility for working within the framework established within the LWMS rests with the proponent, although it is anticipated that future UWMPs will be developed in consultation with the CoR and DoW as these will be the ultimate approval agencies.

It will be the responsibility of the proponent to prepare detailed designs and supportive UWMPs. It is also the responsibility of the proponent to demonstrate that the proposed detailed civil designs and the supportive UWMPs comply with the objectives and management approaches provided in this LWMS.

It is the lot owner's responsibility to ensure the major event is retained on lot (as discussed in **Section 6.1.1**).

9.2 Funding

The management strategies outlined in this LWMS will be funded by the developer.

9.3 Review

It is not anticipated that this LWMS will be reviewed unless additional land parcels/lots are added to the Spires – Kerosene Lane LSP prior to detailed design or the Spires – Kerosene Lane LSP undergoes significant change post-lodgement. If additional areas are required to be covered by the LWMS it is most likely that an addendum to cover these areas could be prepared. If the Spires – Kerosene Lane LSP is substantially modified this LWMS will need to be reviewed and the criteria reviewed to ensure that all are still appropriate.

The next stages of water management are anticipated to be detailed design. Detailed civil designs should be supported by a UWMP. The UWMP is largely an extension of the LWMS, as it should provide detail to the designs proposed within this LWMS, and will demonstrate compliance with the criteria proposed in **Section 4**.

10 References

10.1 General references

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10.2 Online references

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FIGURES

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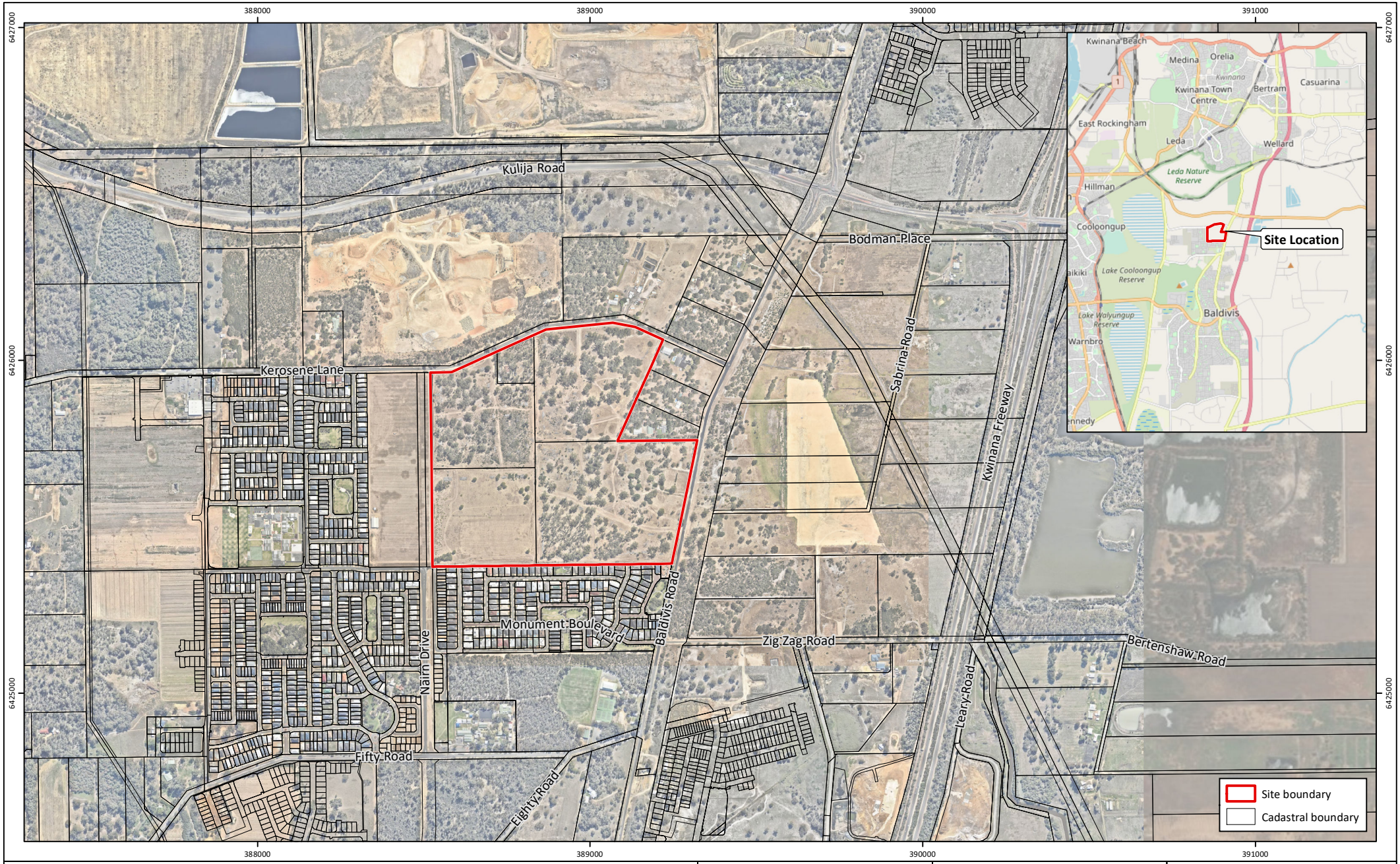

Figure 1: Site Location

Project: Local Water Management Strategy
Spires – Kerosene Lane Local Structure Plan
Client: Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F04b
Drawn: KNM
Date: 21/08/2019
Checked: RLE
Approved: RLE
Date: 21/08/2019

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Scale: 1:15,000@A4
GDA 1994 MGA Zone 50

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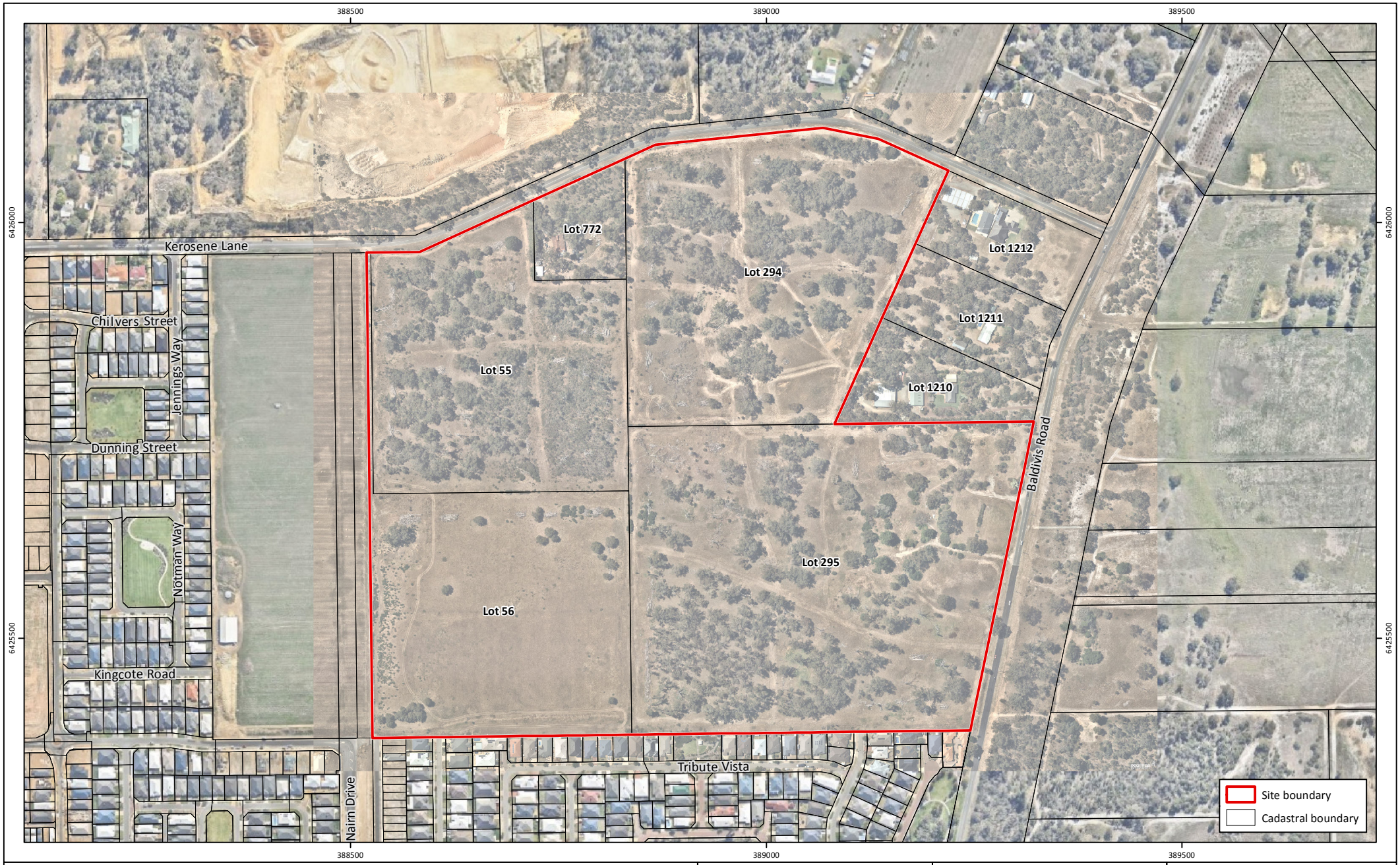

