4.0 Technical Appendices

Appendix	Document Title	Author	Approval Status
A	Bushfire Management Plan	Eco Logical Australia	
B	Environmental Assessment Report	360 Environmental	
C	Local Water Management Strategy	Hyd2o	
D	Transport Impact Assessment	Transcore	
E	Engineering Infrastructure Report	TABEC	

APPENDIX A

Bushfire Management Plan

Bushfire Management Plan: Local Structure Plan: Caporn Street, Wanneroo

Acumen Development Solutions

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A TETRA TECH COMPANY

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

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DOCUMENT TRACKING

Project Name	Bushfire Management Plan: Local Structure Plan Caporn Street, Wanneroo
Project Number	19PER-12726
Project Manager	James Leonard
Prepared by	James Leonard
Reviewed by	Daniel Panickar (BPAD Level 3 – 37802)
Approved by	Daniel Panickar (BPAD Level 3 – 37802)
Status	**Final**
Version Number	**v2**
Last saved on	**26 November 2020**

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ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Acumen Development Solutions.

Template 2.8.1

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1. Introduction

1.1 Proposal details

Eco Logical Australia (ELA) was commissioned by Acumen Development Solutions to prepare a Bushfire Management Plan (BMP) to support a Local Structure Plan being lodged over Multiple Lots Caporn Street, Wanneroo (hereafter referred to as the subject site; Figure 1; Figure 2).

The entire subject site is within a designated bushfire prone area as per the *Western Australia State Map of Bush Fire Prone Areas* (DFES 2019; Figure 3), which triggers bushfire planning requirements under *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7; WAPC 2015) and reporting to accompany submission of the Structure Plan in accordance with the associated *Guidelines for Planning in Bushfire Prone Areas v 1.3* (the Guidelines; WAPC 2017).

This assessment has been prepared by ELA Bushfire Consultant James Leonard with quality assurance undertaken by ELA Senior Bushfire Consultant, Daniel Panickar (FPAA BPAD Level 3 Certified Practitioner No. BPAD37802-L3).

1.2 Purpose and application of the plan

The primary purpose of this BMP is to act as a technical supporting document to inform planning assessment. This BMP is also designed to provide guidance on how to plan for and manage the bushfire risk to the subject site through implementation of a range of bushfire management measures in accordance with the Guidelines.

1.3 Environmental considerations

Some bushfire prone areas also have high biodiversity values. SPP 3.7 policy objective 5.4 recognises the need to consider bushfire risk management measures alongside environmental, biodiversity and conservation values.

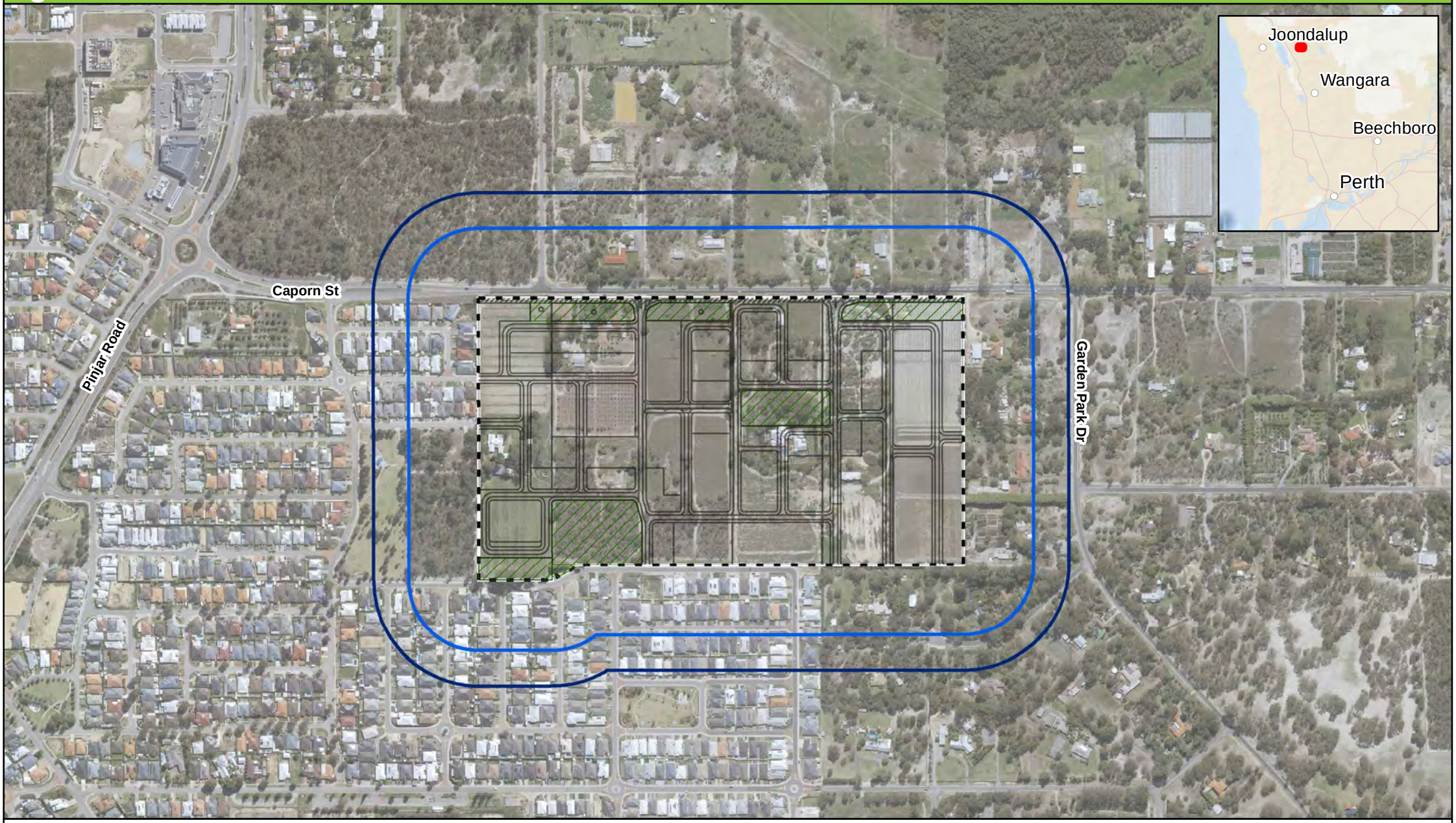
Environmental approvals for the development are being obtained and impacts associated with bushfire protection measures have been considered through consultation with the project team.

Some retention and revegetation is proposed within the subject site and this has been accounted for in the post development Bushfire Hazard Level assessments. A summary of the retention considerations is provided below and depicted in Figure 2:

- Within the Public Open Space (POS) areas, it is noted that clearing/thinning of vegetation will be required for drainage, POS facilities etc. Areas to be retained are yet to be determined and will be finalised through the subsequent planning processes (e.g. Structure Plans and subdivision); and
- It is not anticipated that any revegetation within POS areas will be undertaken.

These considerations are addressed further in section 2 and any changes to revegetation and/or landscaping will be addressed in future BMPs.

Figure 1: Site Overview



Legend

- Subject site
- 100m assessment area
- 150m assessment area
- Proposed Structure Plan layout
- Public Open Space (POS)

0 65 130 260

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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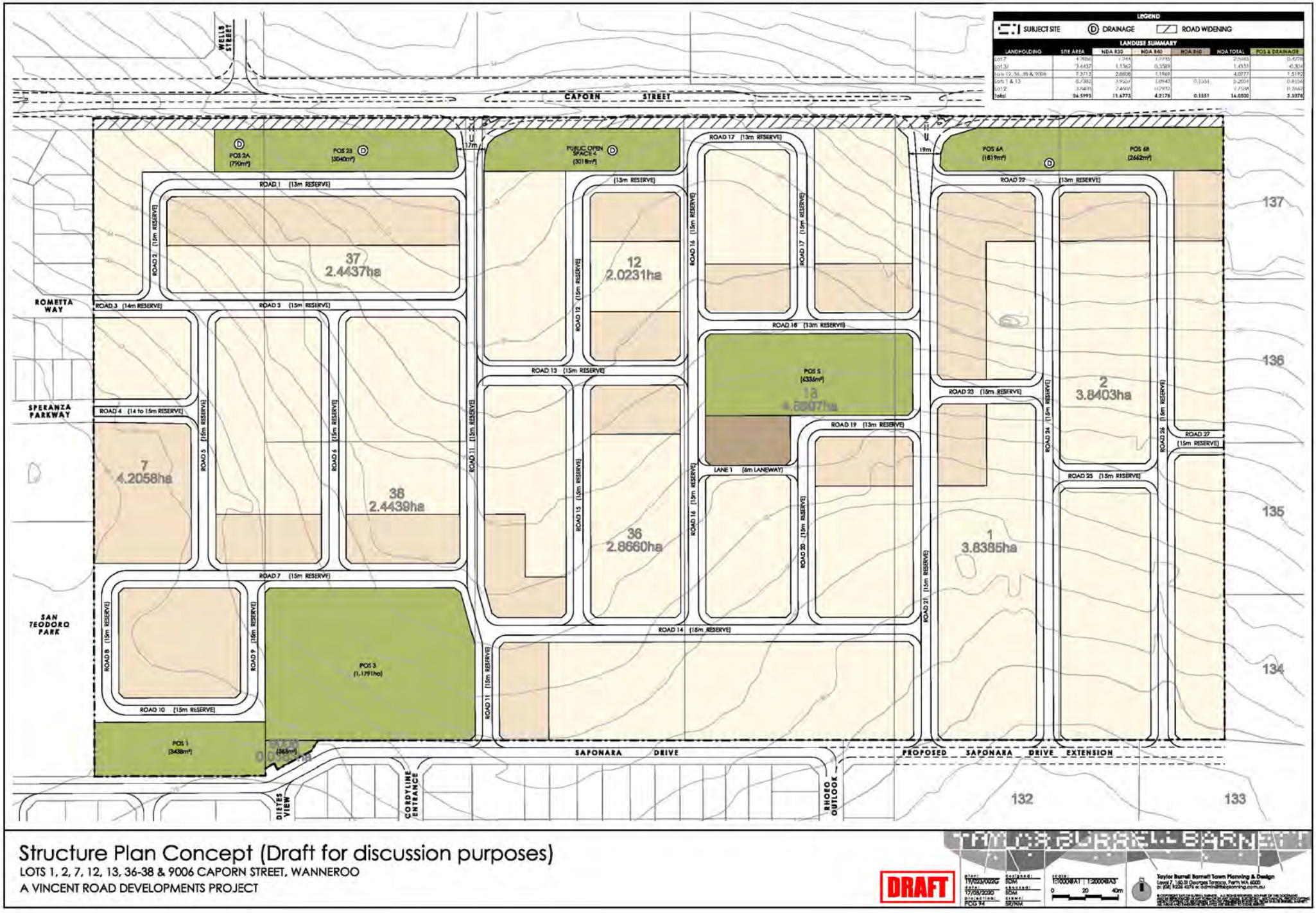
Figure 2: Proposed Structure Plan



LANDHOLDING	SITE AREA	NDA R30	NDA R40	NDA R60	NDA TOTAL	POS & DRAINAGE
Lot 7	4.7856	1.244	1.7710		2.9150	0.4706
Lot 37	3.4437	1.1360	0.3589		1.4951	0.304
Lots 12, 36, 38 & 9006	7.3713	2.8898	1.1969		4.0877	1.5192
Lots 1 & 13	8.7382	3.9569	1.0943	0.1551	5.2061	0.8106
Lot 2	3.9489	2.4998	1.0990		3.5988	0.3501
Total	26.5993	11.6775	4.2178	0.1551	16.0530	3.3278

Structure Plan Concept (Draft for discussion purposes)

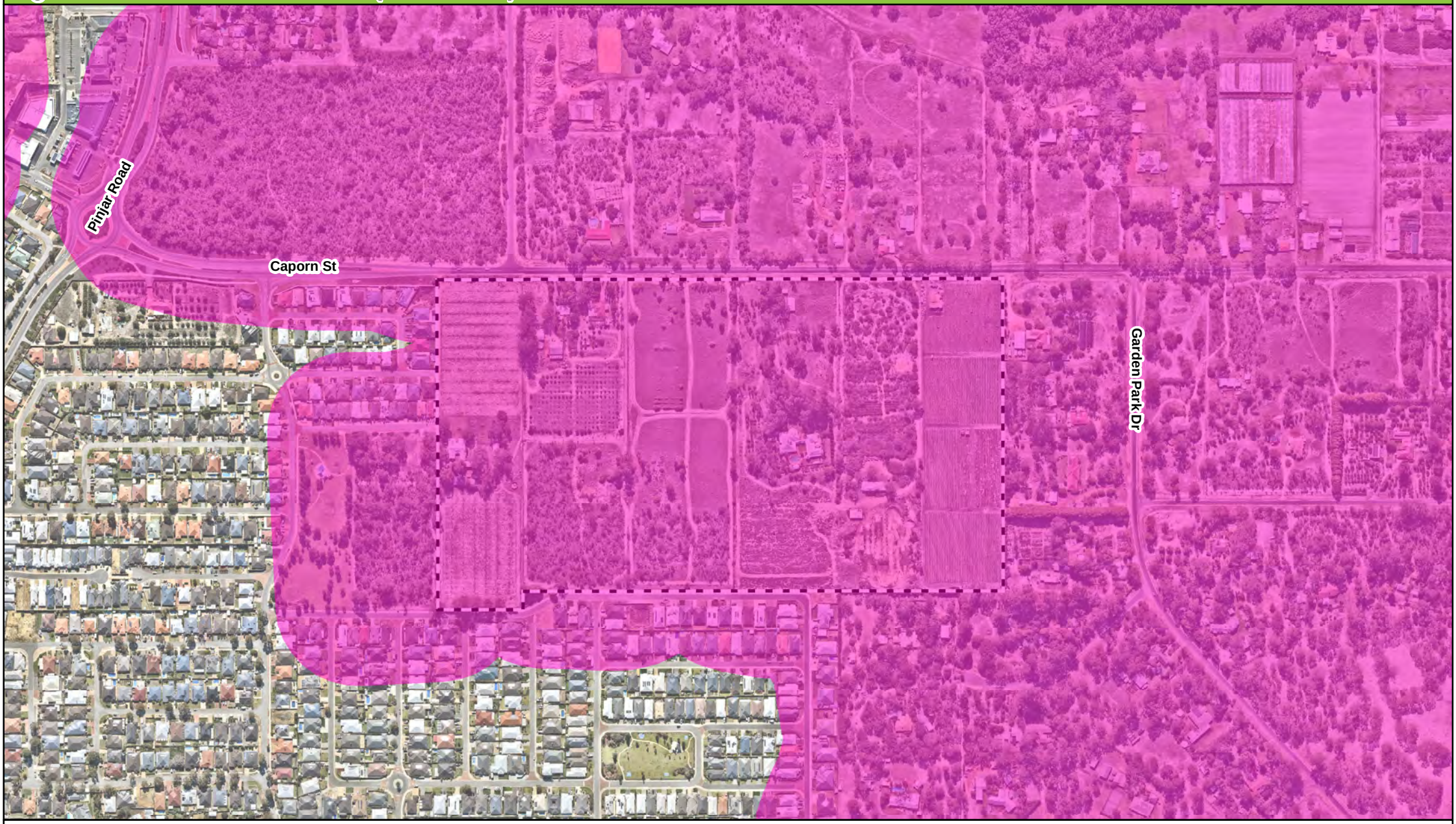
LOTS 1, 2, 7, 12, 13, 36-38 & 9006 CAPORN STREET, WANNEROO

A VINCENT ROAD DEVELOPMENTS PROJECT

DRAFT

Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
p: (08) 9226 4276 e: admin@tbbplanning.com.au

Figure 3: Bushfire Prone Areas (DFES 2019)



Legend

- Subject site
- Bushfire Prone Areas (DFES 2019)

0 55 110 220

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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2. Bushfire assessment results

2.1 Bushfire assessment inputs

The following section is a consideration of spatial bushfire risk and has been used to inform the bushfire assessment in this report.

2.1.1 Vegetation classification

Vegetation within the subject site and surrounding 150 m (the assessment area) was assessed in accordance with the Guidelines and AS 3959-2018 *Construction of Buildings in Bushfire Prone Areas* (SA 2018) with regard given to the *Visual guide for bushfire risk assessment in Western Australia* (DoP 2016). An initial site assessment was undertaken on 8 July 2020, with a follow-up assessment undertaken on 23 July 2020 to provide justification for assessed vegetation classes in response to comments received from the Department of Fire and Emergency Services (DFES) received on 30 October 2020 (DFES reference number D14097).

The following vegetation classes and exclusions were identified within the assessment area as depicted in Figure 4 and listed below:

- Class B woodland;
- Class D scrub;
- Class G grassland; and
- Exclusions as per clause 2.2.3.2 (e) and (f) (i.e. non-vegetated areas and low-threat vegetation).

Photographs and justification relating to each vegetation type and plot are included in Appendix A.

2.1.2 Topography and slope under vegetation

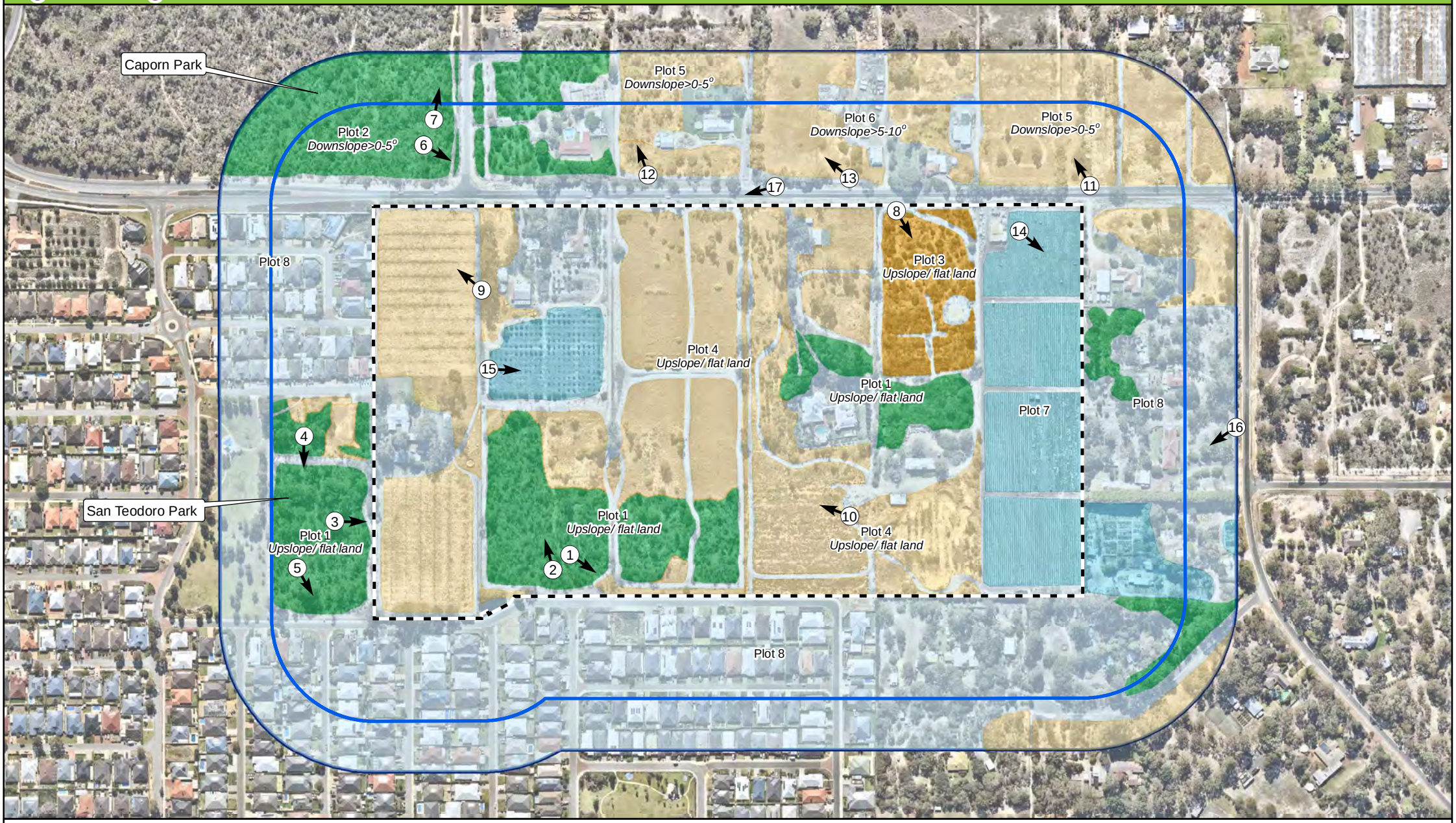
Effective slope under vegetation was assessed for a distance of 150 m from the subject site in accordance with the Guidelines and AS 3959-2018. Slope under vegetation ranged from upslope/flat land to downslope >5-10° as depicted in Figure 4.

2.1.3 Post-development bushfire assessment

An assessment of vegetation and slope was undertaken based on the proposed development concept in Figure 2. Retention and revegetation areas described in Section 1.3 as well as a management agreement being progressed with a neighbour to the east have also been considered and the results of this 'post-development' vegetation assessment are depicted in Figure 5

The vegetation within each of the Public Open Spaces (POS) has been retained for the purposes of this assessment to assess the worst-case scenario. Future landscaping plans will be developed for POS areas at subdivision stage.

Figure 4: Vegetation classification



Legend

- Subject site
- 100m Assessment Area
- 150m Assessment Area
- Photo locations
- Contours 5m Intervals (Statewide)

Vegetation classification

- Class B woodland
- Class D scrub
- Class G grassland
- Excluded under clause 2.2.3.2 (f)
- Excluded under clause 2.2.3.2 (e) and (f)

0 37.5 75 150
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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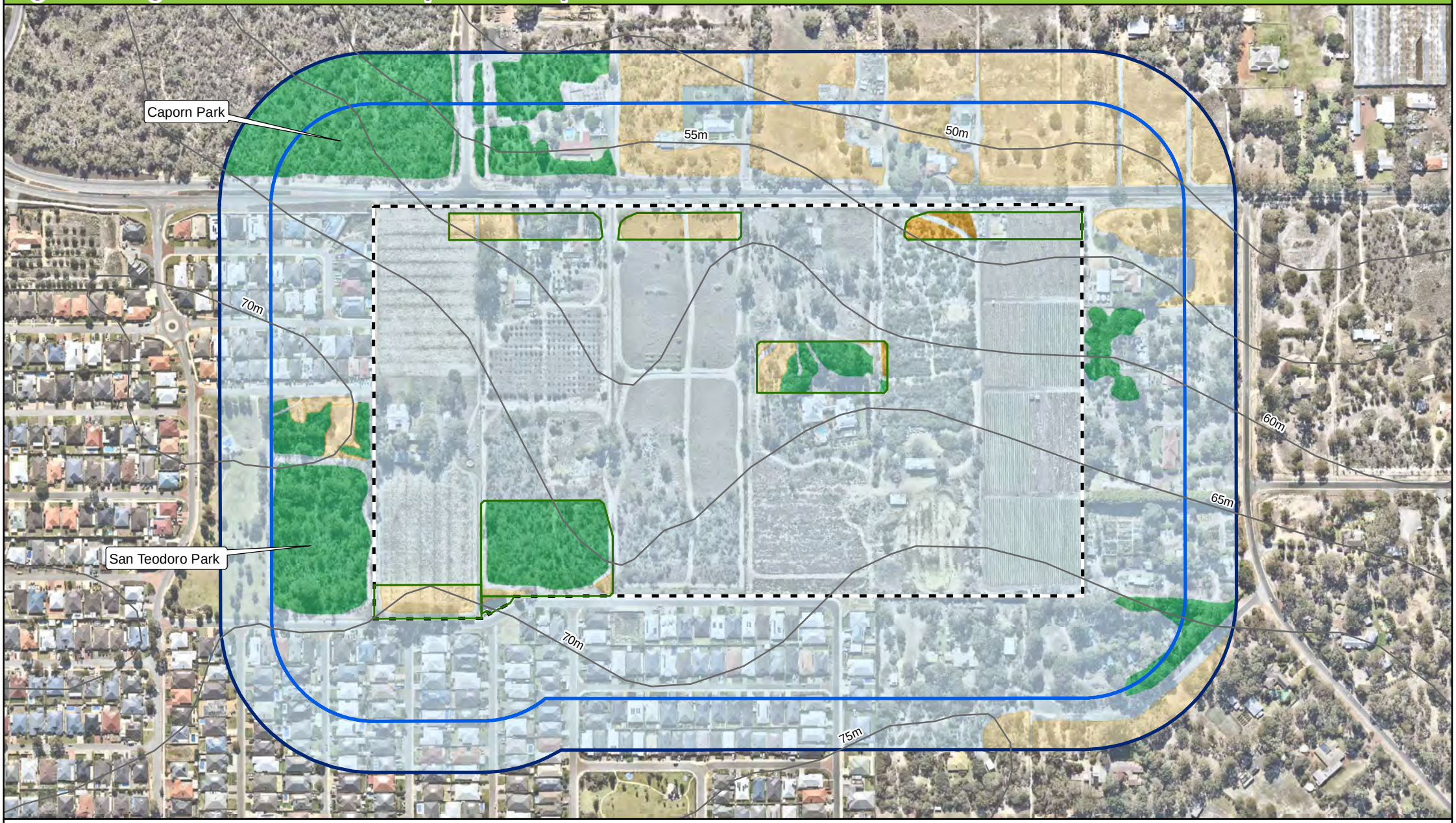
Figure 5: Vegetation classification - post-development



Legend

- Subject site
- 100m Assessment Area
- 150m Assessment Area
- Proposed Public Open Space (POS)
- Contours 5m Intervals (Statewide)

Vegetation classification

- Class B woodland
- Class D scrub
- Class G grassland
- Excluded under clause 2.2.3.2 (f)
- Excluded under clause 2.2.3.2 (e) and (f)

0 37.5 75 150
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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2.2 Assessment outputs

A Bushfire Hazard Level (BHL) assessment has been undertaken in accordance with SPP 3.7, the Guidelines and the bushfire assessment inputs in Section 2.1.

2.2.1 BHL assessment

All land located within 100 m of the classified vegetation depicted in Figure 4 is considered bushfire prone and is subject to a BHL assessment in accordance with the Guidelines.

Pre-development BHLs have been assessed for the subject site in accordance with the methodology contained within the Guidelines and incorporates the following factors:

- Vegetation class; and
- Slope under classified vegetation.

Table 1 contains a summary of the BHL assessment for each vegetation plot depicted in Figure 4. All land within 100 m of Extreme and Moderate BHLs has also been mapped as a Moderate hazard as per the Guidelines, and the final result is depicted in Figure 6**.**

Descriptions of each vegetation classification are with each of the plates in Appendix A.

Table 1: Bushfire Hazard Level assessment

Plot	Vegetation classification	Effective Slope	Bushfire Hazard Level
1	Class B woodland	Upslope/ flat land	Extreme
2	Class B woodland	Downslope >0-5°	Extreme
3	Class D scrub	Upslope/ flat land	Extreme
4	Class G grassland	Upslope/ flat land	Moderate
5	Class G grassland	Downslope >0-5°	Moderate
6	Class G grassland	Downslope >5 to 10°	Moderate
7	Excluded as per clause 2.2.3.2 (f)	N/A	Low
8	Excluded as per clause 2.2.3.2 (e) and (f)	N/A	Low

2.3 Identification of issues arising from the BHL assessment

Clearing and revegetation will be undertaken within the subject site for development purposes, and consequently the pre-development BHLs are subject to change. A post-development BHL assessment is provided in Figure 7 based on expected changes to vegetation within the subject site depicted in Figure 5.

The on-site vegetation extent is proposed to be cleared to enable development of a significant urban built footprint amongst areas of landscaped/managed Public Open Space (POS) and various easements. Therefore, for the purposes of strategic level planning, ELA does not consider the current on-site vegetation extent to be a bushfire hazard issue post-development, since these hazards can be managed through a staged clearing process, adequate separation of future built assets from classified vegetation (both external and internal [e.g. retained vegetation] to the subject site), and ongoing fuel management that can be undertaken in and around individual development stages.

On the basis of the above information, ELA considers that the bushfire hazards within and adjacent to the subject site and the associated bushfire risk is readily manageable through standard management responses and compliance with acceptable solutions outlined in the Guidelines. These management measures will need to be factored into the development design as early as possible to ensure a suitable, compliant and effective bushfire management outcome is achieved to ensure protection of future life and property assets.

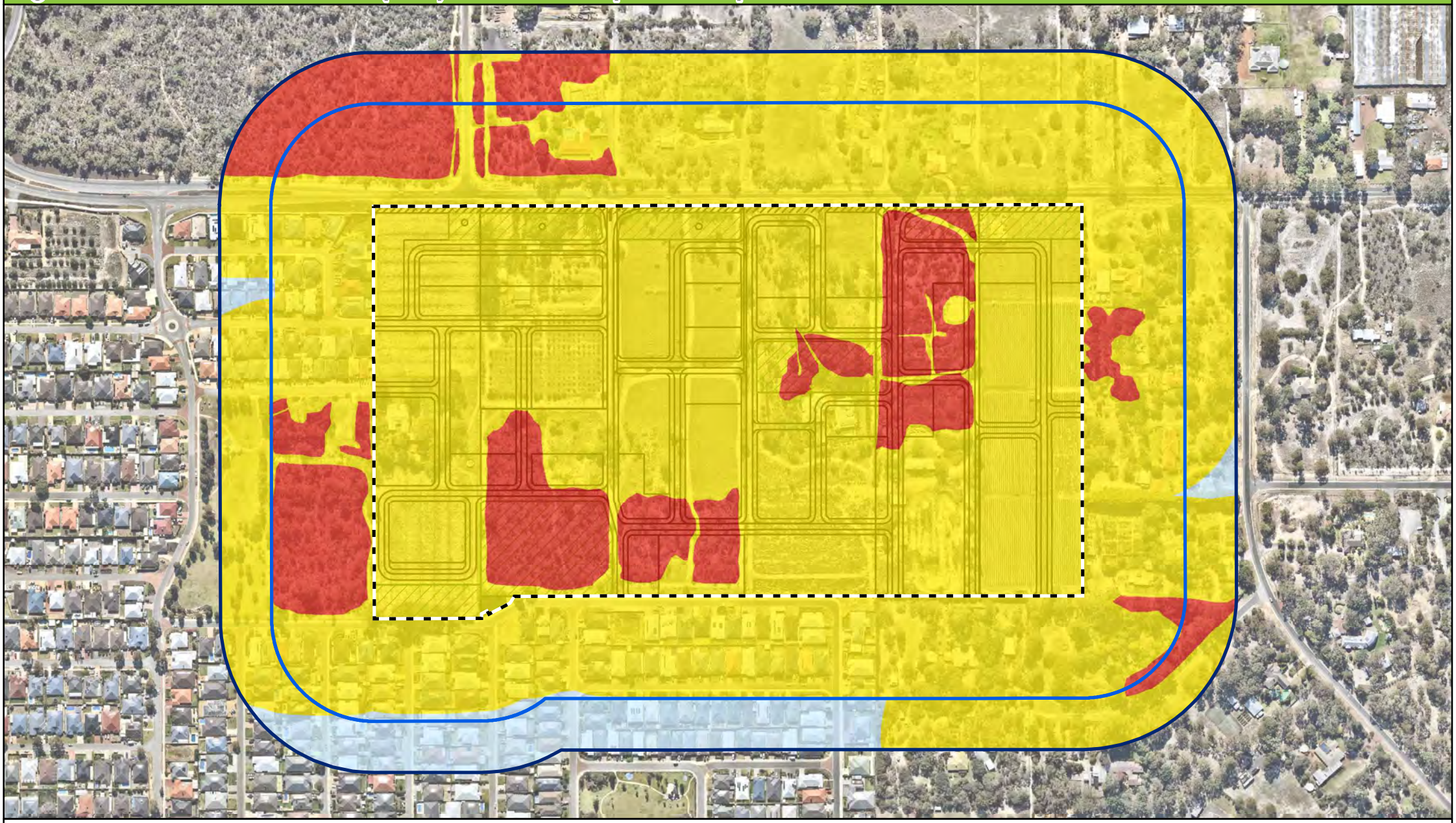
Demonstration of compliance with the relevant requirements of SPP 3.7, the Guidelines and AS 3959-2018 at future planning stages will also depend on the developer's ability to coordinate the timing and staging of clearing and development works within the subject site with the aim of avoiding bushfire impacts from temporary, retained vegetation.

2.3.1 Bushfire risk and setbacks

The vegetation to the east of the subject site is situated on private land (Figure 8), which is proposed for future development at an unknown date. It is expected that future lots on the eastern portion of the subject will be withheld until the adjacent vegetation is either cleared or managed to a suitable standard as to not pose a bushfire risk.

Due to the Class B woodland classification on the western portion of the subject site, a setback of 14 m from the vegetation line will be implemented within the subject site to ensure that future dwellings will be subject to a Bushfire Attack Level of ≤BAL-29.

Figure 6: Bushfire Hazard Level (BHL) assessment - pre-development



Legend

- Subject site
- 100m Assessment Area
- 150m Assessment Area
- Proposed Structure Plan layout

Bushfire Hazard Level (BHL)

- Extreme
- Moderate
- Low

0 37.5 75 150

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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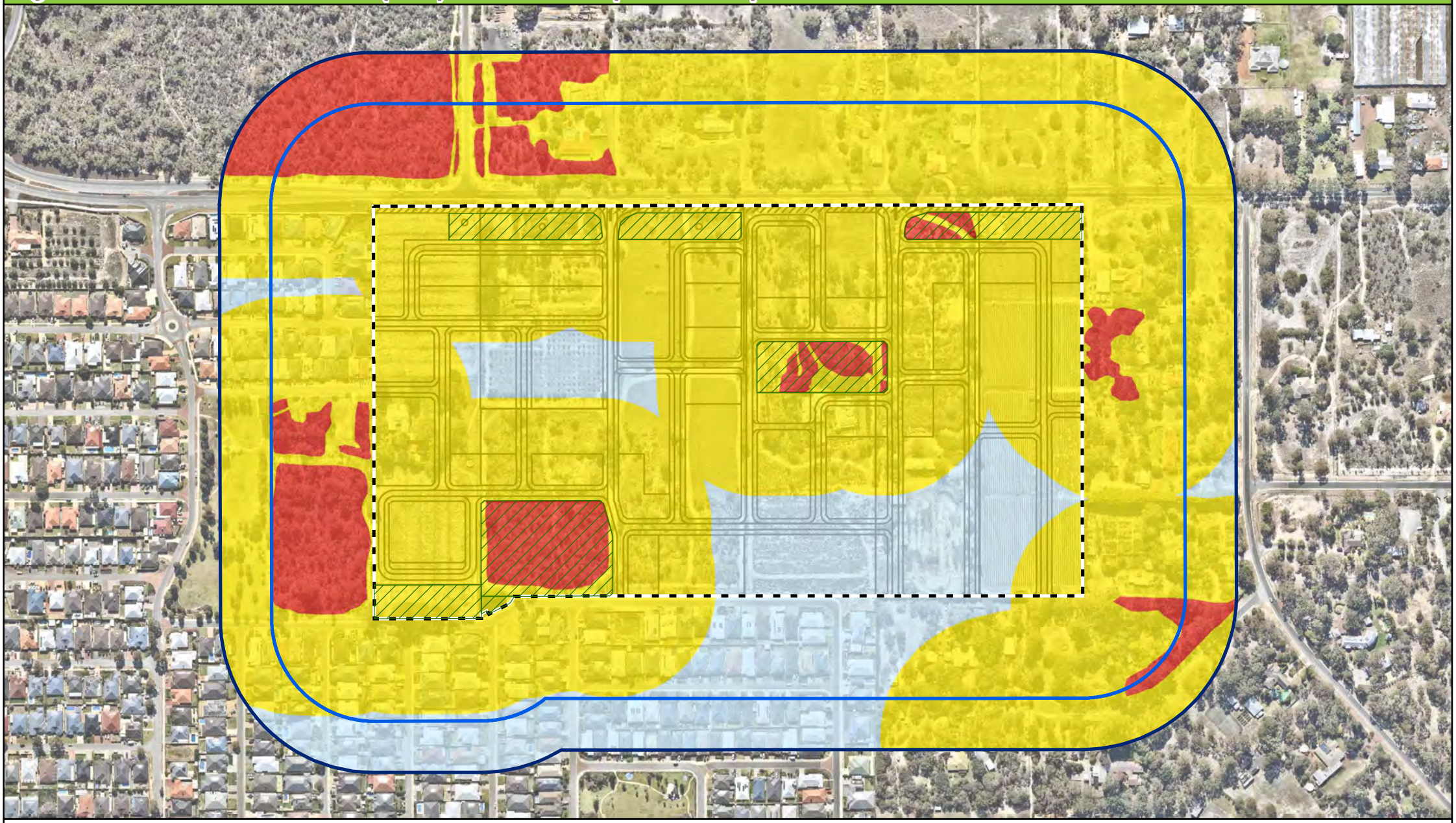
Figure 7: Bushfire Hazard Level (BHL) assessment - post-development



Legend

- Subject site
- 100m Assessment Area
- 150m Assessment Area
- Proposed Structure Plan layout
- Proposed Public Open Space (POS)

Bushfire Hazard Level (BHL)

- Extreme
- Moderate
- Low

0 37.5 75 150

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

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3. Assessment against the Bushfire Protection Criteria

3.1 Compliance

The proposed Structure Plan is required to comply with policy measures 6.2 and 6.3 of SPP 3.7 and the Guidelines. Implementation of this BMP is expected to meet objectives 5.1 - 5.4 of SPP 3.7. Bushfire management measures have been devised for the proposed development in accordance with Guideline acceptable solutions to meet compliance with bushfire protection criteria.

The 'acceptable solutions assessment' is provided below to assess the proposed bushfire management measures against each bushfire protection criteria in accordance with the Guidelines. The assessment demonstrates that the proposed measures meet the intent of each element of the bushfire protection criteria. Figure 8 depicts bushfire management strategies where necessary.

Table 2: Summary of solutions used to achieve bushfire performance criteria

Bushfire Performance Criteria	AS	PS	N/A	Comment
Element 1: Location A1.1 Development location	☒	☐	☐	Post-development, all buildings within the subject site will be situated in areas subject to BHLs of moderate or low (refer to Figure 8). Due to the proximity of vegetation outside the subject site, the future lots on the east will be withheld until future vegetation management can occur (Figure 8). Vegetation to the west of the subject site (within San Teodoro Park, managed by the City of Wanneroo) will result in a 14 m setback being applied to proposed lots abutting the western boundary of the subject site (Figure 8), thereby allowing future development to occur within areas subject to a BAL rating of ≤BAL-29. The proposed development is considered to be compliant with A1.1.
Element 2: Siting and design of development A2.1 Asset Protection Zone (APZ)	☒	☐	☐	As the lot layout is currently unconfirmed, APZs are unable to be prescribed at this level of planning. APZs will be defined in BMPs supporting future planning applications (subdivisions) to ensure that all future lots will be subject to a BAL rating of BAL-29 or lower. Indicative APZs are shown between vegetation to the west of the subject site (within San Teodoro Park, managed by the City of Wanneroo) and proposed lots abutting the western boundary of the subject site (Figure 8). This will allow future development to occur within areas subject to a BAL rating of ≤BAL-29. This indicative APZ will be maintained to APZ standards in the Guidelines(Appendix B). Figure 8 demonstrates that future lots within the subject site will be subject to BHLs of Moderate or Low and ELA expects that APZs will be able to be accommodated between classified vegetation and

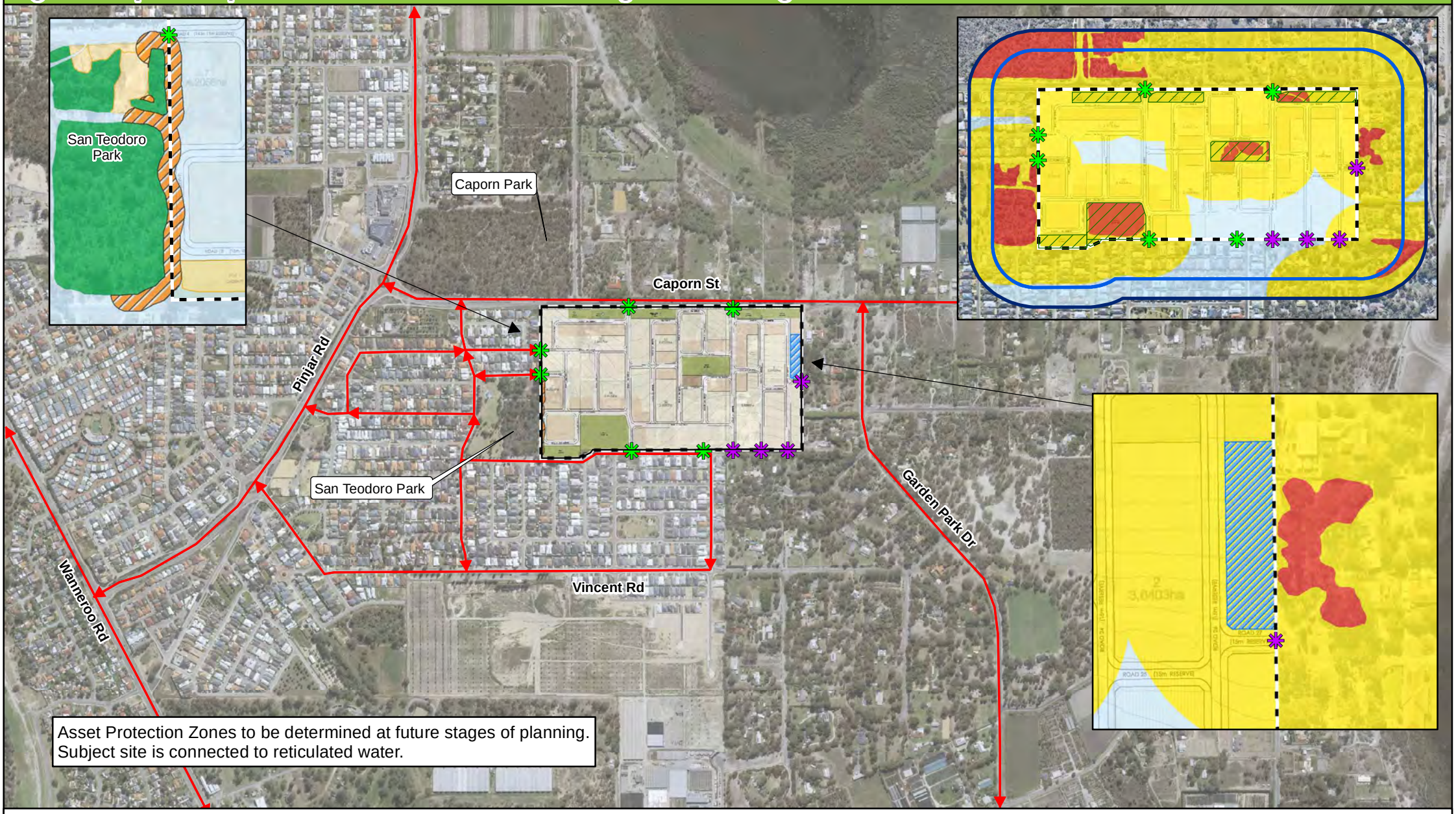
Bushfire Performance Criteria	AS	PS	N/A	Comment
				future buildings within road reserves, maintained Public Open Space areas etc. The proposed development is considered to be compliant with A2.1.
Element 3: Vehicular access A3.1 Two access routes	☒	☐	☐	There are six proposed vehicular access points from the subject site that join onto the existing road network (refer to Figure 8). BMPs supporting future planning applications (subdivisions) will provide greater detail on road networks and ensure that all stages of development are provided with two forms of access at all times. The proposed development is considered to be compliant with A3.1.
Element 3: Vehicular access A3.2 Public road	☐	☐	☒	The road network internal to the subject site is not known at this level of planning. BMPs supporting future planning applications (subdivisions) will address this element in greater detail if required.
Element 3: Vehicular access A3.3 Cul-de-sac	☐	☐	☒	Four proposed temporary cul-de-sacs will be created as part of the Local Structure Plan until surrounding land is developed (Figure 8). These cul-de-sacs will be less than 200 m long and have temporary turn around areas constructed with a minimum diameter of 17.5 m. BMPs supporting future planning applications (e.g. subdivisions) will address this element in greater detail if required.
Element 3: Vehicular access A3.4 Battle-axe	☐	☐	☒	No battle-axe lots are proposed as part of the development. BMPs supporting future planning applications (subdivisions) will address this element in greater detail if required.
Element 3: Vehicular access A3.5 Private Driveway longer than 50 m	☐	☐	☒	No private driveways longer than 50 m are proposed as part of the development. BMPs supporting future planning applications (subdivisions) will address this element in greater detail if required.
Element 3: Vehicular access A3.6 Emergency Access way	☐	☐	☒	No emergency access ways are proposed or required as part of the development. BMPs supporting future planning applications (subdivisions) will address this element in greater detail if required.
Element 3: Vehicular access A3.7 Fire-service access routes	☐	☐	☒	No fire service access routes are required or proposed. BMPs supporting future planning applications (subdivisions) will address this element in greater detail if required.