Figure 2: Cadastral Boundaries

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
Client:	Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F05b

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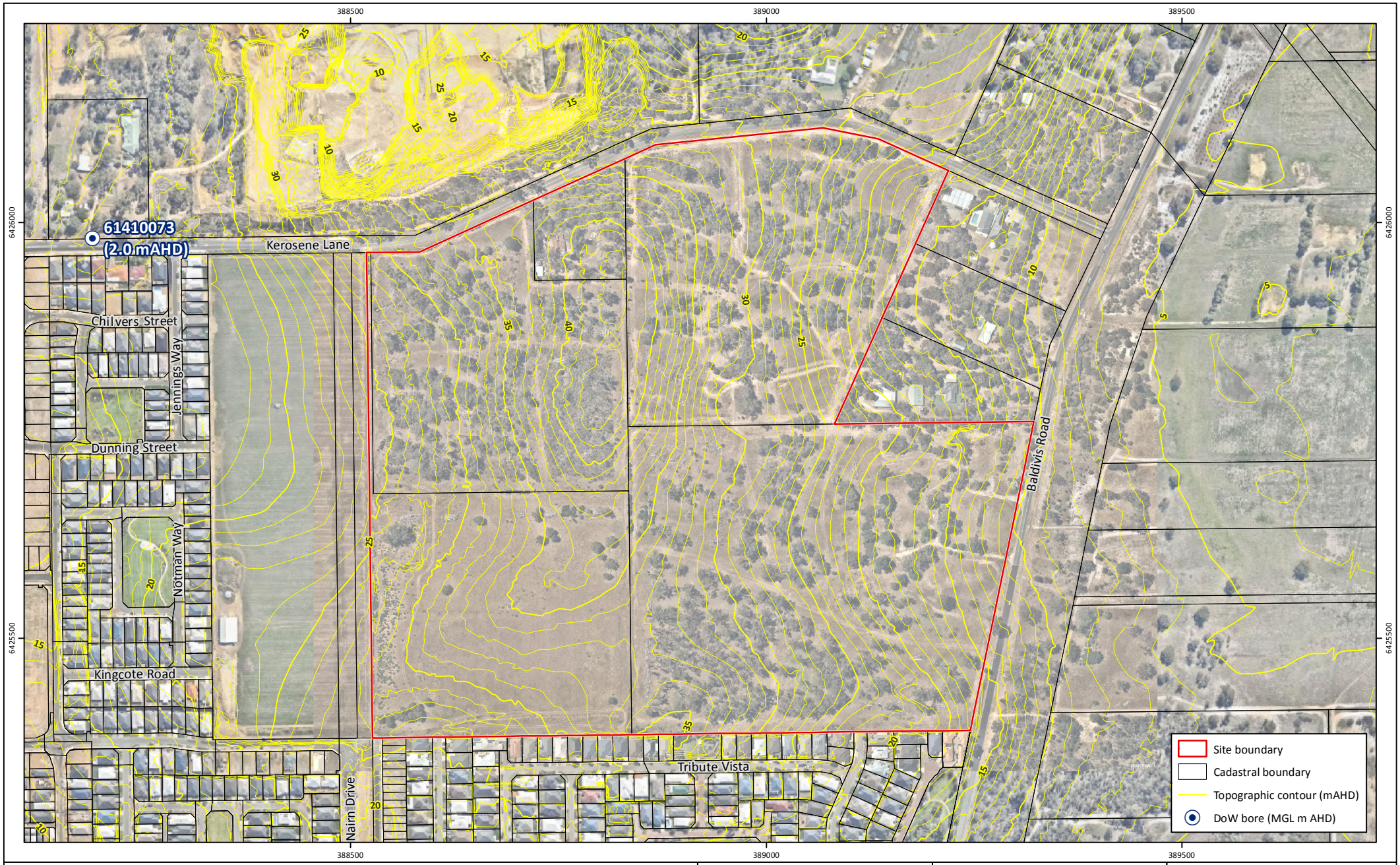

Figure 3: Topography and Groundwater

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
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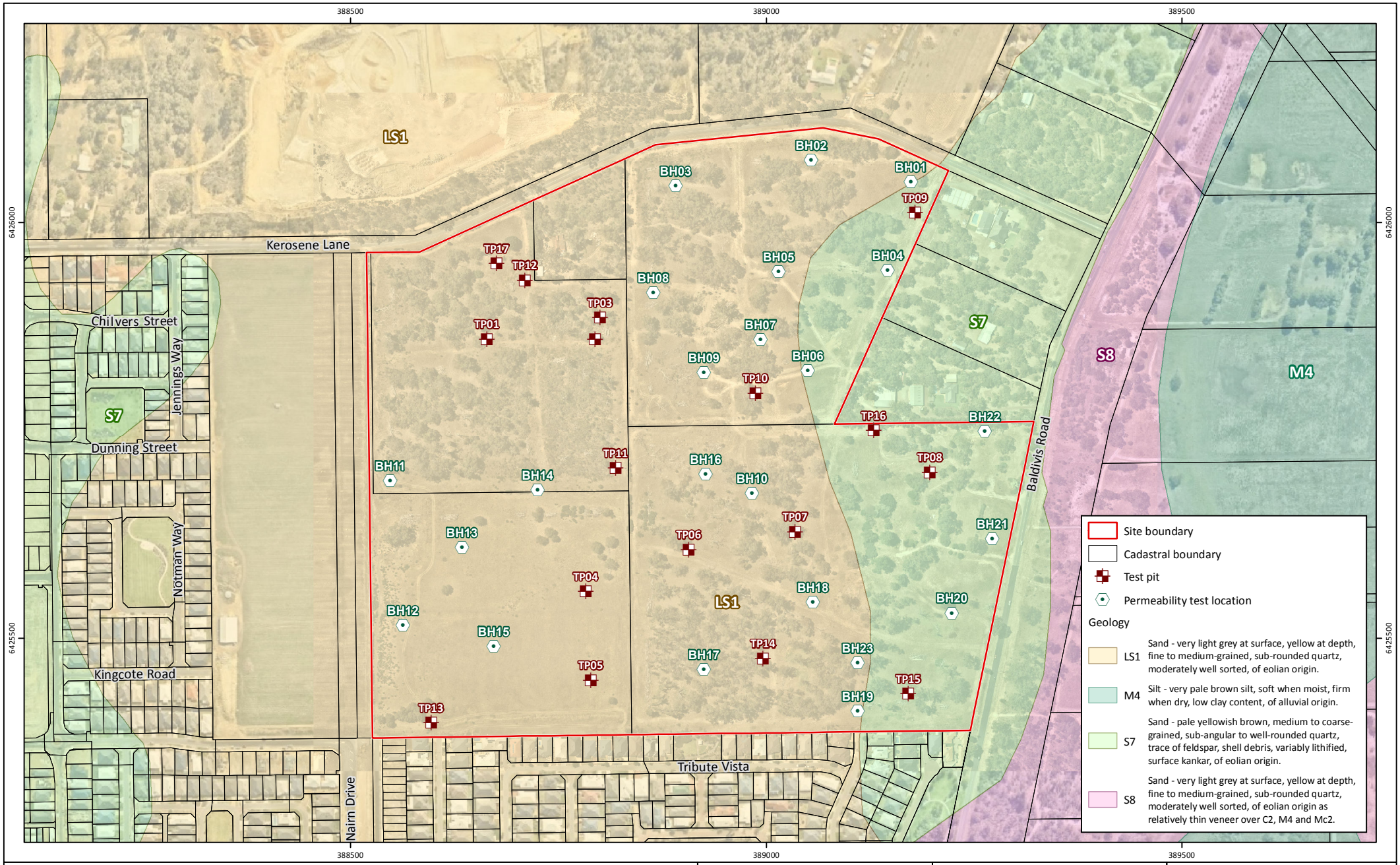