Bushfire Performance Criteria	AS	PS	N/A	Comment
Element 3: Vehicular access A3.8 Firebreak width	☒	☐	☐	All lots within the subject site will be managed in accordance with the City of Wanneroo Fire Hazard Reduction Notice (City of Wanneroo 2020), if applicable. Caporn Park and San Teodoro Park each have a 4 m wide firebreak surrounding the portions of vegetation and are managed by the City (City of Wanneroo 2020). BMPs supporting future planning applications (subdivisions) will address this element in greater detail. The proposed development is considered to be compliant with A3.8.
Element 4: Water A4.1 Reticulated areas	☒	☐	☐	The subject site will be connected to a reticulated water supply. BMPs supporting future planning applications (subdivisions) will address this element in greater detail. The proposed development is considered to be compliant with A4.1. A4.2 and A4.3 are not applicable to this proposed development.

3.2 Additional management strategies

Future demonstration of compliance with the relevant requirements of SPP 3.7, the Guidelines and AS 3959-2018 will depend on the developer's ability to coordinate the timing of development works within the subject site. Updated BMPs will be prepared to support subsequent planning applications where relevant and will contain re-assessments of bushfire risk including Bushfire Attack Level assessments etc.

Figure 8: Spatial representation of the bushfire management strategies



Legend

- Subject site
- 100m Assessment
- 150m Assessment
- Lots withheld until future vegetation management occurs to the east
- Proposed western 14m setback
- Access/ egress route
- Access point
- Proposed temporary cul-de-sac* (see
- **Vegetation classification**
- Class B woodland
- Class D scrub
- Class G grassland
- Excluded under clause 2.2.3.2 (f)
- Excluded under clause 2.2.3.2 (e) and (f)
- **Bushfire Hazard Level**
- Extreme
- Moderate
- Low

0 100 200 400
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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4. Implementation and enforcement

Implementation of the BMP applies to Acumen Development Solutions, the City of Wanneroo, and future landowners to ensure bushfire management measures are adopted and implemented on an ongoing basis. This BMP has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. In this respect, management measures documented in Section 3, where applicable, will be incorporated into development design as early as possible and confirmed through Structure Plan and subdivision design. Therefore, aside from the revision of this BMP or preparation of a BMP addendum to accompany future subdivision applications, there are no further items to implement, enforce or review at this stage of the planning process.

The revised BMPs or addendums to this BMP are required to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measure 6.4) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions to meet the performance requirements of the Guidelines.

5. Conclusion

In the author's professional opinion, the bushfire protection requirements listed in this assessment provide an adequate standard of bushfire protection for the proposed development. As such, the proposed development is consistent with the aim and objectives of SPP 3.7 and associated guidelines and is recommended for approval.

6. References

City of Wanneroo. 2020. *Fire Mitigation Notice.* Available from: https://www.wanneroo.wa.gov.au/downloads/file/3465/firebreak_notice_2019 .

Department of Fire and Emergency Services (DFES). 2019. *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: http://www.dfes.wa.gov.au/regulationandcompliance/bushfireproneareas/Pages/default.aspx

Department of Planning (DoP). 2016. *Visual guide for bushfire risk assessment in Western Australia.* DoP, Perth.

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Western Australian Planning Commission (WAPC). 2015. *State Planning Policy 3.7 Planning in Bushfire Prone Areas*. WAPC, Perth.

Western Australian Herbarium (1998–). FloraBase—the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/

Western Australian Planning Commission (WAPC). 2017. *Guidelines for Planning in Bushfire Prone Areas Version 1.3 (including appendices).* WAPC, Perth.

Appendix A – Plates

Plot	Photo ID	Photo and vegetation class
1	1	 Class B woodland – upslope / flat land This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation will be retained in site as POS, however, it is currently unknown if this will be cleared and landscaped or retained. The POS area is surrounded by a road to provide seperation from any potential hazard. The trees in this portion of vegetation are less than 30 m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-). No revegetation is anticipated in this portion of the vegetation. If revegetation is proposed at a later date, this will be addressed through subsequent BMPs.

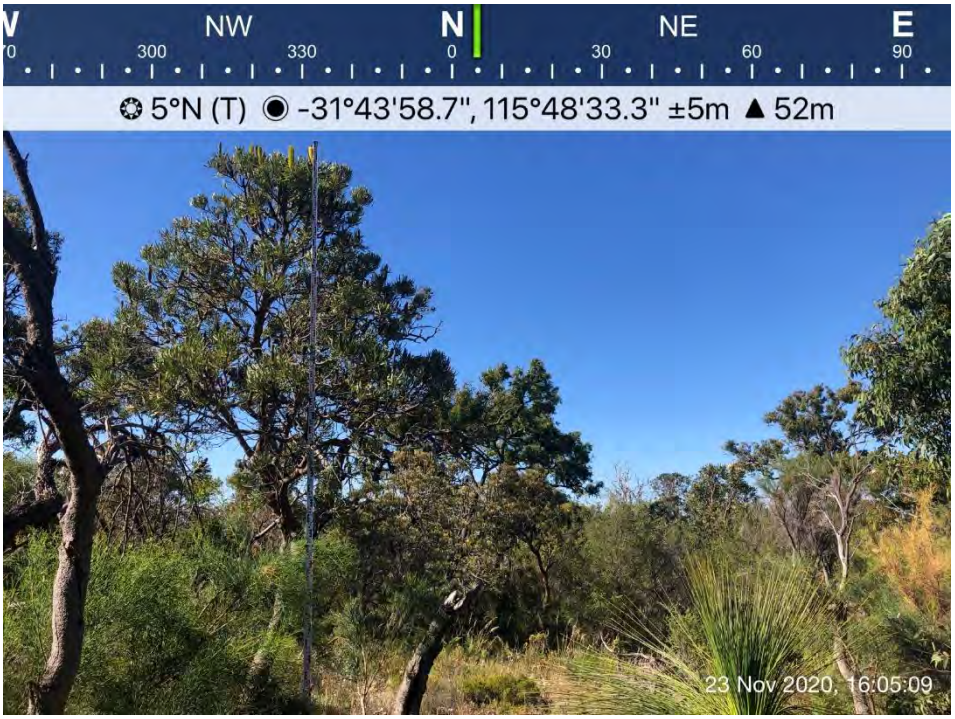
Plot	Photo ID	Photo and vegetation class
1	2	 Class B woodland This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation will be retained in site as POS, however, it is currently unknown if this will be cleared and landscaped or retained. The POS area is surrounded by a road to provide seperation from any potential hazard. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-). No revegetation is anticipated in this portion of the vegetation. If revegetation is proposed at a later date, this will be addressed through subsequent BMPs.

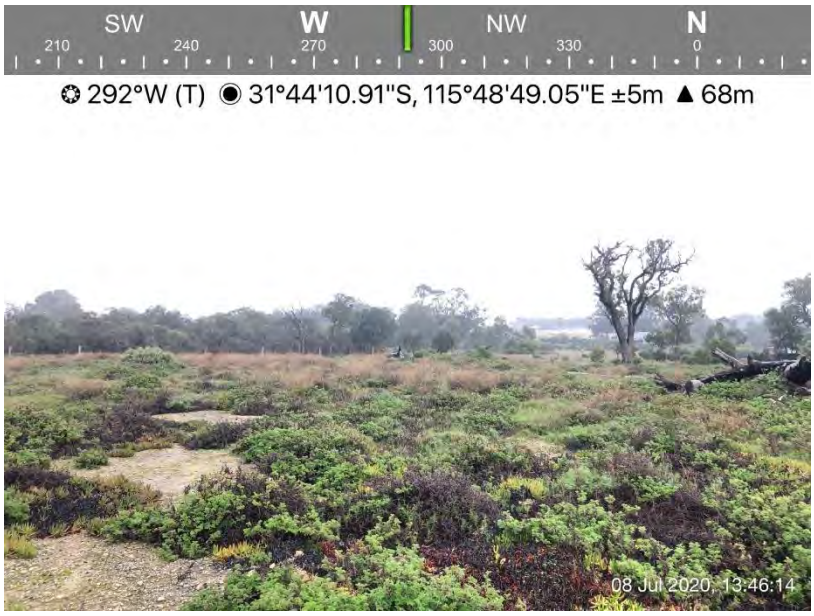
Plot	Photo ID	Photo and vegetation class
1	3	 Class B woodland - upslope / flat land This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation is in the San Teodoro Park, managed by the City of Wanneroo. This area has a surrounding firebreak as per the City of Wanneroo Firebreak notice (City of Wanneroo 2020), providing a seperation distance between the vegetation and any future development. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-).

Plot	Photo ID	Photo and vegetation class
1	4	 Class B woodland This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation is in the San Teodoro Park, managed by the City of Wanneroo. This area has a surrounding firebreak as per the City of Wanneroo Firebreak notice (City of Wanneroo 2020), providing a seperation distance between the vegetation and any future development. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-).

Plot	Photo ID	Photo and vegetation class
1	5	 Class B woodland This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation is in the San Teodoro Park, managed by the City of Wanneroo. This area has a surrounding firebreak as per the City of Wanneroo Firebreak notice (City of Wanneroo 2020), providing a seperation distance between the vegetation and any future development. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-).
1	6	 Class B woodland - upslope / flat land

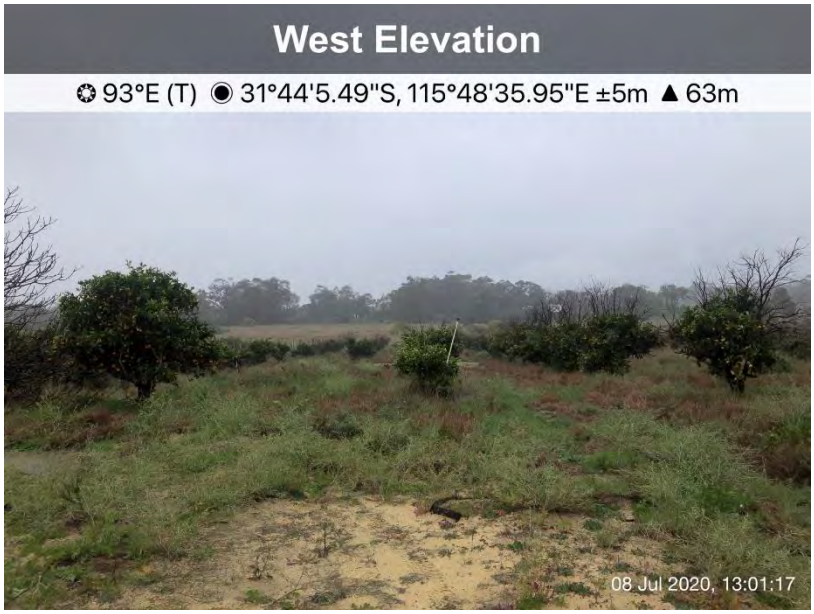
Plot	Photo ID	Photo and vegetation class
2	7	 Class B woodland – downslope >0-5 degrees This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation is in the Caporn Park, managed by the City of Wanneroo. This area has a surrounding firebreak as per the City of Wanneroo Firebreak notice (City of Wanneroo 2020), providing a seperation distance between the vegetation and any future development. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-).

Plot	Photo ID	Photo and vegetation class
2	8	 Class B woodland This vegetation is more representative of Class D scrub due to the vegetation height, composition and the canopy cover, however, a conservative approach has been taken as a worst-case scenario and has been classed as Class B woodland. This portion of vegetation is in the Caporn Park, managed by the City of Wanneroo. This area has a surrounding firebreak as per the City of Wanneroo Firebreak notice (City of Wanneroo 2020), providing a seperation distance between the vegetation and any future development. The trees in this portion of vegetation are less than 30m high with a foliage cover of less than 30%. The dominant species in this area are Banksia and have a grassy understorey, as shown in the foreground of the photograph. The projected maximum height *Banksia attenuata* and *Banksia menziesii* will grow to is 10 m and 7 m respectively (WA Herbarium, 1998-).
3	9	 Class D scrub – upslope / flat land

Plot	Photo ID	Photo and vegetation class
4	10	 Class G grassland- upslope / flat land
4	11	 Class G grassland- upslope / flat land

Plot	Photo ID	Photo and vegetation class
5	12	 Class G grassland - downslope >0-5 degrees
5	12	 Class G grassland - downslope >0-5 degrees

Plot	Photo ID	Photo and vegetation class
6	13	 Class G grassland - downslope >5-10 degrees
7	14	 Excluded under clause 2.2.3.2 (f)

Plot	Photo ID	Photo and vegetation class
7	15	 Excluded under clause 2.2.3.2 (f)
5	16	 Excluded under clause 2.2.3.2 (e) and (f)

Plot	Photo ID	Photo and vegetation class
5	17	 Excluded under clause 2.2.3.2 (e) and (f)

Appendix B – Standards for Asset Protection Zones

The following standards have been extracted from the *Guidelines for Planning in Bushfire Prone Areas v 1.3* (WAPC 2018).

Every habitable building is to be surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements:

a. Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL 29) in all circumstances.

b. Location: the APZ should be contained solely within the boundaries of the lot on which a building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes).

c. Management: the APZ is managed in accordance with the requirements of '*Standards for Asset Protection Zones*' (below):

- Fences: within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used
- Objects: within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors
- Fine Fuel load: combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare
- Trees (> 5 metres in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy (**Figure 9**).

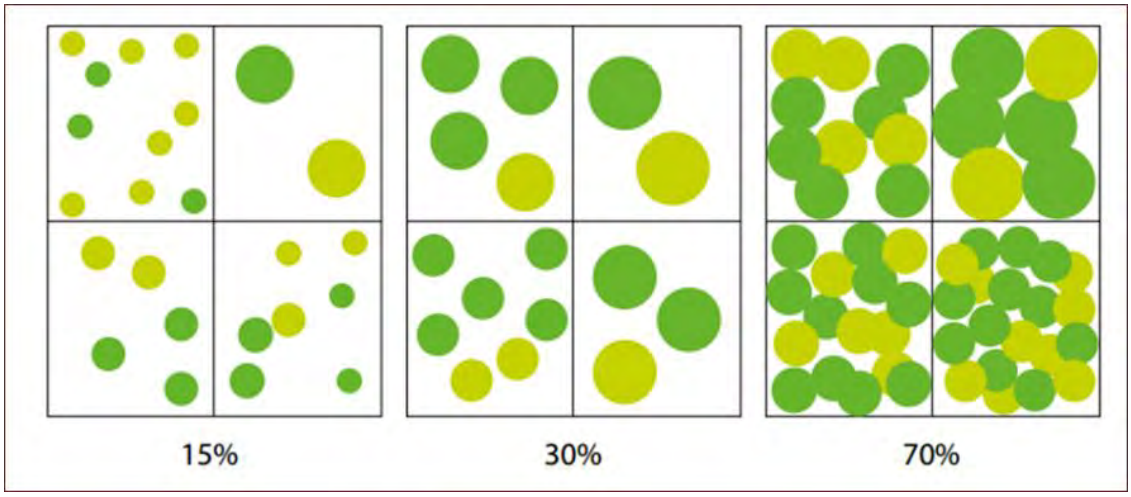


Figure 9: Illustrated tree canopy cover projection (WAPC 2017)

- **Shrubs (0.5 metres to 5 metres in height):** should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m^2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees
- **Ground covers (<0.5 metres in height):** can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs
- **Grass:** should be managed to maintain a height of 100 millimetres or less.

Additional notes

The Asset Protection Zone (APZ) is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level. Hazard separation in the form of using subdivision design elements or excluded and low threat vegetation adjacent to the lot may be used to reduce the dimensions of the APZ within the lot.

The APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity. The APZ may include public roads, waterways, footpaths, buildings, rocky outcrops, golf courses, maintained parkland as well as cultivated gardens in an urban context, but does not include grassland or vegetation on a neighbouring rural lot, farmland, wetland reserves and unmanaged public reserves.

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APPENDIX B

Environmental Assessment Report

360 environmental

Various Lots Caporn Street, Wanneroo

Environmental Assessment Report

Prepared for:

Acumen Development Solutions Pty Ltd

August 2020

people planet professional

Document Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
3192AA Rev0	INTERNAL DRAFT	SoS	SB	-	12/06/19
3192AA Rev1	CLIENT DRAFT	SoS	SB	1 Electronic (email)	18/08/20
3192AA Rev2	CLIENT FINAL	SoS	SB	1 Electronic (email)	19/08/20

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1 Introduction

360 Environmental Pty Ltd (360 Environmental) was commissioned by Acumen Development Solutions Pty Ltd to undertake an Environmental Assessment Report (EAR) for a grouping of properties on Caporn Street, Wanneroo (known as the "site") as shown in Figure 1. This report is designed to support the local structure planning approval process for the site.

The site covers an area of approximately 27 ha and includes nine individual lots. The site is located approximately 25 km north of Perth's Central Business District and is zoned 'Urban' under the Metropolitan Region Scheme (MRS). The site was determined to be 'not assessed' under Part IV of the Environmental Protection Act 1986 (EP Act) when referred to the Environmental Protection Authority (EPA) as part of the MRS Amendment. The EPA determination describes that the amendment does not raise any significant environmental issues that cannot be adequately managed through detailed planning processes in consultation with the relevant agencies.

This EAR provides an overview of the current environmental features of the site as determined through a review of existing information. It describes how the local structure plan provided in Figure 2 has taken into account the environmental features of the site and it makes recommendations in relation to the need for further environmental work during subsequent planning approval processes.

2 Relevant Legislation, Policies and Guidelines

2.1 Commonwealth Legislation

2.1.1 Environmental Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the central piece of environmental legislation which protects Matters of National Environmental Significance (MNES) and broadly, to conserve Australia's biodiversity. If a proposed action is likely to have a significant impact on any MNES, a referral to the Commonwealth Department of Agriculture, Water, and Environment (DAWE) is required.

2.2 State Legislation

2.2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the key legislative tool for environmental protection in Western Australia. It is administered by the EPA and the Minister for the Environment. Under Part IV of the EP Act, the EPA undertakes environmental impact assessment of proposals and schemes to provide advice on environmental acceptability of developments. The environment impact assessment process provides an orderly and systematic evaluation of a proposal and its potential impact on the environment. A critical component of the assessment is the consideration of ways in which the implemented proposal could avoid or reduce any potential impact on the environment.

2.2.2 Relevant Legislation and Regulations

All future development will be required to comply with the requirements of other relevant state legislation and regulations. Table 1 provides a summary of the key state legislation and regulations relevant to the proposed residential development.

Table 1: Key State Legislation

Key Legislation	Responsible Government Agency	Aspect
Aboriginal Heritage Act 1972	Department of Planning, Lands and Heritage	Archaeological and ethnographic heritage
Aboriginal Heritage Regulations 1974	Department of Planning, Lands and Heritage	Archaeological and ethnographic heritage
Agricultural and Related Resources Protection Act 1976	Department of Primary Industries and Regional Development	Weeds and feral animals
Biosecurity and Agriculture Management Act 2007	Department of Primary Industries and Regional Development	Weeds / pests / diseases

Key Legislation	Responsible Government Agency	Aspect
Bush Fires Act 1954	Department of Fires and Emergency Services	Bush fire control
Conservation and Land Management Act 1984	Department of Biodiversity, Conservation and Attractions	Flora and fauna / habitat / weeds / pests / diseases
Conservation and Land Management Regulations 2002	Department of Biodiversity, Conservation and Attractions	Flora and fauna / habitat / weeds / pests / diseases
Contaminated Sites Act 2003	Department of Water and Environmental Regulation	Management of contaminated soils and water
Environmental Protection Act 1986	Department of Water and Environmental Regulation	Part IV – Environmental Impact Assessment Part V – Works Approvals and Licences
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Department of Water and Environmental Regulation	Clearing of native vegetation
Planning and Development Act 2005	Department of Planning, Lands and Heritage	Structure planning and subdivision approval
Rights in Water and Irrigation Act 1914	Department of Water and Environmental Regulation	Governs management of the use, service and health of water and watercourses (including beds and banks). Water licensing is required in all proclaimed areas and for all artesian groundwater wells throughout the state.
Biodiversity Conservation Act, 2016	Department of Biodiversity, Conservation and Attractions	Wildlife conservation and protection
Biodiversity Conservation Regulations 2018	Department of Biodiversity, Conservation and Attraction	Wildlife conservation and protection

2.2.3 Relevant Standards, Guidelines and Policies

Future development within the LSP is subject to compliance with applicable standards, guidelines and policies developed by the State's regulators to assist proponents in understanding the minimum requirements for environmental protection. The following table details the key standards, guidelines, and State Planning Policies relevant to future residential development of the site.

Table 2: Relevant Standards, Guidelines and Policies

Document	Description
EPA Guidance Statements	
Guidance Statement No. 3: Separation Distances between Industrial and Sensitive Land Uses	Provides guidance on the generic separation (buffer) distances between Industrial and Sensitive land uses to avoid conflicts between these land uses.
Guidance Statement No. 6: *Rehabilitation of Terrestrial Ecosystems* (EPA 2006)	Provides guidance to ensure the return of biodiversity in rehabilitated areas by increasing the quality, uniformity, and efficiency of standards and processes for rehabilitation of native vegetation in Western Australia and to allow more effective monitoring and auditing of outcomes.
Guidance Statement No. 33: *Environmental Guidance for Planning and Development* (EPA 2008)	Provides information and advice to assist land use planning and development processes to protect, conserve and enhance the environment. Describes the processes the EPA may apply under the EP Act to land use planning and development in Western Australia, and the environmental impact assessment process applied by the EPA to schemes.
Guidance Statement No. 41: *Aboriginal Heritage Assessment* (EPA 2004b)	Provides guidance on the EPA's position on the assessment of Aboriginal heritage and information that the EPA will consider when assessing proposals where Aboriginal heritage is a relevant environmental factor.
Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004c)	Provides guidance and information on the EPA's expected standards and protocols for terrestrial flora and vegetation surveys to environmental consultants and proponents.
Guidance Statement No. 55: *Implementing Best Practice in Proposals submitted to the Environmental Impact Assessment Process* (EPA 2003)	Provides guidance on the EPA's position on the use of best practice to protect the environment, and the approach that the EPA will take when assessing best practice implementation in proposals.
Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004d)	Provides guidance and information on the EPA's expected standards and protocols for terrestrial flora and vegetation surveys to environmental consultants and proponents.
EPA Bulletins	
Environmental Protection Bulletin No. 1: *Environmental Offsets* (EPA 2014b)	Clarifies how the EPA will consider offsets through the environmental impact assessment process.

Document	Description
Environmental Protection Bulletin No. 16: *Minor or preliminary works and investigation work* (EPA 2011b)	Clarifies what information a proponent needs to submit to the EPA if it wants the EPA's consent to undertake minor or preliminary works.
State Planning Policies	
State Planning Policy 2.8: *Bushland Policy for the Perth Metropolitan Region* (WAPC 2010)	Provide policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision making. Ensure the long-term protection of biodiversity and associated environmental values.
State Planning Policy 2.9: *Water Resources* (WAPC 2006)	Provides clarification and additional guidance to planning decision-makers for consideration of water resources identified as having significant economic, social, cultural, or environmental values.
State Planning Policy 3.7: *Planning in Bushfire Prone Areas* (WAPC 2015)	Provides guidance on the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure.
DER Guidelines	
Assessment and management of contaminated sites Guideline (DER 2014)	Provides guidance on the assessment and management of contaminated sites in Western Australian within legislative framework of the Contaminated Sites Act 2003 and the Contaminated Sites Regulations 2006.

3 Site Description and Assessment

3.1 Site Location

The site is within the suburb of Wanneroo (Figure 1) and comprises of Lots 1, 2, 7, 12, 13, 36, 37, 38 and 9006 located directly south of Caporn Street, (Figure 2).

3.2 Property and Zoning Information

Under the Metropolitan Region Scheme (MRS), the site is currently zoned 'Urban'; an area in which a range of activities are undertaken, including residential, commercial recreational and light industry.

3.3 Surrounding Land Uses

The surroundings north of Caporn Street consist of rural residential, cleared pasture and patches of native vegetation including Bush Forever Site 469. Market gardens and nurseries to the east and southeast of the site and standard residential development exists to the south and west.

Current land uses surrounding the site which require buffers are listed below. The impacts of these surrounding land uses on the proposed residential development have been assessed with the use of the EPA 'Guidance Statement No.3: Separation Distances between Industrial and Sensitive Land Uses' (2005) and the Department of Health (DOH) 'Guidelines for Separation of Agricultural and Residential Land Uses'. These guidelines indicate the minimum recommended distance that should be accommodated in planning design to minimise negative impacts to future residents. The recommended distances are suggested on the basis that no site-specific investigations are undertaken.

3.3.1 Market Gardens

The Department of Health Guidelines for Separation of Agricultural and Residential Land Uses should be referred to regarding the active Market Gardens (Lots 2 and 7) and an orchard (Lot 37). The guidelines recommend a minimum separation or buffer distance of 300 m to 500 m between market gardens and residential land uses (Department of Health, 2018). It is noted however that the lots in question are zoned Urban and will be developed in accordance with the LSP for the site.

3.3.2 Nurseries

To the east of the site there are several nurseries which are currently in operation. The EPA recommends a 100 m generic buffer for nurseries without composting facilities to prevent noise conflicts (EPA, 2005). Those with composting facilities will require a 150-500 m buffer to prevent odour, dust, and noise pollution. It is unlikely these operations will impact the site as the closest nursery is approximately 480 m.

3.4 Topography

The site slopes upwards from the northeast to the south. The gradient ranges from 53 m in the north, to just over 71 m Australia Height Datum (AHD) at several locations along the southern boundary.

3.5 Groundwater

3.5.1 DWER Groundwater Bore Database Search

The Perth Groundwater Map (Department of Water and Environmental Regulation, online) provides groundwater contours at the site ranging from approximately 39 mAHD to 42 mAHD, with flow to the west. These contours typically reflect a summer minimum condition.

Groundwater mapping was undertaken as part of the Integrated Water Management Framework: East Wanneroo District Structure Plan (RPS, 2019). The historic maximum groundwater levels (MGL) and average annual maximum groundwater levels (AAMGL) were produced from long-term DWER monitoring data and mapped over the entire district structure plan area. Historic MGL ranging from 37 mAHD-41 mAHD across the site and the AAMGL slightly lower ranging from 37mAHD-40 mAHD. The natural surface clearance above these contours ranges from 12 m to 32 m.

A search of the DWER WIN Groundwater bore database identified 62 groundwater bores within a 1 km radius of the site, of which 7 were indicated to be operational as shown in Figure 3 (Department of Water and Environmental Regulation, 2019b). information of each WIN bore's ID, purpose, status, drill depth and owner are provided in Appendix A.

3.5.2 Groundwater Allocation

Four Groundwater Licenses apply to Lots within the site and are presented in Table 3.

Table 3: Groundwater Allocation

Lot	Licence	Allocation (kL)	Expiration
Lot 7 on Diagram 21467	#58046	48650	18/12/2026
Lot 37 on Diagram 74522	#58047	16875	30/05/2027
Lot 1 on Diagram 41651	#87116	22500	09/02/2025
Lot 13 on Diagram 27581			
Lot 2 on Diagram 41651	#91679	53100	26/05/2023

3.6 Geology and Soils

The site is located within the Spearwood soil system and is described as; Sand dunes and plains with yellow deep sands and yellow/brown shallow sands (Department of Primary Industries and Regional Development, 2018).

The Soil Subsystems mapping indicates the site is within one soil subsystem; the Karrakatta Sand Yellow Phase. Described as low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 meres. Banksia spp. Woodland, scattered with emergent *Eucalyptus gomphocephala, E. marginate* and a dense shrub layer (Department of Primary Industries and Regional Development, 2018) (Figure 4).

Hyd2o conducted permeability testing at the site in July 2020 as part of the preparation of a local water management strategy (LWMS) to support the proposed LSP for the site. This testing provides estimates of the field saturated hydraulic conductivity of the soils and assess their suitability for stormwater infiltration. It was concluded that the site has favourable conditions for stormwater retention and infiltration on-site given its sandy soils, and good separation to groundwater.

3.7 Acid Sulfate Soils

The site is identified to have "No known risk of ASS occurring within 3 m of natural soil surface" (Department of Water and Environmental Regulation, 2019a).

3.8 Contamination

A search of the Contaminated Sites Database identified no registered contaminated sites within a 1 km radius. The site does contain two active market gardens (Lots 2 and 7) and a small orchard (Lot 37) (Department of Water and Environmental Regulation, 2018b). Intensive agriculture is a potentially contaminating land use and therefore the market gardens result in a requirement for a Preliminary Site Investigation (PSI). A PSI includes a desktop study, site inspection and interviews with relevant personnel to identify the potential for contamination and thus the need for further detailed site investigation.

3.9 Heritage

3.9.1 Aboriginal Heritage

In Western Australia, the *Aboriginal Heritage Act 1972* protects places and objects customarily used by or traditional to the original habitants of Australia. A register of such places and objects are maintained under the Act, however, all sites are protected under the Act regardless if they are registered or not.

A desktop search of the Aboriginal Heritage Inquiry System identified no Aboriginal sites occurring within the site. The nearest Aboriginal site is the Wanneroo located approximately 200 m north of the site (Department of Planning Lands and Heritage, 2018) (Table 4).

Table 4: Aboriginal Heritage Sites

Site Name	Number	Type	Status	Distance from Site
Lake Marginiup	3741	Mythological, Hunting Place	Registered	200 m

It is unlikely that the presence of this Aboriginal Heritage Site would be impacted by proposed residential development.

3.9.2 European Heritage

A desktop search of State culturally significant heritage sites was undertaken using the WA Heritage Council Search Tool. No registered State Heritage Sites were found to occur within the site or within a 2 km radius.

3.10 Environmentally Sensitive Areas

There are no recorded Environmentally Sensitive Area's (ESA) or wetlands within the site. The nearest ESA's occur 0.3 km northeast, 0.3 km north and 0.7 km west of the site (Department of Biodiversity Conservation and Attractions, 2017b; Department of Water and Environmental Regulation, 2018a).

3.11 Reserves and Conservation Areas

Two Ecological Linkages run through the northwest and north-eastern corners of the site as shown in Figure 5 (ID: 24 and 12) (Perth Biodiversity Project, 2008).

There are no conservation sites recorded within the site (Department of Biodiversity Conservation and Attractions, 2017a).

3.12 Flora and Vegetation

3.12.1 Bioregion

The site is located within the Swan Coastal Plain bioregion of the Interim Biogeographic Regionalisation of Australia (IBRA). The Swan Coastal Plain sub-region 2 (SWA02) is a low lying coastal plain composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone rising to duricrusted Mesozoic sediments in the east. Outwash plains are extensive only in the south, while a complex series of seasonal wetlands and swamps extends from north to south. Vegetation comprises heath and/or Tuart woodlands on limestone, Banksia and Jarrah- Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvial soils, *Casuarina obesa* on out-wash plains, and paperbark (*Melaleuca spp*.) in wetland areas (Mitchell et.al 2002).

3.12.2 Broad Vegetation Types

Vegetation mapping of the Swan Coastal Plain subregion of WA was completed on a broad scale (1:250,000) by Beard (1972-80). These vegetation units were re-assessed by

Shepherd et al. (2001) to account for clearing in the intensive land use zone, dividing some larger vegetation units into smaller units.

The site is within one vegetation unit described below (Shepherd et al. 2001).

- **Spearwood 6:** Medium woodland, Tuart and Jarrah.

Remnant vegetation statistics of the IBRA region and the above vegetation associations are detailed in Table 5.

Table 5: Remnant Vegetation Statistics (Government of Western Australia 2016)

	Pre–European (ha)	Current Extent (ha)	% Remaining	% Remaining in DPaW reserves
IBRA Region Swan Coastal Plain	1,501,221.93	578,432.17	38.53	37.85
State Wide				
Beard Veg Assoc No. 6	56,343.01	13,353.48	23.70	37.46
In IBRA Region SWA02				
Beard Veg Assoc No. 6	56,343.01	13,353.48	23.70	37.46
Local Government Authority – City of Wanneroo				
Beard Veg Assoc No. 6	12,662.10	2,757.49	21.78	50.80

Vegetation complexes of the Southwest botanical district have been mapped by Heddle et al. (1980). One vegetation complex exists across the site which relates to the underlying soil profile.

- **'Karrakatta Complex - Central and South':** Open forest of *Eucalyptus gomphocephala*, *E. marginata, Corymbia calophylla* and woodland of *E. marginata* and Banksia species.

Within constrained areas on the Swan Coastal Plain, the EPA *Guidance Statement 33: Environmental Guidance for Planning and Development* has set a threshold for retention of 10% of the pre-existing extent of native vegetation (EPA 2008). The site is considered a constrained area as it is with the Perth MRS and is within proximity to urban areas, which means there is a reasonable expectation that development will be able to proceed. The above-mentioned vegetation association/complex extents within the Swan Coastal Plain 2 IBRA subregion are greater than the 10 % threshold and less than 30 %. Therefore, aligning with the draft Broad Commitments within the draft Green Growth Plan.

3.12.3 Threatened and Priority Ecological Communities

Desktop searches of the DAWE's Protected Matters Search Tool (PMST) identified the following Threatened Ecological Community as potentially occurring within a 5 km radius of the site:

Table 6: Threatened and Priority Ecological Communities Potentially Occurring within the Area

Threatened Ecological Community	EPBC Status	Likelihood
Banksia Woodlands of the Swan Coastal Plain	Endangered	Community may occur within area

Banksia Woodlands of the Swan Coastal Plain ecological community was listed as Endangered under the EPBC Act on 16 September 2016. The ecological community's extent has declined considerably with an approximate loss of 60 per cent of its original extent. The Banksia Woodlands ecological community vary in structure and species composition but have a generally dominant Banksia component which includes at least one of four key species; *Banksia attenuata, B. menziesii, B. prionotes* and *B. ilicifolia.* The Flora and Vegetation survey conducted in 2010 suggests that the vegetation within the survey area contains *Banksia attenuata, B. menziesii and B. ilicifolia* species.

Section 158 (3) (4) of the EPBC Act states that as EPBC approval was granted prior (30 June 2012) for Lots to the listing of the Banksia Woodland TEC, the listing is to be disregarded for the action approval granted for the site. The validity of the approval is not affected by any future listing events under the EPBC Act within the validity period of the approval.

3.12.4 Flora and Vegetation Surveys

ENV Australia 2010 Survey

A spring flora and vegetation survey was undertaken by ENV Australia in 2010 of the site, with the exclusion of Lots 1 and 2. Lot 2 is completely cleared of native vegetation. The results of this survey were reported in the Environmental Assessment Report prepared in 2012 to support the MRS Amendment for the site's rezoning from Rural to Urban. Figure 6 describes the results of this work and the following is taken from the ENV Australia EAR.

A spring flora and vegetation survey was conducted in November 2010 to determine native vegetation type(s) and conditions across the subject land. The subject land was found to have two primary native vegetation communities:

1) C. calophylla (Marri) Open Forest. This occurs in remnant patches over weeds or in homesteads across Lots 7, 12 and 13.

2) Open Woodland of *E. marginata* (Jarrah) and *Banksia attenuata* over *Kunzea glabrescens*, *Jacksonia sternbergiana, Hibbertia spicata, Corynotheca micrantha,*

Conostylis setigera subsp. *setigera, Mesomelaena preissii, Desmocladus asper,*

**Ehrharta calycinus* and *Briza maxima. This occurs across Lots 13, 36 and 38.

The vegetation condition of the site has been greatly affected by; soil disturbance; the presence of weeds; and the edge effects from nearby roads, tracks, housing developments and associated clearing. Based on the Bush Forever Vegetation Condition Scale (Government of Western Australia, 2000), the condition of the subject land ranged from 'Good' to 'Completely Degraded'.

In general. the Marri Open Forest was considered 'Completely Degraded' and the Jarrah and *Banksia* Open Woodland was considered 'Good' to 'Degraded'. From a floristic diversity perspective, the Marri Open Forest is considered 'Completely Degraded'.

The Jarrah and *Banksia* Open Woodland has an understorey which retains some floristic diversity, however it is so severely impacted by weeds and disturbance that it is not considered to have any long-term viability as natural bushland. Both vegetation communities are however still considered to have aesthetic and fauna habitat values.

No 'Threatened' flora species listed under the *EPBC Act 1999* or plant species gazetted as Declared Rare Flora (DRF) under the *WC Act 1950* were located during the ENV field surveys of the subject land.

360 Environmental 2019 Survey

In April 2019, 360 Environmental completed a detailed flora and vegetation survey of Lots 1 and 13. The resulting report is provided in Appendix B. No threatened flora species pursuant to the EPBC Act (1999) and/or gazetted as Threatened/ Declared Rare Flora pursuant to the BC Act (2016) were recorded during the survey. One Priority 4 species, *Jacksonia sericea*, was recorded in two locations within the survey area. A total of 19 weed species were recorded during the survey, none of which represent a Declared Plant or Weed of National Significance.

The vegetation condition of the site has been greatly affected by; soil disturbance, the presence of weeds and the edge effects from nearby roads, tracks, housing developments and associated clearing. The condition of the site ranges from 'Good' to 'Completely Degraded'. The Marri Open Forest is considered 'Completely Degraded' and the Jarrah and *Banksia* Open Woodland was considered 'Good' to 'Degraded'.

3.13 Fauna

3.13.1 Threatened and Priority Fauna

Desktop searches of the PMST and NatureMap databases identified conservation significant fauna species potentially occurring within a 5 km radius of the site. The search returned several marine birds and waders, as well as the water rat, that require specific habitats including wetlands, oceans, shorelines, and waterways. As the site does not contain these suitable habitats, these species have been omitted from further discussion.

In addition, several species returned in the databases were historical records of extinct species (ie. Malleefowl) and these have been omitted from further discussion.

A likelihood assessment was undertaken to determine the likelihood of these species occurring on the site. This assessment assumed that the flora and vegetation habitat has remained unchanged from the original survey in 2010, and the suitable habitats and species known distribution.

The likelihood of each species is based on the following criteria:

- Likely: Suitable habitat is present in the site and the site is within the species' known distribution
- Possible: Limited or no suitable habitat is present in the site, can be found nearby. The species has good dispersal abilities but is known from the general area
- Unlikely: No suitable habitat present on the site but is nearby. Species has poor dispersal abilities but is known from the general area or suitable habitat present; however, the site is outside of the species' known distribution.

Table 7: Likelihood Assessment of Conservation Significant Fauna Occurring within the Site (Department of Biodiversity Conservation and Attractions, 2019; Department of the Environment and Energy, 2019)

Taxa	State Status	EPBC Status	Likelihood
Calyptorhynchus banksii naso (Forest Red-tailed Black-Cockatoo)	Vulnerable	Vulnerable	Likely
Calyptorhynchus latirostris (Carnaby's Black-Cockatoo)	Endangered	Endangered	Likely
Dasyurus geoffroii (Chuditch)	Vulnerable	Vulnerable	Unlikely
Isoodon fusciventer (Quenda, southwestern brown bandicoot)	P4	-	Likely
Neelaps calonotos (Black-striped snake)	P3	-	Unlikely
Synemon gratiosa (Graceful Sunmoth)	P4	-	Likely

The likelihood assessment identified six conservation significant fauna species potentially occurring within the site. A total of four species were considered 'Likely' and two species 'unlikely' to occur within the site.

The site offers minimal quality or protected habitat for fauna as much of the land has been cleared or contains weeds. The southern portion of Lot 36 and most of Lot 38 contain Jarrah and *Banksia* Open Woodland, which offers potential fauna habitat, and is known for black cockatoo foraging habitat.

Surrounding uncleared bushland such as the Bush Forever Site 469, (Figure 5) maintains similar vegetation types as the site, in better condition. Marijiniup Lake and Lake Jandabup would provide more substantial foraging and breeding habitat for the black cockatoos and other fauna within the region.

An area of the site (Lot 13, 36 and 38) have an existing approval under the EPBC Act as a 'Not Controlled Action'. The proposed development is recognised as having no adverse impact on any Matters of National Environmental Significance (MNES), and any future listings under the EPBC Act will not affect the current approval established for these Lots.

4 Outcome and Key Findings of Assessment

The local structure planning process has considered the findings of the environmental surveys conducted on the site. While the site has been largely cleared of native vegetation and no DRF, Priority flora or EPBC-listed species were found during the spring flora and vegetation surveys there remains the opportunity to retain native vegetation within the development.

A 1.2 ha area within the southern part of Lot 38 has been identified as a suitable location for public open space (POS), in a way which allows vegetation of 'Good' condition to be retained (Figure 2). Other proposed POS has been located where remnants of the Marri Open Forest remain, where possible and this will result in the retention of trees. This is the case for the centrally located area of POS within Lot 13 which includes relatively large Marri trees.

An LWMS has been prepared by Hyd2o (2020) to support the LSP for the site and this has been reviewed as part of the preparation of this EAR. It is concluded that the proposed approach to stormwater management has no wider environmental implications. An Urban Water Management Plan (UWMP) will be required at the subdivision stage(s).

The site contains two market gardens and an orchard which are considered potentially contaminating land uses. DWER recommends that a preliminary site investigation be undertaken to ascertain the likelihood of soil and groundwater contamination.

In conclusion it is considered that the site has few remaining environmental values. Even so much of the remaining native vegetation present is to be retained within the development. The only environmental issue that requires further consideration is the potential for parts of the site to have been impacted by intensive agriculture.

5 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data and analyses ("client's information") provided by the client and other individuals and entities. In most cases where client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the client's information is accurate, exhaustive or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the client's information is contingent upon the accuracy, exhaustiveness and currency of the client's information. 360 Environmental shall not be liable to the client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the client's information was not accurate, exhaustive and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions, and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions, and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

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6 References

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FIGURES

Legend

- Site Boundary
- Lot Boundaries

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
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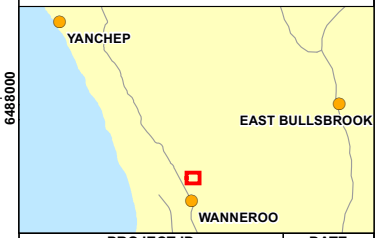
LOCALITY MAP



PROJECT ID	DATE
3192	31/07/2020

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

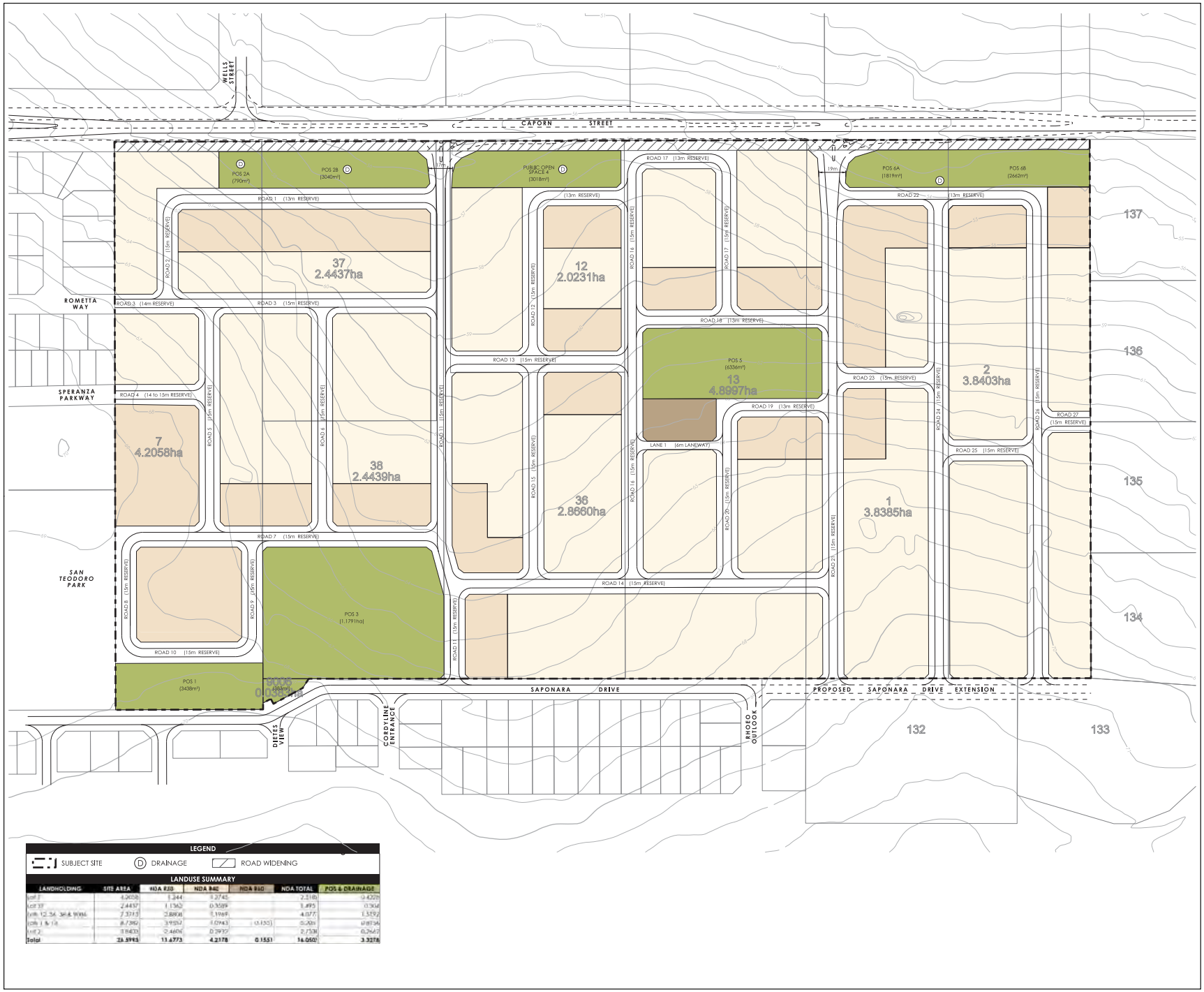
CREATED	CHECKED	APPROVED	REVISION
LF	SB	SB	0

Acumen Development Solutions
Caporn Street, Wanneroo

EAR Local Structure Planning

Figure 1
Site Location

K:\Projects\9.0 APP\3192 Caporn St Wanneroo EAR\3192 F1 Site Location.mxd



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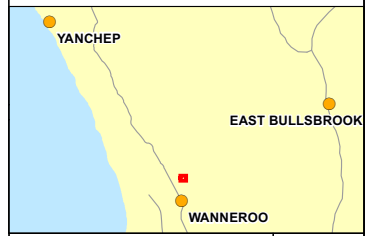

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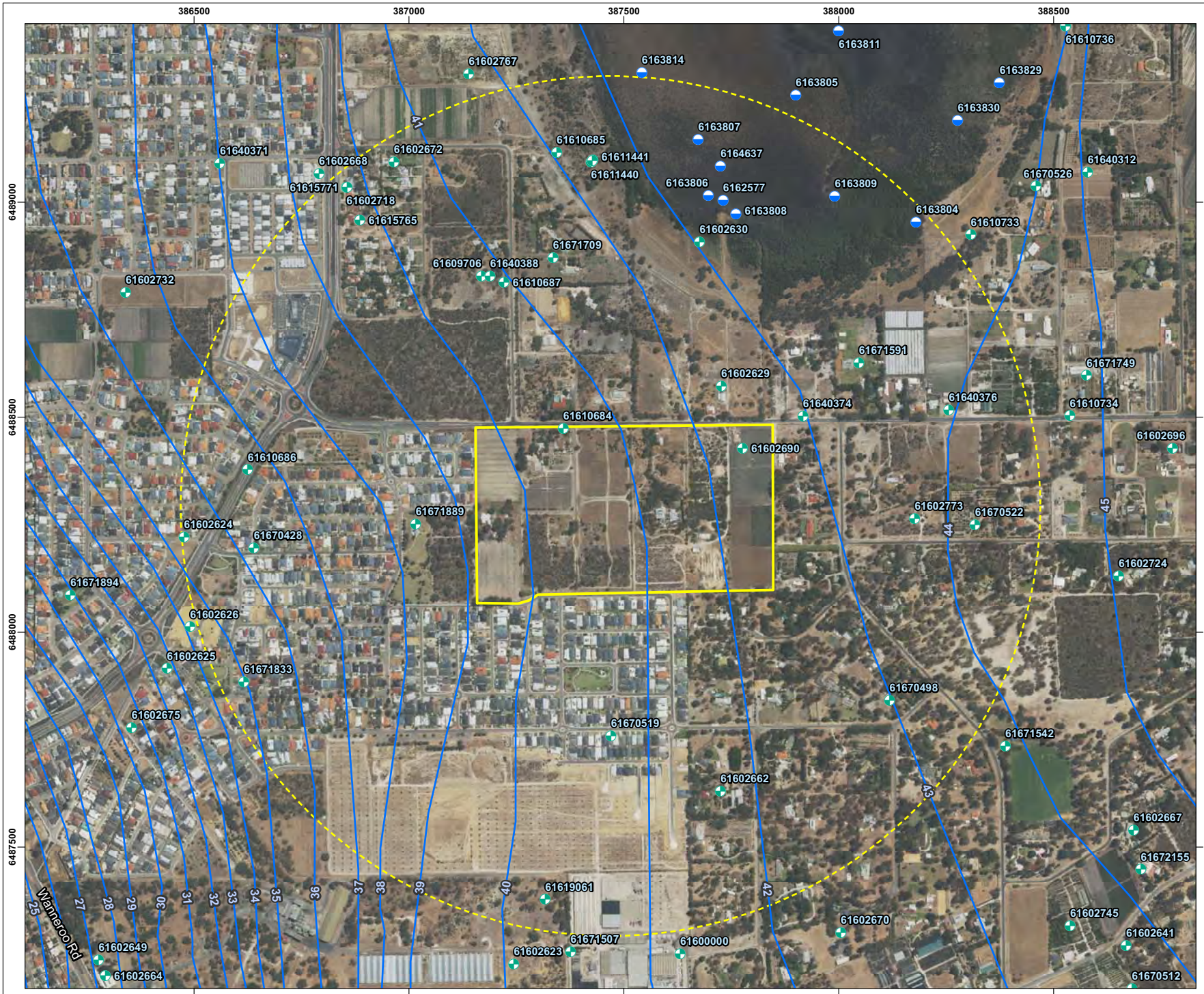
EAR Local Structure Planning

Figure 2
Local Structure Plan



Legend

- Site Boundary
- 1km Buffer
- Groundwater Contours - Max (mAHD)

DWER Registered Bores

- Groundwater
- Surface

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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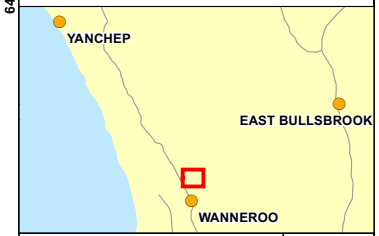

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Figure 3
Groundwater Bores

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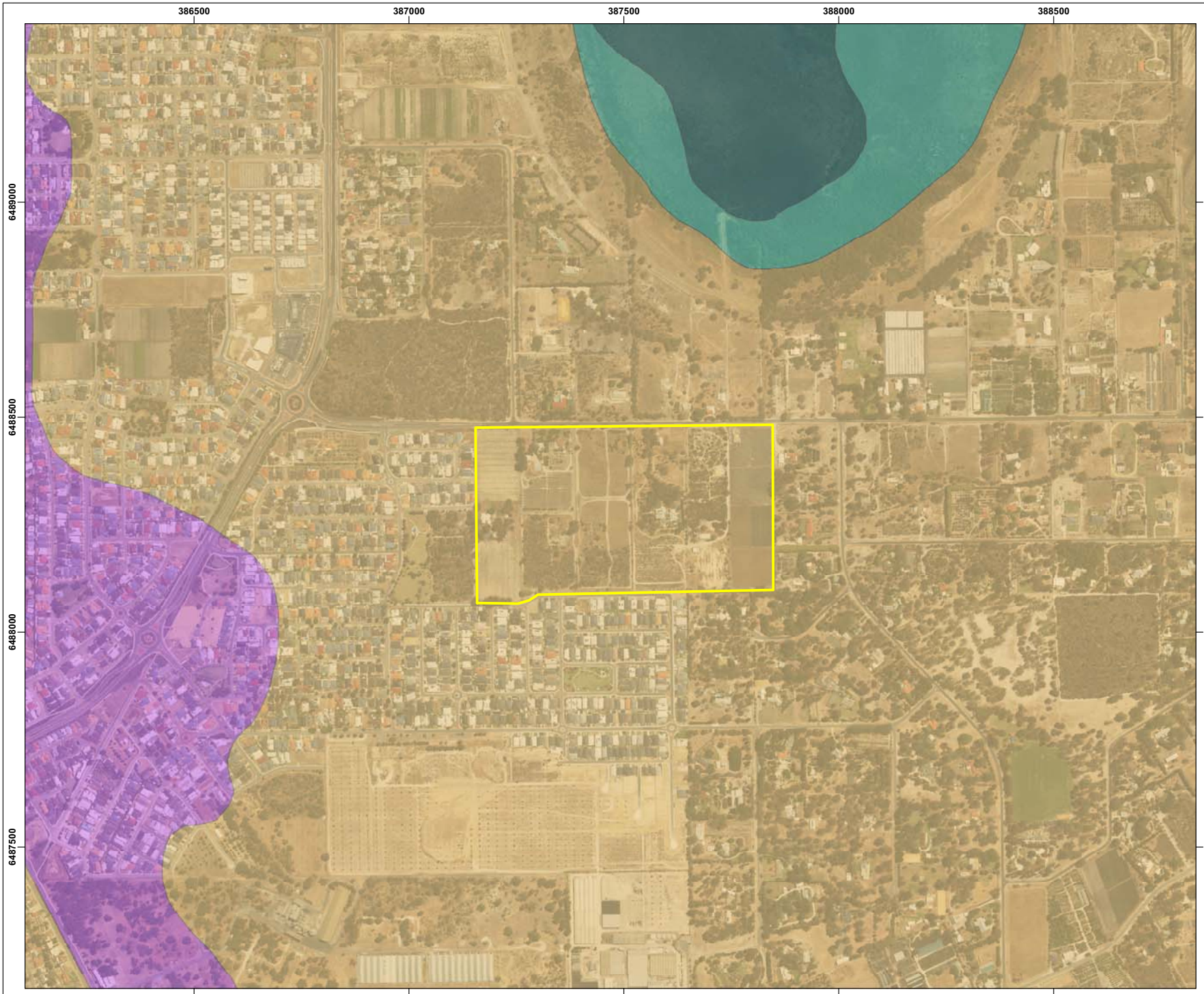

Legend

Site Boundary

Soils Subsystem Central

Depressions with free water in winter. Humus podzols and peat. Dense M. preissiana; M. rhaphiophylla and E. rudis around the edges with reeds and sedges in the centre.

Depressions. Humus podzols and peats around the edges often with some diatomite zoned vegetation with heath on upper slopes. Melaleuca spp. and E. rudis at waters edge. Reeds and sedges in shallow water.

Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. Banksia spp. woodland with emergent E. gomphocephala and E. marginata; dense shrub layer.

Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. Banksia spp. woodland with scattered emergent E. gomphocephala and E. marginata and a dense shrub layer.

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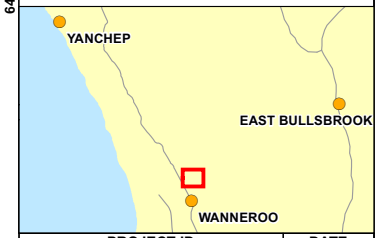

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Figure 4
Soils Subsystems

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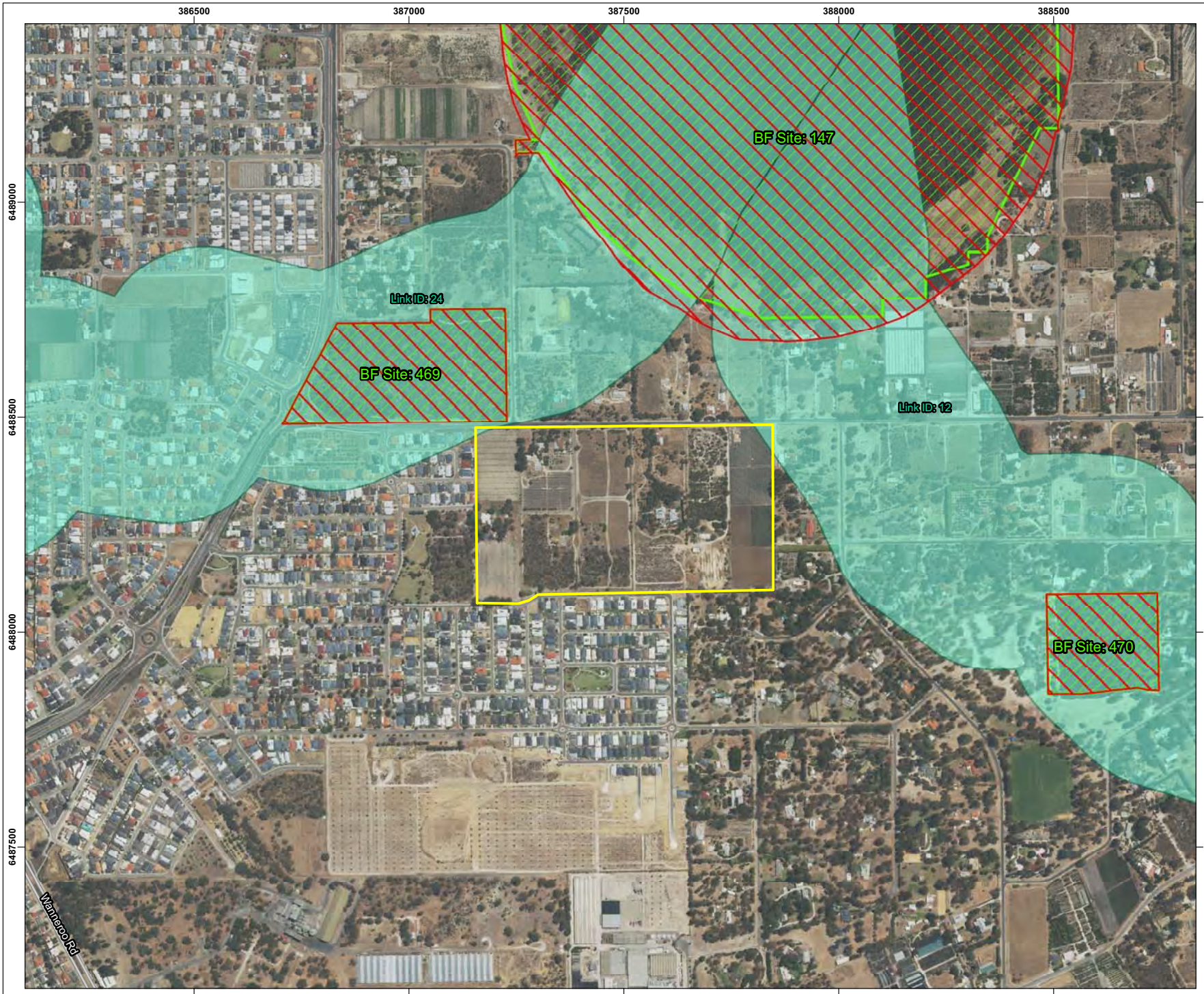

Legend

- Site Boundary
- Environmentally Sensitive Areas
- Bush Forever Sites
- Perth Regional Ecological Linkage

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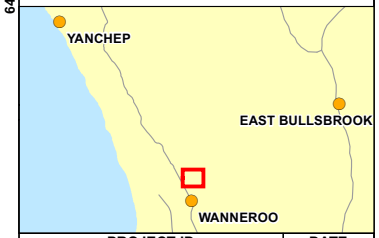

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Figure 5
Conservation Areas

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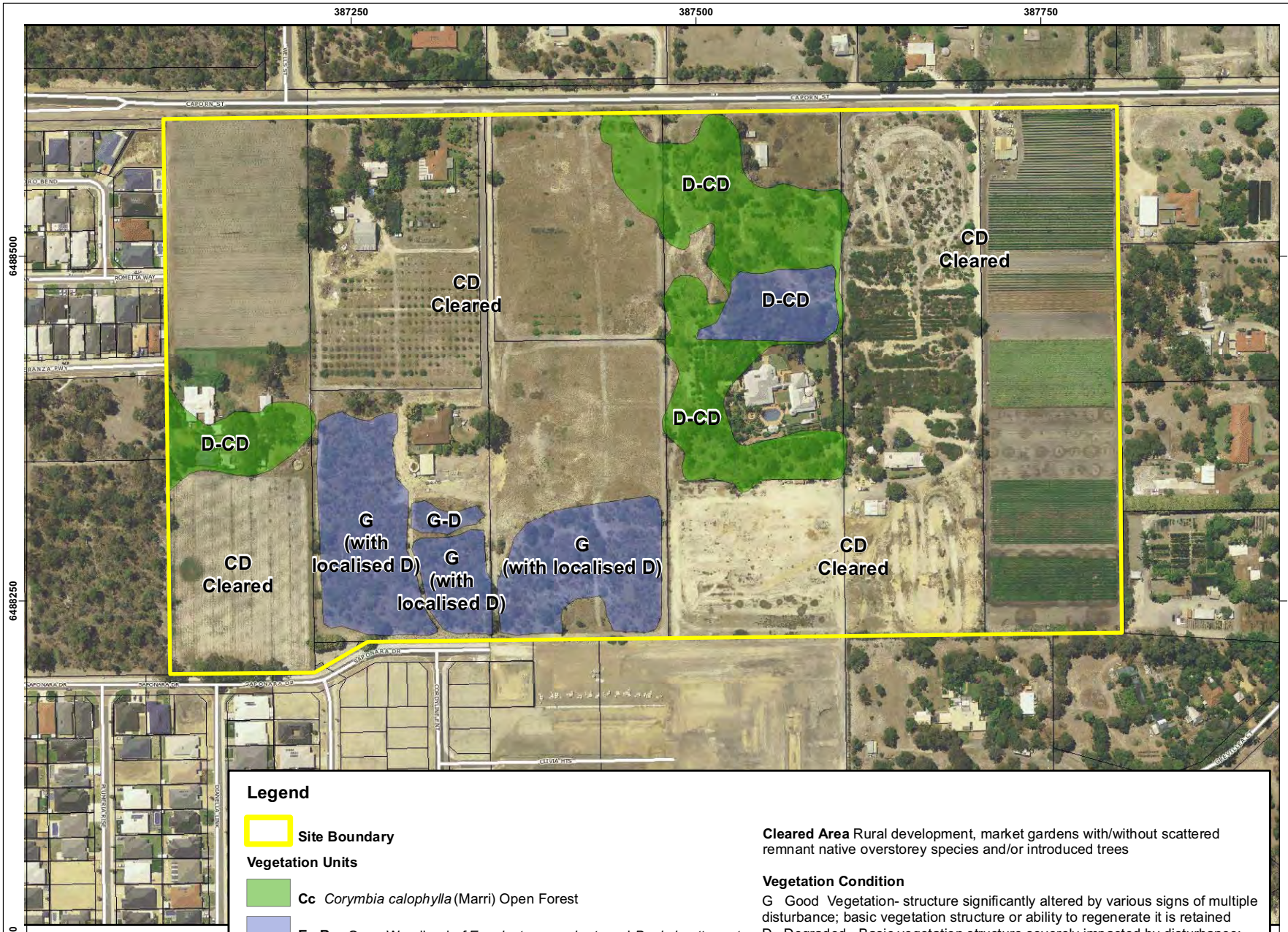

Legend

Site Boundary

Vegetation Units

Cc *Corymbia calophylla* (Marri) Open Forest

EmBa Open Woodland of *Eucalyptus marginata* and *Banksia attenuata* over *Kunzea glabrescens, Jacksonia sternbergiana, Hibbertia spicata, Corynotheca micrantha, Conostylis setigera* subsp. *setigera, Mesomelaena preissii, Desmocladus asper, *Ehrharta calycina* and *Briza maxima*

Cleared Area Rural development, market gardens with/without scattered remnant native overstorey species and/or introduced trees

Vegetation Condition

G Good Vegetation- structure significantly altered by various signs of multiple disturbance; basic vegetation structure or ability to regenerate it is retained

D Degraded- Basic vegetation structure severely impacted by disturbance; scope for regeneration but not a state approaching good (sic) condition without intensive management

CD Completely Degraded- Vegetation structure not intact; the area completely or almost completely without native species (parkland cleared)

Source: ENV Flora and Vegetation Assessment mapping 2010 and RPS Vegetation Condition 2007

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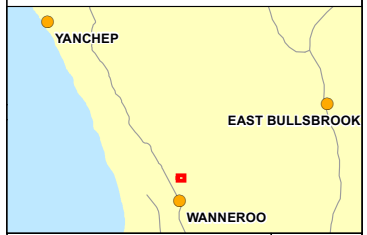

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Acumen Development Solutions
Caporn Street, Wanneroo

EAR Local Structure Planning

Figure 6
Vegetation Type and Condition

APPENDIX A

Department of Water - Water Information Network (WIN) Database Search Results

BORE ID	CURRENT PURPOSE	STATUS	DRILL DEPTH FROM GROUND LEVEL (M)	DRILL DATE	OWNER
5026	Monitoring; Observation	Operational	9.00	19/01/1979	Department of Water
6004	-	Unknown	304.80	30/06/1970	No Current Owner
20025570	Garden Irrigation	Unknown	9.14	30/06/1968	No Current Owner
20025669	Domestic/Household	Unknown	50.30	21/12/1988	No Current Owner
20025688	Irrigation	Unknown	34.00	14/05/1993	No Current Owner
20083798	Domestic/Household	Unknown	33.00	2/08/1999	No Current Owner
23024001	Monitoring; Project bore	Not operating	57.00	7/06/2007	Department of Water
23029608	WRL linked	Unknown	-	-	Private Owner
23029616	WRL linked	Unknown	-	-	Private Owner
23029471	WRL linked	Unknown	-	-	Private Owner
23029495	WRL linked	Unknown	-	-	Private Owner
23029496	WRL linked	Unknown	10.00	1/01/1900	Private Owner
23029505	WRL linked	Unknown	-	-	Private Owner
23029513	WRL linked	Unknown	-	-	Private Owner
23029526	WRL linked	Unknown	33.00	Unknown	Private Owner
23029542	WRL linked	Unknown	-	-	Private Owner
23029546	-	Unknown	-	-	Private Owner
23049751	-	Unknown	-	-	Quito-Benara Nurseries
23049753	-	Unknown	-	-	Quito-Benara Nurseries
23045857	WRL linked	Unknown	-	-	Private Owner
23045409	WRL linked	Unknown	-	-	Private Owner
23045413	WRL linked	Unknown	-	-	Private Owner

BORE ID	CURRENT PURPOSE	STATUS	DRILL DEPTH FROM GROUND LEVEL (M)	DRILL DATE	OWNER
23049724	-	Unknown	-	-	All Perfect Pty Ltd
23046612	WRL linked	Unknown	-	-	Private Owner
23049625	-	Unknown	-	-	Private Owner
23051463	-	Unknown	-	-	Private Owner
23051478	-	Unknown	< 72.00	Unknown	Private Owner
5027	Groundwater Assessment Network	Not operating	38.50	29/01/1979	Department of Water
23029569	WRL linked	Unknown	-	-	Private Owner
23029576	WRL linked	Unknown	-	-	Private Owner
20025565	-	Unknown	44.50	30/06/1968	No Current Owner
23029541	WRL linked	Unknown	-	-	Private Owner
23029554	WRL linked	Unknown	-	-	Private Owner
23029557	WRL linked	Unknown	-	-	Private Owner
23029570	WRL linked	Unknown	-	-	Private Owner
23047259	WRL linked	Unknown	-	-	Private Owner
23049696	-	Unknown	-	-	Private Owner
23029556	WRL linked	Unknown	-	-	Private Owner
23029609	WRL linked	Unknown	-	-	Private Owner
23024000	Monitoring; Project bore	Not operating	30.00	11/06/2007	Department of Water
20025716	-	Unknown	22.00	5/07/1994	No Current Owner
5028	Groundwater Assessment Network	Not operating	19.50	20/01/1979	Department of Water
23029477	WRL linked	Unknown	-	-	Private Owner
23029610	WRL linked	Unknown	-	-	Private Owner

BORE ID	CURRENT PURPOSE	STATUS	DRILL DEPTH FROM GROUND LEVEL (M)	DRILL DATE	OWNER
23049702	-	Unknown	-	-	Private Owner
23049750	-	Unknown	-	-	Quito-Benara Nurseries
23049538	-	Unknown	-	-	Private Owner
23049754	-	Unknown	-	-	Quito-Benara Nurseries
23029498	WRL linked	Operational	37.00	30/10/1992	Private Owner
23029560	WRL linked	Unknown	-	-	Private Owner
23029494	WRL linked	Unknown	-	-	Private Owner
20025614	-	Unknown	30.50	Unknown	No Current Owner
23051188	-	Unknown	42.00	30/07/2004	All Perfect Pty Ltd
20025717	-	Unknown	45.00	5/07/1994	No Current Owner
20025571	Garden Irrigation	Unknown	9.14	30/06/1968	No Current Owner
20025630	-	Unknown	45.30	15/08/1980	No Current Owner
23051475	-	Unknown	62.35	1/01/1900	Quito-Benara Nurseries
20025772	Domestic/Household	Unknown	29.00	13/01/1999	No Current Owner
23051455	-	Unknown	~ 40.00	Unknown	Private Owner
23023999	Project bore; Monitoring	Operational	8.30	24/05/2007	Department of Water
23029624	WRL linked	Unknown	-	-	Private Owner
5025	Monitoring; Observation	Operational	27.40	Unknown	Department of Water

APPENDIX B

360 Environmental Flora and Vegetation Survey

Lots 1 and 13

360 environmental

Lot 1 and 13 Caporn Street

Detailed Flora and Vegetation Survey

Prepared for:

Michael Glendinning Property

February 2019

people • planet • professional

Document Reference	Revision	Prepared by	Reviewed by	Admin Review	Submitted to Client	
					Copies	Date
2966AB	A CLIENT DRAFT	C. McDonald N. Whittington	T. Smith	N. Lindroos	1 Electronic (email)	31/01/19
2966AB	0 CLIENT FINAL	N. Whittington	MG Property	S. Hick	1 Electronic (email)	06/02/19

Abbreviations

ABBREVIATION	DEFINITION
360 Environmental	360 Environmental Pty Ltd
BAM Act	*Biodiversity and Agriculture Management Act 2007* (state)
BoM	Bureau of Meteorology
DBCA	Department of Biodiversity, Conservation and Attractions
DEE	Department of the Environment and Energy
EN	Endangered
EPA	Environmental Protection Authority (state)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESA	Environmentally Sensitive Area
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometres
m	Metres
mm	Millimetres
MNES	Matters of National Environmental Significance
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
TEC	Threatened Ecological Community
TPFL	Threatened and Priority Flora Database
TP List	Threatened and Priority Flora List
VU	Vulnerable
WAH	Western Australian Herbarium
WAOL	Western Australian Organism List
WC Act	*Wildlife Conservation Act 1950* (state)
WoNS	Weeds of National Significance

Executive Summary

360 Environmental Pty Ltd was commissioned by Michael Glendinning Property to undertake a detailed flora and vegetation survey in November 2018. The survey delineated key flora and vegetation values and potential environmental sensitivities within Lots 1 and 13 Caporn Street, Wanneroo (Survey Area) (Figure 1).

Key findings from the Detailed Flora and Vegetation Survey

A total of 36 vascular flora species representing 20 families and 35 genera were recorded within the Survey Area. The most commonly occurring families were Poaceae (seven taxa), and Fabaceae (six taxa). The most frequently recorded genus was *Jacksonia*.

No Threatened flora species pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and/or gazetted as Threatened/ Declared Rare Flora pursuant to the Wildlife Conservation Act 1950 were recorded during the survey. One Priority 4 species, *Jacksonia sericea*, was recorded in two locations within the Survey Area.

Based on the Likelihood of Occurrence assessment, six species were considered to have a High Likelihood of Occurrence and six species are considered to have a Medium Likelihood of Occurrence within the Survey Area based on known distribution, flowering period and habitat preference. The six species with a High Likelihood of occurrence are: *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425) (P1), *Thelymitra variegata* (P2), *Austrostipa mundula* (P3), *Conostylis bracteata* (P3), *Pimelea calcicola* (P3) and *Styphelia filifolia* (P3).

The six species with a Medium Likelihood of occurrence are: *Melaleuca* sp. Wanneroo (G.J. Keighery 16705) (T), *Calectasia elegans* (P2), *Stenanthemum sublineare* (P2), *Sarcozona bicarinata* (P3), *Anigozanthos humilis* subsp. *chrysanthus* (P4) and *Schoenus griffinianus* (P4).

A total of 19 weed species were recorded during the survey, none of which represent a Declared Plant or Weed of National Significance.

Vegetation condition ranged from Degraded to Completely Degraded with the majority of the Survey Area considered being in Completely Degraded condition. A review of historical aerials dating back to 1974 have confirmed the Survey Area has been cleared on at least two separate occasions, with minimal large trees remaining. The clearing was to enable the establishment of a market garden and commercial flower production.

No TECs or PECs are considered to be present on site due to the condition and altered state of the vegetation within the Survey Area.

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1 Introduction

1.1 The Project

Michael Glendinning Property (MG Property) requested 360 Environmental Pty Ltd (360 Environmental) to undertake a detailed flora and vegetation survey of Lots 1 and 13 Caporn Street, Wanneroo, approximately 24 km north of the Perth CBD, in the Swan Coastal Plain bioregion (herein referred to as the Survey Area).

Previous work has been undertaken of the two lots as part of a larger survey area, namely Lots 1, 2, 7, 12, 13, 36, 37 and 38 Caporn Street, Wanneroo, for the purposes of re-zoning the lots. The Site was determined to be 'not assessed' under Part IV of the Environmental Protection Act 1986 (EP Act) when referred to the Environmental Protection Authority (EPA) as part of the MRS Amendment.

A portion of the Site (Lots 13, 36 and 38) has an existing approval under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) as a 'Not Controlled Action'. The proposal was considered to not adversely impact on any Matters of National Environmental Significance.

The results of the previous reports while useful with regards to general information, are now considered dated. The information from these studies were used to determine the appropriate scope for the current survey.

The Survey Area comprised of two lots, 1 and 13, that equate to approximately 8.7 hectares (ha) (Figure 1). The Survey was undertaken to provide supporting information for any approval processes required.

1.2 Objectives and Scope

The objective of the survey was to assess the significance of the flora and vegetation present within the two lots.

The Scope included a desktop assessment and a single-season Detailed flora and vegetation survey, inclusive of:

- Conduct a desktop assessment of relevant literature, databases and spatial datasets to determine the environmental values and any potential issues, such as Threatened/Rare and significant species, Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), that may be present in the Survey Area and the surrounding areas;
- Undertake a field survey including the use of quadrats along with targeted searches for species of conservation significance where required to verify the accuracy of the desktop assessment;

- Delineate and characterise the flora and the range of vegetation units present in the Survey Area;
- Assess and map the vegetation condition in the Survey Area;
- Prepare a technical flora and vegetation survey report; and
- Provide all spatial/mapping data collected during the survey compliant with IBSA standard.

Legend

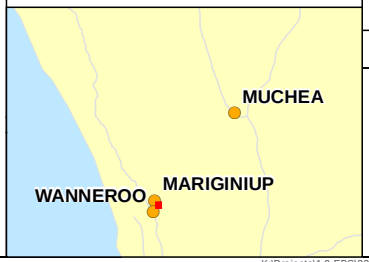
- Survey Area
- Local Road

0 20 40 60 80 Meters
1:3,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
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PROJECT ID	DATE
2966	18/01/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
SL	CM	SB	0

Michael Glendinning Property
Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation Survey

Figure 1 Survey Area

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 Fx Background Maps.mxd

2 Background

2.1 Protection of Flora, Vegetation and Fauna

Western Australian flora and fauna is protected formally and informally by legislative and non-legislative measures, which are as follows:

Legislative measures:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Threatened Species Scientific Committee, 2015);
- WA *Wildlife Conservation Act 1950* (WC Act);
- WA *Biodiversity Conservation Act 2016* (BC Act);
- WA *Environmental Protection Act 1986* (EP Act); and
- WA *Biosecurity and Agriculture Management Act 2007* (BAM Act).

Non-legislative measures:

- WA Department of Biodiversity Conservation and Attractions (DBCA) Priority lists for fauna, flora and ecological communities;
- Weeds of National Significance (WoNS); and
- Recognition of locally significant populations by DBCA.

A short description of each is provided in Appendix A. Other definitions, including species conservation categories are presented in Appendix B, conservation categories for Ecological Communities are provided in Appendix C, and Environmental Weeds and Declared Plant Categories are provided in Appendix D.

2.2 Biophysical Environment

2.2.1 Climate

The closest long-term Bureau of Meteorology (BoM) weather station with a complete dataset is Pearce RAAF (Station 09053), located approximately 21 km northeast of the Survey Area.

The long-term mean minimum temperature for Pearce RAAF ranges from 8.2°C (August) to 17.6°C (February) (1937 to 2019) and the long-term mean maximum temperature ranges from 17.9°C (July) to 34°C (January) (1937 to 2019) (Bureau of Meteorology, 2018). The long-term annual average rainfall is 655.1 millimetres (mm) (1937 to 2018) (Bureau of Meteorology, 2018) (Figure 2).

The Pearce RAAF weather station recorded 696.6 mm of rainfall in the 12 months prior to the survey (October 2017 to September 2018), which is 41.5 mm above to the long-term

average of 655.1 mm (Bureau of Meteorology, 2018). In the three months prior to the survey (July 2018 to September 2018), 365.4 mm of rainfall was recorded, which is 56 mm above the long-term average of 309.4 mm for the same time period (1937 to 2018) (Bureau of Meteorology, 2018).

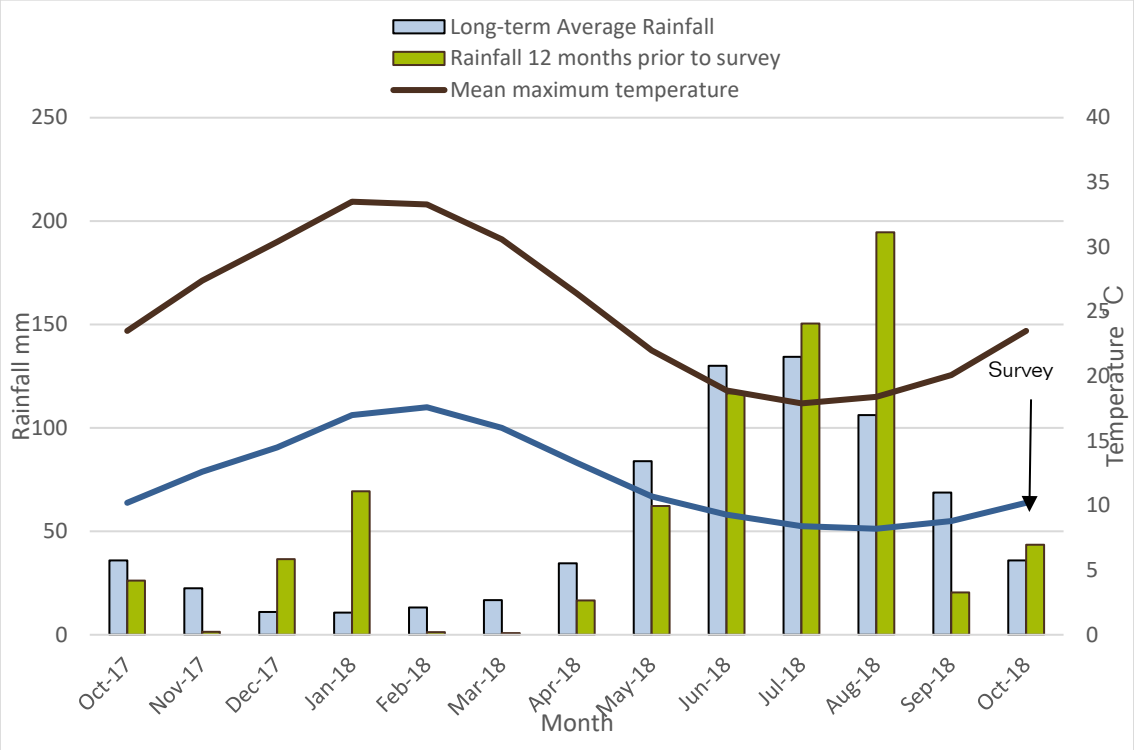


Figure 2: Long-term and Monthly Total Rainfall, Maximum and Minimum Temperatures for Pearce RAAF (9053) Bureau of Meteorology, 2018).

2.2.2 Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into 89 bioregions based on major biological, geographical and geological attributes. These bioregions are subdivided into 419 subregions as part of a refinement of the IBRA framework (Department of the Environment and Energy, 2016). The Survey Area occurs within the Swan Coastal Plain bioregion and Swan Coastal Plain 02 subregion.

The Swan Coastal Plain bioregion is described as a low lying coastal plain, mainly covered with woodlands. It is dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *C. obesa*-marri woodlands and *Melaleuca* shrublands, are extensive only in the south (Mitchell, Williams and Desmond, 2002).

The Perth subregion (SWA02) is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, *Banksia* and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and

alluvials. Includes a complex series of seasonal wetlands and also includes Rottnest, Carnac and Garden Islands etc. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean (Mitchell, Williams and Desmond, 2002).

2.2.3 Soil-Land Systems

Soil-landscape system mapping of Western Australia describes broad soil and landscape characteristics from regional to local scales, and has been captured at scales ranging from 1:20,000 to 1:250,000 (Department of Primary Industries and Regional Development, 2018b). The Survey Area occurs within the Spearwood System (211Sp) which is characterised by sand dunes and plains. Yellow deep sands, pale deep sands and yellow/brown shallow sands. The Survey Area also occurs entirely within the Karrakatta Sand Yellow Phase subsystem (211Sp__Ky). The subsystem is described as low hills to gently undulating terrain with yellow sand over limestone at 1-2 m. *Banksia* spp. woodland with scattered emergent *E. gomphocephala* and *E. marginata* and a dense shrub layer (Department of Primary Industries and Regional Development, 2018b).

2.3 Biological Environment

2.3.1 Broad Vegetation Types

Mapping of pre-European broad vegetation within Western Australia was completed on a broad scale (1:1,000,000) by Beard, (1981). These Vegetation Types were later re-assessed by Shepherd et. al. (2002) with some larger vegetation units divided into smaller units. Together, this pre-European database contains a total of 819 vegetation types within Western Australia.

There is one broad Vegetation Type mapped over the Survey Area. The Shepherd et. al. (2002) Vegetation Type is described as Spearwood 6, a southwest woodland inclusive of Jarrah, marri and wandoo (*Eucalyptus marginata*, *Corymbia calophylla* and *E. wandoo)*. The Vegetation representation at a local, regional and state level is shown in Table 1.

Table 1: Broad Vegetation Types within the State, Regional and Local Representation (Government of Western Australia, 2018)

Vegetation Type	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)	Current Extent Managed in DBCA Lands (%)
Vegetation Types (Shepherd, Beeston and Hopkins, 2002) in WA				
Spearwood 6	56,343	13,304	23.61	40.02
Vegetation Types (Shepherd, Beeston and Hopkins, 2002) in the Swan Coastal Plain Bioregion				
Spearwood 6	56,343	13,304	23.61	40.02
Vegetation Types (Shepherd, Beeston and Hopkins, 2002) in the City of Wanneroo				

Vegetation Type	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)	Current Extent Managed in DBCA Lands (%)
Spearwood 6	12,662	2,760	21.80	50.94

Mapping by Heddle, Loneragan and Havel (1980) used landform-soil units determined by Churchward and McArthur (1978). The delineation of vegetation complexes is based on the concept of a series of plant communities forming regularly repeating complexes associated with a particular soil unit. One Heddle, Loneragan and Havel (1980) vegetation complex occurs within the Survey Area and is described below;

- **Karrakatta Complex – Central and South:** Predominantly open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri) and woodland of *Eucalyptus marginata* (Jarrah) - *Banksia* species. *Agonis flexuosa* (Peppermint) is co-dominant south of the Capel River.

2.3.2 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared to prevent degradation of important environmental values such as Threatened flora, TECs or significant wetlands. Exemptions contained in the *Environmental Protection (Clearing of Native vegetation) Regulations 2004* for low impact land clearing do not apply in ESAs and a clearing permit is required.

There are no mapped ESAs occurring within the Survey Area. The nearest ESAs occur 0.3 km northeast, 0.3 km north and 0.7 km west of the Survey Area (Figure 3; Department of Water and Environmental Regulation, 2018). These ESAs are associated with designated conservation areas such as geomorphic wetlands, nature reserves and Bush Forever sites.

2.3.3 Conservation Areas

According to DBCA (2017) there are no conservation areas within the Survey Area. The nearest conservation areas are (Figure 3):

- Lake Joondalup Nature Reserve (R 31048), approximately 2 km west of the Survey Area;
- Jandabup Nature Reserve (R 7349), approximately 1.8 km to the east of the Survey Area;
- Gnangara-Moore River State Forest (F 65), approximately 4.3 km northeast of the Survey Area; and
- Woodvale Nature Reserve (R 30809), approximately 4.7 km southwest of the Survey Area.

The Survey Area is located 50 m from the Perth Ecological Linkage (Western Australian Local Government Authority, 2014) which is mapped to the north of the Survey Area (Figure 3).

There are no Bush Forever sites mapped across the Survey Area. However, there are six Bush Forever Sites mapped within 2 km of the Survey Area (Figure 3), which include:

- Site 469, 0.3 km north west of the Survey Area;
- Site 164, 1.5 km north west of the Survey Area;
- Site 471, 1.5 km south east of the Survey Area;
- Site 470, 0.7 km east of the Survey Area;
- Site 324, 1.6 km east of the Survey Area; and
- Site 147, 0.3 km north of the Survey Area.

2.3.4 Hydrology and Wetlands

No waterways are mapped across the Survey Area. Geomorphic wetland mapping demonstrates that there are numerous waterbodies within the Wanneroo area (Figure 4).

There are four geomorphic wetlands mapped within 2 km of the Survey Area (Figure 4). These include three Conservation Category Wetlands (CCWs) and one Multiple Use Wetland (MUW), these are detailed below:

- Mariginiup Lake (CCW, ID:7953) approximately 0.3 km to the north of Survey Area;
- Jandabup Lake (CCW, ID:15006 and MUW, ID:7957) approximately 1.8km to the east of Survey Area;
- Little Mariginiup Lake (CCW, ID:8161) approximately 1.9km to the north of Survey Area; and
- Lake Joondalup (CCW, ID:7954) approximately 2 km to the west of Survey Area.

2.4 Historical Land Use

A review of historical aerials from 1974 have confirmed previous land uses of the Survey Area (Lot 13 to the west and Lot 1 to the east). The Survey Area has been cleared on at least two separate occasions leaving minimal native trees.