Figure 4: Soil Types

Project: Local Water Management Strategy
Spires – Kerosene Lane Local Structure Plan
Client: Carcione Nominees Pty Ltd

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EP15-009(02)--F07b
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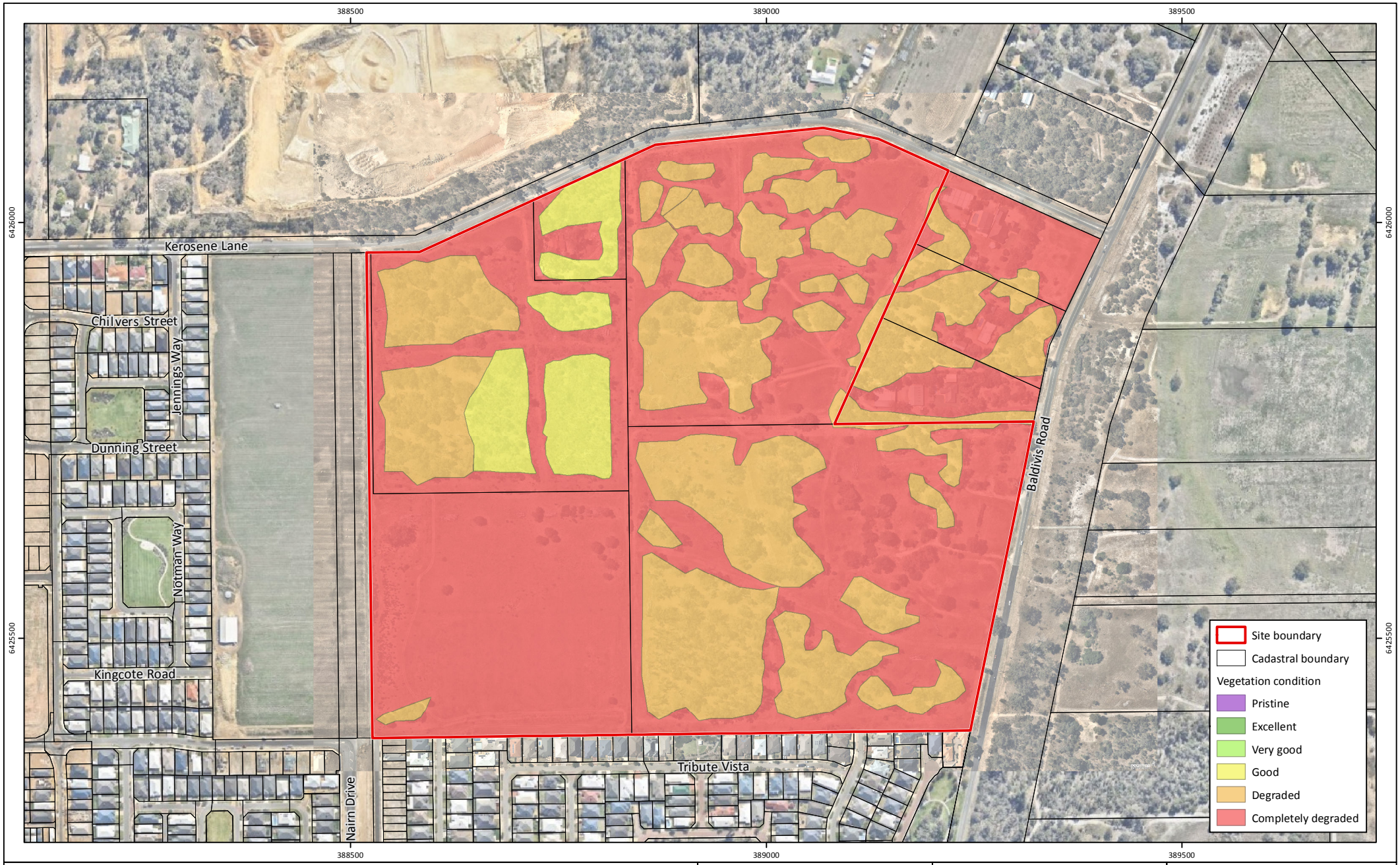

Figure 5: Vegetation Condition

Project: Local Water Management Strategy
Spires – Kerosene Lane Local Structure Plan
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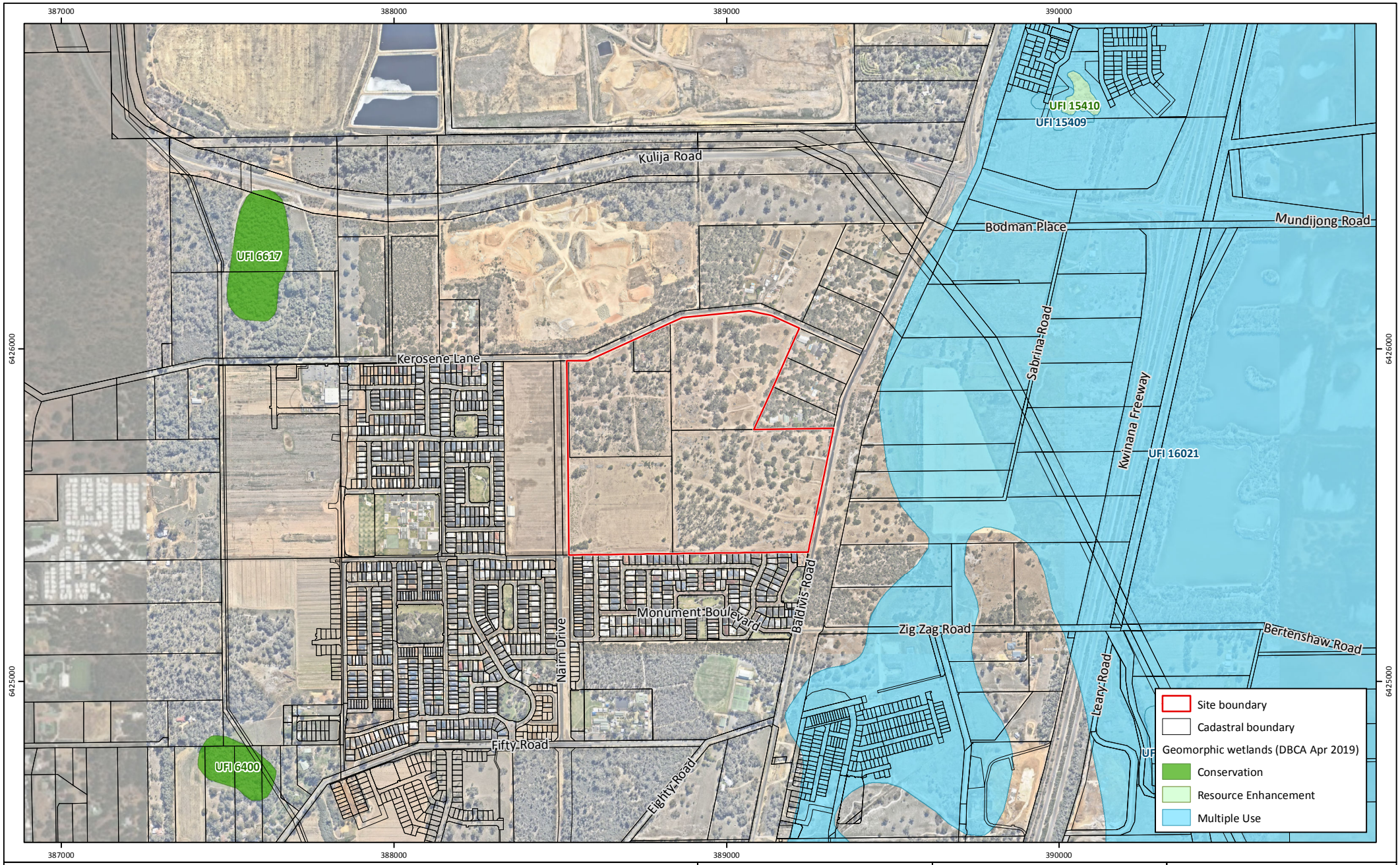

Figure 6: Geomorphic Wetlands

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
Client:	Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F08b