Aerials from 1974 (Plate 1) demonstrates that the northern half of Lot 1 had been completely cleared, with the southern end remaining as bushland. Lot 13 appeared to have access tracks cleared throughout.

By 1983 (Plate 2) aerials show that the cleared areas in Lot 1 have regenerated. No additional clearing appears to have been undertaken.

In 1995 (Plate 3) Lot 1 had been almost entirely cleared for rows of commercial market gardens with some scattered vegetation remaining to the south of the Lot. Lot 13 also showed areas with distinct commercial market gardens to the south and a residential property constructed in the centre of the lot. The understory vegetation remaining in the northern section of Lot 13 appears to have declined and/or the removal of large trees has been undertaken decreasing the canopy cover.

In 2000 (Plate 4) the aerials show that the market gardens on Lot 1 have reduced in size and are present only in the centre of the Lot.

In 2005 (Plate 5) the market gardens on both Lots has reduced.

By 2010 (Plate 6) the market gardens on both Lots appear to be abandoned, with Lot 13 completely cleared with only minimal mature native trees and Lot 1 left to regenerate with the commercially produced flower crops (*Chamelaucium uncinatum* [Geraldton Wax]) to become overgrown.

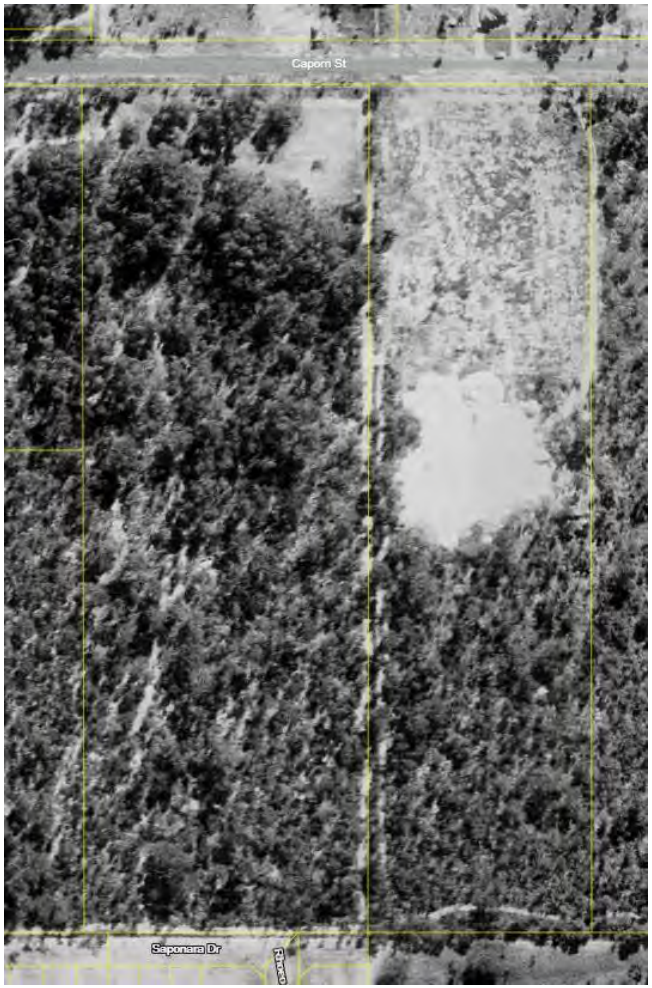


Plate 1: Aerial 1974

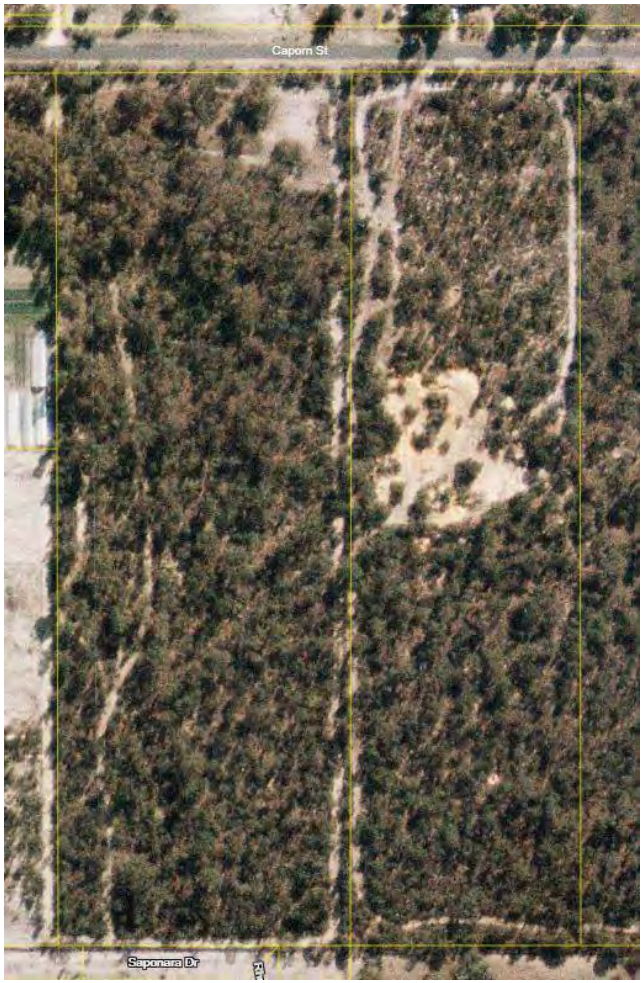


Plate 2: Aerial 1983

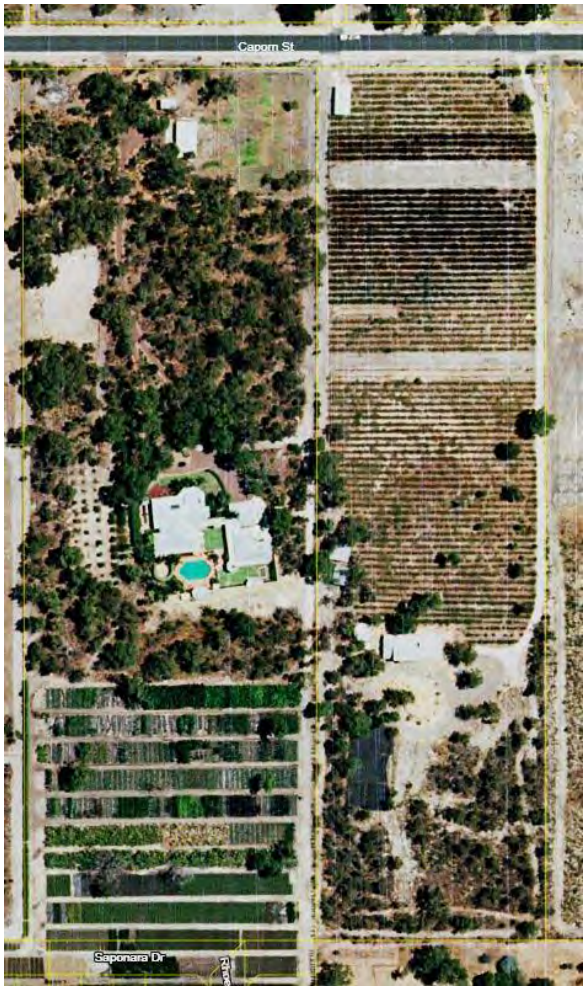
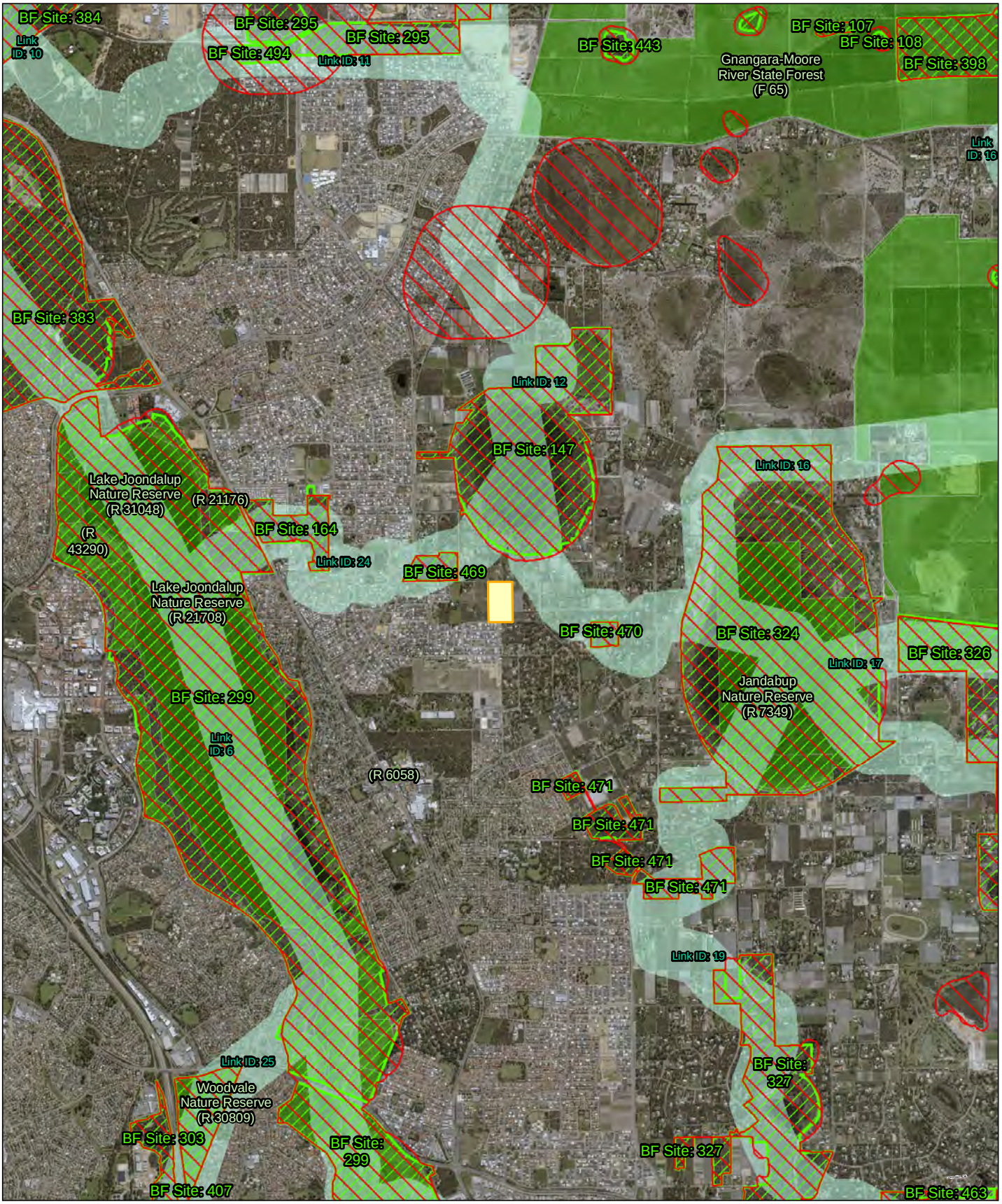


Plate 3: Aerial 1995

Plate 4: Aerial 2000

Plate 5: Aerial 2005

Plate 6: Aerial 2010



Legend

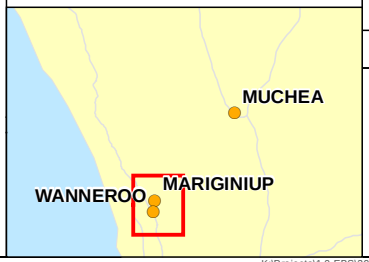
- Survey Area
- Environmentally Sensitive Areas
- Bush Forever Sites
- Perth Regional Ecological Linkage
- DBCA Managed Land

Meters
0 400 800 1,200 1,600
1:50,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
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2966	18/01/2019

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GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
SL	CM	SB	0

Michael Glendinning Property
Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation Survey

Figure 3 Environmentally Sensitive Areas and Conservation Areas

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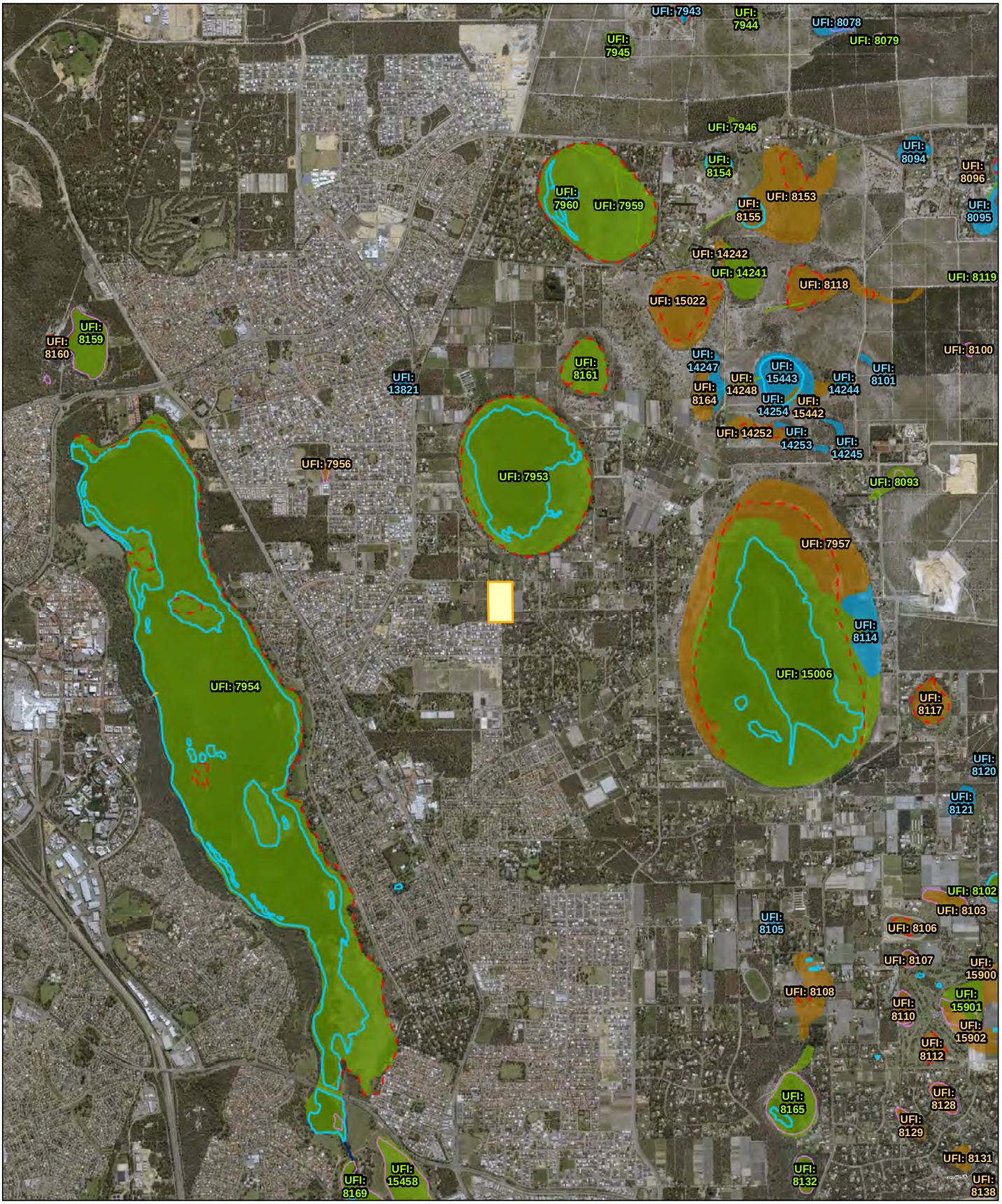

Legend

- Survey Area

Hydrography

- Watercourse - major
- Drain - major
- Lakes
- Swamp
- Area Subject to Inundation
- Marine Construction - wharf/jetty

Geomorphic Wetlands

- Conservation Category
- Resource Enhancement Category
- Multiple Use Category

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- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
(© Western Australian Land Information Authority 2017)

0 400 800 1,200 1,600 Meters
1:50,000 @ A4
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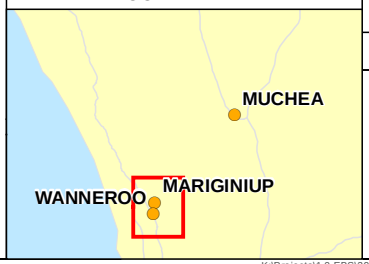
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



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Michael Glendinning Property
Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation Survey

Figure 4
Hydrology and Wetlands

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 Fx Background Maps.mxd

3 Methods

3.1 Requirements for Flora and Fauna Surveys

This survey has been carried out as per the EPA requirements for environmental surveying and reporting of flora and fauna surveys in Western Australia where relevant, and as documented in:

Western Australia

- Technical Guidance – *Flora and Vegetation Surveys for Environmental Impact Assessment* (Environmental Protection Authority, 2016).

Federal

- *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment, 2013).

3.2 Desktop Assessment

3.2.1 Database Searches

Database searches were undertaken to identify potential conservation significant flora and Ecological Communities within or surrounding the Survey Area. Database search particulars are outlined in Table 2.

Priority Ecological Communities (PEC) and Threatened Ecological Communities (TEC) within the Swan Coastal Plain bioregion were examined to determine if any corresponded with the Survey Area. In addition, an EPBC Protected Matters Search (PMST) was undertaken to identify the potential for Matters of National Environmental Significance (MNES) to occur within or surrounding the Survey Area (Department of the Environment and Energy, 2018).

Table 2: Database Searches of the Study Area

DATABASE NAME	DATE RECEIVED	SEARCH TARGET	SEARCH AREA
Threatened and Priority Ecological Communities database (Department of Biodiversity Conservation and Attractions, 2018d)	15 Nov 2018	Listed TECs and PECs	5 km radial search around Survey Area centre point
Threatened and Priority Flora Database (TPFL) (Department of Biodiversity Conservation and Attractions, 2018e)	16 Nov 2018	Threatened Priority Flora	5 km radial search around Survey Area centre point
DBCA Threatened and Priority Flora Species List (TP list) (Department of Biodiversity Conservation and Attractions, 2018e)	16 Nov 2018		5 km radial search around Survey Area centre point

DATABASE NAME	DATE RECEIVED	SEARCH TARGET	SEARCH AREA
Western Australian Herbarium flora (Department of Biodiversity Conservation and Attractions, 2018b)	16 Nov 2018		5 km radial search around Survey Area centre point
NatureMap (Department of Biodiversity Conservation and Attractions, 2018c)	2 Nov 2018	Threatened Priority Flora	5 km radial search around Survey Area centre point
Protected Matters Search Tool (Department of the Environment and Energy, 2018)	2 Nov 2018		5 km radial search around Survey Area centre point

3.2.2 Likelihood of Occurrence

Conservation significant flora species identified from the desktop assessment were further examined to determine a Likelihood of Occurrence within the Survey Area. The assessment was completed based on the following Likelihood of Occurrence criteria:

Recorded:

- Flora species recorded within the Survey Area during the field survey.

'High' Likelihood of Occurrence:

- Previously recorded within Survey Area; or within 5 km and suitable habitat potentially occurs in the Survey Area.

'Medium' Likelihood of Occurrence:

- Previously recorded within 5 to 15 km of the Survey Area; and/or suitable habitat potentially occurs in the Survey Area.

'Low' Likelihood of Occurrence:

- No suitable habitat appears to be present in the Survey Area and records are greater than 15 km.

Only species either recorded within the Survey Area or considered as having a High or Medium Likelihood of Occurrence will be discussed in detail. Species classified as having a Low likelihood of occurrence based on the above criteria will not be discussed unless a justification for this classification is required.

3.2.3 Literature Review

Reports from previous surveys undertaken nearby to the Survey Area were reviewed to assist with understanding of the key biological findings. The following reports were reviewed;

- Caporn Steet, Wanneroo – Environmental Assessment Report Addendum (360 Environmental Pty Ltd, 2017) and

- Dundebar Road – Detailed Flora and Vegetation Survey [unpublished] (360 Environmental Pty Ltd, 2019).

3.3 Flora and Vegetation

3.3.1 Field Survey

A Detailed single season Flora and Vegetation Survey was undertaken by qualified Principal Botanist Narelle Whittington (Flora Licence SL12480 and DRF Permit 58-1819) on the 30th of October 2018.

The field survey included mapping notes, vegetation condition notes, opportunistic flora collections and observations and a targeted Priority flora search. Due to the altered state of the Survey Area and the absence of intact native vegetation communities the use of quadrats was not warranted. Instead the Survey Area was traversed, and extensive data collected on the following:

- Landform and soil description
- Site descriptors – location information that might be useful in vegetation classification including, slope, aspect, litter cover, bare ground cover and fire history;
- Species list – a comprehensive vascular flora species list, including weeds
- Height – the average height (in meters) of each species recorded;
- Vegetation description – a description of the vegetation according to the National Vegetation Information System (NVIS), Level 5. According to this level, vegetation is classified to 'association', where the dominant growth form, height, cover and species (three species) for the three traditional strata (upper, mid and ground) are described;
- Vegetation condition – assessed according to the vegetation condition scale (Environmental Protection Authority, 2016) as adapted from Keighery (1994) and Trudgen (1988) (Appendix C); and
- Photographs

3.3.2 Flora of Conservation Significance

In addition to vegetation data being collected, traverses throughout the Survey Area were undertaken to search for conservation significant flora, including but not limited to Threatened and Priority flora.

3.3.3 Taxonomy and Nomenclature

Where field identification of plant taxa was not possible, specimens were collected systematically for later identification using resources of the WAH. Taxonomy was completed by experienced Principal Botanist Narelle Whittington at the WA herbarium.

The finalised species list was checked against FloraBase (Department of Biodiversity Conservation and Attractions, 2018b) to determine the species' conservation status and known distribution. Introduced species were compared against the BAM Act Declared Plants list the WONS list to determine their status (Thorp and Lynch, 2000).

3.3.4 Vegetation Type and Condition Mapping

The vegetation mapping units were described based on their structure and species composition, as defined by the quadrat data observations from each of the study years. In addition to the data collected from quadrats, traverses throughout the Survey Area were undertaken for vegetation mapping purposes.

Vegetation types and vegetation condition boundaries were mapped in the field using handheld GPS (Garmin) units, standardised forms, Fulcrum, a mobile data collection application, and high-resolution aerial photographs (1:1,200 scale), which were digitised software in the office using GIS.

3.3.5 Statistical Analyses

Due to the altered state of the Survey Area and the absence of intact native vegetation communities, quadrats were not used in collecting data, therefore, statistical analyses was not undertaken.

4 Results

4.1 Limitations and Constraints

Limitations and constraints of the flora and vegetation survey are detailed below in Table 3.

Table 3: Limitations and Constraints Associated with the Survey

VARIABLE	DEGREE OF LIMITATION	POTENTIAL CONSTRAINTS ON SURVEY OUTCOMES
Access	No limitation	The entirety of the Survey Area was able to be accessed on foot.
Experience	No limitation	The personnel who executed the survey were practitioners suitably qualified in their respective fields: ● Field Staff and Flora Taxonomy: Narelle Whittington (Principal Botanist); ● Data Interpretation and Reporting: Narelle Whittington and Colleen McDonald; and ● Report Review: Tamara Smith (Principal).
Timing, weather, season	Low limitation	The EPA guidelines recommend that flora surveys within the South-West region are completed during spring (September – November), and that a supplementary survey be completed after Autumn rains. Flora composition changes with time, particularly seasonally as a result of changes in conditions such as rainfall. Therefore, botanical surveys completed at different times of the year will often produce varying results. The survey was completed in October which is within the recommended survey period for the South-West region. A supplementary survey has not been undertaken, however, due to the condition of the Survey Area a second survey is unlikely to result in different outcomes.
Life forms sampled	Low limitation	Various life forms were sampled during the survey, excluding non-vascular species. Many flora species were flowering and fruiting and annual species present. A total of 36 flora taxa were recorded, including one Priority 4 species, *Jacksonia sericea*. All species could be confidently identified to species level.
Completeness	No limitation	A Detailed single season Flora and Vegetation Survey assessment was completed. All the flora and vegetation present were adequately surveyed given that not native vegetation communities were present in the Survey Area.

VARIABLE	DEGREE OF LIMITATION	POTENTIAL CONSTRAINTS ON SURVEY OUTCOMES
Disturbance / Current land use	High limitation	The majority of the Survey Area has been cleared previously and has been subject to some degree of soil disturbance. The Survey Area has high weed density.

4.2 Literature Review

The following relevant assessments have been undertaken within 2km of the Survey Area and are summarised below:

Caporn Steet, Wanneroo – Environmental Assessment Report Addendum (360 Environmental Pty Ltd, 2017)

360 Environmental Pty Ltd was commissioned by Perron Developments Pty Ltd to prepare an addendum to the ENV Environmental Assessment Report (EAR) (2012). The findings of the EAR are as follows:

- Banksia Woodlands of the Swan Coastal Plain ecological community were determined likely to occur within the area;
- As EPBC approval was granted for Lots 13, 36 and 38 prior to the listing of the Banksia Woodlands as a TEC, the validity of the approval is not affected by any future listings under the EPBC Act; and
- The proposed development is considered to not adversely impact on any Matters of National Environmental Significance and any future listings under the EPBC Act do not affect the current approval in place for these Lots.

Dundebar Road – Detailed Flora and Vegetation Survey [unpublished] (360 Environmental Pty Ltd, 2019)

360 Environmental was commissioned to undertake a Detailed Flora and Vegetation Survey within Lots 10 and 11 Dundebar Road and Lots 28 and 29 Belgrade Road in November 2018. This survey was undertaken approximately 2 km south of the Survey Area. No Threatened flora species pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and/or gazetted as Threatened/ Declared Rare Flora pursuant to the Wildlife Conservation Act 1950 were recorded during the survey.

4.3 Flora and Vegetation

4.3.1 Desktop Assessment

The database searches identified 38 conservation significant flora species as potentially occurring within a 5 km radius of the Survey Area. Of these, 25 species were Priority and 13 are Threatened (Department of Biodiversity Conservation and Attractions, 2018e, 2018c, 2018a; Department of the Environment and Energy, 2018) The 38 Priority flora included five Priority 1 (P1), eight Priority 2 (P2), nine Priority 3 (P3) and three Priority 4 (P4). Results of the DBCA Flora database searches are illustrated in Figure 5 and the results of all database search are presented in 0.

One Threatened Ecological Community (TEC) under the EPBC Act has been mapped as occurring within the Survey Area (Figure 6), this community is also listed as a Priority Ecological Community (PEC) listed by the State:

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region (Priority 3 [DBCA], Endangered [EPBC]).

4.3.2 Likelihood of Occurrence

A Likelihood of Occurrence assessment was completed on the 38 species of conservation significance recorded in the database searches. The Likelihood of Occurrence of these species identified six species with a 'Medium' Likelihood of Occurrence within the Survey Area and six species with a 'High' Likelihood of Occurrence within the Survey Area (Appendix F); These species include:

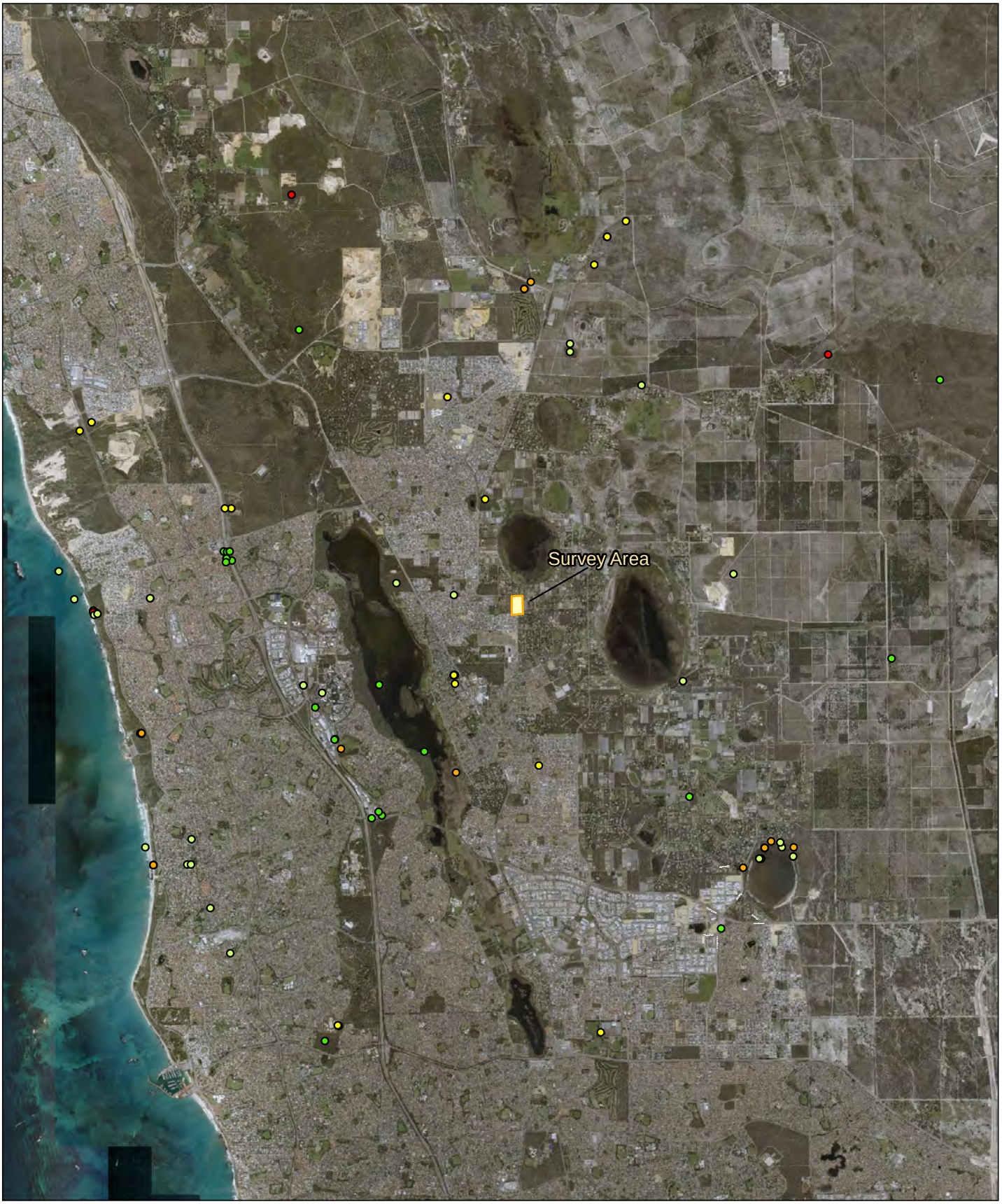
<u>High Likelihood</u>

- *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425) (P1)
- *Thelymitra variegata* (P2)
- *Austrostipa mundula* (P3)
- *Conostylis bracteata* (P3)
- *Pimelea calcicola* (P3)
- *Styphelia filifolia* (P3)

<u>Medium Likelihood</u>

- *Melaleuca* sp. Wanneroo (G.J. Keighery 16705) (T)
- *Calectasia elegans* (P2)
- *Stenanthemum sublineare* (P2)
- *Sarcozona bicarinata* (P3)
- *Anigozanthos humilis* subsp. *chrysanthus* (P4)
- *Schoenus griffinianus* (P4)

One species were 'Recorded' within the Survey Area, *Jacksonia sericea* (P4).



Legend

- Survey Area

DBCA Threatened and Priority Flora Records

- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4

Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
(© Western Australian Land Information Authority 2017)

0 880 1,760 2,640 3,520 Meters

1:110,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP

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f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
2966	18/01/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

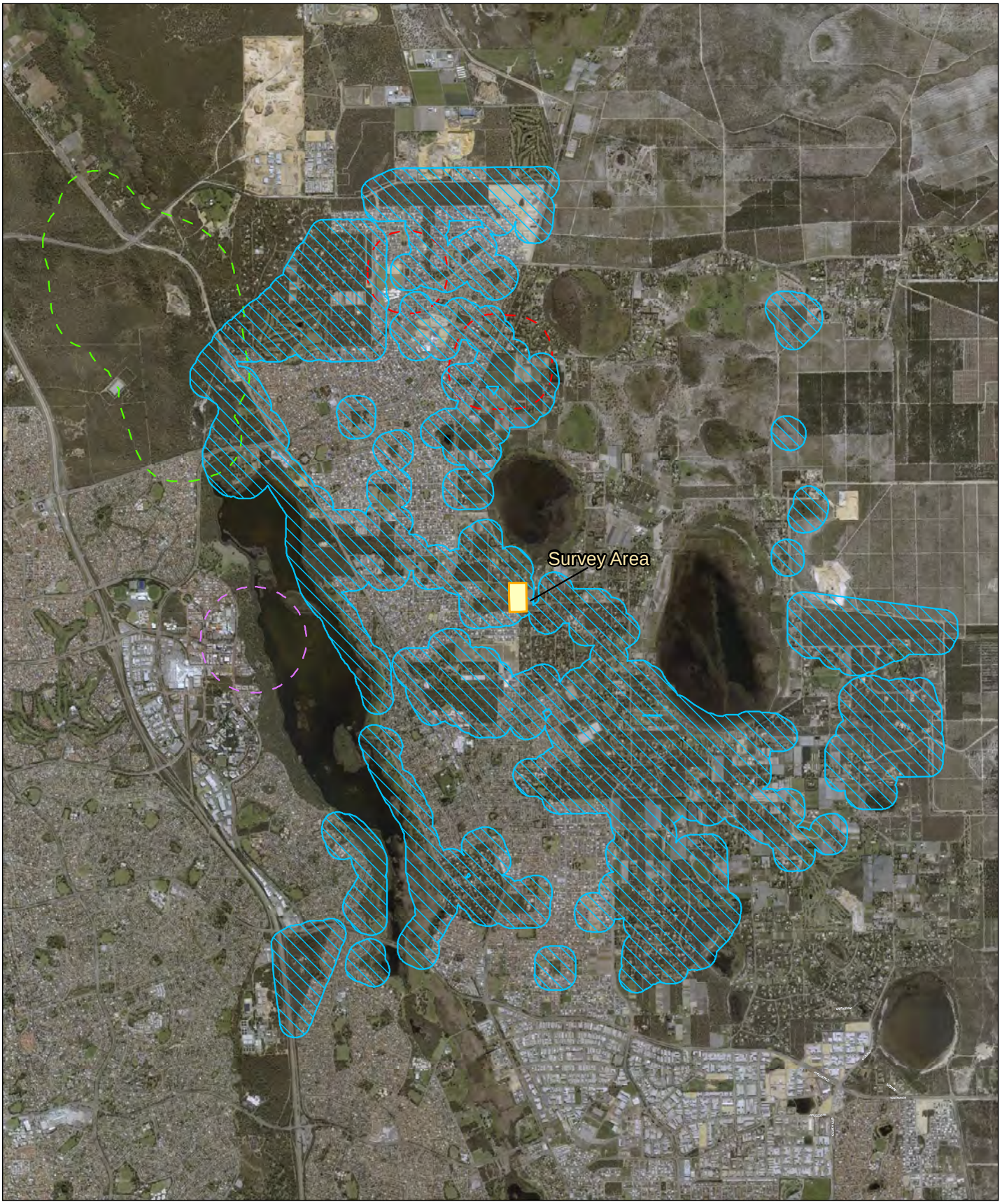
CREATED	CHECKED	APPROVED	REVISION
SL	CM	SB	0

Michael Glendinning Property Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation Survey

Figure 5 DBCA Flora Desktop Assessment Results

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 Fx Background Maps.mxd



Legend

- Survey Area

TECs and PECs

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region, Priority 3 - 200m buffer
- Banksia attenuata woodlands over species rich dense shrublands, Endangered - 500m buffer
- Northern Spearwood shrublands and woodlands, Priority 3 - 500m buffer
- Southern Eucalyptus gomphocephala-Agonis flexuosa woodlands, Priority 3 - 700 m buffer

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- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
(© Western Australian Land Information Authority 2017)

0 560 1,120 1,680 2,240 Meters

1:70,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

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Detailed Flora and Vegetation Survey

Figure 6
Priority Ecological Communities

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 Fx Background Maps.mxd

4.3.3 Flora

A total of 36 flora species (including species, subspecies, varieties and forms) from 20 families and 35 genera were identified within the Survey Area from observations and collections. The most commonly occurring families were Poaceae (seven taxa) and Fabaceae (six taxa). The most frequently recorded genus was *Jacksonia*. All species were fully identified with confidence. A complete flora species list is presented in Appendix G.

The majority of Lot 13 consisted of gardens and fruit trees, these species were not included in the species list. The dominant species on Lot 1 was *Chamelaucium uncinatum* (Geraldton Wax), which is the cut flower crop previously grown on the property.

4.3.4 Flora of Conservation Significance

No Threatened flora species pursuant to EPBC Act and/or gazetted as Threatened/ Declared Rare Flora pursuant to the *Wildlife Conservation Act 1950* were recorded during the survey. One Priority species listed by DBCA were recorded within the Survey Area, *Jacksonia sericea* (P4). The location of these species is presented in Table 4and illustrated in Figure 7.

Table 4: Locations of Conservation Significant Flora within the Survey Area

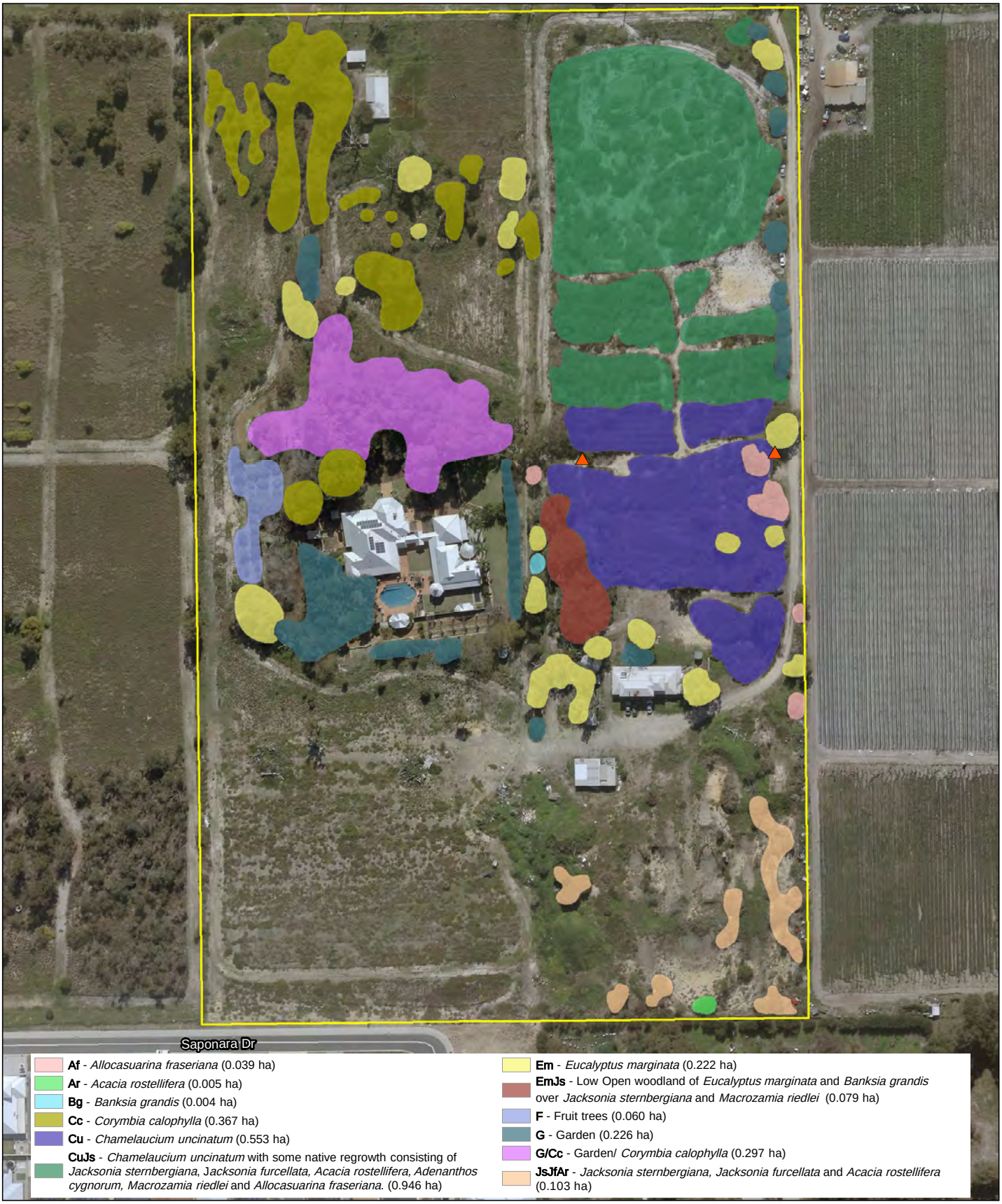
TAXA	COORDINATES UTM		NO. OF PLANTS
Jacksonia sericea (P4)	-31.7351558	115.8141192	6
	-31.7351413	115.8148866	1

Jacksonia sericea (P4)

J. sericea is a low spreading shrub, to 0.6 m in height. It produces orange flowers usually in December or January to February. It is known to grown in calcareous and sandy soils (Department of Biodiversity Conservation and Attractions, 2018b).

Plate 7: *Jacksonia sericea* (P4)

Plate 8: *Jacksonia sericea* (P4)



Af - *Allocasuarina fraseriana* (0.039 ha)
Ar - *Acacia rostellifera* (0.005 ha)
Bg - *Banksia grandis* (0.004 ha)
Cc - *Corymbia calophylla* (0.367 ha)
Cu - *Chamelaucium uncinatum* (0.553 ha)
CuJs - *Chamelaucium uncinatum* with some native regrowth consisting of *Jacksonia sternbergiana, Jacksonia furcellata, Acacia rostellifera, Adenanthos cygnorum, Macrozamia riedlei* and *Allocasuarina fraseriana.* (0.946 ha)
Em - *Eucalyptus marginata* (0.222 ha)
EmJs - Low Open woodland of *Eucalyptus marginata* and *Banksia grandis* over *Jacksonia sternbergiana* and *Macrozamia riedlei* (0.079 ha)
F - Fruit trees (0.060 ha)
G - Garden (0.226 ha)
G/Cc - Garden/ *Corymbia calophylla* (0.297 ha)
JsJfAr - *Jacksonia sternbergiana, Jacksonia furcellata* and *Acacia rostellifera* (0.103 ha)

Legend

Survey Area
Local Road

Priority Flora Locations

▲ *Jacksonia sericea* (P4)

0 20 40 60 Meters
1:2,000 @ A4
N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP

- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
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Michael Glendinning Property
Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation Survey

Figure 7 Vegetation Types and Priority Flora Locations

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 F7 Vegetation Types and Priority Flora Locations.mxd

Legend

- Survey Area
- Local Road

Vegetation Condition

- Degraded (0.08 ha)
- Completely Degraded (8.65 ha)

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- LOCALITY MAP SOURCED FROM LANDGATE 2017
- OTHER DATA SOURCED LANDGATE 2018
- AERIAL PHOTOGRAPHY SOURCED ESRI 2018
(© Western Australian Land Information Authority 2017)

0 10 20 30 40
Meters
1:2,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP

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HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
SL	CM	SB	0

Michael Glendinning Property
Lots 1 and 13 Caporn Street, Wanneroo

Detailed Flora and Vegetation

Figure 8 Vegetation Condition

K:\Projects\1.0 EBS\2966 Lot 1 & 13 Caporn Street Flora and Veg\2966 F8 Vegetation Condition.mxd

4.3.5 Introduced Flora

A total of 19 introduced species were recorded within the Survey Area, representing approximately 53 % of the total taxa recorded. None of these are listed as Declared Pests (Department of Primary Industries and Regional Development, 2018a) or WoNS under the BAM Act (Table 5).

Table 5: Introduced Flora Species within the Survey Area

NAME	COMMON NAME
Acacia iteaphylla	Flinders Range wattle
Aira caryophyllea	Silvery Hairgrass
Avena barbata	Bearded Oat
Briza maxima	Blowfly Grass
Bromus diandrus	Great Brome
Carpobrotus edulis	Hottentot Fig
Cynodon dactylon	Couch Grass
Ehrharta calycina	Perennial Veldt Grass
Eragrostis curvula	African Love Grass
Euphorbia terracina	Geraldton Carnation Weed
Gladiolus caryophyllaceus	Wild Gladiolus
Oenothera stricta	Common Evening Primrose
Oxalis pes-caprae	Soursob
Pelargonium capitatum	Rose Pelargonium
Petrorhagia dubia	Velvet pink
Ricinus communis	Castor Oil Plant
Sonchus oleraceus	Common Sowthistle
Wahlenbergia capensis	Cape Bluebell
Watsonia meriana var. *bulbillifera*	Bugle Lily

4.3.6 Vegetation Types

One Vegetation Type (EmJs) was identified during the survey. It was very low in diversity and dominated by weeds. The remaining vegetation was mapped and described for the purpose of demonstrating the altered state of the two Lots. Descriptions of these are listed in Table 6, along with their extents within the Survey Area.

Table 6: Vegetation Type Descriptions and their Extent within the Survey Area

VEGETATION TYPE CODE	VEGETATION TYPE DESCRIPTION	EXTENT (HA) IN THE SURVEY AREA	EXTENT (%) IN THE SURVEY AREA
Af	*Allocasuarina fraseriana*	0.039	0.45
Ar	*Acacia rostellifera*	0.005	0.06
Bg	*Banksia grandis*	0.004	0.04
Cc	*Corymbia calophylla*	0.367	4.20
Cu	*Chamelaucium uncinatum*	0.553	6.34
CuJs	*Chamelaucium uncinatum* with some native regrowth consisting of *Jacksonia sternbergiana*, *Jacksonia furcellata*, *Acacia rostellifera*, *Adenanthos cygnorum*, *Macrozamia riedlei* and *Allocasuarina fraseriana*.	0.946	10.83
Em	*Eucalyptus marginata*	0.222	2.54
EmJs	Low Open woodland of *Eucalyptus marginata and Banksia grandis* over *Jacksonia sternbergiana* and *Macrozamia riedlei*	0.079	0.91
F	Fruit trees	0.060	0.69
G	Garden	0.226	2.59
G/Cc	Garden with *Corymbia calophylla*	0.297	3.40
JsJfAr	*Jacksonia sternbergiana, Jacksonia furcellata and Acacia rostellifera*	0.103	1.10
Total		**2.902**	**33.23**

4.3.7 Vegetation Condition

The majority of the Survey Area is in Completely Degraded condition (99.1%) with a small patch of vegetation in Degraded condition (0.9%) (Appendix G). The largest impact to the vegetation in the Survey Area is the historical clearing for market gardens, commercial flower production and the residences. Weed infestation is also extensive across the two lots housing. Additional disturbances include rubbish, dilapidated buildings, storage of farming equipment and chemicals and tracks. Vegetation condition and its extent within the Survey Area is presented in Table 7 and Figure 8.

Table 7: Vegetation Condition Assessed within the Survey Area

Vegetation Condition	Extent within Survey Area (ha)	Extent within Survey Area (%)
Degraded	0.08	0.9%
Completely Degraded	8.65	99.1
Total Area	**8.73**	**100**

4.3.8 Threatened and Priority Ecological Communities

Database search results show one TEC under the EPBC Act as being mapped within the Survey Area (Figure 6), this community is also listed as a PEC listed by the State:

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region (Priority 3 [DBCA], Endangered [EPBC]).

No TECs or PECs are considered to be present on site due to the condition and altered state of the vegetation within the Survey Area.

4.3.9 Regional Representation

There is no intact native vegetation present within the Survey Area due to extensive disturbance and planted garden species. The absence of woodland structure and the presence of only isolated native trees within the Survey Area indicates that the vegetation in the Survey Area does not represent the regional vegetation type identified as occurring in the area, Spearwood 6.

5 Discussion

5.1 Vegetation Condition and Introduced Flora

Vegetation condition ranged from Degraded to Completely Degraded with the majority of the Survey Area considered being in Completely Degraded condition. The land-use of the property has been a source of ongoing disturbance. Disturbance sources such as historical clearing for market gardens, commercial flower production and the residences have severely altered both the vegetation and soil profile. Additional disturbances include rubbish, dilapidated buildings, storage of farming equipment and chemicals and tracks.

A total of 19 introduced species were recorded during the survey. None of these are Declared Plants or WoNS. The historical land-use of the property has been a source of extensive weed infestations and ongoing activities continue to exacerbate the issue. The majority of these weeds are common bushland and agricultural weeds (Hussey et al. 2007).

5.2 Flora of Conservation significance

No Threatened species listed under the EPBC Act or gazetted as T/DRF (Threatened) pursuant to the WC Act were recorded during the survey.

The review of the database searches identified 13 T/DRF flora species potentially occurring in the vicinity of the Survey Area. Of these potential Threatened species, 12 are considered to have a Low Likelihood of occurrence, based on the habitat type present and known distribution and no Threatened species are considered to have a High likelihood. One species, *Melaleuca* sp. Wanneroo, is considered to have a Medium likelihood. *Melaleuca* sp. Wanneroo (G.J. Keighery 16705) (T) is described as an erect shrub ranging up to 2.5 metres high with yellow flowers. There are six known records within the WA Herbarium Database which recorded flowers during October, November and December. As the survey was completed within the timing of confirmed flowering periods and due to the nature of the shrub size it is considered likely that if the species were to occur within the Survey Area, it would have been recorded.

Of the Priority Flora (25 taxa) identified as potentially occurring within the Survey Area during the desktop assessment, 13 are considered to have a Low priority, based on the habitat type present and known distribution and six species are considered to have a Medium likelihood. Six species were considered to have a High likelihood of occurrence. These are listed below with their characteristics and as to whether they could be potentially found if further surveys are undertaken.

- *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425) (P1) is a perennial robust upright shrub to 1.5m with masses of white flowers Jun-Dec. Due to the nature of the shrub size it is considered likely that if the species were to occur within the Survey Area, it would have been recorded.

- *Thelymitra variegata* (P2) is the commonly known Queen of Sheba orchid. The tuberous, perennial herb ranges from 0.1-0.35 m high. Flowering periods range from June to September and are distinctly orange, red, purple and pink (Department of Biodiversity Conservation and Attractions, 2019). The survey was completed outside of the flowering period for this species, therefore if they do occur within the Survey Area, they may not have been recorded. Given the altered condition of the vegetation and soil disturbance it would be unlikely that the orchid would be present.
- *Austrostipa mundula* (P3) is described as a fine clumping perennial grass growing up to 0.5 metres high. There are 13 known records of the species in Western Australia within the WA Herbarium Database ranging from Esperance to Perth. Given the altered condition of the vegetation and soil disturbance it would be unlikely that the grass would be present.
- *Conostylis bracteata* (P3) is described as a perennial grass-like herb which ranges between 0.2 – 0.45 metres high. Flowers are yellow and the flowering period is from August to September (Department of Biodiversity Conservation and Attractions, 2019). The survey was completed outside of the flowering period for this species, however, given the species is perennial and is able to be identified without flowers, it is considered likely that if the species were to occur within the Survey Area, it would have been recorded.
- *Pimelea calcicola* (P3) is described as an erect to spreading shrub, ranging between 0.2 and 1 metre high. Flowers are pink, occurring September to November. The survey was completed within the flowering period for this species, and due to the nature of the shrub size it is considered likely that if the species were to occur within the Survey Area, it would have been recorded.
- *Styphelia filifolia* (P3) Erect shrubs to 90 cm high and 70 cm wide, Occurs sporadically from north of Eneabba to the Harvey area in the Geraldton Sandplains and Swan Coastal Plain bioregions. It grows on sandy soils of the coastal plain (with one known occurrence from the northern Darling Scarp), usually in Banksia or Jarrah woodland and in low-lying situations. Given the species is perennial, it is considered likely that if the species were to occur within the Survey Area, it would have been recorded.

One Priority flora species, *Jacksonia sericea* (P4) was recorded within the Survey Area in two locations. A review of Florabase records found 58 records of the species within the Swan Coastal Plain ranging from Mandurah to Nowergup, the earliest collection dated 1842. These records have been described as locally abundant and often widespread across locations (Department of Biodiversity Conservation and Attractions, 2018a).

The presence of a P4 taxa does not form a statutory constraint for the Survey Area. There is no written policy on how to respond to the presence of Priority flora species within

proposed development sites. The presence of the species is dealt with by DWER on a case-by-case basis.

6 Conclusion

The majority of the vegetation within the Survey Area has been previously cleared for market gardens, commercial flower crops and residences. The remining native vegetation consists of mature trees and the sporadic regrowth of understorey species.

In summary, the following conclusions on the existing flora and vegetation are made:

- No Threatened flora species pursuant to the EPBC Act and/or gazetted as Declared Rare Flora pursuant to the WC Act were recorded during the survey or are considered to have a High Likelihood of Occurrence in the Survey Area;
- One DBCA listed Priority flora, *Jacksonia sericea* (P4) was recorded within the Survey Area in two locations. The presence of this species is unlikely to form a statutory constraint for the Survey Area, and is dealt with by DWER on a case by case basis;
- There were 19 introduced species recorded during the survey. None of these are listed as Declared Pests or WoNS under the BAM Act;
- No TECs or PECs are considered to be present on site due to the condition and altered state of the vegetation within the Survey Area.

7 References

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APPENDIX A

Legislative and Non-Legislative Descriptions Definition of Declared Rare/Priority/Threatened Flora and Fauna

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance (MNES). Under the EPBC Act, the Commonwealth Department of the Environment and Energy (DEE) lists threatened species and communities in categories determined by criteria set out in the EPBC Act.

Projects likely to cause a significant impact on MNES should be referred to the DEE for assessment under the EPBC Act.

Wildlife Conservation Act 1950

The WA DBCA lists flora and fauna under the provisions of the WC Act as protected according to their need for protection.

Flora is given Declared Rare status when populations are geographically restricted or are threatened by local processes. In addition, under the WC Act, by Notice in the WA Government Gazette of 9 October 1987, all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) is protected throughout the State. Fauna are classified as Schedule 1 to Schedule 4 according to their need for protection.

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* replaces the *Wildlife Conservation Act 1950* and the *Sandalwood Act 1929*. The BC Act aims to conserve and protect biodiversity and biodiversity components within the State and to promote ecologically sustainable use of biodiversity components in the State. The Act covers important biodiversity conservation matters not previously recognised in the WC Act, including threatened ecological communities, threatening processes, critical habitats and environmental pests and weeds. The Act also provides incentives for private and community conservation initiatives through new biodiversity conservation agreements and biodiversity conservation covenants. In addition, the Act provides for new public and landholder consultation mechanisms previously absent from the WC Act.

Environmental Protection Act 1986

Declared Rare Flora (DRF) and Threatened Ecological Communities (TECs) are given special consideration in environmental impact assessments and have special status as Environmentally Sensitive Areas (ESAs) under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit do not apply in an ESA. In addition, habitat necessary for the maintenance of indigenous fauna is considered in the clearing principles and assessed during consideration of applications for a clearing permit.

Biosecurity and Agricultural Management Act 2007

Plants may be 'Declared' by the Minister for Agriculture and Food under the BAM Act. The Western Australian Organism List contains information on the area(s) in which a plant is declared and the control and keeping categories to which, it has been assigned in

Western Australia. Details of the definitions of these categories are provided in Appendix C. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is 'Declared', landholders are obliged to control that plant on their properties (DAFWA 2017).

Weeds of National Significance

The Australian Government, along with the State and Territory Governments, has endorsed 32 Weeds of National Significance (WONS). Four major criteria were used in determining WONS:

- The invasiveness of a weed species;
- A weed's impact(s);
- The potential for spread of a weed; and
- Socio-economic and environmental values.

Each WONS has a national strategy and a national coordinator responsible for implementing the strategy. WONS are regarded as priority weeds in Australia because of their invasiveness, potential for spread and economic and environmental impacts (Thorp and Lynch 2000).

Department of Biodiversity, Conservation and Attractions Priority Lists

DBCA lists 'Priority' flora and fauna that have not been assigned statutory protection as Declared Rare or 'Scheduled' under the WC Act and are under consideration for declaration as Threatened. Flora and fauna assessed as Priority 1-3 are considered to be in urgent need of further survey. Priority 4 flora requires monitoring every 5 -10 years and Priority 5 flora and fauna is subject to a specific conservation program.

DBCA maintains a list of Priority Ecological Communities (PECs) which identifies plant communities that require further investigation before possible nomination for TEC status. Once listed, a community becomes a PEC and, when endorsed by the WA Minister for Environment, becomes a TEC and protected as an ESA under *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Informal Recognition of Flora and Fauna

Certain populations or communities of flora and/or fauna may be of local significance or interest because of their patterns of distribution and abundance. For example, specific locations of flora and may be locally significant because they are range extensions to the previously known distribution, or are newly discovered taxa (and have the potential to be of more than local significance). In addition, many species are in decline as a result of threatening processes (land clearing, grazing, and changed fire regimes) and relict populations of such species assume local importance for DBCA. It is not uncommon for DBCA to make comment on these species of interest.

APPENDIX B

Definition of Declared Rare/Priority/Threatened Flora and Fauna

Categories of Threatened flora species under the EPBC Act (Department of the Environment and Energy, 1999)

CONSERVATION CODE	DESCRIPTION
Ex	Extinct A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild A native species is eligible to be included in the extinct category at a particular time if, at that time, it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered A native species is eligible to be included in the extinct category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered A native species is eligible to be included in the extinct category at a particular time if, at that time, it is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	Vulnerable A native species is eligible to be included in the extinct category at a particular time if, at that time, it is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent A native species is eligible to be included in the extinct category at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Categories of Declared Rare Flora (WC Act) and DBCA Priority flora rankings (DBCA 2013)

CONSERVATION CODE	DESCRIPTION
X	Presumed Extinct Flora (Declared Rare Flora – Extinct) "Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the *Wildlife Conservation Act 1950*)."
T	Threatened Flora (Declared Rare Flora – Extant) "Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*)." "Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria: CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild; EN: Endangered – considered to be facing a very high risk of extinction in the wild; VU: Vulnerable – considered to be facing a high risk of extinction in the wild."
P1	Priority One: Poorly-known taxa "Taxa which are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes."
P2	Priority Two: Poorly-known taxa "Taxa which are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes."

Conservation Code	Description
P3	**Priority Three: Poorly-known taxa** "Taxa which are known from collections or sight records from several localities not under imminent threat, or few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them."
P4	**Priority Four: Rare, Near Threatened and other taxa in need of monitoring** a. Rare. "Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands." b. Near Threatened. "Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable." c. "Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy."
P5	**Priority Five: Conservation Dependent taxa** "Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years."

Source: Department of Parks and Wildlife (2013). Online: http://florabase.dpaw.wa.gov.au.

APPENDIX C

Conservation Categories of Threatened or Priority Ecological Communities

Definitions of Threatened Ecological Communities as Endorsed by the Western Australian Minister for the Environment (Department of Environment and Conservation, 2013)

PRESUMED TOTALLY DESTROYED (PD)

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B);

A) Records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats or

B) All occurrences recorded within the last 50 years have since been destroyed.

CRITICALLY ENDANGERED (CR)

An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii)

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years)

ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, and one or more of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years)

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years)

ENDANGERED (EN)
An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and either or both of the following apply (i or ii) i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years) ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years) ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).
VULNERABLE (VU)
An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction in the medium to long term future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated. B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Definitions of Priority Ecological Communities as listed DPCA (Department of Environment and Conservation, 2013)

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

PRIORITY ONE: POORLY KNOWN ECOLOGICAL COMMUNITIES
Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
PRIORITY TWO: POORLY KNOWN ECOLOGICAL COMMUNITIES
Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
PRIORITY THREE: POORLY KNOWN ECOLOGICAL COMMUNITIES
(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

PRIORITY FOUR: ECOLOGICAL COMMUNITIES THAT ARE ADEQUATELY KNOWN, RARE BUT NOT THREATENED OR MEET CRITERIA FOR NEAR THREATENED OR THAT HAVE BEEN RECENTLY REMOVED FROM THE THREATENED LIST.
These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
PRIORITY FIVE: CONSERVATION DEPENDENT ECOLOGICAL COMMUNITIES.
Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years

APPENDIX D

WoNS, Declared Plant and Environmental Weed Categories

To help focus national efforts to address weed problems in Australia, a list of Weeds of National Significance (WoNS) was compiled. Plant species were selected on the basis of their invasiveness and impact characteristics, their potential and current area of spread and their primary industry, environmental and socioeconomic impacts. Thirty-two WoNS have been identified by Australian governments. In Western Australia many of these WoNS are also declared pests under the *Biosecurity and Agriculture Management Act 2007*.

To protect Western Australia's agriculture, the Department of Primary Industries and Regional Development:

- Regulates weeds under the Biosecurity and Agriculture Management Act 2007 (BAM Act);
- Provides a weed identification service; and
- Provides information on weed control, crop weeds, regulated/declared plants and herbicides.

Under the BAM Act, all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management).

Declared pest categories under the BAM Act (Department of Primary Industries and Regional Development, 2018a)

C1 CATEGORY (EXCLUSION)
Pests will be assigned to this category if they are not established in WA and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 CATEGORY (ERADICATION)
Pests will be assigned to this category if they are present in WA in low enough numbers or in sufficiently limited areas that their eradication is still a possibility
C3 CATEGORY (MANAGEMENT)
Pests will be assigned to this category if they are established in WA but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

The Weed Prioritisation Process for DBCA contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity (Department of Parks and Wildlife, 2013). These criteria are as follows:

- **Potential Distribution** – Area of potential habitat in the Region that could be occupied or the area at risk of invasion by the weed;
- **Current Distribution -** Area of habitat in the Region currently occupied by the weed, in relation to the habitat that it could invade;
- **Ecological Impact -** Impact of species within the Region, from low impact (causes minimal disruption to ecological processes or loss of biodiversity) to high (causes acute disruption of ecological processes, dominates and/or significantly alters vegetation structure, composition and function of ecosystems);
- **Invasiveness** – rate of spread of a weed in native vegetative, encompassing factors of establishment, reproduction and long distance dispersal (>100m); and
- **Feasibility of Control** - The longer a coordinated control program takes to achieve its desired goal, the more expensive and less feasible it becomes. Is it feasible to eradicate or at least contain the infestation?

Weed Prioritisation Process prioritises weeds in each DBCA region in terms of Ecological impact under each of the categories of very high (VH), high (H), medium (M), low (L) and negligible (N). Weeds are also prioritised by regions in relation to invasiveness according to the categories of slow (S), Moderate (M), Rapid (R) and Unknown (U) ((Department of Parks and Wildlife, 2013).

APPENDIX E

Database Assessment Search Results

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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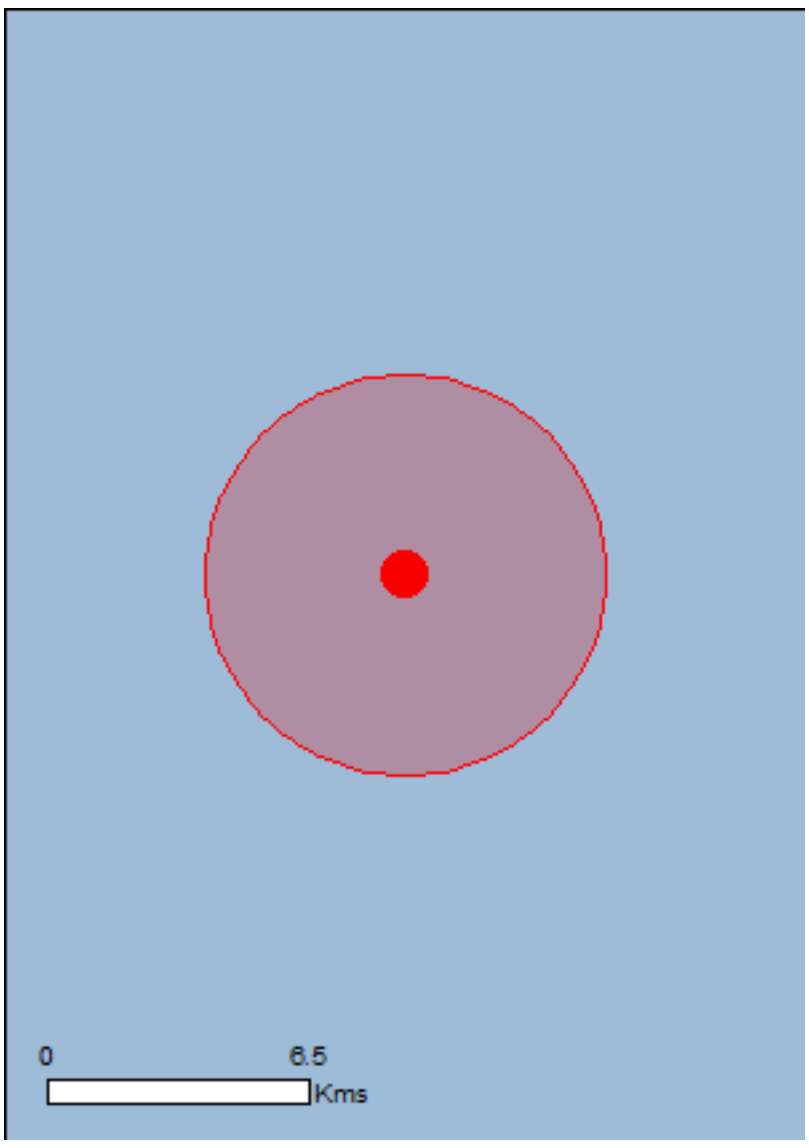

Coordinates

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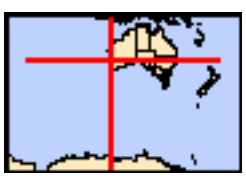

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	19
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	22
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	4
Regional Forest Agreements:	None
Invasive Species:	33
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat may occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat may occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat likely to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Calidris ruficollis](#) Red-necked Stint [860]		Species or species habitat known to occur within area
[Calidris subminuta](#) Long-toed Stint [861]		Species or species habitat known to occur within area
[Charadrius ruficapillus](#) Red-capped Plover [881]		Species or species habitat known to occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
[Himantopus himantopus](#) Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat known to occur within area
[Recurvirostra novaehollandiae](#) Red-necked Avocet [871]		Species or species habitat known to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
[Thinornis rubricollis](#) Hooded Plover [59510]		Species or species habitat may occur within area
[Tringa glareola](#) Wood Sandpiper [829]		Species or species habitat known to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Jandabup	WA
Lake Joondalup	WA
Unnamed WA21176	WA
Unnamed WA43290	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Joondalup Lake	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.73535 115.81383

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 02/11/2018

Kingdom	Plantae
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	115° 48' 50" E,31° 44' 07" S
Buffer	5km
Group By	Family

Family	Species	Records
Aizoaceae	2	2
Amaranthaceae	5	9
Anacardiaceae	1	1
Anarthriaceae	1	1
Apiaceae	4	5
Apocynaceae	2	2
Araliaceae	2	4
Arecaceae	1	1
Asparagaceae	12	16
Asteraceae	29	37
Brassicaceae	7	8
Bryaceae	4	5
Campanulaceae	5	6
Caprifoliaceae	1	1
Caryophyllaceae	3	3
Casuarinaceae	2	2
Celastraceae	1	1
Centrolepidaceae	1	2
Chenopodiaceae	2	3
Colchicaceae	2	2
Commelinaceae	1	2
Convolvulaceae	2	2
Crassulaceae	2	2
Cyperaceae	28	41
Dasypogonaceae	2	3
Dennstaedtiaceae	1	1
Dicranaceae	1	3
Dilleniaceae	9	15
Ditrichaceae	2	2
Droseraceae	4	6
Ericaceae	15	29
Euphorbiaceae	3	5
Fabaceae	38	70
Fissidentaceae	1	1
Geraniaceae	3	6
Goodeniaceae	4	4
Gyrostemonaceae	1	1
Haemodoraceae	11	15
Haloragaceae	3	8
Hemerocallidaceae	5	6
Hydrocharitaceae	1	1
Iridaceae	4	6
Juncaceae	1	2
Lamiaceae	3	6
Lauraceae	1	1
Lentibulariaceae	4	8
Linaceae	1	1
Loranthaceae	1	1
Lythraceae	1	1
Macarthuriaceae	1	1
Malvaceae	1	3
Meliaceae	1	1
Menyanthaceae	1	1
Myrtaceae	27	43
Onagraceae	4	7
Orchidaceae	19	24
Orobanchaceae	1	1
Orthotrichaceae	1	4
Phyllanthaceae	5	6
Phytolaccaceae	1	3
Pittosporaceae	2	2
Plantaginaceae	3	3
Plumbaginaceae	1	1
Poaceae	24	36
Polygalaceae	1	1
Polygonaceae	4	8
Potamogetonaceae	1	1
Pottiaceae	4	5
Proteaceae	18	24
Racopilaceae	1	1
Ranunculaceae	1	1
Restionaceae	2	3
Rhamnaceae	2	2
Rutaceae	5	10
Santalaceae	2	2

Scrophulariaceae	3	3
Solanaceae	3	4
Stylidiaceae	13	14
Thymelaeaceae	4	8
Verbenaceae	1	2
Violaceae	1	4
Xanthorrhoeaceae	1	2
TOTAL	**399**	**591**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Aizoaceae					
1.	48513	*Aizoon pubescens*	Y		
2.	2824	*Tetragonia tetragonoides (New Zealand Spinach)*			
Amaranthaceae					
3.	2652	*Alternanthera nodiflora (Common Joyweed)*			
4.	2653	*Alternanthera pungens (Khaki Weed)*	Y		
5.	25840	*Amaranthus blitum*	Y		
6.	11260	*Ptilotus drummondii var. drummondii (Pussytail)*			
7.	15856	*Ptilotus sericostachyus subsp. sericostachyus*			
Anacardiaceae					
8.	11027	*Schinus terebinthifolius*	Y		
Anarthriaceae					
9.	1097	*Lyginia barbata*			
Apiaceae					
10.	8595	*Apium graveolens (Wild Celery)*	Y		
11.	6214	*Centella asiatica*			
12.	6222	*Homalosciadium homalocarpum*			
13.	6289	*Xanthosia huegelii*			
Apocynaceae					
14.	6565	*Alyxia buxifolia (Dysentery Bush)*			
15.	11051	*Gomphocarpus physocarpus*	Y		
Araliaceae					
16.	20649	*Tetrapanax papyrifer*	Y		Y
17.	6280	*Trachymene pilosa (Native Parsnip)*			
Arecaceae					
18.	17910	*Washingtonia filifera*	Y		
Asparagaceae					
19.	1307	*Laxmannia ramosa (Branching Lily)*			
20.	11911	*Laxmannia ramosa subsp. ramosa*			
21.	1309	*Laxmannia squarrosa*			
22.	1228	*Lomandra hermaphrodita*			
23.	1232	*Lomandra micrantha (Small-flower Mat-rush)*			
24.	1234	*Lomandra nigricans*			
25.	1239	*Lomandra preissii*			
26.	1246	*Lomandra suaveolens*			
27.	1312	*Sowerbaea laxiflora (Purple Tassels)*			
28.	1318	*Thysanotus arbuscula*			
29.	1343	*Thysanotus patersonii*			
30.	1351	*Thysanotus sparteus*			
Asteraceae					
31.	7838	*Arctotheca calendula (Cape Weed, African Marigold)*	Y		
32.	7867	*Brachyscome bellidioides*			
33.	7878	*Brachyscome iberidifolia*			
34.	7945	*Cotula coronopifolia (Waterbuttons)*	Y		
35.	7976	*Galinsoga parviflora (Potato Weed)*	Y		
36.	16311	*Gazania linearis*	Y		
37.	8084	*Helminthotheca echioides (Ox-tongue, Prickly Ox-tongue)*	Y		
38.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
39.	8096	*Lactuca serriola (Prickly Lettuce)*	Y		
40.	18585	*Lagenophora huegelii*			
41.	8105	*Millotia myosotidifolia*			
42.	8106	*Millotia tenuifolia (Soft Millotia)*			
43.	29418	*Monoculus monstrosus*	Y		
44.	32716	*Olearia lehmanniana*			
45.	8149	*Olearia rudis (Rough Daisybush)*			
46.	8165	*Pithocarpa pulchella (Beautiful Pithocarpa)*			
47.	18352	*Pithocarpa pulchella var. melanostigma*			
48.	18353	*Pithocarpa pulchella var. pulchella*			
49.	8175	*Podolepis gracilis (Slender Podolepis)*			
50.	8179	*Podolepis nutans (Nodding Podolepis)*			
51.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
52.	8195	*Quinetia urvillei*			
53.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
54.	8255	*Ursinia anthemoides (Ursinia)*	Y		
55.	8257	*Vellereophyton dealbatum (White Cudweed)*	Y		
56.	46275	*Verbesina encelioides var. encelioides (Crownbeard, Wild Sunflower, Goldweed, South African Daisy)*	Y		
57.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
58.	8286	*Xanthium occidentale (Noogoora Burr)*	Y		
59.	44861	*Xerochrysum macranthum*			
Brassicaceae					
60.	11187	*Brassica barrelieri subsp. oxyrrhina (Smooth-stem Turnip)*	Y		
61.	2993	*Brassica fruticulosa (Twiggy Turnip)*	Y		
62.	3000	*Brassica tournefortii (Mediterranean Turnip)*	Y		
63.	3005	*Cardamine hirsuta (Common Bittercress)*	Y		
64.	18555	*Cardamine sp. Jandakot (P. Luff s.n. 4/7/1969)*	Y		
65.	3061	*Raphanus raphanistrum (Wild Radish)*	Y		
66.	19403	*Stenopetalum gracile*			
Bryaceae					
67.	32331	*Bryum lanatum*			
68.	32380	*Gemmabryum pachythecum*			
69.	32381	*Gemmabryum preissianum*			
70.	44608	*Rosulabryum billarderii*			
Campanulaceae					
71.	7408	*Lobelia tenuior (Slender Lobelia)*			
72.	36860	*Lobelia tenuior subsp. dictyosperma*			Y
73.	7384	*Wahlenbergia capensis (Cape Bluebell)*	Y		
74.	7388	*Wahlenbergia multicaulis*			
75.	7389	*Wahlenbergia preissii*			
Caprifoliaceae					
76.	7368	*Scabiosa atropurpurea (Purple Pincushion)*	Y		
Caryophyllaceae					
77.	2889	*Cerastium glomeratum (Mouse Ear Chickweed)*	Y		
78.	15972	*Silene gallica var. gallica*	Y		
79.	2910	*Silene nocturna (Mediterranean Catchfly)*	Y		
Casuarinaceae					
80.	1728	*Allocasuarina fraseriana (Sheoak, Kondil)*			
81.	18314	*Casuarina cunninghamiana subsp. cunninghamiana*	Y		
Celastraceae					
82.	9069	*Stackhousia huegelii*			
Centrolepidaceae					
83.	1125	*Centrolepis drummondiana*			
Chenopodiaceae					
84.	2490	*Chenopodium glaucum (Glaucous Goosefoot)*	Y		
85.	2491	*Chenopodium macrospermum*	Y		
Colchicaceae					
86.	1385	*Burchardia multiflora (Dwarf Burchardia)*			
87.	1401	*Wurmbea pygmaea*			
Commelinaceae					
88.	1162	*Cartonema philydroides*			
Convolvulaceae					
89.	11021	*Cuscuta planiflora*	Y		
90.	6620	*Ipomoea cairica (Coast Morning Glory)*	Y		
Crassulaceae					
91.	3140	*Crassula glomerata*	Y		
92.	3146	*Crassula thunbergiana*	Y		
Cyperaceae					
93.	741	*Baumea articulata (Jointed Rush)*			
94.	743	*Baumea juncea (Bare Twigrush)*			
95.	744	*Baumea laxa*			
96.	745	*Baumea preissii*			
97.	749	*Bolboschoenus caldwellii (Marsh Club-rush)*			
98.	753	*Carex appressa (Tall Sedge)*			
99.	754	*Carex divisa (Divided Sedge)*	Y		
100.	755	*Carex fascicularis (Tassel Sedge)*			
101.	43241	*Carex thecata*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
102.	16245	*Cyathochaeta teretifolia*		P3	
103.	18318	*Cyperus involucratus*	Y		
104.	816	*Cyperus tenuiflorus (Scaly Sedge)*	Y		
105.	910	*Isolepis cernua (Nodding Club-rush)*			
106.	20200	*Isolepis cernua var. setiformis*			
107.	917	*Isolepis marginata (Coarse Club-rush)*			
108.	919	*Isolepis oldfieldiana*			
109.	921	*Isolepis producta*			
110.	925	*Lepidosperma angustatum*			
111.	937	*Lepidosperma longitudinale (Pithy Sword-sedge)*			
112.	944	*Lepidosperma scabrum*			
113.	953	*Mesomelaena graciliceps*			
114.	955	*Mesomelaena pseudostygia*			
115.	48356	*Schoenoplectus tabernaemontani*			
116.	984	*Schoenus curvifolius*			
117.	992	*Schoenus grandiflorus (Large Flowered Bogrush)*			
118.	1018	*Schoenus subfascicularis*			
119.	1036	*Tetraria octandra*			
120.	35581	*Tetraria sp. Chandala (G.J. Keighery 17055)*		P2	
Dasypogonaceae					
121.	19309	*Calectasia narragara*			
122.	1218	*Dasypogon bromeliifolius (Pineapple Bush)*			
Dennstaedtiaceae					
123.	41651	*Pteridium esculentum subsp. esculentum*			
Dicranaceae					
124.	32338	*Campylopus introflexus*	Y		
Dilleniaceae					
125.	5112	*Hibbertia aurea*			
126.	5117	*Hibbertia cuneiformis (Cutleaf Hibbertia)*			
127.	5134	*Hibbertia huegelii*			
128.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
129.	45534	*Hibbertia hypericoides subsp. hypericoides*			
130.	5154	*Hibbertia perfoliata*			
131.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
132.	43280	*Hibbertia sericosepala*			
133.	5173	*Hibbertia subvaginata*			
Ditrichaceae					
134.	32462	*Ceratodon purpureus subsp. convolutus*			
135.	32351	*Eccremidium pulchellum*			
Droseraceae					
136.	3095	*Drosera erythrorhiza (Red Ink Sundew)*			
137.	3106	*Drosera macrantha (Bridal Rainbow)*			
138.	3116	*Drosera omissa (Bright Sundew)*			
139.	3118	*Drosera pallida (Pale Rainbow)*			
Ericaceae					
140.	6311	*Andersonia heterophylla*			
141.	6323	*Astroloma ciliatum (Candle Cranberry)*			
142.	6334	*Astroloma pallidum (Kick Bush)*			
143.	6339	*Astroloma xerophyllum*			
144.	6348	*Conostephium pendulum (Pearl Flower)*			
145.	6349	*Conostephium preissii*			
146.	6360	*Leucopogon australis (Spiked Beard-heath)*			
147.	6374	*Leucopogon conostephioides*			
148.	6405	*Leucopogon insularis*			
149.	6425	*Leucopogon oxycedrus*			
150.	6434	*Leucopogon polymorphus*			
151.	6436	*Leucopogon propinquus*			
152.	40803	*Leucopogon squarrosus subsp. squarrosus*			
153.	34736	*Lysinema pentapetalum*			
154.	48297	*Styphelia filifolia*		P3	
Euphorbiaceae					
155.	4638	*Euphorbia peplus (Petty Spurge)*	Y		
156.	4648	*Euphorbia terracina (Geraldton Carnation Weed)*	Y		
157.	19942	*Ricinocarpos undulatus*			
Fabaceae					
158.	15466	*Acacia applanata*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
159.	3237	*Acacia benthamii*		P2	
160.	3374	*Acacia huegelii*			
161.	17861	*Acacia longifolia*	Y		
162.	17464	*Acacia longifolia subsp. longifolia*	Y		
163.	3502	*Acacia pulchella (Prickly Moses)*			
164.	15481	*Acacia pulchella var. glaberrima*			
165.	3525	*Acacia rostellifera (Summer-scented Wattle)*			
166.	30032	*Acacia saligna subsp. saligna*			
167.	3541	*Acacia sessilis*			
168.	3602	*Acacia willdenowiana (Grass Wattle)*			
169.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
170.	10861	*Callistachys lanceolata (Wonnich)*			
171.	18156	*Chamaecytisus palmensis (Tagasaste)*	Y		
172.	18560	*Daviesia divaricata subsp. divaricata*			
173.	16585	*Daviesia nudiflora subsp. nudiflora*			
174.	3832	*Daviesia physodes*			
175.	3845	*Daviesia triflora*			
176.	3872	*Euchilopsis linearis (Swamp Pea)*			
177.	20475	*Gastrolobium capitatum*			
178.	20483	*Gastrolobium linearifolium*			
179.	11083	*Gompholobium scabrum*			
180.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
181.	3961	*Hardenbergia comptoniana (Native Wisteria)*			
182.	3968	*Hovea trisperma (Common Hovea)*			
183.	4010	*Jacksonia floribunda (Holly Pea)*			
184.	4012	*Jacksonia furcellata (Grey Stinkwood)*			
185.	4027	*Jacksonia sericea (Waldjumi)*		P4	
186.	4029	*Jacksonia sternbergiana (Stinkwood, Kapur)*			
187.	4044	*Kennedia prostrata (Scarlet Runner)*			
188.	4052	*Latrobea tenella*			
189.	19821	*Lessertia frutescens*	Y		
190.	4079	*Medicago polymorpha (Burr Medic)*	Y		
191.	4100	*Mirbelia spinosa*			
192.	4181	*Pultenaea reticulata*			
193.	4256	*Templetonia retusa (Cockies Tongues)*			
194.	14738	*Trifolium resupinatum var. resupinatum*	Y		
195.	11474	*Vicia sativa subsp. nigra*	Y		
Fissidentaceae					
196.	32369	*Fissidens tenellus*			
Geraniaceae					
197.	4333	*Erodium cicutarium (Common Storksbill)*	Y		
198.	4341	*Geranium solanderi (Native Geranium)*			
199.	4343	*Pelargonium capitatum (Rose Pelargonium)*	Y		
Goodeniaceae					
200.	7454	*Dampiera linearis (Common Dampiera)*			
201.	7574	*Lechenaultia floribunda (Free-flowering Leschenaultia)*			
202.	13181	*Scaevola repens var. angustifolia*			
203.	13152	*Scaevola thesioides subsp. thesioides*			
Gyrostemonaceae					
204.	2791	*Tersonia cyathiflora (Button Creeper)*			
Haemodoraceae					
205.	11261	*Anigozanthos manglesii subsp. manglesii*			
206.	1418	*Conostylis aculeata (Prickly Conostylis)*			
207.	11552	*Conostylis aculeata subsp. bromelioides*			
208.	1423	*Conostylis aurea (Golden Conostylis)*			
209.	1425	*Conostylis bracteata*		P3	
210.	1436	*Conostylis juncea*			
211.	11597	*Conostylis setigera subsp. setigera*			
212.	11870	*Conostylis teretifolia subsp. teretifolia*			
213.	1468	*Haemodorum laxum*			
214.	1475	*Haemodorum spicatum (Mardja)*			
215.	1478	*Phlebocarya ciliata*			
Haloragaceae					
216.	6161	*Gonocarpus pithyoides*			
217.	34676	*Meionectes brownii (Swamp Raspwort)*			
218.	6199	*Myriophyllum tillaeoides*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Hemerocallidaceae					
219.	1264	*Arnocrinum preissii*			
220.	1276	*Caesia micrantha (Pale Grass Lily)*			
221.	1259	*Dianella revoluta (Blueberry Lily)*			
222.	1293	*Hensmania turbinata*			
223.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
Hydrocharitaceae					
224.	138	*Najas marina (Prickly Water Nymph)*			
Iridaceae					
225.	1513	*Chasmanthe floribunda (African Cornflag)*	Y		
226.	1520	*Gladiolus caryophyllaceus (Wild Gladiolus)*	Y		
227.	1550	*Patersonia occidentalis (Purple Flag, Koma)*			
228.	30472	*Patersonia occidentalis var. occidentalis*			
Juncaceae					
229.	1188	*Juncus pallidus (Pale Rush)*			
Lamiaceae					
230.	6836	*Hemiandra incana*			
231.	6839	*Hemiandra pungens (Snakebush)*			
232.	6880	*Leonotis leonurus (Lion's Ear)*	Y		
Lauraceae					
233.	2951	*Cassytha flava (Dodder Laurel)*			
Lentibulariaceae					
234.	7125	*Utricularia australis*			
235.	7131	*Utricularia dichotoma (Fairy Aprons)*			
236.	12493	*Utricularia gibba*			
237.	7158	*Utricularia volubilis (Twining Bladderwort)*			
Linaceae					
238.	4364	*Linum usitatissimum (Flax)*	Y		
Loranthaceae					
239.	2401	*Nuytsia floribunda (Christmas Tree, Mudja)*			
Lythraceae					
240.	5281	*Lythrum hyssopifolia (Lesser Loosestrife)*	Y		
Macarthuriaceae					
241.	2838	*Macarthuria apetala*			
Malvaceae					
242.	5011	*Guichenotia ledifolia*			
Meliaceae					
243.	4516	*Melia azedarach (White Cedar)*			
Menyanthaceae					
244.	36160	*Liparophyllum capitatum*			
Myrtaceae					
245.	20283	*Astartea scoparia (Common Astartea)*			
246.	34161	*Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*		P1	
247.	5382	*Beaufortia elegans (Elegant Beaufortia)*			
248.	5415	*Calothamnus lateralis*			
249.	35816	*Calothamnus quadrifidus subsp. quadrifidus*			
250.	5429	*Calothamnus sanguineus (Silky-leaved Blood flower, Pindak)*			
251.	5439	*Calytrix angulata (Yellow Starflower)*			
252.	5460	*Calytrix fraseri (Pink Summer Calytrix)*			
253.	5476	*Calytrix sapphirina*			
254.	14104	*Eremaea pauciflora var. pauciflora*			
255.	5708	*Eucalyptus marginata (Jarrah, Djara)*			
256.	13547	*Eucalyptus marginata subsp. marginata (Jarrah)*			
257.	5763	*Eucalyptus rudis (Flooded Gum, Kulurda)*			
258.	5790	*Eucalyptus todtiana (Coastal Blackbutt)*			
259.	5817	*Hypocalymma angustifolium (White Myrtle, Kudjid)*			
260.	5825	*Hypocalymma robustum (Swan River Myrtle)*			
261.	13271	*Melaleuca huegelii subsp. huegelii*			
262.	5952	*Melaleuca preissiana (Moonah)*			
263.	5959	*Melaleuca rhaphiophylla (Swamp Paperbark)*			
264.	5964	*Melaleuca seriata*			
265.	18598	*Melaleuca systena*			
266.	5983	*Melaleuca trichophylla*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
267.	16477	*Pericalymma ellipticum var. ellipticum*			
268.	6014	*Regelia inops*			
269.	6077	*Verticordia drummondii (Drummond's Featherflower)*			
270.	6101	*Verticordia nitens (Morrison Featherflower, Kodjeningara)*			
271.	6103	*Verticordia ovalifolia*			
Onagraceae					
272.	6132	*Epilobium ciliatum*	Y		
273.	6133	*Epilobium hirtigerum (Hairy Willow Herb)*			
274.	14289	*Epilobium tetragonum subsp. tetragonum*	Y		
275.	16390	*Oenothera drummondii subsp. drummondii*	Y		
Orchidaceae					
276.	15330	*Caladenia arenicola*			
277.	1592	*Caladenia flava (Cowslip Orchid)*			
278.	15348	*Caladenia flava subsp. flava*			
279.	15360	*Caladenia longicauda subsp. borealis*			
280.	15361	*Caladenia longicauda subsp. calcigena*			
281.	15377	*Caladenia reptans subsp. reptans*			
282.	15114	*Cyanicula gemmata*			
283.	10916	*Cyrtostylis huegelii*			
284.	11049	*Diuris corymbosa*			
285.	1635	*Diuris longifolia (Common Donkey Orchid)*			
286.	12939	*Diuris magnifica*			
287.	1643	*Elythranthera brunonis (Purple Enamel Orchid)*			
288.	1653	*Leporella fimbriata (Hare Orchid)*			
289.	15418	*Leptoceras menziesii*			
290.	15419	*Microtis media subsp. media*			
291.	1672	*Prasophyllum fimbria (Fringed Leek Orchid)*			
292.		*Pterostylis aff. nana*			
293.	1687	*Pterostylis dilatata*			
294.	1717	*Thelymitra variegata (Queen of Sheba)*		P2	
Orobanchaceae					
295.	7122	*Orobanche minor (Lesser Broomrape)*	Y		
Orthotrichaceae					
296.	36218	*Zygodon menziesii*			
Phyllanthaceae					
297.	4675	*Phyllanthus calycinus (False Boronia)*			
298.	17794	*Phyllanthus tenellus*	Y		
299.	4689	*Poranthera ericoides (Heath Poranthera)*			
300.	4691	*Poranthera microphylla (Small Poranthera)*			
301.	42022	*Poranthera moorokatta*		P2	
Phytolaccaceae					
302.	2793	*Phytolacca octandra (Red Ink Plant)*	Y		
Pittosporaceae					
303.	25788	*Billardiera fraseri (Elegant Pronaya)*			
304.	25819	*Marianthus paralius*		T	
Plantaginaceae					
305.	16346	*Bacopa monnieri*	Y		
306.	7299	*Plantago debilis*			
307.	7304	*Plantago major (Greater Plantain)*	Y		
Plumbaginaceae					
308.	6489	*Limonium sinuatum (Perennial Sea Lavender)*	Y		
Poaceae					
309.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
310.	20184	*Amphipogon laguroides subsp. laguroides*			
311.	200	*Amphipogon turbinatus*			
312.	35317	*Austrostipa mundula*		P3	
313.	244	*Briza maxima (Blowfly Grass)*	Y		
314.	13685	*Catapodium rigidum (Rigid Fescue)*	Y		
315.	48259	*Cortaderia selloana subsp. selloana*	Y		
316.	320	*Digitaria sanguinalis (Crab Grass)*	Y		
317.	11485	*Ehrharta brevifolia var. cuspidata*	Y		
318.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
319.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
320.	376	*Eragrostis curvula (African Lovegrass)*	Y		
321.	439	*Hemarthria uncinata (Matgrass)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
322.	444	*Holcus lanatus (Yorkshire Fog)*	Y		
323.	449	*Hordeum leporinum (Barley Grass)*	Y		
324.	20019	*Lachnagrostis filiformis*			
325.	467	*Lagurus ovatus (Hare's Tail Grass)*	Y		
326.	475	*Lolium multiflorum (Italian Ryegrass)*	Y		
327.	485	*Microlaena stipoides (Weeping Grass)*			
328.	532	*Paspalum urvillei (Vasey Grass)*	Y		
329.	571	*Poa annua (Winter Grass)*	Y		
330.	582	*Polypogon monspeliensis (Annual Beardgrass)*	Y		
331.	40426	*Rytidosperma occidentale*			
332.	11137	*Vulpia fasciculata*	Y		
Polygalaceae					
333.	4550	*Comesperma calymega (Blue-spike Milkwort)*			
Polygonaceae					
334.	2415	*Muehlenbeckia polybotrya*			
335.	13911	*Persicaria decipiens*			
336.	16984	*Persicaria lapathifolia*	Y		
337.	2429	*Rumex acetosella (Sorrel)*	Y		
Potamogetonaceae					
338.	109	*Potamogeton crispus (Curly Pondweed)*			
Pottiaceae					
339.	32315	*Barbula calycina*			
340.	32437	*Syntrichia antarctica*			
341.	32438	*Syntrichia pagorum*			
342.	32450	*Trichostomum eckelianum*			
Proteaceae					
343.	11837	*Adenanthos cygnorum subsp. cygnorum (Common Woollybush)*			
344.	1800	*Banksia attenuata (Slender Banksia, Piara)*			
345.	1822	*Banksia ilicifolia (Holly-leaved Banksia)*			
346.	1830	*Banksia littoralis (Swamp Banksia, Pungura)*			
347.	1834	*Banksia menziesii (Firewood Banksia)*			
348.	32077	*Banksia sessilis var. cygnorum*			
349.	15607	*Conospermum acerosum subsp. acerosum*			
350.	15516	*Conospermum canaliculatum subsp. canaliculatum*			
351.	1876	*Conospermum incurvum (Plume Smokebush)*			
352.	15839	*Grevillea preissii subsp. preissii*			
353.	12824	*Grevillea vestita subsp. vestita*			
354.	2175	*Hakea lissocarpha (Honey Bush)*			
355.	2214	*Hakea trifurcata (Two-leaf Hakea)*			
356.	2273	*Persoonia saccata (Snottygobble)*			
357.	20368	*Petrophile axillaris*			
358.	2286	*Petrophile brevifolia*			
359.	2299	*Petrophile linearis (Pixie Mops)*			
360.	2331	*Xylomelum occidentale (Woody Pear, Djandin)*			
Racopilaceae					
361.	32480	*Racopilum cuspidigerum var. convolutaceum*			
Ranunculaceae					
362.	2929	*Clematis pubescens (Common Clematis)*			
Restionaceae					
363.	1056	*Alexgeorgea nitens*			
364.	17833	*Chordifex microcodon*			
Rhamnaceae					
365.	15066	*Stenanthemum notiale subsp. chamelum*			
366.	11665	*Trymalium ledifolium var. ledifolium*			
Rutaceae					
367.	17665	*Boronia purdieana subsp. purdieana*			
368.	11381	*Boronia ramosa subsp. anethifolia*			
369.	4453	*Diplolaena angustifolia (Yanchep Rose)*			
370.	18529	*Philotheca spicata (Pepper and Salt)*			
371.	18547	*Rhadinothamnus anceps*			
Santalaceae					
372.	2344	*Leptomeria empetriformis*			
373.	2350	*Leptomeria pauciflora (Sparse-flowered Currant Bush)*			
Scrophulariaceae					