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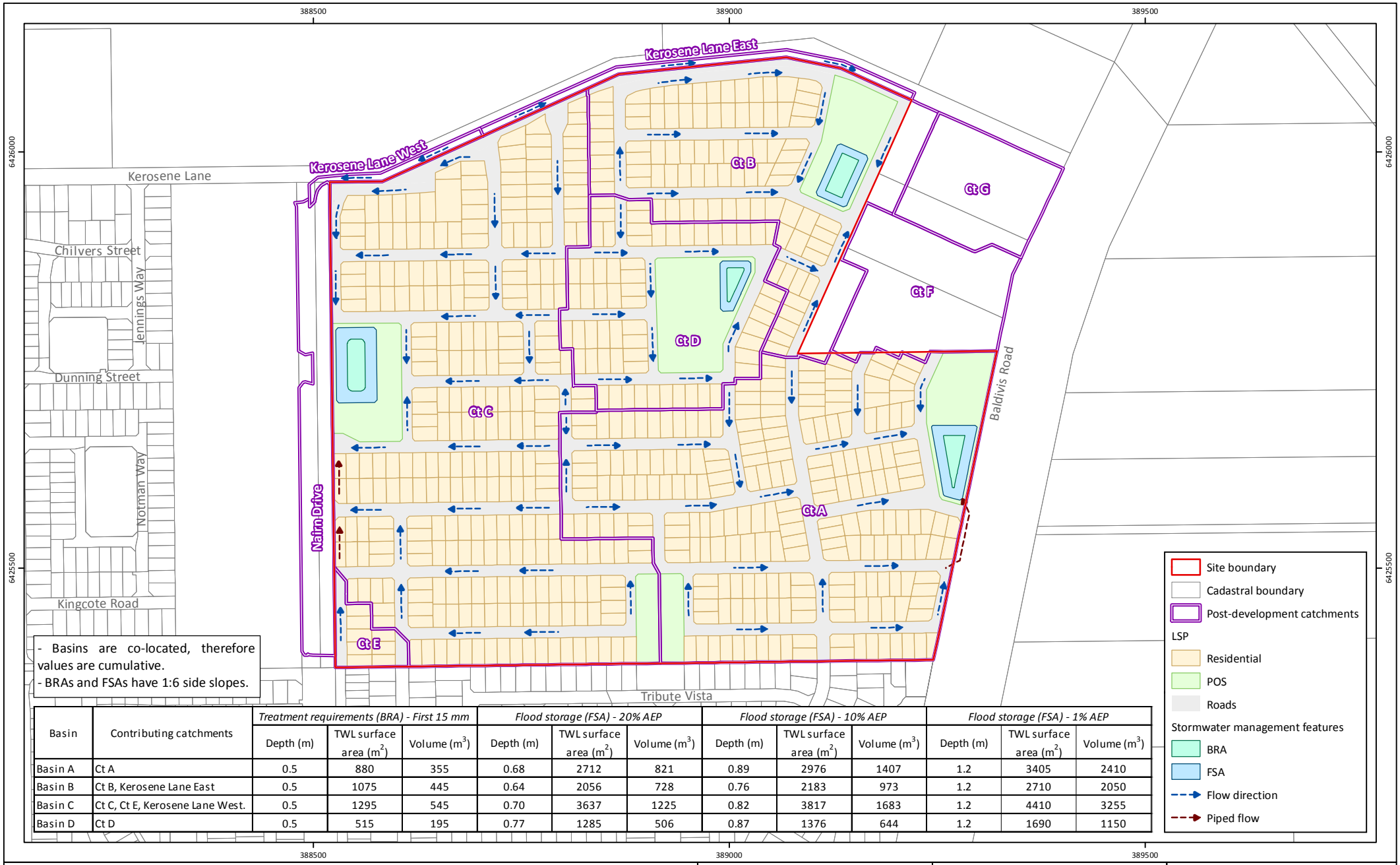

Basin	Contributing catchments	*Treatment requirements (BRA) - First 15 mm*			*Flood storage (FSA) - 20% AEP*			*Flood storage (FSA) - 10% AEP*			*Flood storage (FSA) - 1% AEP*		
		Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)
Basin A	Ct A	0.5	880	355	0.68	2712	821	0.89	2976	1407	1.2	3405	2410
Basin B	Ct B, Kerosene Lane East	0.5	1075	445	0.64	2056	728	0.76	2183	973	1.2	2710	2050
Basin C	Ct C, Ct E, Kerosene Lane West.	0.5	1295	545	0.70	3637	1225	0.82	3817	1683	1.2	4410	3255
Basin D	Ct D	0.5	515	195	0.77	1285	506	0.87	1376	644	1.2	1690	1150

Figure 7: Stormwater Management Features

Project: Local Water Management Strategy
Spires – Kerosene Lane Local Structure Plan
Client: Carcione Nominees Pty Ltd

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EP15-009(02)--F09d
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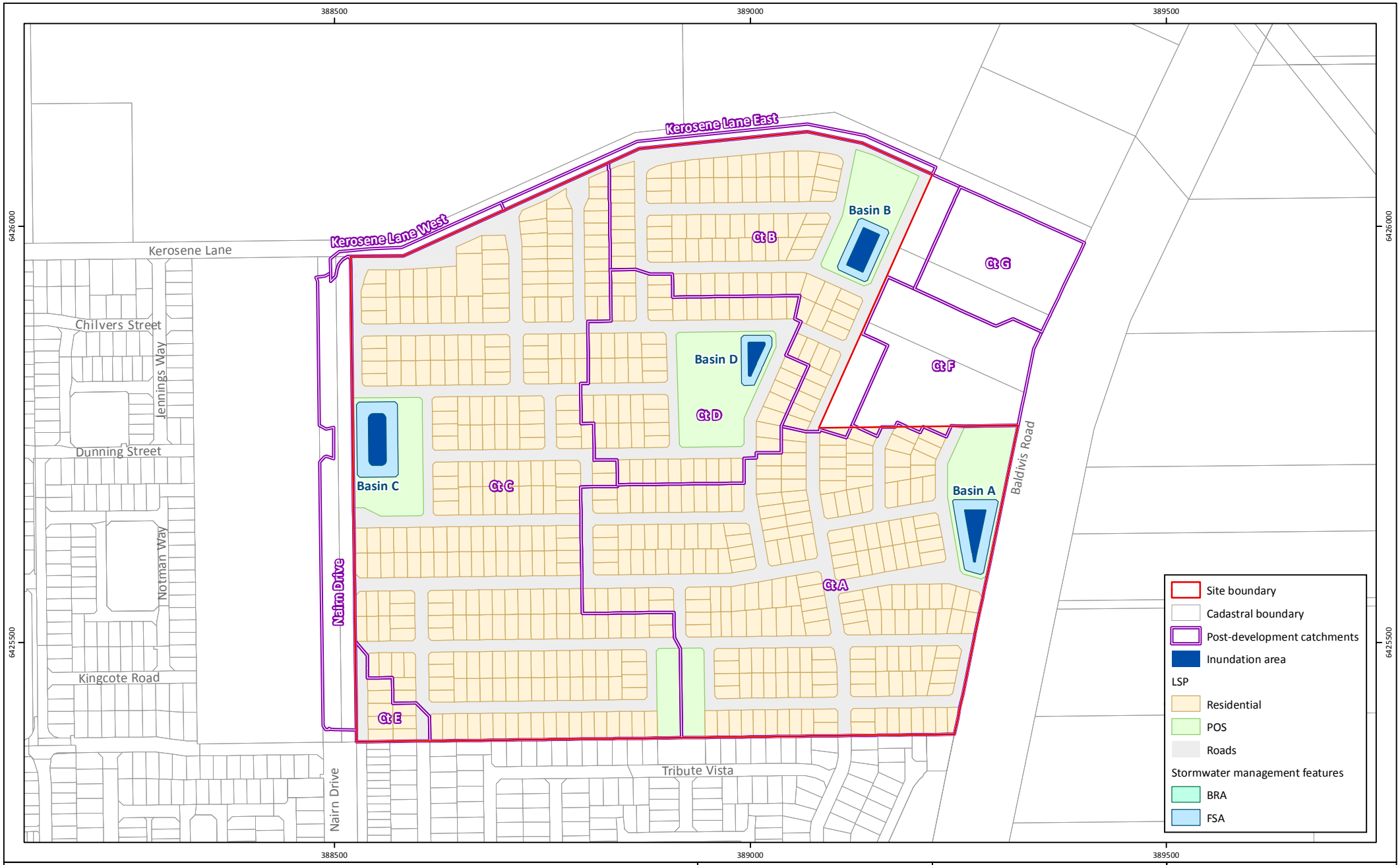