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
374.	7054	*Dischisma arenarium*	Y		
375.	7289	*Myoporum caprarioides (Slender Myoporum)*			
376.	7291	*Myoporum insulare (Blueberry Tree, boobialla)*			
Solanaceae					
377.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
378.		*Solanum physalifolium var. nitidibaccatum*			
379.	7037	*Solanum symonii*			
Stylidiaceae					
380.	7679	*Stylidium adpressum (Trigger-on-stilts)*			
381.	25831	*Stylidium araeophyllum (Stilt Walker)*			
382.	7693	*Stylidium brunonianum (Pink Fountain Triggerplant)*			
383.	7696	*Stylidium calcaratum (Book Triggerplant)*			
384.	7709	*Stylidium crossocephalum (Posy Triggerplant)*			
385.	7710	*Stylidium cygnorum*			
386.	11808	*Stylidium diuroides subsp. diuroides*			
387.	7717	*Stylidium divaricatum (Daddy-long-legs)*			
388.	25829	*Stylidium neurophyllum (Coastal Plain Triggerplant)*			
389.	25800	*Stylidium paludicola*		P3	
390.	7774	*Stylidium piliferum (Common Butterfly Triggerplant)*			
391.	7785	*Stylidium repens (Matted Triggerplant)*			
392.	7798	*Stylidium schoenoides (Cow Kicks)*			
Thymelaeaceae					
393.	5232	*Pimelea argentea (Silvery Leaved Pimelea)*			
394.	5237	*Pimelea calcicola*		P3	
395.	5244	*Pimelea floribunda*			
396.	5254	*Pimelea leucantha*			
Verbenaceae					
397.	6734	*Phyla nodiflora var. nodiflora*	Y		
Violaceae					
398.	5216	*Hybanthus calycinus (Wild Violet)*			
Xanthorrhoeaceae					
399.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

FID	PopId	Name	Taxon	ConsStatus	WARank	PopNumber	SubPop Code	Location	District	Vesting	Count Date	Method	Mature Count	LiveTotal	In Flower
292	86275	3237	*Acacia benthamii*	2		1		Lake edge, W of Lake Goollelal. Near Gavin Way and Astley Pl.	SWAN COASTAL	PRI	27652		0	0	N
4566	84935	1596	*Caladenia huegelii*	T	CR	22		On Neaves Rd, 6.65km E of Pinjar Rd, on N side of road, on crest of sand hill, ca 2-3m from edge of road cutting.	SWAN COASTAL	LGA	38274		0	0	N
4878	104572	45757	*Calectasia elegans*	2		1	A	Lot 205 Perry Rd, ca 300 m E of Perry Road in Chitty Road bushland (Bush Forever Site No. 398), Pinjar (City of Wanneroo)	SWAN COASTAL	SPC	38967	ACT_IND	9	9	Y
4879	104573	45757	*Calectasia elegans*	2		1	B	State Forest No 65, south of Population No 1A on Lot 205 Perry Rd; ca 270m east along Gallager Road then turn south for 170m.	SWAN COASTAL	CC	39010	ACT_IND	2	2	Y
5936	97141	1425	*Conostylis bracteata*	3		1	A	Vacant block, 47 Karalundie Way, Mullaloo, ca.1km inland. Shire of Joondalup.	SWAN COASTAL	LGA	31500		0	0	N
5937	97142	1425	*Conostylis bracteata*	3		1	B	PRI Lot.[18 previously 1506]. Kallaroo, 25km NNW of Perth; 50m SSW of Juno Cresent of the verge of Dampier Ave. Rendered Extinct by housing developement on August 17th. Shire of Joondalup.	SWAN COASTAL	PRI	31640		0	0	N
5938	97143	1425	*Conostylis bracteata*	3		1	C	Un-named Reserve (ID: 28819), Mullaloo, ca.1km inland, recreation reserve W of intersection of Waltham and Gunidia Streets. Shire of Joondalup. GIS coords.	SWAN COASTAL	LGA	31640		0	0	N
5941	84822	1425	*Conostylis bracteata*	3		4		UCL land. Remnant Banksia woodland (Block 9471), ca.2km S of Burns Beach Rd, E side of Lake Joondalup, Yellagonga Regional Park (all around Lake Joondalup). GIS coords.	SWAN COASTAL	NON	35740		0	0	N
6255	93212	16245	*Cyathochaeta teretifolia*	3		3		Shire Reserve (27279). E of Lake Gnagara, N edge, in System 6 Update quandrant gnan02 (System 6 Area M8, Bushforever Site 193).Wanneroo.	SWAN COASTAL	LGA	34634		0	0	N
6276	93209	16245	*Cyathochaeta teretifolia*	3		24		Gnangara-Moore River State Forest. Gnangara Mound. Wanneroo.	SWAN COASTAL	CC	37592		0	0	N
9227	94987	20162	*Fabronia hampeana*	2		2		Private Property. Lot 9022. Between Neerabup NP and suburb of Kinross. Wanneroo.	SWAN COASTAL	PRI	34591		0	0	N
9229	104266	20162	*Fabronia hampeana*	2		4	A	Private Property, Lot 9505. W side of Marmion Ave, Bushforever site 322. S of the proposed Tamala Park Development. [Ca. 900m S of junction of Marmion Ave & Neerabup Rd, then ca. 150m W].	SWAN COASTAL	PRI	39825		0	0	N
9232	104269	20162	*Fabronia hampeana*	2		4	D	Private Property, Lot 9504. Part of the proposed Tamala Park Development (central cell). E side of Marmion Ave. [Ca. 600-800m S of junction of Marmion Ave & Neerabup Rd, then ca. 80-370m E].	SWAN COASTAL	PRI	39825		0	0	N
11558	100789	11461	*Hibbertia spicata subsp. leptotheca*	3		4	A	Crown Reserve 47831. Burns Beach. From 300 to 900 m S of the Caravan Park (Burns Beach Rd). Sea cliff.	SWAN COASTAL	LGA	33137		0	0	Y
11559	100790	11461	*Hibbertia spicata subsp. leptotheca*	3		4	B	Crown Reserve 45122. Burns Beach. From 600 to 900 m S of the Caravan Park (Burns Beach Rd). From 0 to 300 m E of the W boundary of Swan Location M1722.	SWAN COASTAL	LGA	33137		0	0	N
11912	86874	4027	*Jacksonia sericea*	4		1		Lake Joondalup, Edgewater.	SWAN COASTAL	LGA	29174		0	0	N
11914	98915	4027	*Jacksonia sericea*	4		4	A	[PP Lot 805, previously 7898] W side of Joondalup Dr. 200 - 400 m S of Hodges Dr, Joondalup.	SWAN COASTAL	PRI	32869		0	0	N
11915	98916	4027	*Jacksonia sericea*	4		4	B	Between Joondalup Dr and Honeybush Dr, at 1.1 - 1.4 km S of Hodges Dr, Joondalup.	SWAN COASTAL	NON	32869		0	0	N
11916	98917	4027	*Jacksonia sericea*	4		4	C	[PP Lot 807, previously 7899] Between Joondalup Dr and Honeybush Dr, at 1.1 - 1.4 km S of Hodges Dr, Joondalup.	SWAN COASTAL	PRI	32869		0	0	N
11917	98919	4027	*Jacksonia sericea*	4		5	A	[Crown Reserve 43705], 500 m S of Burns Beach Rd at 3 km W of Wanneroo Rd. W side of the proposed route for the Northern Suburbs Railway.	SWAN COASTAL	RAI	32869		0	0	N
11918	98920	4027	*Jacksonia sericea*	4		5	B	700 - 900 m S of Burns Beach Rd at 3 km W of Wanneroo Rd. Between the proposed routes of the Mitchell Freeway and the Northern Suburbs Railway.	SWAN COASTAL	MRD	32869		0	0	N
11919	98921	4027	*Jacksonia sericea*	4		5	C	700 m S of Burns Beach Rd at 3 km W of Wanneroo Rd. E side of the proposed route for the Mitchell Freeway.	SWAN COASTAL	MRD	32869		0	0	N
11920	98922	4027	*Jacksonia sericea*	4		5	D	1 km S of Burns Beach Rd at 3 km W of Wanneroo Rd. E side of the proposed route for the Mitchell Freeway.	SWAN COASTAL	MRD	32869		0	0	N
11921	98923	4027	*Jacksonia sericea*	4		5	E	[Crown reserve 43705] 850 m S of Burns Beach Rd at 3 km W of Wanneroo Rd. W side of the proposed route for the Northern Suburbs Railway.	SWAN COASTAL	RAI	32869		0	0	N
11922	98924	4027	*Jacksonia sericea*	4		5	F	[Private Property lot 251] 1 km S of Burns Beach Rd at 3 km W of Wanneroo Rd. 200 m W of the proposed route for the Northern Suburbs Railway.	SWAN COASTAL	PRI	32869		0	0	N

FID	PopId	Name	Taxon	ConsStatus	WARank	PopNumber	SubPop Code	Location	District	Vesting	Count Date	Method	Mature Count	LiveTotal	In Flower
11924	98926	4027	*Jacksonia sericea*	4		7	A	Hepburn Heights, Padbury. N of Hepburn Ave, E of O'leary Rd, and S of the Reservoir. Bushland Preservation Reserve.	SWAN COASTAL	LGA	33184	ESTMT	750	750	N
11925	98927	4027	*Jacksonia sericea*	4		7	B	Hepburn Heights, Padbury. N of Hepburn Ave and E of the Reservoir. Bushland Preservation Reserve.	SWAN COASTAL	LGA	33184	ESTMT	250	250	N
11927	98929	4027	*Jacksonia sericea*	4		9	A	N verge of Ocean Reef Rd and on both sides of Joondalup Dr, from the intersection with Wedgewood Dr southwood.	SWAN COASTAL	LGA	32958	ESTMT	280	280	N
11928	98930	4027	*Jacksonia sericea*	4		9	B	NW corner of Ocean Reef Rd and Joondalup Dr, Woodvale.	SWAN COASTAL	PRI	33008	ESTMT	7200	7200	N
13261	95536	25819	*Marianthus paralius*	T	EN	2		Iluka Coastal Reserve 47831, Joondalup. Plants are located at approx. 575m and 870m south of Ocean Parade along the pedestrian path. Plants occur approx. 20m and 5m west of the dual-use path respectively.	SWAN COASTAL	LGA	39016	ACT_IND	9	0	Y
13399	110770	33022	*Melaleuca sp. Wanneroo (G.J. Keighery 16705)*	T	EN	2		Lot 8 Wattle Ave, Nowergup. Mid and upper slopes of the limestone ridge.	SWAN COASTAL	PRI	39545	ESTMT	100	0	Y
15150	103688	17543	*Sarcozona bicarinata*	3		1	A	Coastal Reserve 47831 [previously 20561]. 500 metres south at end of Burns Beach Rd [intersection with Ocean Pde].	SWAN COASTAL	LGA	33820		0	0	N
15151	103689	17543	*Sarcozona bicarinata*	3		1	B	[Crown Reserve 45122]. 500 metres south at end of Burns Beach Rd [intersection with Ocean Pde]. (On Locn M1722).	SWAN COASTAL	LGA	33820	ESTMT	0	25	Y

Taxon	Status	Rank	IUCNCriteria	EPBC	DPaWRegion	DPaW District	Distribution	Flowering Period	Recovery Plan
Acacia benthamii	2				SWAN	SWAN COASTAL	Wanneroo, Kings Park, Stake Hill		
Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1				SWAN	SWAN COASTAL	Wanneroo, North Beach, Scarborough, Yanchep, Marmion		
Calectasia elegans	2				SWAN	SWAN COASTAL	Pinjar (Wanneroo)	Jul-Oct	
Conostylis bracteata	3				SWAN	SWAN COASTAL	Mullaloo, Breton Bay, Guilderton, Yanchep	Jul,Aug	
Cyathochaeta teretifolia	3				SWAN,WARR	FRANKLAND,SWAN COASTAL	Whiteman Park, Lake Gnangara, Ellenbrook, Muchea, Denbarker, Yelverton, Wellard, Mundijong	Dec	
Dasymalla axillaris	T	CR	C1+C2a(i)b	CR	MWST,SWAN,WHTB	GERALDTON,SWAN COASTAL,CENTRAL WHEATBELT	Pithara, Morawa, Lake Moore, Gnangara, Wongan Hills, Maya, Caron, Buntine, Latham, Perenjori	Jul-Oct	IRP
Drosera patens	1				SWAN	SWAN COASTAL	Wanneroo		
Drosera x sidjamesii	1				SWAN	SWAN COASTAL	Gnangarra, Wanneroo, Beechboro	Nov-Mar	
Grevillea sp. Ocean Reef (D. Pike Joon 4)	1				SWAN	SWAN COASTAL	Ocean Reef	Nov	
Hibbertia spicata subsp. leptotheca	3				MWST,SWAN,SWST	MOORA,SWAN COASTAL,WELLINGTON	Yalgorup, Lancelin, Burns Beach, Cataby		
Jacksonia sericea	4				SWAN	SWAN COASTAL	Wanneroo, Trigg, Perth, Karrinyup, Mandurah-Pinjarra, Neerabup NPk, Ardross, Stakehill, Singleton	Oct-Jan	
Lecania turicensis var. turicensis	2				SWAN	SWAN COASTAL	Yanchep N.P., Burns Beach, Eastern States		
Leucopogon maritimus	1				SWAN	SWAN COASTAL	Burns Beach, Yanchep, Two Rocks	Apr	
Leucopogon sp. Yanchep (M. Hislop 1986)	3				SWAN	SWAN COASTAL	Yanchep N.P., Gnangarra-Moore River S.F., Neerabup N.P.	Apr-Jun, Sep	
Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C1		SWAN	SWAN COASTAL	Wanneroo	Dec	
Pimelea calcicola	3				SWAN	SWAN COASTAL	Yanchep N.P., Burns Beach, Yalgorup N.P., Rockingham, Henderson, Beaconsfield	Sep-Nov	
Sarcozona bicarinata	3				SCST,SWAN	ESPERANCE,SWAN COASTAL	Hepburn Heights, Burns Beach, Wanneroo, Yanchep, Seabrid, Espereance, Guilderton, S. Aust,		
Schoenus griffinianus	4				MWST,SWAN,WHTB	MOORA,GERALDTON,SWAN COASTAL,CENTRAL WHEATBELT	Eneabba, Wongan Hills,Greenough, Chittering, Hazelmere, Wanneroo	Oct-Nov	
Styphelia filifolia	3				MWST,SWAN,SWST	MOORA,SWAN COASTAL,WELLINGTON	Eneabba, Bullsbrook, WAttle Grove, Huntingdale, Leeming, Boonanarring N.R., Wanneroo, Keysbrook	Mar-May	
Tetraria sp. Chandala (G.J. Keighery 17055)	2				SWAN	SWAN COASTAL	Gingin, Wanneroo, Muchea		

FID	Sheet	Name	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Locality	Geo	Precision	Date
683	8598320	3237	*Acacia benthamii*	2	Spindly shrub, 1 m high x 0.5 m wide.	Consolidated sand dune (Quindalup - Spearwood Dunes boundary). Light brown sand, leaf litter over Tamala Limestone. Area burnt > 5 years ago.	Woodland of Banksia menziesii, B. attenuata, Eucalyptus marginata, Allocasuarina fraseri (FCT 28). Associated species: Hibbertia hypericoides, Jacksonia sternbergiana, Opercularia vaginata, Orthrosanthus laxus var. laxus, Ricinocarpus glaucus, Schoenus c	2 plants only.	Hepburn Heights Bushland Padbury, N boundary	GPS	1	09-09-13
685	920320	3237	*Acacia benthamii*	2					E [of] Wanneroo	AUTO	3	23-09-65
687	169579	3237	*Acacia benthamii*	2		Sand.			Woodville [Almost surely Woodvale in W.A.: R.S. Cowan].	MAN	1	/09/1901
694	718297	3237	*Acacia benthamii*	2					East Wanneroo	AUTO	3	23-09-65
698	7622090	3237	*Acacia benthamii*	2		Flat, sand.	Areas of degraded - modified remnant jarrah woodland and weed dominated areas.		Kingsway Sporting Complex, Hepburn Avenue, Madeley, City of Wanneroo	UNK	2	22-11-05
709	703656	3237	*Acacia benthamii*	2					Wanneroo	MAN	0	/09/1975
6397	8497257	11957	*Anigozanthos humilis subsp. chrysanthus*	4	In flower.	Crest - upper slope with grey sand.	Associated species: Pinus pinaster, Eucalyptus todtiana, Adenanthos cygnorum, Nuytsia floribunda, Alexgeorgea nitens, Hibbertia subvaginata, Scholtzia involucrata.		Gnangara pine plantation	GPS	1	16-09-05
7481	5166071	35317	*Austrostipa mundula*	3			Tuart woodland.		Yanchep Road,	AUTO	4	/08/1963
7735	8443122	34161	*Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*	1	Erect shrub 1 m high x 1 m wide.	Limestone outcrop/ridge. Yellow sand. Sand derived from Tamala Limestone - Spearwood Dune System. Limetone. Burnt 5+ years.	Heath thickets in good condition. Banksia sessilis var. cygnorum, Spyridium globulosum, Acacia rostellidera, Calothamnus quadrifidus, Melaleuca systena, Hibbertia hypericoides, Lechenaultia linarioides, Conostylis candicans subsp. candicans, Pelargonium	widespread on limestone, 100+ plants.	Edgewater Quarry, bound by Joondalup Drive, Treetop Avenue and Regatta Drive, City of Joondalup	GPS	1	17-09-12
7737	3378632	34161	*Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*	1	Open shrub 1 m high. Flowers white.	Soil - sand (dry).			Trichet Road, Wanneroo	AUTO	3	09-12-81
7739	3378640	34161	*Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*	1	Tall compact-straggly shrub, 2 m high. Flowers white.	Grey sand. Hill side.	Banksia woodland.		Trischett Road, SW of Jandabup Lake, Wanneroo	MAN	0	21-12-81
7746	3416089	34161	*Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*	1					Wanneroo	AUTO	3	/11/1901
12050	255947	1596	*Caladenia huegelii*	T					Gnangara,	MAN	3	19-09-45
12488	7215363	45757	*Calectasia elegans*	2	Herbaceous perennial shrub ca 40 cm x 50 cm in height with multiples stems and stilted roots. Flowers blue and fading to white.	On gentle slope above dampland, deep grey quartz sand. Last fire ca 20-30 years ago.	Banksia menziesii - Banksia attenuata - Banksia woodland (30-50% cover < 6m in height) over Regelia inops (2-10% cover <1.2 m in height) mixed low shrubs (10- 30% cover <0.5 m in height) rushes, sedges, perennial monocots (10-30%) and herbs-grasses (2-10	only two plants found.	ca 300 m E of Perry Road in Chitty Road bushland (Bush Forever Site No. 398), Pinjar (City of Wanneroo)	GPS	1	08-11-05
12489	8008213	45757	*Calectasia elegans*	2	Small compact shrub to 30 cm high and 30 cm wide. mature fruit present.	Flat to gentle slope. Grey sand.	With Banksia attenuata, Banksia menziesii, Stirlingia latifolia.		Ca 300 m E of Perry Road within Chitty Road Nature Reserve. Pinjar, City of Wanneroo	GPS	1	11-12-08
14991	2052121	1425	*Conostylis bracteata*	3	Loosely tufted herb, leaves in flattened fascicles, margins with white appressed to spreading plumose hairs.	Swale in undulating consolidated dunes, some outcropping limestone.	In coastal scrub of Dryandra sessilis, Acacia saligna, A. xanthina, Xanthorrhoea preissii, Banksia attenuata, Melaleuca acerosa.		Mullaloo, c. 1 km inland, recreation reserve W of intersection of Waltham and Gunida Streets	AUTO	3	16-08-86
14992	2052091	1425	*Conostylis bracteata*	3	Proliferous herb, leaves with hirsute, not spinescent margins.	On steep slope of consolidated sand dune.	Overlooking Blackboy Reserve, Acacia saligna scrub over dense low heath to 1m, on fringes of remnant tuart (Eucalyptus gomphocephala) woodland. Associated species include Xanthorrhoea and Banksia attenuata.		Vacant block, 47 Karalundie Way, Mullaloo, c. 1 km inland	MAN	0	29-03-86
14993	5305691	1425	*Conostylis bracteata*	3	Perennial herb, flowers yellow.	Plain near lake. Grey sand.	Jarrah with Banksia attenuata, B. menziesii, Burchardia congesta, Hibbertia hypericoides, Acacia spp., Ehrharta calycina.	occasional.	Remnant Banksia woodland (Block 9471), ca 2 km S of Burns Beach Road, E side of Lake Joondalup, Yellagonga Regional Park,	MAN	0	06-11-97
14995	5931436	1425	*Conostylis bracteata*	3		Top of sand dune.			Mullaloo	MAN	3	19-11-62

FID	Sheet	Name	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Locality	Geo	Precision	Date
14997	1744321	1425	*Conostylis bracteata*	3	Loosely tufted herb to 80 cm diameter; leaf margins with white plumose appressed hairs <1 mm long; perianth 10-12 mm long, pale yellowish green outside, golden yellow inside tube, lobes cream inside, becoming golden yellow at base and near apex, conspicu	E slopes of a consolidated sand dune.	Low heath of Acanthocarpus preissii, Acacia lasiocarpa.		Kallaroo, 25 km NNW of Perth; 50 m SSW of Juno Crescent on the verge of Dampier Avenue	MAN	0	16-08-86
15700	4098374	16245	*Cyathochaeta teretifolia*	3	Perennial herb up to 2 m tall, clumped.	On grey sandy clay on seasonally wet slope beside permanent lake.	In Melaleuca preissiana and Eucalyptus rudis Open Low Woodland A over Aotus gracillima and Astartea aff. fascicularis Heath A over Herbs, Very Open Tall Sedges and Open Low Sedges.		Site 02, Gnangara	MAN	0	//
15717	4097394	16245	*Cyathochaeta teretifolia*	3	Perennial herb up to 2 m tall, clumped.	On grey sandy clay on seasonally wet slope beside permanent lake.	In Melaleuca preissiana and Eucalyptus rudis Open Low Woodland A over Aotus gracillima and Astartea aff. fascicularis Heath A over Herbs, Very Open Tall Sedges and Open Low Sedges.		Site 02, Gnangara	MAN	0	//
15721	2076802	16245	*Cyathochaeta teretifolia*	3	Tall grass like plant 1 m high.	In peat swamp.			8.38 km N along Galacher Road off Neeves Road	MAN	0	07-02-80
15723	4654773	16245	*Cyathochaeta teretifolia*	3	Perennial herb up to 2 m tall, clumped.	On grey sandy clay on seasonally wet slope beside permanent lake.	In Melaleuca preissiana and Eucalyptus rudis Open Low Woodland A over Aotus gracillima and Astartea aff. fascicularis Heath A over Herbs, Very Open Tall Sedges and Open Low Sedges.		Site 02, Gnangara	MAN	0	//
15731	6427774	16245	*Cyathochaeta teretifolia*	3	Tufted perennial herb, flowers straw colour.	Damp margin of lake, flat ground, grey sand with clay, poor drainage, wet during winter/spring.	Open Low Woodland A. Associated species: Melaleuca preissiana, Eucalyptus rudis.		E of Lake Gnangara in System 6 Update quadrat gnan02 (System 6 Area M8, Bush Forever Site 193)	GPS	1	27-10-94
15734	6808077	16245	*Cyathochaeta teretifolia*	3	Grass like or sedge.		Low forest, Melaleuca preissiana, Astartea fascicularis, Hypocalymma angustifolium, Banksia littoralis.		Gnangara Mound	MAN	3	02-12-02
16094	8190518	7485	*Dampiera triloba*	3		Loamy sand.	Melaleuca priessiana, Corymbia calophylla to 9.0 m, 5% cover, over Astartea scoparia to 2.1 m, 25% cover, over Hypocalymma angustifolia to 1.0 m, 40% cover, over Patersonia occidentalis, Hypochaeris glabra, Trachymene pilosa to 0.7 m, 10% cover, Lepidosp		Crown Reserve 8399, Lake Gnangara Park, 30 m W towards lake from track, 900 m N of a point in the recreation area 630 m N of intersection of Gnangara Road and Alexander Drive Gnangara, 7.5 km SE of Wanneroo, GSS site GN1	GPS	1	24-09-09
16102	2554682	7485	*Dampiera triloba*	3					Gnangara	AUTO	3	/10/1945
16103	8138869	7485	*Dampiera triloba*	3	Erect perennial.	Loamy sand.	Melaleuca preissiana, Corymbia calophylla to 9 m, 5% cover, astartea scoparia to 2.1 m, 25% cover, Hypocalymma angustifolia to 1 m, 40% cover, Patersonia occidentalis, Hypochaeris glabra, Trachymene pilosa to 0.7 m, 10% cover, Lepidosperma striatum to 1.		Crown Reserve 8399, Lake Gnangara Park, 30 m W towards lake from track, 900 m N of a point in the recreation area, 630 m N of intersection of Gnangara Road and Alexander Drive, Gnangara, 7.5 km SE of Wanneroo, GSS site GN1	GPS	1	28-09-08
18420	7881282	31233	*Drosera patens*	1					Lake Gnangarra	GPS	1	31-01-92
18421	7881312	31233	*Drosera patens*	1					Pinjar Road, Wanneroo	UNK	2	19-11-91
18422	7881274	31233	*Drosera patens*	1	Fibrous rooted perennial herb with a solitary, compact leafy rosette, 1.8-2.5 cm diam.	On the margin of swamps, lakes and winter wet depression in sandy soils.			NW shore of Lake Gnangarra	GPS	1	17-01-98
18453	8723303	30712	*Drosera x sidjamesii*	1		Grows on the northern margins of lake.			Lake Gnangarra, Wanneroo	GPS	1	05-02-85
18454	7579101	30712	*Drosera x sidjamesii*	1					Pinjar Road, Wanneroo	GPS	1	04-12-84
18455	7579152	30712	*Drosera x sidjamesii*	1					Shores of Lake Gnangarra [Gnangara]	UNK	2	17-01-98
18456	7881525	30712	*Drosera x sidjamesii*	1					Pinjar Road, Wanneroo	UNK	2	04-12-84
18457	7881533	30712	*Drosera x sidjamesii*	1					Shores of Lake Gnangarra, N of Perth	UNK	2	17-01-98
18458	7881517	30712	*Drosera x sidjamesii*	1	A natural hybrid, firbous rooted perennial herb.	On margins of swamps, lakes and winter wet depressions in sandy soil.			Northern shores of Lake Gnangarra	UNK	2	31-03-92
20303	4110544	13091	*Eucalyptus argutifolia*	T	Mallee to 3 m.	Dune slope, grey sand over limestone.	Mallee, Eucalyptus petrensis over heath.	rare in area.	Mindarie South, 30 km N of Perth	AUTO	3	22-04-91
20310	2160765	13091	*Eucalyptus argutifolia*	T		Slight gully situation nestles between two limestone ridges. Sand/boulder/brown/ yellow/dry/limestone.	Completely open and treeless with dense scrubland. Dryandra's nivea/ sessilus, Hakea trifurcata, Melaleuca huegelii, Blackboys (Xanthorrhoea preissii), Templetonia retusa.	32 clumps.	Quarry Reserve 5204, 250 m from junction of Myrtle road and 380 m at 195 deg.	MAN	0	15-11-91

FID	Sheet	Name	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Locality	Geo	Precision	Date
20311	2117223	13091	*Eucalyptus argutifolia*	T		Slight gully situation nestled between two limestone ridges. Limestone/boulder/ sand/brown/yellow/dry.	Completely open & treeless with dense scrubland. Dryandra's nivea/ sessilus, Hakea trifurcata, Melaleuca huegelii, Blackboys (Xanthorrhoea preissii), Templetonia retusa.	32 clumps, undisturbed.	Quarry Reserve 5204, 250 m from the junction of Myrtle road and 380 m at 195 deg. to rare mallees	MAN	0	15-11-91
23890	5939658	20162	*Fabronia hampeana*	2	Fertile moss.	On trunk of Macrozamia.	Emergent large Banksia over Macrozamia, Hibbertia, Xanthorrhoea, grasses, weeds and thick Dryandra regrowth.		Between Neerabup National Park and developing suburb of Kinross, 28 km NNW of Perth	MAN	3	14-09-94
28504	8422710	33737	*Grevillea sp. Ocean Reef (D. Pike Joon 4)*	1	Erect, spreading shrub. To 1.5 m x 3 m.	Sand dune. Dry brown / grey sand.	Coastal sand scrub with Acacia, Banksia sessilis, Spiridium globulosum, Clematis, Calothamnus, Pelargonium, Dianella, Hardenbergia.	40 - 60 plants (D. Pike November 2008).	Ocean Reef Road, Ocean Reef	GPS	1	15-08-12
28505	8509603	33737	*Grevillea sp. Ocean Reef (D. Pike Joon 4)*	1	Compact perennial shrub 150 cm high x 200-300 cm wide.	Broad dune swails. Grey shallow sand. Numerous limestone boulders.	Acacia rostilifera, Conostylis sp., Tetraria octandra, Spyridium globulosum, Acanthocarpos preissii, Desmocladus flexuosus, Phyllanthus calycinus, Dianella revoluta, Lepidosperma sp., Banksia sessilis, Clematis sp., Hardenbergia comptoniana, Rhagodia bac	26-50 plants plus additional 6-10 juveniles within 40 m radius.	Bush Forever Site 325, bounded by Boat Harbour Quay and Ocean Reef Road in Ocean Reef	GPS	1	16-10-13
28506	8422605	33737	*Grevillea sp. Ocean Reef (D. Pike Joon 4)*	1	Erect, spreading shrub - clonal. To 1.5 m x 3 m.	Sand dune / gully. Dry brown / grey sand.	Coastal sand scrub with Acacia, Banksia sessilis, Spiridium globulosum, Clematis, Calothamnus, Pelargonium, Dianella, Hardenbergia.	40 - 60 plants (D. Pike November 2008).	Ocean Reef Road, Ocean Reef: between the boat harbour and Ocean Reef Road	GPS	1	06-09-12
28507	7860579	33737	*Grevillea sp. Ocean Reef (D. Pike Joon 4)*	1	Dense, spreading shrub to 2 m high x 3 m wide. Plants in late flower.	Quindalup dunes. Dry, bare, light yellow-brown sand.	Tall shrubland. With Acacia rostellifera, Dryandra sessilis, Spyridium globulosum.	One apparently clonal population of 40-60 plants.	Ocean Reef, suburb of Perth	GPS	1	/11/2008
30709	3096424	11461	*Hibbertia spicata subsp. leptotheca*	3	Domed green shrub, to 30 cm x 40 cm. Flowers yellow, reflexed over sepals when in flower. In full flower.	Sea cliff. Grey-black sand over limestone.	Low Melaleuca cardiophylla closed heath.		Burns Beach; 26 km N of Perth	AUTO	3	21-09-90
32328	1131192	4027	*Jacksonia sericea*	4	Prostrate shrub, 50 cm x 1.5 m diam. Flowers orange-yellow; eye yellow.	Hilltop, sand over limestone.	Banksia low woodland.		Ocean Reef Road, Wanneroo, 30 km N Perth	MAN	3	20-01-88
32329	5437806	4027	*Jacksonia sericea*	4	Prostrate shrub 0.1 m high, 1 m wide; sterile.	Side of Spearwood Dune, grey sand over deep yellow sand.	Banksia attenuata and B. menziesii woodland.	scattered.	Bushplan Site 463, ca 1 km W of Gnangara Road in bushland W of Sydney Road	AUTO	3	15-06-99
32337	2171449	4027	*Jacksonia sericea*	4	Low spreading shrub to .3 m high. Brown pods.	In yellowish/brown sand on low ground.	In open woodland over low heath and disturbed areas, with Banksia attenuata, B. menziesii, Gomphlobium aristatum, Xanthorrhoea sp., Eucalyptus gomphocephalum.		NW corner of Ocean Reef road and Joondalup Drive, Woodvale	MAN	0	15-05-90
32338	1131176	4027	*Jacksonia sericea*	4	Low spreading shrub 0.5 m high.	Highly disturbed.	Highly disturbed Tuart/Jarrah forest.		Lake Joondalup (Edgewater)	MAN	3	/11/1979
32347	6410731	4027	*Jacksonia sericea*	4		Slope/flat. Dry grey sand over limestone.	Eucalyptus marginata, Banksia attenuata, B. menziesii Woodland. Associated species: Banksia attenuata, B. grandis, Allocasuarina fraseriana, Dryandra sessilis, Calothamnus sp.		Lot 21, Flynn Drive, Neerabup, Shire of Wanneroo	MAN	3	/07/2001
32349	6730620	4027	*Jacksonia sericea*	4	Shrub 30-60 cm high x 1 m wide. Perennial, prostrate, dense spreading. Flowers orange.	Hillside. Dry sand. Old soil disturbance.	Tuart, Banksia, Allocasuarina woodland.	over 50 plants, quite widespread.	Periwinkle Park, Periwinkle Road, Mullaloo	MAN	3	14-10-02
32366	8001189	4027	*Jacksonia sericea*	4	Spreading shrub 0.3 m wide with orange flowers.	Residential plain with grey sand.	Low trees and low shrubland with Eucalyptus marginata, Banksia attenuata, Adenanthos cygnorum, Xanthorrhoea preissii, Calytrix fraseri, Mesomelaena pseudostygia, Laxmannia squarrosa, Waitzia suaveolens, Corynotheca micrantha, Alexgeorgea nitens, Conosper	2 - 5.	Directly N of Gnangara Road, Landsdale (approximately 17 km N of Perth)	GPS	1	12-11-08
32367	8148511	4027	*Jacksonia sericea*	4	50 cm.	Slope. Recently burnt.	Woodland. With Eucalyptus marginata, Allocasuarina fraseriana, Banksia menziesii, Banksia attenuata, Ehrharta calycinus, Hibbertia hypericoides.	6-20 plants.	End of Carmignani Road in Gnangara	GPS	1	22-10-07
33544	2973499	31312	*Lecania turicensis var. turicensis*	2		Coastal rocks, limestone.			Burns Beach, N of Perth	AUTO	3	28-08-88
34890	6210082	40801	*Leucopogon maritimus*	1					Burns - Mullaloo	MAN	3	27-06-66
36096	8386811	25819	*Marianthus paralius*	T		Well drained dry white sand. Limestone ridge. Fire history: long ago.	Melaleuca cardiophylla, Scaevola crassifolia, Olearia axillaris, Rhagodia baccata Closed Low Heath.		Dual use path & north of Silver Sands Drive, Joondalup	TOPO	3	29-12-10
36100	7782144	25819	*Marianthus paralius*	T	Prostrate shrub with red flowers.	Limestone cliff with dry, brown sand. Exposed limestone outcropping.	Dense Heath B. Coastal heath vegetation including Spyridium sp., Thomasia sp., Melaleuca sp., Scaevola sp., Acanthocarpus sp.	9 plants recorded.	Iluka foreshore reserve, Iluka R47831, plants are located approx 575 m and 870 m S of Ocean Parade along the pedestrian path	GPS	1	26-10-06
39423	3409171	5237	*Pimelea calcicola*	3	Shrub-like herb up to 18 inches high. Flowers pale mauve.		Heathland.		N of Wanneroo	AUTO	3	16-10-62
39432	3409341	5237	*Pimelea calcicola*	3	Shrub to 2.5 ft. Flowers light pink-white.	Sand-limestone.			Burns Beach Road (Quarry)	AUTO	3	27-09-68

FID	Sheet	Name	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Locality	Geo	Precision	Date
39433	1812130	5237	*Pimelea calcicola*	3	Slender erect shrub, to 60 cm. Flowers deep pink to very pale pink. In full flower.	Low hill. Shallow grey sand over massive limestone.	Dryandra sessilis closed heath.		Hepburn Heights; Wanneroo, 25 km N of Perth	AUTO	3	07-11-90
40051	8766185	42022	*Poranthera moorokatta*	2	Small herb, 1 cm high.	Crest of low dune with yellow sand (ant mounds). Greater than 10 years since a fire.	Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana low woodland over Xanthorrhoea preissii open shrubland over Hibbertia hypericoides, Calothamnus sanguineus, Calytrix flavescens low shrubland over Mesomelaena pseudostygia scattered sedges.		Corner of Joseph Banks Boulevard and Woolly Drive, Banksia Grove, 33 km N of Perth CBD	GPS	1	25-10-12
41645	4583744	17543	*Sarcozona bicarinata*	3	Herbaceous succulent 8 cm high and spreading to generally less than 30 cm across the ground. Leaves dull grey, green in colour; seeds brown and rough all over.	Grey sand over rocky limestone outcrops. Exposed sunny areas.	Edge of Dryandra sessilis (Parrot Bush) heathlands and cleared area for housing.		Iluka-Beaumaris Estate near Sales Office, 100 m N of Miami Beach Promenade, Location B (refer to map attached)	AUTO	3	02-03-97
41646	4583736	17543	*Sarcozona bicarinata*	3	Herbaceous succulent 8 cm high and spreading to generally less than 30 cm across the ground. Leaves dull grey, green in colour; seeds brown and rough all over.	Grey sand over rocky limestone outcrops. Exposed sunny areas. Fire approximately 12 months prior to collection. The fire most probably stimulates seed germination and opens up the very dense Dryandra heath providing a sunny environment for this species t	Dryandra sessilis (Parrot Bush) heathlands.		Iluka-Beaumaris Estate (near Burns Beach), track off Burns Beach Road, Location A (refer to map attached)	AUTO	3	02-03-97
41902	4526422	17606	*Schoenus griffinianus*	4	Perennial sedge.	Soil: White sand. Topography/drainage: Well drained gentle SW facing slope. Geomorphology: Bassendean sands over guildford formation.	Vegetation: Banksia attenuata Open Low Woodland A over mixed Low Heath C over mixed Open Dwarf Scrub D over Lyginia barbata Very Open Low Sedges.		Melaleuca Park conservation area, N Cooper Rd, 12 km NE of Wanneroo (plot mela-8).	GPS	1	19-10-93
43449	7526989	19704	*Stenanthemum sublineare*	2		Low rise on an undulating plain. Dry, grey sand. Unburnt for 20 + years.	Open Banksia attenuata/Banksia menziesii low woodland, over heath (Beaufortia elegans, Eremaea pauciflora subsp. pauciflora, Regelia inops) Caltyrix flavescens, Scholtzia involucrata, Bossiaea eriocarpa, Gompholobium tomentosum, Petrophile linearis, over	one plant.	Proposed Nerrabup Infilitration site, SE of Lake Pinjar, E of Wanneroo Golf Club, adjacent to Bush Forever site 398	GPS	1	17-11-05
44315	8540942	25800	*Stylidium paludicola*	3		Sandy flats near winter-wet damplands.	Low woodland of marri and Banksia grandis over Baumea juncea sedgeland and mixed open heath adjacent to Melaleuca preissiana and Banksia littorea woodland.		Edith Cowan University campus, Joondalup, Perth	MAN	3	//2007
45013	8604223	48297	*Styphelia filifolia*	3		On brown sand on midslopes.	Woodland of Banksia attenuata, B. menziesii, B. ilicifolia over Heath dominated by Allocasuarina humilis.		Near Pinjar Powerstation	UNK	2	11-09-07
45015	2997290	48297	*Styphelia filifolia*	3					Melaleuca Park	AUTO	3	11-06-78
45017	1016539	48297	*Styphelia filifolia*	3	Erect shrub to 50 cm.	Sandy soil.			8.38 km N along Galagher Road, Wanneroo	TOPO	3	07-02-80
46504	4864743	35581	*Tetraria sp. Chandala (G.J. Keighery 17055)*	2	Rhizomatous herb 1.6 m high, 1 m wide; flowers brown; fruits brown.	Mound spring, black peat over clay & humic sand.	Assoc. vegn.: Melaleuca rhaphiophylla forest over sedges.		Property on W side of Neaves Road, Wanneroo	MAN	0	04-02-97
46992	278696	1717	*Thelymitra variegata*	2	Petals purple, spotted. Sepals orange, purplish in the centre, with reddish-purple spots. Column purple with orange wings.	On limestone hills towards the coast.			Wanneroo	AUTO	3	/09/1919

APPENDIX F

Flora Likelihood Assessments

FAMILY	SPECIES	CONSERVATION CODES DBCA	EPBC	NM	PMST	DBCA	DISTANCE TO CLOSEST RECORD	HABITAT INFORMATION	LIKELIHOOD OF OCCURRENCE
Ericaceae	*Andersonia gracilis*	T	EN		X		32.8	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Low
Orchidaceae	*Caladenia huegelii*	T	EN		X	X	7.08	Grey or brown sand, clay loam.	Low
Orchidaceae	*Diuris purdiei*	T	EN		X		32.77	Grey-black sand, moist. Winter-wet swamps.	Low
Orchidaceae	*Drakaea elastica*	T	EN		X		41.23	White or grey sand. Low-lying situations adjoining winter-wet swamps.	Low
Cyperaceae	*Lepidosperma rostratum*	T	EN		X		34.78	Peaty sand, clay.	Low
Pittosporaceae	*Marianthus paralius*	T	EN	X	X	X	8.69	White sand over limestone. Low coastal cliffs.	Low
Myrtaceae	*Melaleuca* sp. Wanneroo (G.J. Keighery 16705)	T	EN			X	9.5	Yellow/Brown/ Grey/ Black sand. Limestone outcropping.	Medium
Orchidaceae	*Thelymitra dedmaniarum*	T	EN		X		23.69	Slope, brown, dry sand/clay/gravel over granite/boulder.	Low
Haemodoraceae	*Anigozanthos viridis subsp. terraspectans*	T	VU		X		66.95	Grey sand, clay loam. Winter-wet depressions.	Low
Orchidaceae	*Diuris micrantha*	T	VU		X		52	Brown loamy clay. Winter-wet swamps, in shallow water.	Low
Orchidaceae	*Drakaea micrantha*	T	VU		X		38.62	White-grey sand.	Low
Cyperaceae	*Eleocharis keigheryi*	T	VU		X		18.03	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Low
Myrtaceae	*Eucalyptus argutifolia*	T	VU				8.39	Shallow soils over limestone. Slopes or gullies of limestone ridges, outcrop	Low
Myrtaceae	*Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425)	P1		X		X	1.74	Sand over limestone.	High
Droseraceae	*Drosera patens*	P1				X	6.37	Sandy soils. Margins of winter-wet depressions, swamps and lakes.	Low
Droseraceae	*Drosera x sidjamesii*	P1				X	6.37	Peaty sand. Along lake margins, close to winter high-water line.	Low
Proteaceae	*Grevillea* sp. Ocean Reef (D. Pike Joon 4)	P1				X	8.07	Sand dune / gully. Dry brown / grey sand.	Low
Ericaceae	*Leucopogon maritimus*	P1				X	9.4	Upper slopes of coastal dunes. Dry pale yellow sand.	Low
Fabaceae	*Acacia benthamii*	P2		X		X	1.74	Sand. Typically on limestone breakaways.	Low
Dasypogonaceae	*Calectasia elegans*	P2				X	7.02	Grey Sand	Medium
Fabroniaceae	*Fabronia hampeana*	P2				X	6.09	limestone outcrops, yellow sand, growing on other plants, often in association with Macrozamia reidlei	Low
Ramalinaceae	*Lecania turicensis var. turicensis*	P2				X	9.42	on coastal rocks and limestone (lichen)	Low
Phyllanthaceae	*Poranthera moorokatta*	P2		X			1.74	White silica sand in open spaces between shrubs, shallow dampland on mixed grey and white sand with scattered leaf litter	Low
Rhamnaceae	*Stenanthemum sublineare*	P2				X	8.06	Littered white sand. Coastal plain.	Medium

FAMILY	SPECIES	CONSERVATION CODES DBCA	EPBC	NM	PMST	DBCA	DISTANCE TO CLOSEST RECORD	HABITAT INFORMATION	LIKELIHOOD OF OCCURRENCE
Cyperaceae	*Tetraria sp. Chandala (G.J. Keighery 17055)*	P2		X		X	1.72	Grey brown peaty soil.	Low
Orchidaceae	*Thelymitra variegata*	P2		X		X	1.74	Sandy clay, sand, laterite.	High
Poaceae	*Austrostipa mundula*	P3		X		X	4.26	Grey sand over limestone.	High
Haemodoraceae	*Conostylis bracteata*	P3		X		X	2.4	Sand, limestone. Consolidated sand dunes.	High
Cyperaceae	*Cyathochaeta teretifolia*	P3		X		X	3.61	Grey sand, sandy clay. Swamps, creek edges.	Low
Goodeniaceae	*Dampiera triloba*	P3				X	7.07	Damp peaty-loamy sand.	Low
Dilleniaceae	*Hibbertia spicata subsp. leptotheca*	P3				X	8.62	Sand. Near-coastal limestone ridges, outcrops & cliffs.	Low
Thymelaeaceae	*Pimelea calcicola*	P3		X		X	1	Sand. Coastal limestone ridges.	High
Aizoaceae	*Sarcozona bicarinata*	P3				X	8.61	White Sand	Medium
Stylidiaceae	*Stylidium paludicola*	P3		X		X	4.58	Peaty sand over clay. Winter wet habitats.	Low
Ericaceae	*Styphelia filifolia*	P3		X		X	1.19	Whiter / brown / yellow sand.	High
Haemodoraceae	*Anigozanthos humilis subsp. chrysanthus*	P4				X	7.71	Grey or yellow sand.	Medium
Fabaceae	*Jacksonia sericea*	P4		X		X	3.38	Calcareous & sandy soils.	Recorded
Cyperaceae	*Schoenus griffinianus*	P4				X	9.76	White sand.	Medium

APPENDIX G

Species List

Complete Species List

FAMILY	SPECIES
Asparagaceae	*Thysanotus dichotomus*
Asteraceae	**Sonchus oleraceus*
Campanulaceae	**Wahlenbergia capensis*
Carpobrotus edulis	**Carpobrotus edulis*
Caryophyllaceae	**Petrorhagia dubia*
Casuarinaceae	*Allocasuarina fraseriana*
Cyperaceae	*Gahnia trifida*
Cyperaceae	*Mesomelaena pseudostygia*
Dilleniaceae	*Hibbertia hypericoides*
Ericaceae	*Leucopogon nutans*
Euphorbiaceae	**Euphorbia terracina*
Euphorbiaceae	**Ricinus communis*
Fabaceae	**Acacia iteaphylla*
Fabaceae	*Gompholobium tomentosum*
Fabaceae	*Jacksonia sericea* (P4)
Fabaceae	*Kennedia prostrata*
Fabaceae	*Hardenbergia comptoniana*
Fabaceae	*Jacksonia sternbergiana*
Geraniaceae	**Pelargonium capitatum*
Hemerocallidaceae	*Dianella revoluta*
Iridaceae	**Gladiolus caryophyllaceus*
Iridaceae	**Watsonia meriana var. bulbillifera*
Myrtaceae	*Chamelaucium uncinatum (planted)*
Myrtaceae	*Eucalyptus marginata*
Onagraceae	**Oenothera stricta*
Oxalidaceae	**Oxalis pes-caprae*
Poaceae	**Aira caryophyllea*
Poaceae	**Avena barbata*
Poaceae	**Briza maxima*
Poaceae	**Bromus diandrus*
Poaceae	**Cynodon dactylon*
Poaceae	**Ehrharta calycina*
Poaceae	**Eragrostis curvula*
Proteaceae	*Adenanthos cygnorum*
Proteaceae	*Banksia grandis*
Zamiaceae	*Macrozamia riedlei*

APPENDIX H

Vegetation Condition Scale

Vegetation Condition Scale (Environmental Protection Authority, 2016)

VEGETATION CONDITION	SOUTH WEST AND INTERZONE BOTANICAL PROVINCES
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Poor	
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

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APPENDIX C

Local Water Management Strategy

Lots 1, 2, 7, 12, 13, 36-38 &9006 Caporn St Wanneroo
Local Water Management Strategy

August 2020

Client: Acumen Development Solutions

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Executive Summary

Hyd2o was commissioned by Acumen Development Solutions to compile this local water management strategy (LWMS) to support the proposed local structure plan (LSP) for the Lots 1, 2, 7, 12, 13, 36-38 & 9006 Caporn St in the suburb of Wanneroo (the site).

The site is approximately 27 ha in size and located approximately 35 km north of the Perth central business district within the City of Wanneroo.

The local structure plan for the site has been prepared by Taylor Burrell Barnett (TBB). The proposed residential development consists of residential lots, roads and public open space.

The site is predominantly cleared with three existing dwellings and a market garden. Some remnant patches of woodland will be retained post. Topography across the site varies between 52mAHD-71mAHD with groundwater at a depth of over 12 m. The site is underlain by sandy soils suitable for the infiltration of stormwater.

Stormwater management within the site post development proposes infiltration storage for all events based on the suitability of soils for infiltration based on site specific testing.

This document has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008).

Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of Urban Water Management Plans for individual stages of development within the site.

1. Introduction

Hyd2o was commissioned by Acumen Development Solutions to compile this local water management strategy (LWMS) to support the proposed local structure plan (LSP) for the Lots 1, 2, 7, 12, 13, 36-38 & 9006 Caporn St in the suburb of Wanneroo (the site).

The site is approximately 27 ha in size and located approximately 35 km north of the Perth central business district within the City of Wanneroo (Figure 1).

The local structure plan for the site has been prepared by Taylor Burrell Barnett (TBB). The proposed residential development consists of residential lots, roads and public open space.

The proposed development of the site has considered the predevelopment environment and uses this information to inform the development of the local structure plan.

This LWMS provides an integrated total water cycle management approach to the development of the subdivision guide plan, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, a groundwater management strategy and a plan for implementation.

A copy of the Better Urban Water Management (WAPC, 2008) LWMS Checklist for Developers is included as Appendix A to assist the Department of Water and Environmental Regulation (DWER) and City of Wanneroo (City) in review of this document.

1.1 Planning Context

This site is currently zoned 'Urban' under the Metropolitan Region Scheme (2007) and zoned 'Urban' within the North-West Sub-regional Planning Framework (WAPC, 2018) and as 'Suburban Neighbourhood' within the Draft East Wanneroo District Structure Plan (WAPC, 2019).

The urban water management planning process for the site is shown in Table 1. This LWMS supports the proposed development of the area to a residential development.

Table 1: Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
MRS scheme amendment	MRS Rezoning	Caporn St, Sinagra: District Water Management Strategy (JDA, 2012) **APPROVED**
District Planning	Draft East Wanneroo District Structure Plan	Integrated Water Management Framework: East Wanneroo District Structure Plan (RPS, 2019) **DRAFT**
Local	Local Structure Plan	Lots 1, 2, 7, 12, 13, 36-38 & 9006 Caporn St: Local Water Management Strategy **THIS DOCUMENT**
Subdivision	Subdivision Application	Urban Water Management Plan **FUTURE PREPARATION**

1.2 Key Documents

This LWMS uses the following key documents to define its principles, criteria, objectives, and implementation responsibilities:

- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (DoW, 2007)
- Decision Process for Stormwater Management in WA (DWER, 2017)
- Caporn St, Sinagra: District Water Management Strategy (JDA, 2012)
- Integrated Water Management Framework: East Wanneroo District Structure Plan (RPS, 2019)

2. Proposed Development

The proposed local structure plan is shown in Figure 2.

It consists of a mix of residential lots, roads, public open space (POS), and conservation area.

This LWMS aims to assist in maintaining the predevelopment hydrological regime of the environment by maintaining flows within the development area through the use of stormwater infiltration storage areas. Stormwater storage areas will be integrated into POS through a landscaped solution which integrates drainage with amenity.

This will allow POS areas to maximise their public amenity and maintain principles of water sensitive urban design.

3. Design Criteria

Key design criteria for the site are shown in Table 2 and have been established consistent with criteria specified in the key reference documents previously detailed in Section 1.2.

These design criteria are used to formulate the water management strategy for the site within the identified constraints and opportunities of the pre-development environment.

Table 2: Design Criteria

Strategy Elements	LWMS Method & Approach
Water Use Sustainability	
Water Efficiency	• Water efficiency requirements consistent with Building Codes of Australia • Maximising infiltration of stormwater where possible • "Waterwise" Public Open Space • Aim for less than 100 kL/person/year
Water Supply	• Water Corporation IWSS for lots, rainwater tanks • Minimise use of scheme water for non-drinking purposes
Wastewater	• Water Corporation reticulated sewerage
Stormwater	
Flood Protection	• Overland flow paths within road reserves identified for safe conveyance of flows exceeding pipe drainage system capacity • LSP does not discharge any flows outside its boundary (RPS, 2019) • 1% AEP event to be infiltrated within POS area. • Establish minimum habitable floor levels at 0.5m above the 1% AEP flood levels. • All stormwater to be infiltrated within a time period not exceeding 96hrs to prevent mosquito and midge breeding.
Serviceability	• Piped drainage system sized to convey 20% AEP event • 20% AEP to be detained or infiltrated within POS area.
Ecological Protection	• Use of soakwells at lot scale to infiltrate first 15mm on site. • Establishment of biofiltration area for treatment and infiltration of first 15mm road runoff within POS.
Groundwater	
Fill Requirement & Subsoil Drainage	• Adequate separation to groundwater will be maintained post development. • No subsoil drainage proposed.
Acid Sulphate Soils & Contamination	• If required, management of Acid Sulphate Soils to be handled as a separate process to LWMS consistent with DoE (2004) requirements and reported in future UWMP's.

4. Pre-Development Environment

4.1 Site Conditions

The site is approximately 27 ha in size and located approximately 35 km north of the Perth central business district within the suburb of Wanneroo in the City of Wanneroo (Figure 1).

The site is bound to the north by Caporn Street, to the west and south by existing residential development and to the east by rural type development (Figure 1).

The site currently consists of rural landholdings with existing buildings and sheds consistent with use as a rural property. There is some remnant vegetation on some lots across the site and some lots have been previously cleared and revegetated. There is also a market garden site located on the eastern side of the site.

Figure 3 shows an aerial photograph with existing land use and topography.

The topography of the site is highest along the southern boundary at 71 mAHD and falls to 52 mAHD along the northern boundary.

4.2 Geotechnical

Environmental geology mapping on the Muchea Sheet (Jordan, 1986) indicates the site is characterised by:

- S7 SAND – derived from Tamala Limestone- pale yellowish brown, medium to coarse grained, sub-angular quartz, trace of feldspar, moderately sorted, of residual origin.

Hyd2o conducted permeability testing at the site in July 2020 to provide estimates of the field saturated hydraulic conductivity of the soils and assess their suitability for stormwater infiltration. Three permeability tests were undertaken at five locations across the site including areas proposed for drainage post development. Results are provided in Table 3 below, locations shown in Figure 4 and test results provided in Appendix B.

Test results vary across the site from 2.73 m/day to 20.4 m/day. Permeability results in the order of 10-20 m/day are expected in areas with deep sands in comparison to the Stormwater Management Manual (DoW, 2007). It is suspected that test results at locations PM2 and PM3 may be influenced by market gardening activities and soil improving agents typically used in market gardens to improve moisture retention.

Table 3: Permeability Testing

Test Site	Test Depth Below Surface	In Situ Condition of Tested Material	Measured Permeability K_s m/day
PM1	0.5m	Sand	20.4
PM2	0.5m	Sand	3.47
PM3	0.5m	Sand	2.73
PM4	0.5m	Sand	13.32
PM5	0.5m	Sand	9.88

4.3 Acid Sulphate Soils

Acid Sulphate Soil (ASS) is the common name given to naturally occurring soil and sediment containing iron sulfides. These naturally occurring iron sulfides are generally found in a layer of waterlogged soil or sediment and are benign in their natural state.

When disturbed and exposed to air, however, they oxidise and produce sulfuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. Release of acid and metals as a result of the disturbance of ASS can cause significant harm to the environment and infrastructure.

The presence of ASS has been a recognised issue of concern in Western Australia since 2003. The Department of Environment and Conservation and the WAPC have released guidance notes on ASS, covering the requirement for assessing sites and the management of sites where ASS are identified. ASS investigations are commonly required as part of the conditions of subdivision or as a requirement for a dewatering license application.

The WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the site indicates that the site is classified as having no known risk of ASS occurring within 3m of natural surface.

If further ASS investigations are required they will be undertaken as a separate process to the urban water management planning process.

4.4 Contaminated Sites

A search of the Contaminated Sites Database identified no registered contaminated sites within a 1 km radius.

The site does contain two active market gardens (Lots 2 and 7) and a small orchard (Lot 37) (Department of Water and Environmental Regulation, 2018b). Intensive agriculture is a potentially contaminating land use and therefore the market gardens result in a requirement for a Preliminary Site Investigation (PSI). A PSI includes a desktop study, site inspection and interviews with relevant personnel to identify the potential for contamination and thus the need for further detailed site investigation.

4.5 Wetlands

There are no mapped geomorphic wetlands within the site.

Lake Mariginiup is a mapped conservation category wetland located 400m north of the site. Groundwater flows are in an east to west direction across the site away from the lake (discussed further in Section 4.7).

4.6 Surface Water

There are no natural watercourses or drains within the site. All surface runoff is infiltrated through the sandy soils underlying the site. As shown in Figure 3, the topography of the site grades steadily from south to north (towards Caporn St). No surface runoff is expected from the site.

4.7 Groundwater

The Perth Groundwater Map (DWER, online) provides groundwater contours at the site ranging from approximately 39 mAHD to 42 mAHD, with flow to the west. These contours typically reflect a summer minimum condition.

Groundwater mapping was undertaken as part of the Integrated Water Management Framework: East Wanneroo District Structure Plan (RPS, 2019). The historic maximum groundwater levels (MGL) and average annual maximum groundwater levels (AAMGL) were produced from long-term DWER monitoring data and mapped over the entire district structure plan area. Groundwater mapping is shown in Figure 5 with the historic MGL ranging from 37 mAHD-41 mAHD across the site and the AAMGL slightly lower ranging from 37mAHD-40 mAHD.

The natural surface clearance above these contours ranges from 12 m to 32 m. Typically, predevelopment monitoring and mapping at the local scale is only required by DWER where groundwater is within 4 m of natural surface.

The combination of sandy soils and good separation to groundwater indicate the site as having favourable conditions for stormwater retention and infiltration on-site.

5. Water Use Sustainability Initiatives

5.1 Water Efficiency Measures

Water conservation measures will be implemented within the development and will be consistent with Water Corporation's "Waterwise" land development criteria, and include:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping).
- Water efficiency consistent with Building Codes of Australia.
- Use of groundwater bores for irrigation of public open space.
- Maximising on site retention of stormwater.

Agreed water conservation measures and locations will be detailed at the UWMP stage.

5.2 Water Supply

The Water Corporation's Integrated Water Supply System (IWSS) will supply potable water to the future homes on the site.

The Department of Planning, Lands and Heritage and the City of Wanneroo have accepted that landscape plans can be submitted at a later stage of planning. In the interim, the public open space areas have designated where drainage will be directed and which spaces are left for conservation. As such, no formal landscape planning will be submitted as part of the LWMS. Areas allocated for drainage and treatments within bioretention are detailed in Section 6 below.

The site is located within the Wanneroo (Perth- Superficial Swan) Groundwater Management Area (GMA), Mariginiup groundwater sub area. DoW's online Water Register for Licence and Water Availability Information indicates that the superficial aquifer is fully allocated within this sub area.

The development proposes 3.32 ha of public open space that will require irrigation. The proposed structure plan will require 22,410 kL/annum of groundwater for irrigation.

The following groundwater licences are already operational within the site and will be investigated for transfer to the future urban development (Table 4).

Table 4: Current Groundwater Allocations with the Site

GW Licence	Property	Allocation (kL)	Expiry
58046	Lot 7 on Diagram 21467	48650	18/12/2026
58047	Lot 37 on Diagram 74522	16875	30/5/2027
87116	Lot 1 on Diagram 41651 Lot 13 on Diagram 27581	22500	09/02/2025
91679	Lot 2 Diagram 41651	53100	26/5/2023

5.3 Wastewater Management

Wastewater will be deep sewerage (reticulated) with management by Water Corporation.

6. Stormwater Management Strategy

Stormwater management post development has been designed consistent with DWER water sensitive design practices and overarching water management strategy documentation. The system will consist of a series of lot soakwells, road drainage pits, piped drainage, overland flows paths, and bioretention and flood storages areas within POS for water quality treatment.

At lot scale, all runoff from the first 15mm event will be retained on site via soakwells.

6.1 Stormwater Modelling

Stormwater modelling of proposed stormwater management areas was undertaken by Hyd2o using the PONDS shallow water table infiltration model. PONDS is a program specifically designed for modelling groundwater/surface water interactions for the design of stormwater infiltration areas based on the finite difference computer program MODFLOW developed by the US Geological Survey.

The design storms modelled by PONDS were calculated with reference to the methodology in Australian Rainfall and Runoff (ARR) and the Bureau of Meteorology Computerised Design IFD Rainfall System (CDIRS). The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 1 hour to 72 hours.

To provide an at-source approach to stormwater management post development the site was delineated into five catchments based on pre development catchments, flow paths, proposed earthworks, and the location of the proposed POS areas. Post-development catchments were developed in consultation with TABEC engineers and are shown in Figure 6.

The following key parameters were used for stormwater modelling:

- A groundwater level of 41 mAHD (historical maximum assumed).
- Varying side slopes for biofiltration areas to a maximum depth of 0.3m.
- Minimum side slopes of 1 in 6 for major event flood storage.
- A maximum storage depth of 1.0 m adopted consistent with the CoW (2015).
- A saturated hydraulic conductivity based on the results of infiltration testing across the site inclusive of a 50% clogging factor and reduced by 2/3 for soil moderation.

Various runoff coefficients applied to different land uses for each of the AEP's modelled areas are shown in Table 5.

Table 5: Runoff Coefficients

Land use Type	First 15mm	20% AEP	1% AEP
R10	Retained on site all events		
R30/R40	Retained on site	10%	20%
R60	Retained on site	10%	85%
Caporn St (Regional Rd)	Retained on site	70%	85%
Roads	64%	70%	85%
POS	Retained on site	5%	17%

Modelling results for the POS storages are provided in Table 6 and Figure 6. It has been assumed that all stormwater is retained on site for all catchment in all events.

Catchment C also provides flood storage for and external catchment south of the site. A previous arrangement between landowners resulted in the drainage from the existing residential development south of the site to convey drainage for infiltration towards Catchment C.

Unsaturated hydraulic conductivity used for Catchment E in the modelling represents the tested result at PM5 due to suspected soil modification because of market gardening. Further infiltration testing will be undertaken as part of a geotechnical investigation prior to the development of the urban water management plan to confirm infiltration rates.

6.1.1 Flood Protection (1% AEP & 20% AEP)

Modelled storage volumes, areas, flood rise and inverts are detailed in Table 6 and Figure 6 for the 20% AEP and 1 % AEP flood events.

Stormwater storage is proposed as follows:

- All Catchment will infiltrate the 1% AEP storm with no discharge externally to the site.
- The minimum habitable building floor levels will comply with requirements for a 0.5 m clearance above estimated 1 % AEP flood levels as shown in Table 6

Table 6: Modelling Results for Infiltration Storage Areas

Catchment	Catch A	Catch B	Catch C	Catch D	Catch E
Total Area	6.63	0.74	14.07	4.02	8.96
First 15mm Equivalent impervious area (ha)	1.17	0.09	2.24	0.67	1.46
20 % Equivalent impervious area (ha)	1.85	0.14	3.38	1.11	2.35
1 % Equivalent impervious area (ha)	2.60	0.23	4.79	1.58	3.33
Unsaturated vertical K	4.4	6.1	4.4	3.3	3.3
Bioretention Basin (15mm)					
Basin invert (mAHD)	57.0	68.0	56.0	62	54
Base area (m^2)	375	0.4	660	225	500
Side slopes (v:h)	0	6	0	0	0
15 mm					
Flood rise (m)	0.29	0.27	0.33	0.31	0.30
TWL (mAHD)	57.29	68.27	56.33	62.31	54.30
Volume (m^3)	108	2	217	89	160
TWL surface area (m^2)	375	18	660	225	500
Basin characteristics					
Basin invert (mAHD)	57.0	68.0	56.0	62	54
Base area (m^2)	700	0.4	1500	450	1200
Side slopes (v:h)	6	6	6	6	6
Unsaturated vertical K	4.4	6.1	4.4	3.3	3.3
20% AEP					
Flood rise (m)	0.37	0.50	0.32	0.36	0.31
TWL (mAHD)	57.37	68.50	56.32	62.36	54.31
Volume (m^3)	306	10	539	199	413
TWL surface area (m^2)	963	49.6	1879	663	1474
Critical Storm (hr)	1	1	1	3	3
1%AEP					
Flood rise (m)	1.02	0.94	0.98	0.97	0.97
TWL (mAHD)	58.02	68.94	56.98	62.97	54.97
Volume (m^3)	1108	52	2062	734	1603
TWL surface area (m^2)	1523	152	2755	1109	2150
Critical Storm (hr)	6	1	3	6	12

6.1.2 Minor Event and Ecological Protection (15mm)

Runoff from roads in minor events will be directed to the biofiltration area in the POS for treatment.

A total biofiltration storage volume of 576m^3 is required to manage minor event runoff, as shown in Table 7 and Figure 6. The storages have been designed with various side slopes and to a depth of 0.3m. A total area of 1778 m^2 is required for this purpose.

Biofiltration areas will be lined with suitable soil amendment material and planted with a range of littoral plants to assist with nutrient stripping. Where possible the use of landscaped median swales, verge swales, tree pits and at source infiltration will be promoted and reported in the UWMP.

Table 7 details a summary from the Stormwater Management Manual for Western Australia (DoW, 2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria contained in WAPC (2008).

While DoW (2007) does not provide expected pollutant removal efficiencies for all best management practices (BMPs), application of a treatment train approach using a combination of the non-structural and structural measures will therefore clearly achieve the design objectives for water quality for the site.

Table 7: BMP Water Quality Performance in Relation to Design Criteria

Water Quality Parameter	WAPC (2008) Design Criteria (required removal as compared to a development with no WSUD)	Structural Controls Nutrient Output Reduction [1]	
		Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	80%	65-99%
Total Phosphorus	60%	60%	40-80%
Total Nitrogen	45%	50%	50-70%
Gross Pollutants	70%	-	>90%

1. Typical Performance Efficiencies via DoW (2007)

7. Groundwater Management Strategy

7.1 Fill and Subsoil Drainage

Development levels in the site will be largely dominated by cut and fill to achieve required grades and level lots. Subsoil drainage will not be required within this development.

Finished lot levels and fill requirements are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP and will be ultimately submitted for council approval at that stage.

RPS(2019) provides groundwater modelling projection for the district structure plan area which suggest that regional groundwater levels may rise 3m-4m by 2030. The excess recharge is expected largely through the progressive clearing of pine plantations and decline in abstraction for public drinking water. It should be noted that should this groundwater rise occur, the site and its associated drainage will not be impacted given the minimum separation between groundwater levels and the site would still be 8m-9m.

7.2 Acid Sulphate Soils

There future requirement for ASS management within the stie as there is no known risk of ASS occurring within 3m of natural surface.

8. Urban Water Management Plans

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

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of City of Wanneroo and DWER.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Detailed stormwater management design including refining stormwater modelling detailed in the LWMS.
- Management of groundwater levels including proposed fill levels.
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed on going management arrangements.
- Landscape plans.
- Management of subdivisional works.
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Contingency plans (where necessary).

More detail of the POS and stormwater storage integration will be provided during the development of the UWMP, including refinement of stormwater modelling, preparation of landscape plans (species selection and treatments), and detailed design drawings.

Preparation of the UWMP will be the responsibility of the developer.

9. Monitoring

9.1 Pre Development

Predevelopment monitoring is not anticipated for the purpose of informing the UWMP and subdivision process.

9.2 Post Development

No post development monitoring is proposed for the site as no pre-development monitoring was undertaken, the site is infiltrating all stormwater and is unlikely to impact on any water sensitive ecosystems.

10. Implementation

Table 8 details the roles, responsibilities, and funding to implement the LWMS for this site.

Any modification required to the LWMS would be identified through the UWMP process and would require the agreement of all parties (DWER, City of Kwinana, and developer).

Given the size of the site and likely development timeframes, monitoring outcomes will be used in a continual improvement capacity to review the implemented WSUD within the site with outcomes used to inform future planning and design approaches for subsequent developments in the area.

Specific maintenance responsibilities will be detailed at the UWMP stage. It is envisaged that the schedule for maintenance works will be consistent with typical requirements of the City.

Table 8: Implementation Responsibility

Implementation Action	Responsibility & Funding	
	Developer	City
Preparation of UWMP	☑	
Review & Approval of UWMP		☑
Construction of Stormwater System	☑	
Post Development Monitoring Program	☑	
Operation & Maintenance		
a) Prior to Handover	☑	
b) Following Handover		☑

11. References

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RPS (2019) Integrated Water Management Framework. Prepared for Department of Planning Lands and Heritage

Western Australian Planning Commission, (2003). Planning Bulleting No. 64: Acid Sulphate Soils. Western Australian Planning Commission, November 2003.

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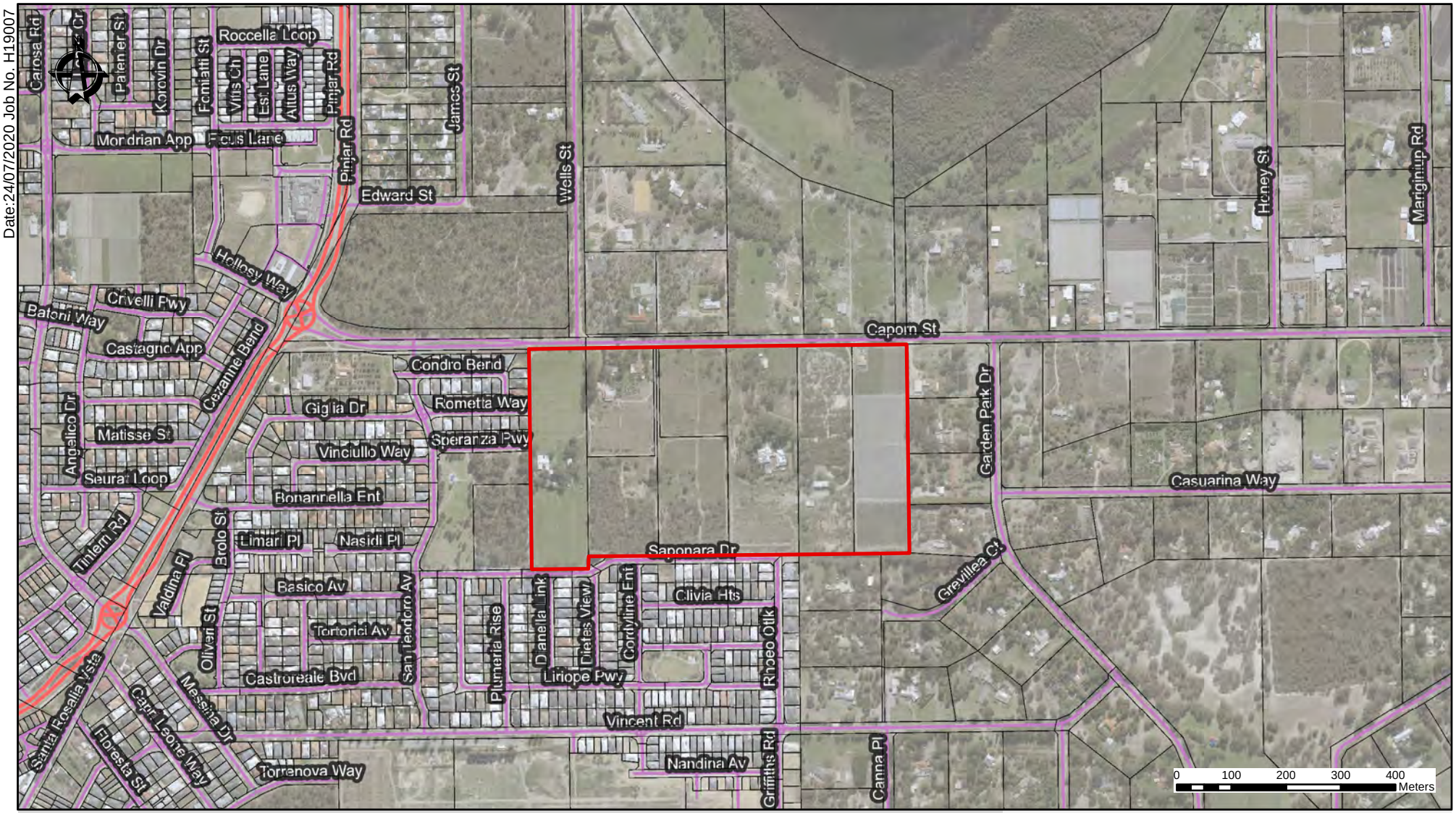
Western Australian Planning Commission (2018) North-West Sub-regional Framework. March 2018

Western Australian Planning Commission (2019), Draft East Wanneroo District Structure Plan, September 2019

FIGURES

Date:24/07/2020 Job No. H190007



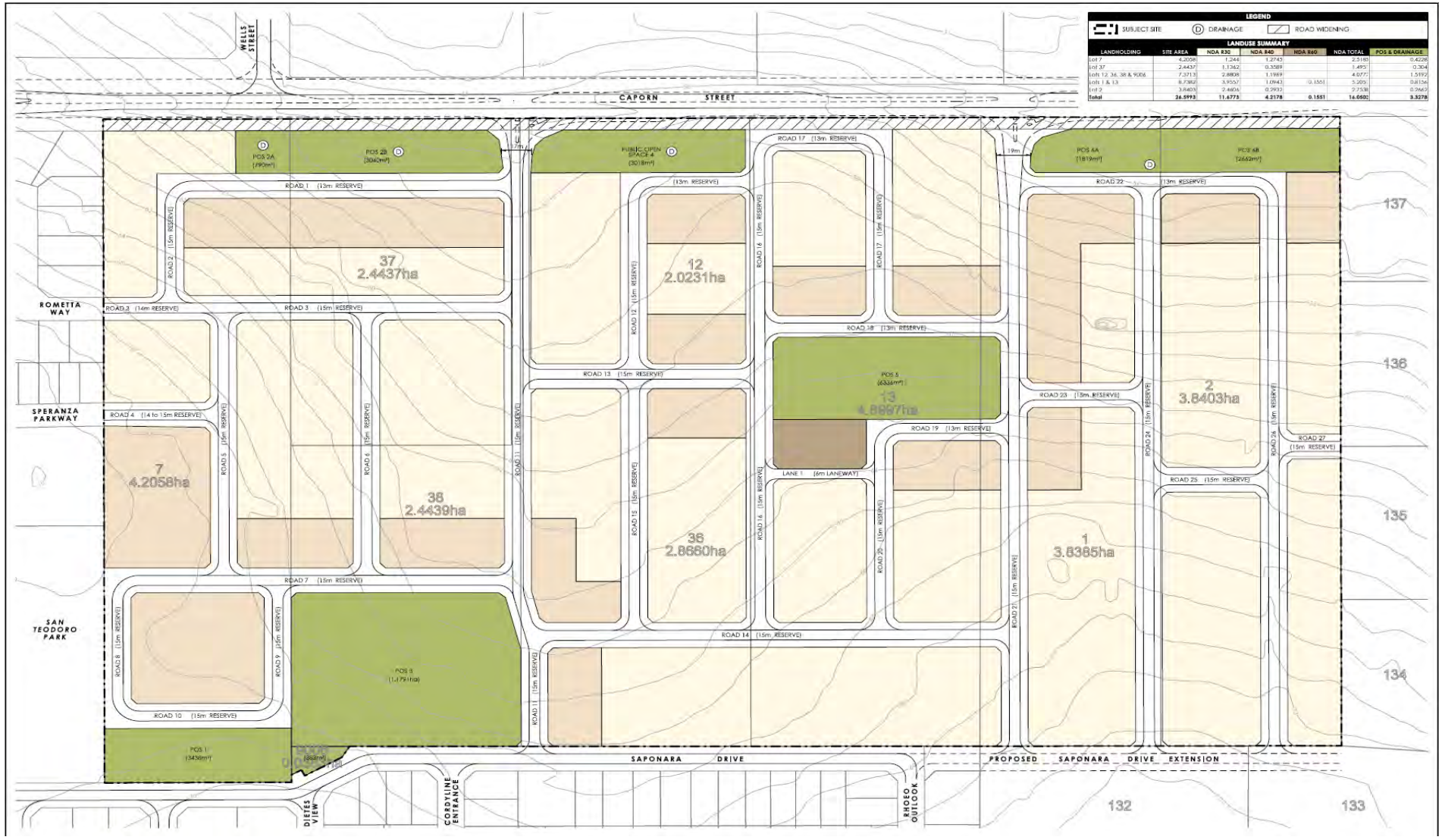
Site

hyd2o

Location Plan

Figure 1

Date : 18/08/2020 Job No: H19007



Source: Taylor Burrell Barnet (2020)

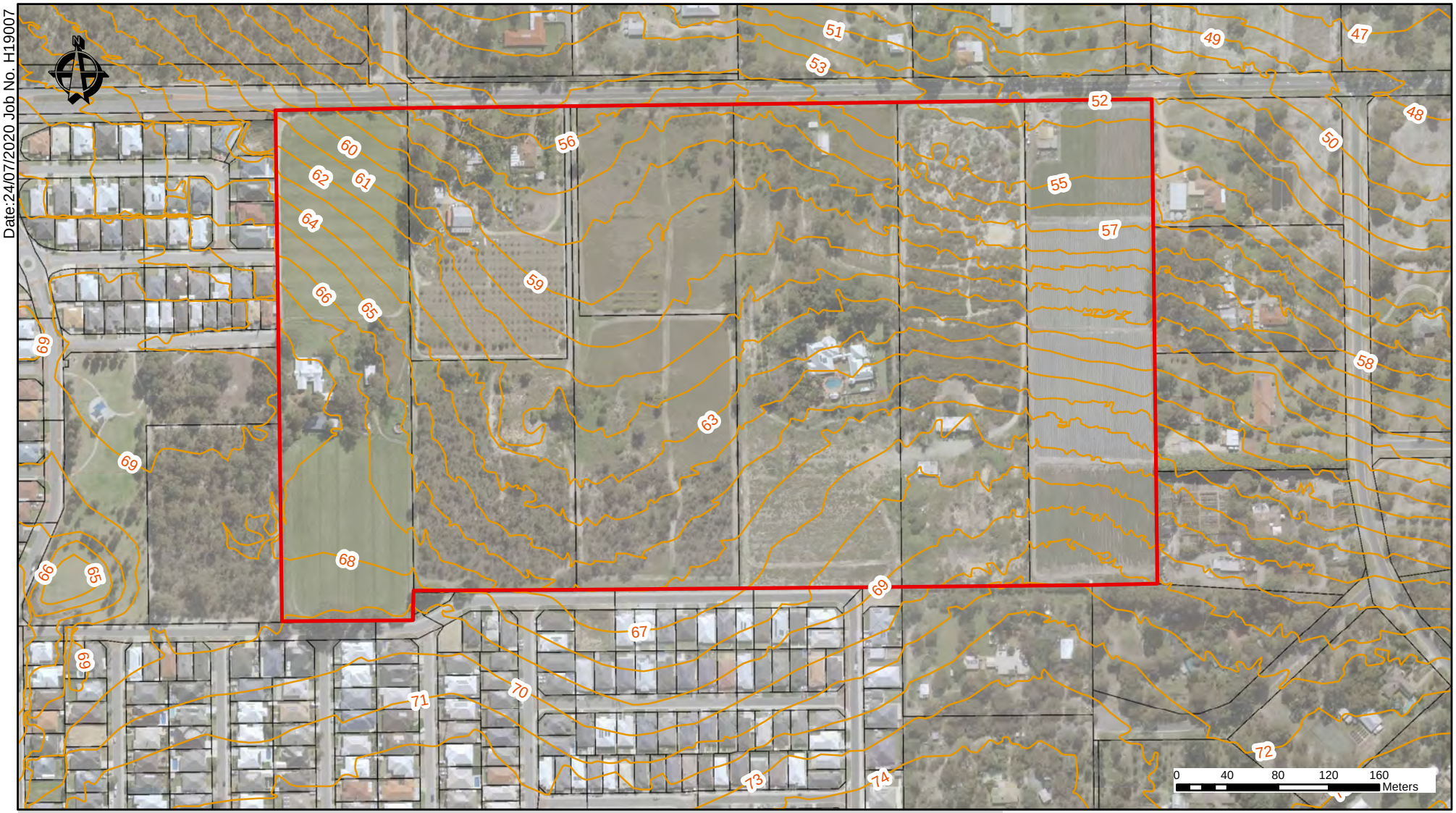
hyd2o

Various Landholdings Caporn St: LWMS

Local Structure Plan

Figure 2

Date:24/07/2020 Job No. H19007



Site

Topography (mAHD)