Figure 8: Small Event Inundation

Project: Local Water Management Strategy
Spires – Kerosene Lane Local Structure Plan
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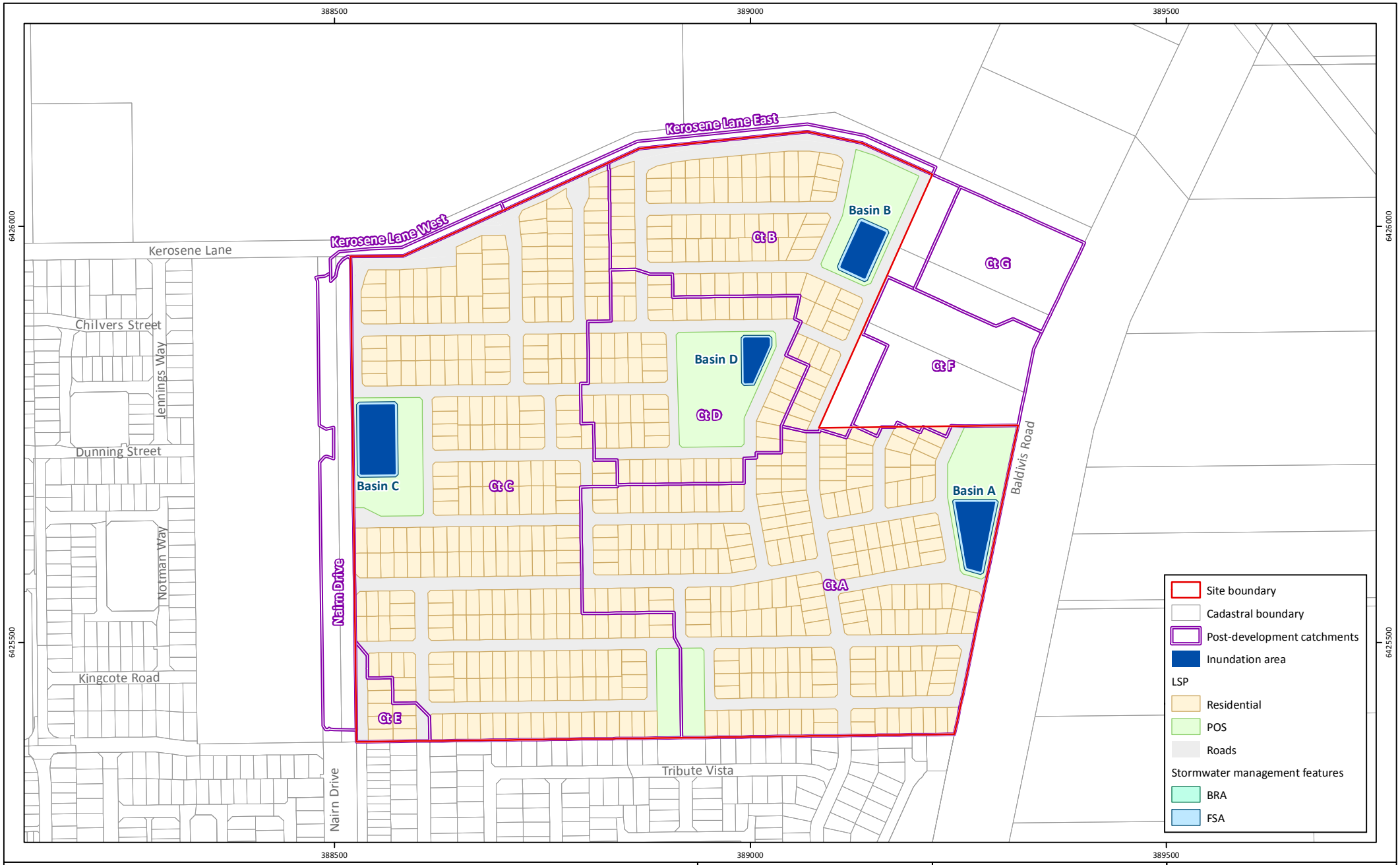

Figure 9: 20% AEP inundation

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
Client:	Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F37d

Drawn:	KNM
Date:	21/08/2019
Checked:	RLE
Approved:	RLE
Date:	21/08/2019

N

0 100 200
Metres

Scale: 1:6,000@A4

GDA 1994 MGA Zone 50

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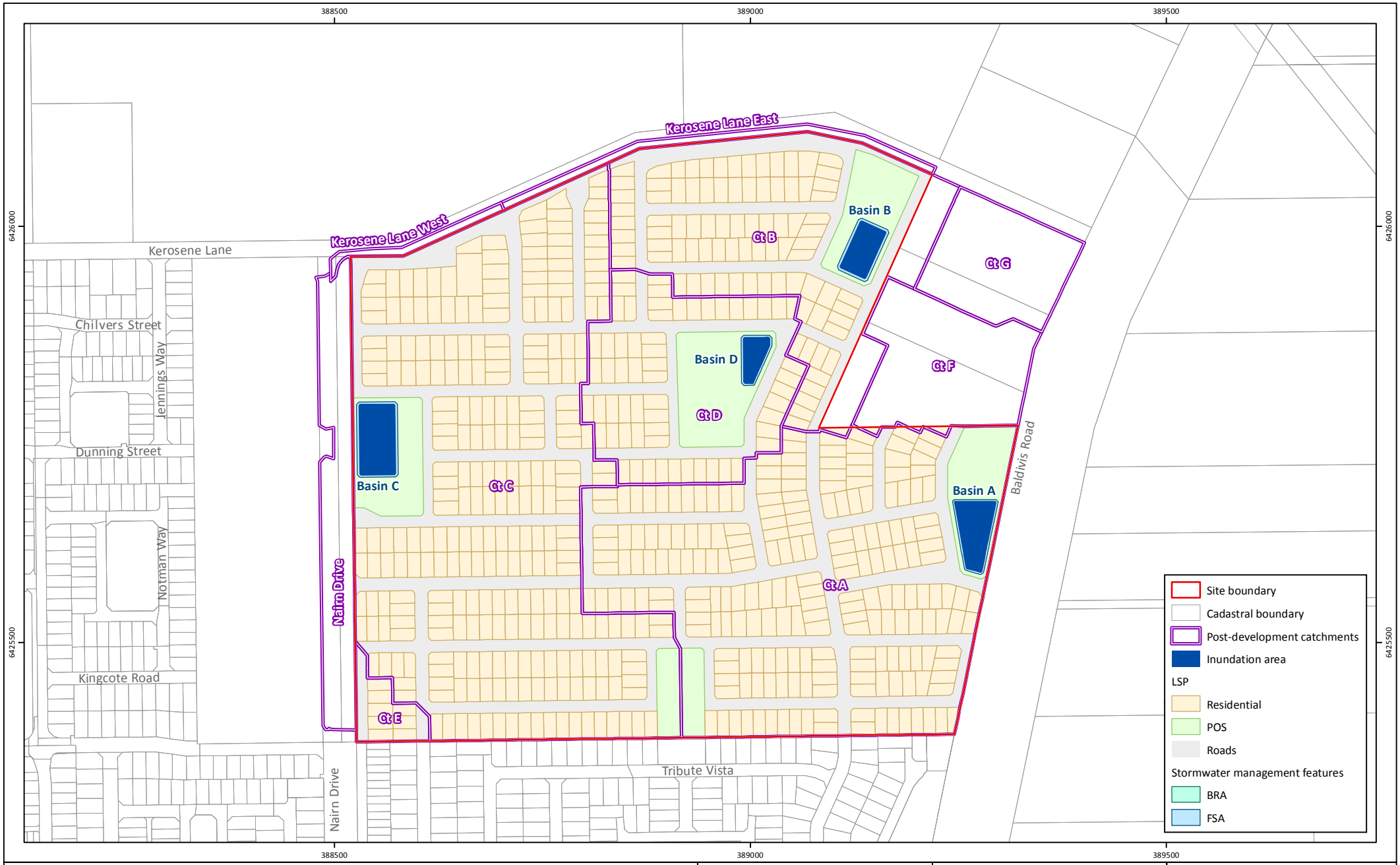

Figure 10: 10% AEP inundation

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
Client:	Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F38d

Drawn:	KNM
Date:	21/08/2019
Checked:	RLE
Approved:	RLE
Date:	21/08/2019

N

0 100 200
Metres

Scale: 1:6,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES
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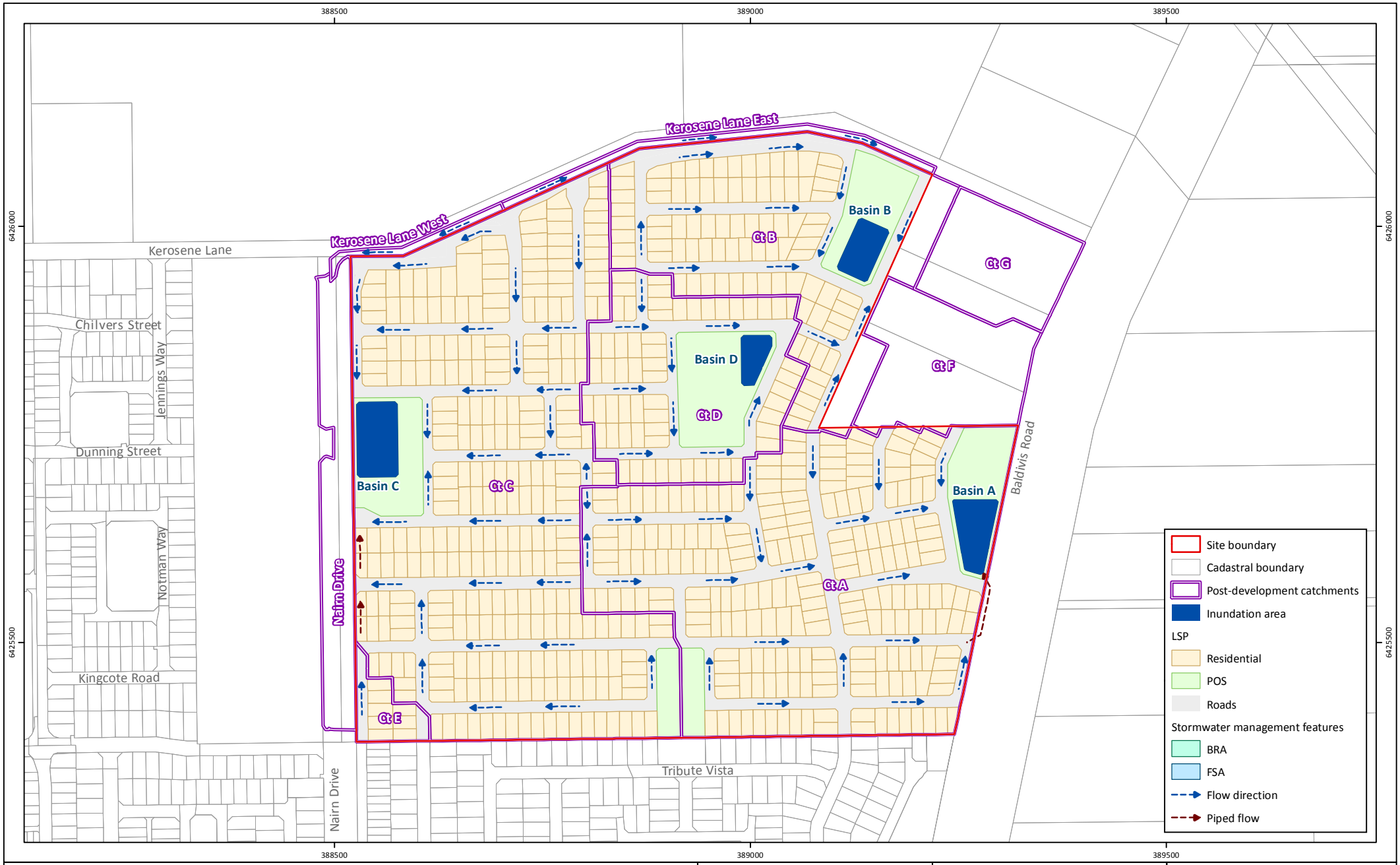

Figure 11: 1% AEP inundation

Project:	Local Water Management Strategy Spires – Kerosene Lane Local Structure Plan
Client:	Carcione Nominees Pty Ltd

Plan Number:
EP15-009(02)--F39d

Drawn:	KNM
Date:	21/08/2019
Checked:	RLE
Approved:	RLE
Date:	21/08/2019

N

0 100 200
Metres

Scale: 1:6,000@A4

GDA 1994 MGA Zone 50

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APPENDIX A

SPIRES – KEROSENE LANE LSP

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LEGEND

- STRUCTURE PLAN BOUNDARY
- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- 300m BUFFER TO LIMESTONE QUARRY (NOTIFICATIONS ON TITLE AS PER PART ONE, CLAUSE 4.3)

LAND USE

- RESIDENTIAL - R25
- RESIDENTIAL - R30
- RESIDENTIAL - R40
- PUBLIC OPEN SPACE

ROAD HIERARCHY

- INTEGRATOR A
- INTEGRATOR B
- NEIGHBORHOOD CONNECTOR A
- ACCESS STREET C

CADASTRAL INFORMATION
SOURCE: WATERCORP
YYMMDD: NA
DWG REF: NA
PROJECTION: MGA94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

great places

SIZE A3_1:4000

0 metres 40 80 120 160 200

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
H	INCREASE STRUCTURE BNDY	190416	SB	DP
G	WAPC MODS	190321	SB	DP
F	POS + DENSITY REDESIGN	180711	LI	DP
E	POS REDESIGN	180703	LI	DP
D	LOT UPDATE	160812	HH	DP
C	ROAD HIERARCHY	160127	RF	ED/DP

STRUCTURE PLAN MAP (PLAN 1)

Lots 55, 56, 294 & 295 Kerosene Lane
Baldivis

REF NO.	DRAW NO.	REV.
CGC NBA	**RD1 200**	**H**

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APPENDIX B

DWER BORE HISTORICAL RECORD

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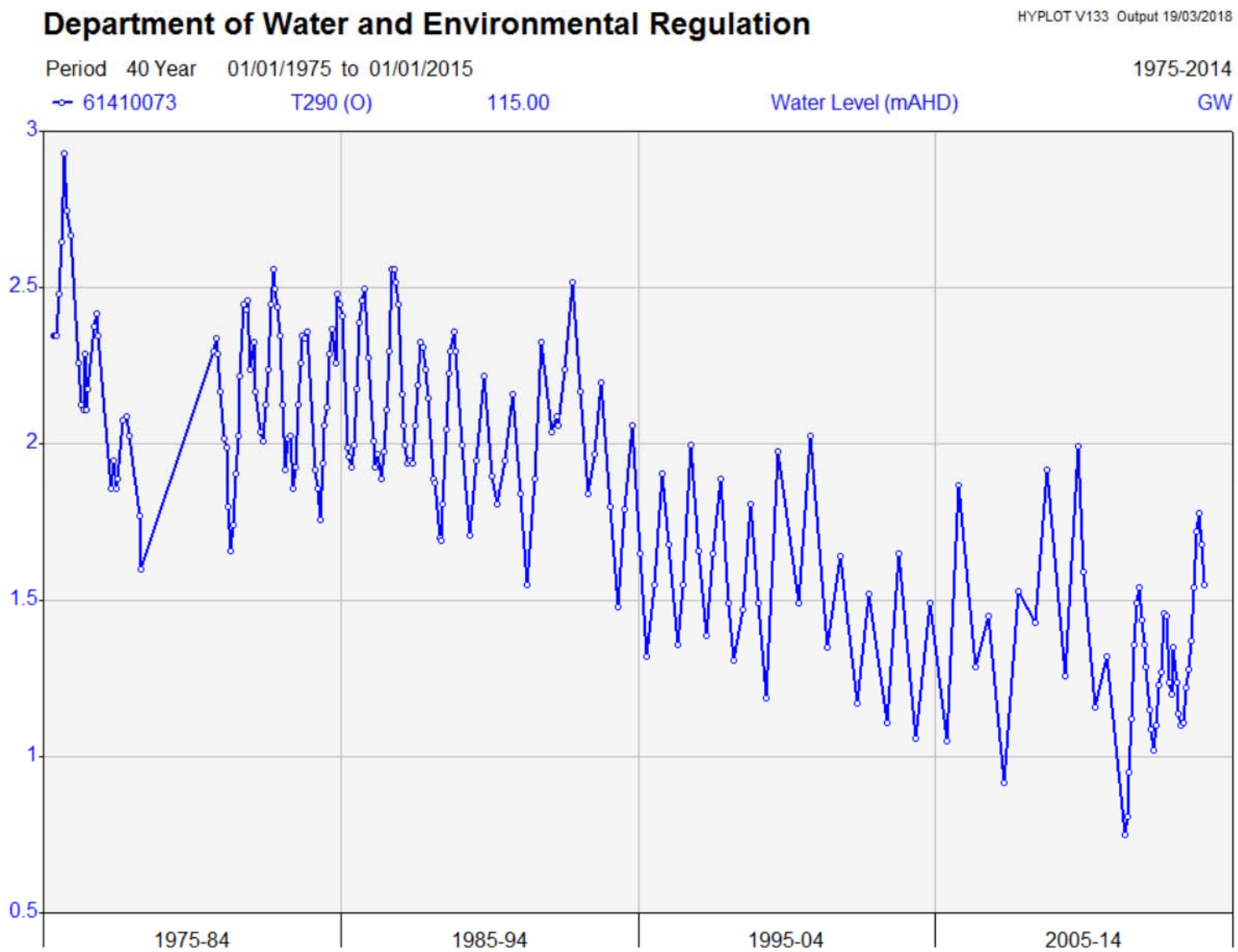
Department of Water and Environmental Regulation
HYPLOT V133 Output 19/03/2018
Period 40 Year 01/01/1975 to 01/01/2015
1975-2014
61410073
T290 (O)
115.00
Water Level (mAHD)
GW
3
2.5
2
1.5
1
0.5
1975-84
1985-94
1995-04
2005-14

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APPENDIX C

GROUNDWATER LICENCE

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File No: RF13475

Government of Western Australia
Department of Water

Instrument No. GWL180812(1)

LICENCE TO TAKE WATER

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

Licensee(s)	Carcione Nominees Pty Ltd		
Description of Water Resource	Stakehill Perth - Superficial Swan	**Annual Water Entitlement**	113325 kL
Location of Water Source	Lot 295 On Plan 202704 - Volume/Folio 1694/854 - Lot 295 Baldivis Rd Baldivis Lot 56 On Diagram 53074 - Volume/Folio 1490/900 - Lot 56 Kerosene L Baldivis		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes	Lot 295 On Plan 202704 - Volume/Folio 1694/854 - Lot 295 Baldivis Rd Baldivis Lot 56 On Diagram 53074 - Volume/Folio 1490/900 - Lot 56 Kerosene L Baldivis Lot 294 On Plan 202704 - Volume/Folio 1591/498 - Lot 294 Kerosene Lane Baldivis Lot 55 On Diagram 53074 - Volume/Folio 1490/899 - Lot 55 Kerosene Lane Baldivis
	Irrigation of up to 5.75 ha of public open space	Lot 295 On Plan 202704 - Volume/Folio 1694/854 - Lot 295 Baldivis Rd Baldivis Lot 56 On Diagram 53074 - Volume/Folio 1490/900 - Lot 56 Kerosene L Baldivis Lot 294 On Plan 202704 - Volume/Folio 1591/498 - Lot 294 Kerosene Lane Baldivis Lot 55 On Diagram 53074 - Volume/Folio 1490/899 - Lot 55 Kerosene Lane Baldivis
Duration of Licence	From 8 October 2015 to 2 October 2025	

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

1 The licensee shall not use water for public open space 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.

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:

4 The annual water year for water taken under this licence is defined as 1July 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 returned to the Department of Water every 12 month(s) commencing 14/07/2016.

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.

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

APPENDIX D

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MODELLING SUMMARY REPORT

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MODELLING ASSUMPTIONS

SPIRES – KEROSENE LANE LOCAL STRUCTURE PLAN

Project Number EP15-009

Prepared for Carcione Nominees Pty Ltd
August 2019

Document Control

DOC NAME	**MODELLING ASSUMPTIONS FOR THE SPIRES – KEROSENE LANE LOCAL STRUCTURE PLAN**				
DOC NO.	**EP15-009(02)—008B AP**				
REVISION	**DATE**	**AUTHOR**		**REVIEWER**	
1	November 2015	Amila Prasad	AP	David Coremans	DPC
	Appendix to the LWMS				
A	November 2015	Shayne Fudge	SMF	David Coremans	DPC
	Appendix to the LWMS				
B	August 2019	Marley Butler	MB	Rachel Evans	RLE
	Appendix to the LWMS				

1 Modelling Assumptions

In order to analyse the surface water runoff characteristics within the Spires – Kerosene Lane Local Structure Plan (LSP) area, XPSWMM hydrologic and hydraulic modelling software was used.

The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a major (1% AEP) event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Sub surface storages, bio-retention areas (BRAs) and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.
- No ponding conditions have been allowed within storage nodes for events greater than the small (first 15 mm) event.

2 Post-development Model

An "initial loss - continual loss" infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience with similar vegetation and soil types to those found within the site. **Table 1** gives the parameters used within the post-development model.

Table 1 Post-development parameters

Land type	Initial loss (mm)	Continual loss (mm/hr)	Manning's 'n'
Road impervious	1	0.1	0.02
Road pervious	25	3.5	0.05
Lot impervious	1	0.1	0.02
Lot pervious	25	3.5	0.05
POS	22.5	3	0.05

The post-development catchment areas were taken from the catchment plan for Spires – Kerosene Lane LSP provided by the project team engineers. Land types within the catchments were guided by the Spires - Kerosene Lane LSP (provided in Appendix A of the *Spires – Kerosene Lane Local Water Management* (LWMS)). A summary of post-development catchment information is provided in **Table 2**. The post-development catchment boundaries are shown in Figure 7 of the LWMS. Slopes were guided by spot heights provided on the catchment plan and were designated as 2%, 3.5% and 1% for lots, road reserves and Kerosene Lane respectively.

Table 2 Post-development catchment areas

Catchment	Area (ha)							
	Total area	Total road	Total road pavement	Total road verge	Total lot	Front of lot - impervious	Front of lot - pervious	POS
Ct A	14.753	2.860	2.002	0.858	9.608	0.961	0.961	2.285
Ct B	8.307	2.325	1.627	0.697	4.962	0.496	0.496	1.020
Ct C	19.085	4.413	3.089	1.324	12.885	1.289	1.289	1.787
Ct D	5.391	1.277	0.894	0.383	2.776	0.278	0.278	1.337
Ct E	0.578	0.220	0.154	0.066	0.359	0.036	0.036	-
Kerosene Lane West	0.230	0.230	0.138	0.092	-	-	-	-
Kerosene Lane East	0.506	0.506	0.304	0.202	-	-	-	-
Total	*48.115*	*11.095*	*7.766*	*3.328*	*30.590*	*0.036*	*0.036*	*6.43*

The post-development modelling was predominantly based upon the following assumptions:

- All lots will provide on-lot storage from roof and rear garden areas (80% of lot area) within soakwells and pervious garden areas. Runoff from front of lot areas (50% impervious and 50% pervious) above the infiltration capacity (detailed in Table 1) will discharge to downstream storage areas.
- Garden areas in all lots will have high loss rates as it is likely that sand-based landscape mix or mulch will be used.
- POS areas are assumed to be 100% pervious and will have high loss rates as it is likely that sand-based landscape mix or mulch will be used.
- There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss, this is accounted for in the initial and continuing loss values.
- Internal road reserves contain 30% pervious areas (i.e. landscaped verge) and 70% impervious bitumen and paved areas (i.e. road pavement, foot paths, parking bays and cross overs).
- Kerosene Lane is assumed to contain 40% pervious area and 60% impervious bitumen and paved areas.
- Kerosene Lane catchments retain up to the 10% AEP, 6 hour rainfall event within soakwells and pervious verge area.
- The pervious road reserve areas are similar in characteristics to POS areas.
- Runoff from road reserves will be conveyed downstream and the small event runoff will be retained in bio-retention areas (BRA) with runoff up to the major event retained in flood storage areas (FSA), both located in downstream POS.
- A hydraulic conductivity of 5×10^{-5} m/s is assumed for the infiltration in BRAs. A 50% clogging factor has been applied to the assumed infiltration rate for BRAs.
- A hydraulic conductivity of 5×10^{-5} m/s is assumed for the infiltration in FSAs. No clogging factor has been applied in FSAs.
- Infiltration through side slopes of BRAs and FSAs was considered in the overall infiltration rating curve for these areas. This accounts for infiltration across the entire wetted surface area.
- The storage capacity within the piped drainage network has not been accounted for.
- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of model run was comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

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APPENDIX E

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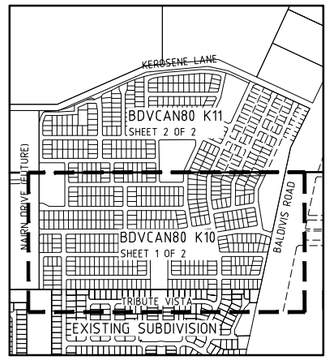
PRELIMINARY CATCHMENT AND LOT LEVEL PLAN



LOCATION PLAN

SCALE 1:10000

LEGEND

- EXISTING SURFACE CONTOURS
- FINISHED SURFACE CONTOURS
- PROPOSED LOT LEVEL
- PROPOSED ROAD LEVEL
- DRAINAGE CATCHMENT BOUNDARY

MATCHLINE JOINS DWG K11

BASIN 'C'

BASIN 'A'

NAIRN DRIVE (FUTURE)

BALDIVIS ROAD

REMEMBERANCE DRIVE

TRIBUTE VISTA

EXISTING SUBDIVISION

HERBERT MEANDER

1:1250 (A1)

No.	DATE	BY	REVISION	
B	22/08/19	PMS	BASIN LAYOUTS UPDATED, DRAINAGE CATCHMENT BOUNDARY ADDED	SRA
A	1/07/19	PMS	INITIAL ISSUE	SRA

CLIENT: CARCIONE NOMINEES PTY LTD

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

PROJECT: LOT 295 BALDIVIS RD & LOT 294 KEROSENE LANE BALDIVIS

W.A.P.C. No. -

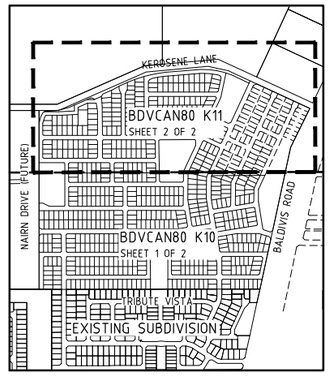
DRAWING: EARTHWORKS LAYOUT PLAN SHEET 1 OF 2

CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
1:1250	PMS	SRA	B
DATE: JULY '19	DESIGNED: PMS	APPROVED: SRA	

PROJECT NUMBER: BDVCAN80 K10

DRAWING NUMBER: S:\CAN\BDVCAN80\Drawings\BDVCAN80 K10.dwg22/08/2019



LOCATION PLAN

SCALE 1:10000

LEGEND

- EXISTING SURFACE CONTOURS
- FINISHED SURFACE CONTOURS
- PROPOSED LOT LEVEL
- PROPOSED ROAD LEVEL
- DRAINAGE CATCHMENT BOUNDARY

KEROSENE LANE

NAIRN DRIVE (FUTURE)

BALDIVIS ROAD

BASIN 'A'

BASIN 'B'

BASIN 'C'

BASIN 'D'

MATCHLINE JOINS DWG K10

1:1250 (A1)

No.	DATE	BY	REVISION	
B	22/08/19	PMS	BASIN LAYOUTS UPDATED, DRAINAGE CATCHMENT BOUNDARY ADDED	SRA
A	1/07/19	PMS	INITIAL ISSUE	SRA

CLIENT: CARCIONE NOMINEES PTY LTD

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

PROJECT: LOT 295 BALDIVIS RD & LOT 294 KEROSENE LANE BALDIVIS

W.A.P.C. No. -

DRAWING: EARTHWORKS LAYOUT PLAN SHEET 2 OF 2

CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
1:1250	PMS	SRA	B
DATE	DESIGNED	APPROVED	
JULY '19	PMS	SRA	

PROJECT NUMBER: BDVCAN80 K11

DRAWING NUMBER: S:\CAN\BDVCAN80\Drawings\BDVCAN80 K11.dwg22/08/2019

BASIN DETAILS - CATCHMENT B

TOTAL IMPERVIOUS AREA (1% AEP)	2.70ha
1% AEP STORAGE REQUIRED	2034m³
AREA AT TWL (1% AEP)	2778m²
RL (TWL) (1% AEP)	17.90m AHD
20% AEP STORAGE REQUIRED	707m³
AREA AT TWL (20% AEP)	2053m²
RL (TWL) (20% AEP)	17.36m AHD
63.2% AEP STORAGE REQUIRED	432m³
AREA AT TWL (63.2% AEP)	864m²
RL (TWL) (63.2% AEP)	17.20m AHD
PEAK OUTFLOW (1% AEP)	0 l/s

BASIN DETAILS - CATCHMENT D

TOTAL IMPERVIOUS AREA (1% AEP)	1.48ha
1% AEP STORAGE REQUIRED	1130m³
AREA AT TWL (1% AEP)	1696m²
RL (TWL) (1% AEP)	24.40m AHD
20% AEP STORAGE REQUIRED	494m³
AREA AT TWL (20% AEP)	1237m²
RL (TWL) (20% AEP)	23.97m AHD
63.2% AEP STORAGE REQUIRED	192m³
AREA AT TWL (63.2% AEP)	1536m²
RL (TWL) (63.2% AEP)	23.70m AHD
PEAK OUTFLOW (1% AEP)	0 l/s

BASIN DETAILS - CATCHMENT A

TOTAL IMPERVIOUS AREA (1% AEP)	4.51ha
1% AEP STORAGE REQUIRED	2749m³
AREA AT TWL (1% AEP)	4276m²
RL (TWL) (1% AEP)	9.80m AHD
20% AEP STORAGE REQUIRED	804m³
AREA AT TWL (20% AEP)	1581m²
RL (TWL) (20% AEP)	9.28m AHD
63.2% AEP STORAGE REQUIRED	540m³
AREA AT TWL (63.2% AEP)	1080m²
RL (TWL) (63.2% AEP)	9.10m AHD
PEAK OUTFLOW (1% AEP)	0 l/s

BASIN DETAILS - CATCHMENT C

TOTAL IMPERVIOUS AREA (1% AEP)	5.67ha
1% AEP STORAGE REQUIRED	3259m³
AREA AT TWL (1% AEP)	4370m²
RL (TWL) (1% AEP)	22.80m AHD
20% AEP STORAGE REQUIRED	1280m³
AREA AT TWL (20% AEP)	3325m²
RL (TWL) (20% AEP)	22.30m AHD
63.2% AEP STORAGE REQUIRED	644m³
AREA AT TWL (63.2% AEP)	1288m²
RL (TWL) (63.2% AEP)	22.10m AHD
PEAK OUTFLOW (1% AEP)	0 l/s

LEGEND

- CATCHMENT AREA
- 23 — FINISHED SURFACE CONTOURS
- 2.90 — GROUND WATER CONTOURS
- DRAINAGE BASIN
- FLOW ARROW
- MB01 — NAME; E 680.806m; N 493.252m; R.L 0.00m — SURFACE LEVEL; 2.5m — DEPTH; Ø 150 — BORE DIAMETER — MONITORING BORE
- x25.40 — PROPOSED ROAD LEVEL
- 1 IN 1 YEAR STORAGE
- 1 IN 5 YEAR STORAGE
- 1 IN 10 YEAR STORAGE
- 1 IN 100 YEAR STORAGE
- D — PROPOSED DRAINAGE PIPE, JUNCTION PIT & SIDE ENTRY PIT

CATCHMENT AREA

CATCHMENT	TOTAL AREA	LOT AREA	ROAD RESERVE AREA	POS AREA
A	147602	96128	37723	13751
B	81641	50502	20930	10209
C	193645	132496	46371	14778
D	52077	26908	11789	13380
TOTALS	474965	306034	116813	52118

1:2000 (A1)

No.	DATE	BY	REVISION	
D	22/08/19	PMS	CATCHMENT BOUNDARY AMENDED	SRA
C	16/8/19	JEG	UPDATED DESIGN	SRA
B	4/07/19	PMS	BASIN DETAILS UPDATED	SRA
A	1/07/19	PMS	INITIAL ISSUE	SRA

CLIENT: CARCIONE NOMINEES PTY LTD

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

PROJECT: LOT 295 BALDIVIS RD & LOT 294 KEROSENE LANE BALDIVIS
W.A.P.C. No. -

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

SCALE	DRAWN	CHECK	REV No.
1:2000	PMS	SRA	D
DATE: JULY '19	DESIGNED: PMS	APPROVED: SRA	

PROJECT NUMBER / DRAWING NUMBER: BDVCAN80 L04
S:\CAN\BDVCAN80\Drawings\BDVCAN80 L04.dwg22/08/2019