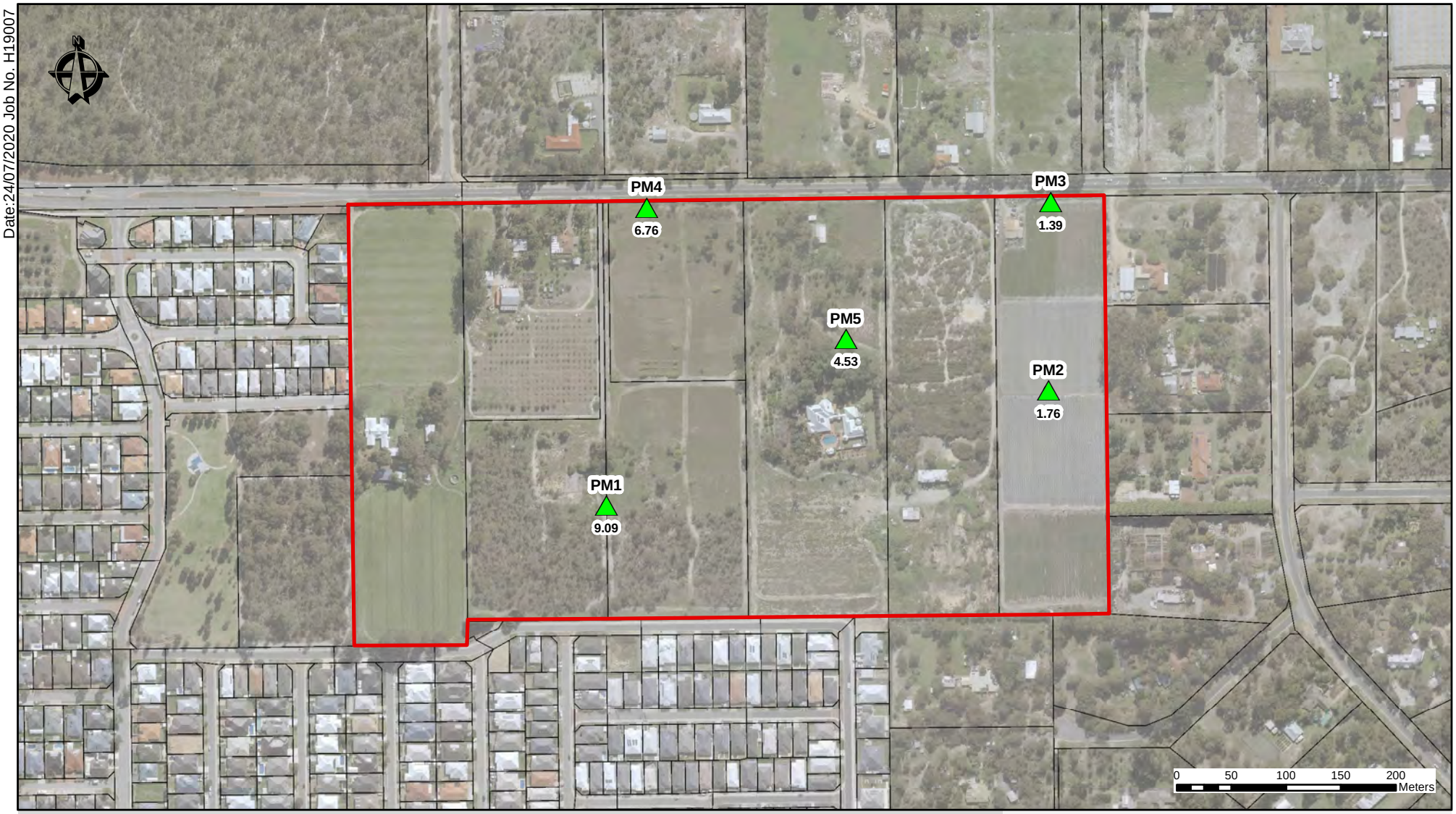
hyd2o

Various Landholdings Caporn St LWMS

Site Conditions

Figure 3

Date:24/07/2020 Job No. H19007



Site

Permeability Test Locations (K in m/day)

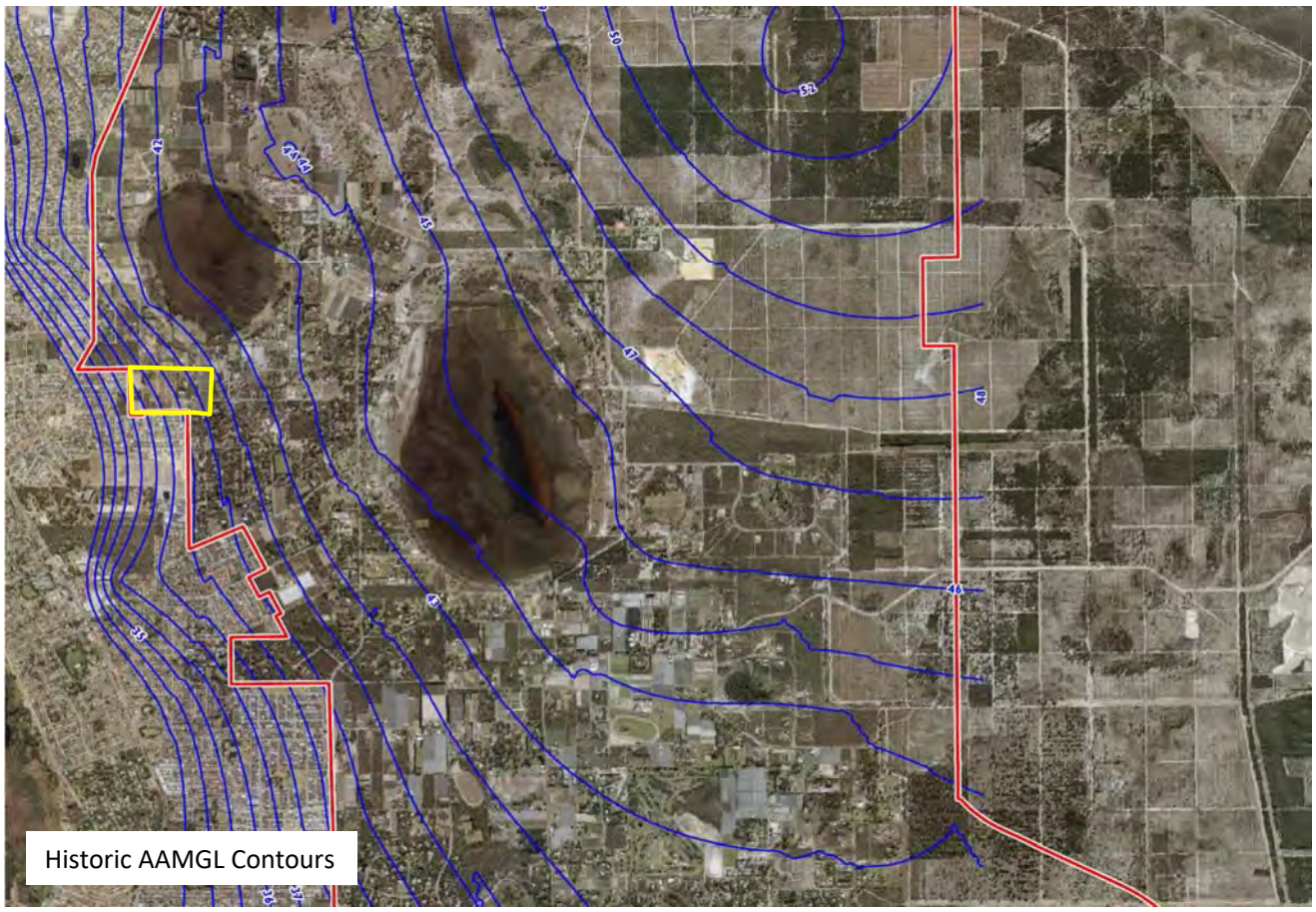
hyd2o

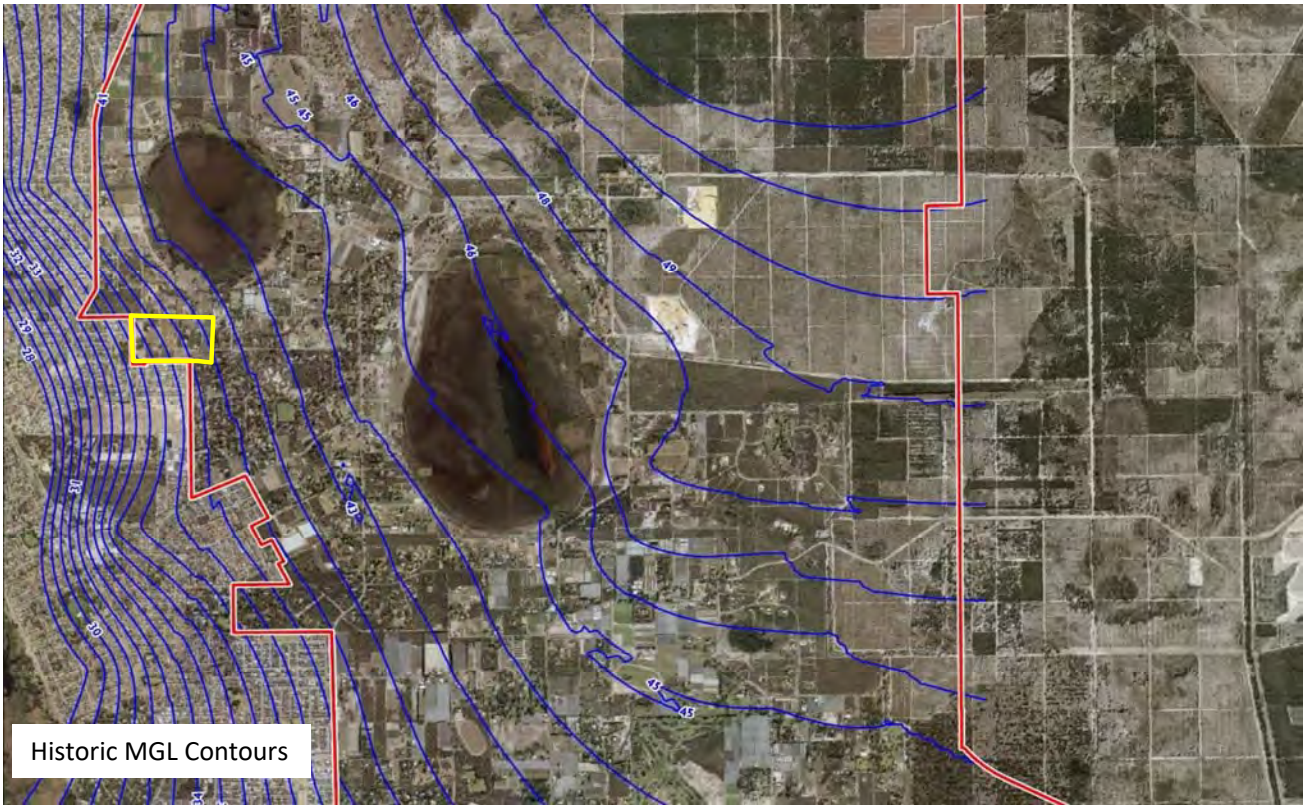
Various Landholdings Caporn St LWMS

Environmental Geology

Figure 4

Date: 14/08/2020 Job No. H190007





Source: RPS (2019)

Site

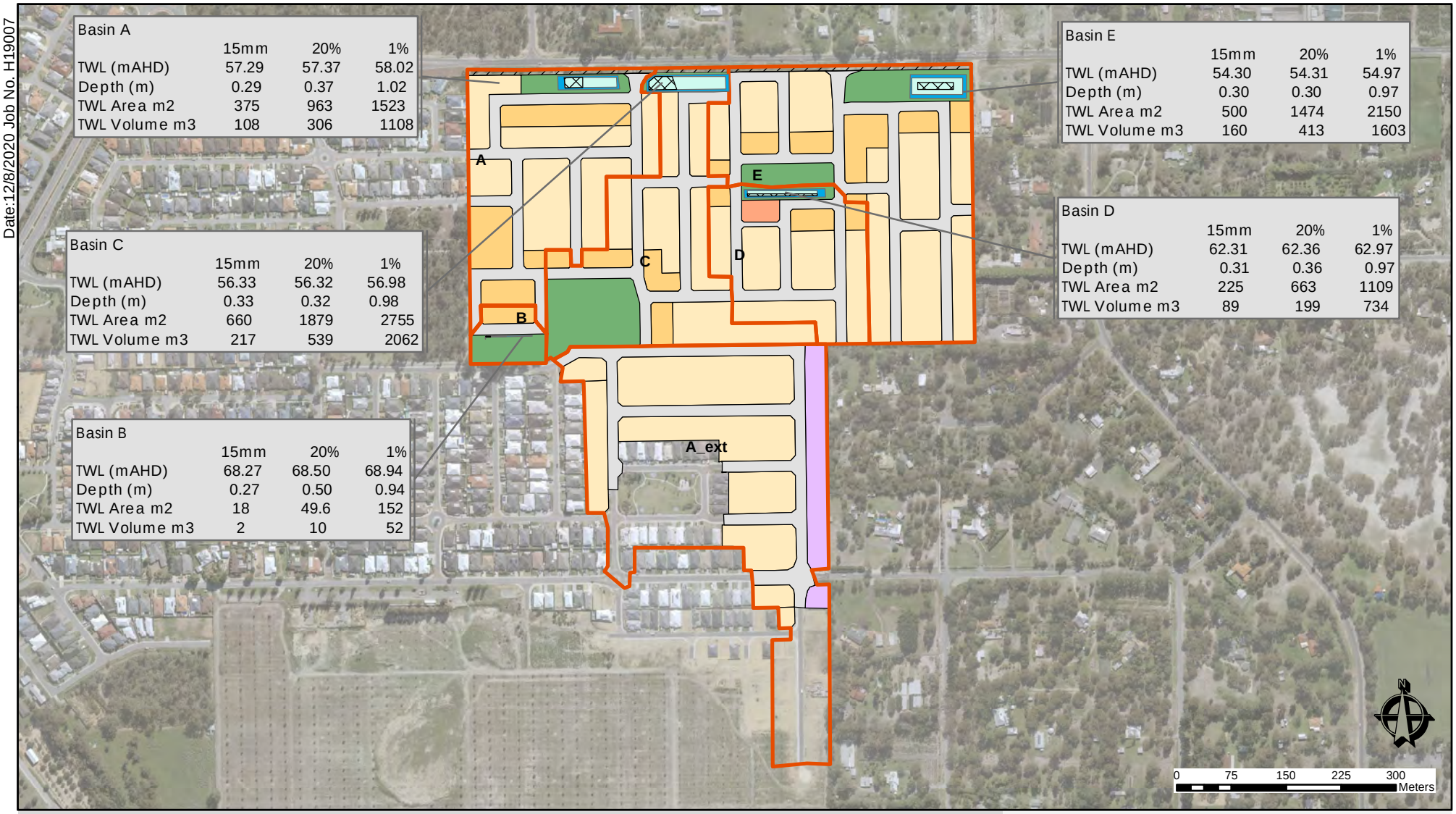
hyd$_2$o

Various Landholdings Caporn St: LWMS

Groundwater Plan

Figure 5

Date:12/8/2020 Job No. H19007



Local Structure Plan

- Caporn St Ext
- POS
- R10
- R30
- R40
- R60
- Road
- 20% Stormwater Storage
- 1% Stormwater Storage
- Bioretention Storage
- Catchments
- Tabec Subcatchments

hyd2o

Various Landholdings CapornSt LWMS

Stormwater Management

Figure 6

APPENDIX A
LWMS Checklist for Developers

Better Urban Water Management LWMS Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Design elements and requirements for BMP's and critical control points	☑	Executive Summary & Section 3
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Introduction, Sections 1.1 & 1.2
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Structure plan	☑	Section 1, 2, & 3. Figure 1, Figure 2, Figure 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	Stormwater Areas and Volumes to inform POS credits in Section 6 & Figures 6. Water availability identified in Section 5.2.
Design criteria			
Agreed design objective and source of objective		☑	Section 3
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 4 & Figures 3-7
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 4.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 4.2-4.3, Figure 4
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Sections 4.4-4.6,
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 4.7,
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 4.8, Figure 5, Appendix D
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.2
Wastewater management		☑	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Long section of critical points	☑	Section 6 & 6.1-6.3, Figure 6
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Section 6 & 6.1-6.3, Figure 6
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan Typical cross sections	☑	Section 6 & 6.1 & 6.4, Figure 6

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil plan	☑	Section 7, 7.1-7.2
Actions to address acid sulphate soils or contamination		☑	Section 7.3
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☑	Section 9
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 8, Figure 7
Implementation			
Developer commitments		☑	Section 10
Roles, responsibilities, funding for implementation		☑	Section 10
Review		☑	Section 10

APPENDIX B
Permeability Test Results (Hyd2o, 2020)

Borehole Permeameter : Field Result Analysis

Project/Site	H19007 Caporn St P1	
Location	387389	mE
	6488197	mN

TEST 1

r	4.0	cm
H	10.0	cm
time step	10	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**2.5**	0.0
10	**27.0**	24.5
20	**38.7**	11.7
30	**55.4**	16.7
40	**72.5**	17.1

	17.5
q (cm^3/s)	15.4

TEST 2

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**6.3**	0.0
5	**20.4**	14.1
10	**26.0**	5.6
15	**31.5**	5.5
20	**41.4**	9.9
25	**47.0**	5.6
30	**53.5**	6.5
35	**61.7**	8.2
40	**69.0**	7.3

Avg Diff (cm)	7.8
q (cm^3/s)	13.8

TEST 3

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**2.2**	0.0
5	**16.5**	14.3
10	**23.6**	7.1
15	**34.6**	11.0
20	**40.0**	5.4
25	**47.5**	7.5
30	**62.0**	14.5
35	**71.0**	9.0
40	**76.0**	5.0

Avg Diff (cm)	9.2
q (cm^3/s)	16.2

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0240	Ks (cm/s)	0.0215	Ks (cm/s)	0.0253
Ks (m/day)	20.75	Ks (m/day)	18.59	Ks (m/day)	21.88
Average (m/day)	**20.40**				

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	924.0	827.6	cm3/min	974.2	cm3/min
r (cm)	4	4.0	cm	4.0	cm
H (cm)	10.0	10.0	cm	10.0	cm
$0.5\sinh^{-1}(H/2r)$	0.52	0.52		0.52	
-sqrt((r/H)^2+0.25)	-0.64	-0.64		-0.64	
r/H	0.40	0.40		0.40	
Sum	0.28	0.28		0.28	
Sum*4.4*q	1152.53	1032.34		1215.10	
$2*pi*H^2$	628.32	628.32		628.32	
Ksat (cm/min)	1.8	1.6		1.9	
Ksat (m/day)	26.41	23.66		27.85	
Average (m/day)	**25.97**				

Borehole Permeameter : Field Result Analysis

Project/Site	H19007 Caporn St P2	
Location	387793	mE
	6488302	mN

TEST 1

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**2.5**	0.0
10	**11.9**	9.4
20	**16.0**	4.1
30	**24.5**	8.5
40	**28.5**	4.0
50	**32.9**	4.4
60	**41.0**	8.1
70	**45.0**	4.0
80	**54.7**	9.7
90	**59.2**	4.5
100	**66.0**	6.8
110	**75.5**	9.5
		6.6
	q (cm^3/s)	5.8

TEST 2

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**6.0**	0.0
10	**15.0**	9.0
20	**18.0**	3.0
30	**25.4**	7.4
40	**33.4**	8.0
50	**39.0**	5.6
60	**46.0**	7.0
70	**52.4**	6.4
80	**62.7**	10.3
90	**67.0**	4.3
100	**74.0**	7.0
	Avg Diff (cm)	6.8
	q (cm^3/s)	6.0

TEST 3

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**5.3**	0.0
10	**14.7**	9.4
20	**21.6**	6.9
30	**29.6**	8.0
40	**39.0**	9.4
50	**45.7**	6.7
60	**53.0**	7.3
70	**60.5**	7.5
80	**67.0**	6.5
90	**76.0**	9.0
	Avg Diff (cm)	7.9
	q (cm^3/s)	6.9

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0038	Ks (cm/s)	0.0038	Ks (cm/s)	0.0044
Ks (m/day)	3.24	Ks (m/day)	3.32	Ks (m/day)	3.84

Average (m/day) **3.47**

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	350.4		359.0	cm3/min	414.8	cm3/min
r (cm)	4		4.0	cm	4.0	cm
H (cm)	20.0		20.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82		0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54		-0.54		-0.54	
r/H	0.20		0.20		0.20	
Sum	0.49		0.49		0.49	
Sum*4.4*q	747.91		766.35		885.31	
$2*pi*H^2$	2513.27		2513.27		2513.27	
Ksat (cm/min)	0.3		0.3		0.4	
Ksat (m/day)	4.29		4.39		5.07	

Average (m/day) **4.58**

Borehole Permeameter : Field Result Analysis

Project/Site	H19007 Caporn St P3	
Location	387795	mE
	6488474	mN

TEST 1

r	4.0	cm
H	20.0	cm
time step	20	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**20.1**	0.0
20	**33.5**	13.4
40	**46.0**	12.5
60	**57.4**	11.4
80	**69.2**	11.8

	12.3
q (cm^3/s)	5.4

TEST 2

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**1.9**	0.0
10	**9.4**	7.5
20	**13.7**	4.3
30	**19.2**	5.5
40	**25.5**	6.3
50	**30.3**	4.8
60	**36.5**	6.2
70	**43.0**	6.5
80	**49.0**	6.0
90	**54.6**	5.6
100	**59.0**	4.4
110	**65.3**	6.3
120	**70.5**	5.2

Avg Diff (cm)	5.7	
q (cm^3/s)	5.0	

TEST 3

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**3.7**	0.0
10	**11.1**	7.4
20	**14.0**	2.9
30	**18.7**	4.7
40	**23.7**	5.0
50	**29.0**	5.3
60	**32.2**	3.2
70	**38.0**	5.8
80	**43.7**	5.7
90	**46.5**	2.8
100	**52.5**	6.0
110	**57.2**	4.7
120	**62.0**	4.8
130	**66.7**	4.7
140	**72.7**	6.0

Avg Diff (cm)	4.9	
q (cm^3/s)	4.3	

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0035	Ks (cm/s)	0.0032	Ks (cm/s)	0.0028
Ks (m/day)	3.00	Ks (m/day)	2.79	Ks (m/day)	2.41
Average (m/day)	**2.73**				

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	324.1	301.8	cm3/min	260.2	cm3/min
r (cm)	4	4.0	cm	4.0	cm
H (cm)	20.0	20.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82	0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54	-0.54		-0.54	
r/H	0.20	0.20		0.20	
Sum	0.49	0.49		0.49	
Sum*4.4*q	691.69	644.26		555.44	
$2*pi*H^2$	2513.27	2513.27		2513.27	
Ksat (cm/min)	0.3	0.3		0.2	
Ksat (m/day)	3.96	3.69		3.18	
Average (m/day)	**3.61**				

Borehole Permeameter : Field Result Analysis

Project/Site	H19007 Caporn St P4	
Location	387426	mE
	6488469	mN

TEST 1

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**5.1**	0.0
10	**30.0**	24.9
20	**53.8**	23.8
30	**76.0**	22.2
		23.6
	q (cm³/s)	20.8

TEST 2

r	4.0	cm
H	20.0	cm
time step	5	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**2.7**	0.0
5	**22.0**	19.3
10	**35.0**	13.0
15	**44.0**	9.0
20	**56.5**	12.5
25	**76.0**	19.5
	Avg Diff (cm)	14.7
	q (cm³/s)	25.8

TEST 3

r	4.0	cm
H	20.0	cm
time step	5	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**2.7**	0.0
5	**23.0**	20.3
10	**29.7**	6.7
15	**49.0**	19.3
20	**63.0**	14.0
25	**75.0**	12.0
	Avg Diff (cm)	14.5
	q (cm³/s)	25.4

METHOD 1 : Elrick and Reynolds (1992)

	Test 1	Test 2	Test 3
Ks (cm/s)	0.0134	0.0166	0.0163
Ks (m/day)	11.54	14.32	14.12

Average (m/day) **13.32**

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

	Test 1	Test 2		Test 3	
q (cm3/min)	1247.8	1548.1	cm3/min	1527.0	cm3/min
r (cm)	4	4.0	cm	4.0	cm
H (cm)	20.0	20.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82	0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54	-0.54		-0.54	
r/H	0.20	0.20		0.20	
Sum	0.49	0.49		0.49	
Sum*4.4*q	2663.43	3304.31		3259.23	
$2*pi*H^2$	2513.27	2513.27		2513.27	
Ksat (cm/min)	1.1	1.3		1.3	
Ksat (m/day)	15.26	18.93		18.67	

Average (m/day) **17.62**

Borehole Permeameter : Field Result Analysis

Project/Site	H19007 Caporn St P5	
Location	387608	mE
	6488349	mN

TEST 1

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**4.2**	0.0
5	**10.9**	6.7
10	**14.2**	3.3
15	**18.0**	3.8
20	**21.0**	3.0
25	**27.7**	6.7
30	**30.7**	3.0
35	**33.7**	3.0
40	**39.7**	6.0
45	**42.3**	2.6
50	**48.7**	6.4
55	**51.5**	2.8
60	**55.5**	4.0
65	**61.5**	6.0
70	**64.2**	2.7
75	**70.0**	5.8
80	**72.5**	2.5
		4.3
	q (cm^3/s)	7.5

TEST 2

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**3.0**	0.0
5	**12.5**	9.5
10	**16.7**	4.2
15	**22.2**	5.5
20	**25.0**	2.8
25	**30.3**	5.3
30	**34.5**	4.2
35	**38.0**	3.5
40	**41.5**	3.5
45	**50.2**	8.7
50	**54.9**	4.7
55	**60.0**	5.1
60	**65.0**	5.0
65	**74.7**	9.7
	Avg Diff (cm)	5.5
	q (cm^3/s)	9.7

TEST 3

r	4.0	cm
H	20.0	cm
time step	5	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**4.7**	0.0
5	**14.0**	9.3
10	**20.5**	6.5
15	**26.5**	6.0
20	**33.0**	6.5
25	**36.0**	3.0
30	**43.0**	7.0
35	**51.0**	8.0
40	**58.5**	7.5
45	**64.5**	6.0
50	**70.5**	6.0
	Avg Diff (cm)	6.6
	q (cm^3/s)	11.6

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0117	Ks (cm/s)	0.0151	Ks (cm/s)	0.0074
Ks (m/day)	10.12	Ks (m/day)	13.08	Ks (m/day)	6.43

Average (m/day)	**9.88**

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	450.8	582.4	cm3/min	694.8	cm3/min
r (cm)	4	4.0	cm	4.0	cm
H (cm)	10.0	10.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.52	0.52		0.82	
-sqrt((r/H)^2+0.25)	-0.64	-0.64		-0.54	
r/H	0.40	0.40		0.20	
Sum	0.28	0.28		0.49	
Sum*4.4*q	562.27	726.48		1483.11	
$2*pi*H^2$	628.32	628.32		2513.27	
Ksat (cm/min)	0.9	1.2		0.6	
Ksat (m/day)	12.89	16.65		8.50	

Average (m/day)	**12.68**

APPENDIX D

Transport Impact Assessment

Proposed Local Structure Plan

Multiple Lots Caporn Street, Wanneroo

Transport Impact Assessment

PREPARED FOR:
Acumen Development Solutions

August 2020

Document history and status

Author	Revision	Approved by	Date approved	Revision type
Vladimir Baltic	r01	B Bordbar	30/04/2019	Draft
Vladimir Baltic	r01a	B Bordbar	31/07/2020	Final
Vladimir Baltic	r01b	B Bordbar	18/08/2020	1st Revision

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Author: Vladimir Baltic

Project manager: Behnam Bordbar

Client: Acumen Development Solutions

Project: Multiple Lots Caporn Street, Wanneroo

Document revision: r01b

Project number: t19.051

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1.0 Summary

This Transport Impact Assessment (TIA) has been prepared for the proposed Local Structure Plan (LSP) over several lots located at the southern side of Caporn Street in Wanneroo, City of Wanneroo. The proposed LSP contemplates creation of approximately 469 residential lots over the subject site.

The *Transport Impact Assessment Guidelines (WAPC, Vol 2 – Planning Schemes, Structure Plans and Activity Centre Plans, August 2016)* states that a supporting transport assessment is to be prepared for all scheme amendments, structure plans and activity centre plans.

This TIA addresses the transport implications of the LSP proposal including the estimation of the development-generated traffic and the resultant traffic pattern and impact on the surrounding road network. This TIA also includes the capacity assessment of the proposed LSP access system.

2.0 Introduction and Background

This Transport Impact Assessment has been prepared by Transcore on behalf of Acumen Development Solutions with regard to the proposed LSP for a number of lots located at the southern side of Caporn Street in Wanneroo, City of Wanneroo. Refer **Figure 1** for locality map.

The subject site occupies an area of approximately 26.6ha situated between Caporn Street and Saponara Drive, extending some 600m east of Wells Street. The subject site comprises a number of lots including Lots 1, 2, 7, 12, 13, 36 to 38 and 9006 Caporn Street, most of which are currently undeveloped.

The subject site is situated immediately northwest of the *East Wanneroo Cell 2 – Adopted Structure Plan No.4* (*EWC2 ASP*), copy of which is attached in **Appendix B**. The LSP is designed to integrate with the existing EWC2 ASP road network and take principal access from Caporn Street with additional links to the west and south.

According to the plan provided to Transcore the subject land is proposed to accommodate a residential subdivision with a total yield of 469 lots.

Figure 1: Subject site

This TIA evaluates the traffic volumes that will be generated within and attracted to the subject area and assesses the impact of the proposal on the surrounding road network. Capacity assessment of the proposed future subdivision intersections on

Caporn Street is undertaken to establish its control and layout requirements, including review of the existing public transport services and pedestrian/cycle paths.

The location of the subject site in its regional context within the *Metropolitan Region Scheme (MRS)* is illustrated in **Figure 2**.

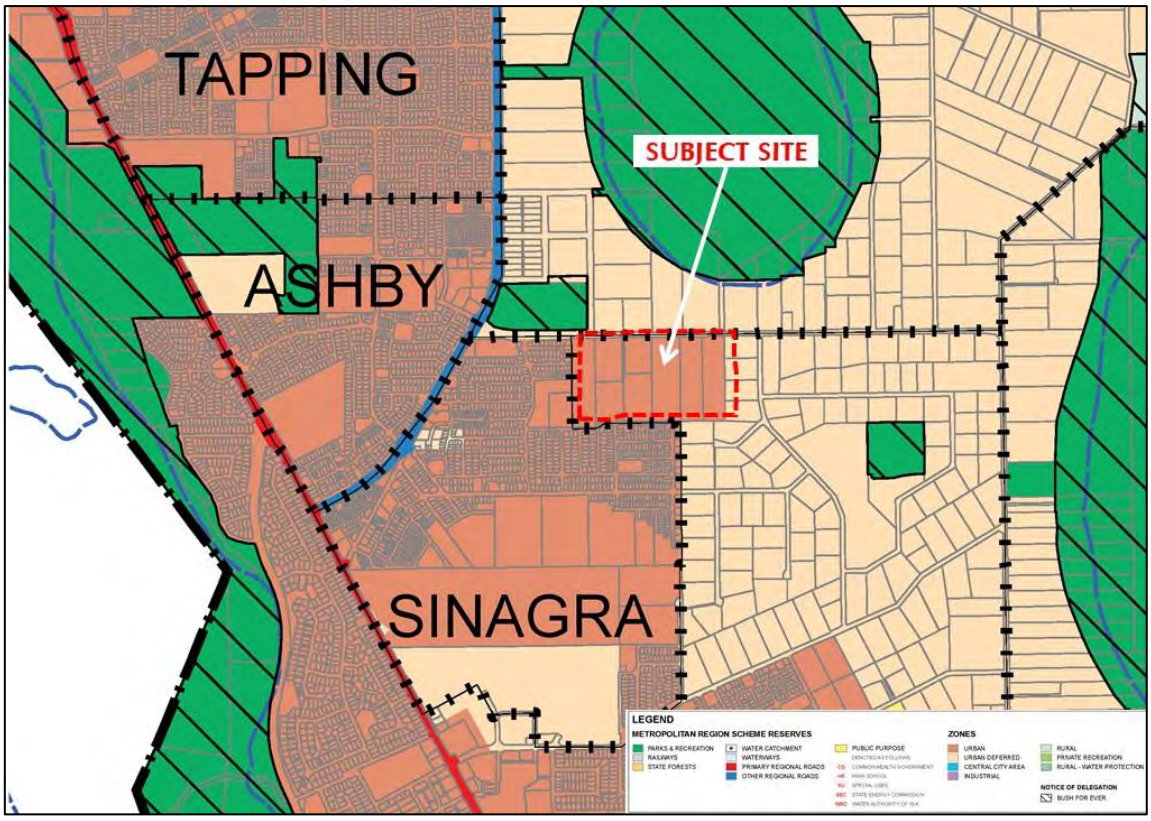


Figure 2: Local Structure Plan location within MRS context

The MRS plan reflects recent rezoning of the subject site from "Urban Deferred" to "Urban". The MRS plan also indicates that Pinjar Road is classified as an *Other Regional Road* (Blue Road) and as such is under control of WAPC with its management delegated to the Local Authority. Caporn Street is a local road under care and control of City of Wanneroo.

The subject site is generally vacant with only a few residential dwellings located centrally and at the northwest corner of the site. The immediately surrounding areas comprises residential and rural residential uses with several horticultural businesses as well.

3.0 Local Structure Plan Proposal

The proposed LSP contemplates creation of about 469 residential lots (i.e. 469 residential dwellings) comprising individual housing lots (R30 to R60 density) and six public open space areas (P.O.S.) distributed throughout the site. The LSP would be served by internal network of access roads which would integrate with the surrounding road system through several connections at three sides with principal external access from Caporn Street.

The proposed LSP movement network facilitates internal LSP distribution of vehicular, pedestrian and cyclist traffic. The internal LSP road system connects to perimeter roads via several access/egress intersections. The proposed access/egress system for the LSP is detailed as follows:

- **Western LSP Caporn Street Access Intersection** is proposed as Road 11/Caporn Street intersection approximately 135m east of the existing Wells Street intersection and is proposed to operate as a full-movement T-intersection;
- **Eastern LSP Caporn Street Access Intersection** is proposed as Road 21/Caporn Street approximately 390m east of the existing Wells Street intersection and is proposed to operate as a full-movement T-intersection;
- **Road 21 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 24 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 26 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 27 Extension Access** is proposed as an extension of Road 27 into the future residential areas to the east (initially will be cul-de-saced at eastern end);
- **Road 11 Saponara Drive Access** is proposed as a T-intersection at the SW end of the LSP area;
- **Rometta Way (Road 3) Access** is proposed as an extension of Rometta Way directly into the LSP at the northwest corner of the LSP area; and,
- **Speranza Parkway (Road 4) Access** is proposed as an extension of Speranza Parkway directly into the LSP at the southwest corner of the LSP area.

In the short-term and before Saponara Drive is extended eastbound and residential areas to the east of the LSP developed sufficiently, southern end of roads 21, 24 and 26 as well as eastern end of Road 27 will be terminated with a cul-de-sac head. This would facilitate servicing of relevant lots by waste collection and other larger vehicles in the initial stages of the development.

The proposed LSP access/egress strategy was developed to achieve the following key outcomes:

- Provide balanced internal LSP traffic flows;

- Distribute the traffic from the LSP to three sides so to minimise the traffic load onto Caporn Street;
- Allow for the potential future road widening of Caporn Street along the southern side of the road; and,
- Ensure alternative access/egress options are available for safety reasons.

Refer to **Appendix A** for the proposed concept LSP plan.

4.0 Existing Situation

The subject site occupies approximately 26.6ha and is located at the south side of Caporn Street immediately east of Wells Street in Wanneroo. It is also located approximately 1.5km northeast of Wanneroo town site and immediately to the south of Mariginiup Lake (refer **Figure 1** for more details).

4.1 Existing Land Uses

The subject site presently accommodates a few rural dwellings but is largely undeveloped. The areas to the north and east of the subject site are also predominantly of rural character with rural residential estates, small-scale farms, market gardens and limited horticulture operations while the areas to the south and west are urbanised. The Ashby Neighbourhood Centre is located approximately 500m to the west, at the northwest corner of the Pinjar Road/Hollosy Way/Caporn Street intersection.

4.2 Existing Road Network

Pinjar Road, in the vicinity of Capron Street, is a four-lane dual-carriageway arterial road with a wide landscaped median. It operates under a sign-posted speed limit of 60km/h south just north of Capron Street and 70km/h north of Edward Street. A pedestrian path is in place along the western side of the road and along the neighbourhood centre side only. The nearest formal pedestrian crossing facilities are in place at the Pinjar Road/Hollosy Way/Caporn Street roundabout intersection (refer **Figure 3** and **Figure 4** for more details).

According to the Main Roads WA *Metropolitan Functional Road Hierarchy* document, Pinjar Road is classified as a *Distributor A* road. It is also covered by the *Other Regional Roads* (*Blue Roads*) reservation in the *Metropolitan Region Scheme* as shown in **Figure 2**.

Based on the latest available traffic count data supplied by Main Roads WA, Pinjar Road (east of Wanneroo Road) carried approximately 13,240vpd on a regular weekday in 2018/19. The morning peak of 1,082vph and the afternoon peak of 1,147vph were recorded at the time.

Figure 3: Southbound view along Pinjar Road

Figure 4: Northbound view along Pinjar Road towards Blackberry Drive intersection

Caporn Street is a 7.6m wide single-carriageway wide, single-carriageway, east-west distributor road that widens to a four-lane, dual-carriageway standard on its approach to Pinjar Road intersection. There are no paths on either side of the road in the immediate vicinity of subject site. Refer **Figure 5** and **Figure 6** for more details.

Caporn Street is classified as a *Local Distributor* (*MRWA, Metropolitan Functional Road Hierarchy document*) and presently operates under a 70km/h speed limit regime. Based on June 2017 traffic counts provided by City of Wanneroo, Caporn

Street, west of Franklin Road, carried about 11,380vpd on a regular weekday with AM and PM peaks recording 915vph and 1,306vph, respectively. According to the count data the heavy vehicle participation of 7.8% was recorded in the traffic mix.

Figure 5: Eastbound view along Caporn Street from Pinjar Road intersection

Figure 6: Westbound view along Caporn Street towards Pinjar Road intersection

Rometta Way, **Speranza Parkway** and **Saponara Drive** form part of the existing local road system and are all typical 6.0m wide single-carriageway residential roads with a pedestrian path on one side of the road.

All three roads are classified as *Access Roads* (*MRWA, Metropolitan Functional Road Hierarchy*). There are no traffic counts available for either of the roads; however,

based on the layout of the local road network and the size of residential areas that these roads serve, it is estimated that all three roads presently carry very low level of traffic. All three roads operate under a default built-up area speed limit of 50km/h.

Approximately 500m west of the subject site, Caporn Street forms a dual-lane, four-way roundabout with Hollosy Way and Pinjar Road.

Wells Street forms a priority-controlled T-intersection with Caporn Street to the northwest of the subject site.

Information available on the Main Roads WA website indicates that the Pinjar Road/Hollosy Way/Caporn Street roundabout recorded a total of 25 crashes including three causalities during the five-year period ending in December 2019.

During the same period, Caporn Street/Wells Street intersection recorded a total of three crashes with no casualties.

More than 50% of all crashes at Pinjar Road/Hollosy Way/Caporn Street intersection and all crashes at Caporn Street/Wells Street intersection were rear end crashes with majority taking place during daytime (for details on the crash records refer **Table 1** and **Table 2.**

Table 1. Crash history for the Pinjar Road/Hollosy Way/Caporn Street intersection

Intersection				Total Crashes	Casualty
Pinjar Rd/Hollosy Wy/Caporn St				25	3
Rear End	Side swipe	Pedestrian	Cycle	Wet	Night
15	4	0	N/A	5	5

Table 2. Crash history for the Caporn Street/Wells Street intersection

Intersection				Total Crashes	Casualty
Caporn St/Wells St				3	0
Rear End	Sideswipe	Pedestrian	Cycle	Wet	Night
3	0	0	N/A	2	0

4.3 Public Transport Access

The subject site, including the existing residential areas to the immediate south have no direct or practical/convenient access to the public transport network at present. The nearest pair of bus stops is located on Carosa Way some 1km (as-crow-flies) to the west of the subject site. The map of existing public transport services within the locality is provided in **Figure 7**.

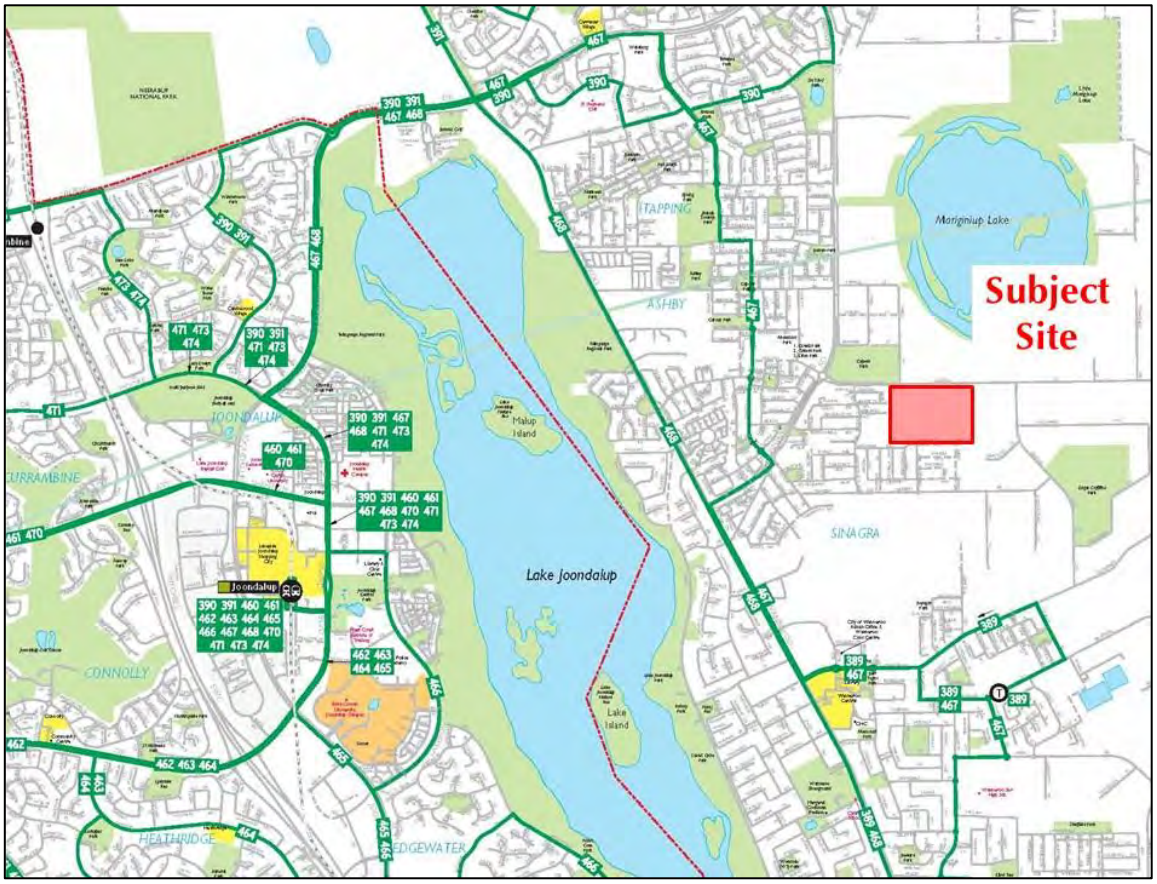


Figure 7: Existing bus routes (source: Transperth)

4.4 Pedestrian and Cyclist Facilities

Pedestrian connectivity to the subject site is available via the existing external path network comprising paved paths on surrounding residential roads to the immediate south and west (i.e. Rometta Way, Speranza Parkway and Saponara Drive). Saponara Drive entails a 2.5m wide shared path along the northern side of the road.

Bike access to the site is limited with no direct shared path links to the site itself and only with Caporn Street (section west of San Teodoro Avenue) identified as "good road riding environment" with on-road bike lane. The Department of Transport's *Perth Bike Map* series (see **Figure 8**) shows available pedestrian and cyclist routes to the site.

Figure 8. Bike map (source: Department of Transport)

4.5 Public Transport Network Planning

At this stage, no new public transport option in form of bus services are planned or justified for the subject site. However, subject to further urbanisation of the immediate locality and feasibility investigation outcomes, the Public Transport Authority (PTA) may choose to investigate introduction of appropriate new public transport service for the locality.

5.0 Proposed Internal LSP Transport Network

5.1 Road Hierarchy

Based on the road design principles contained within the WAPC *Liveable Neighbourhoods* publication (2009) for road classification and the estimated total traffic generation of the LSP all internal LSP roads are likely to be classified as *Access Street C, Access Streets D* and *Laneways*.

The sections of LSP roads connecting to Caporn Street (Roads 11 and 21) are estimated to carry up to 1,500vpd (along sections approaching Caporn Street) qualifying them for the *Access Street C* status. The rest of the internal subdivision road network is estimated to carry well below 1,000vpd. Accordingly, the remainder of the internal subdivision roads can be classified as *Access Street D*. One short laneway is also proposed to connect Roads 16 and 19 near to POS 5 (refer **Figure 9** for more details).

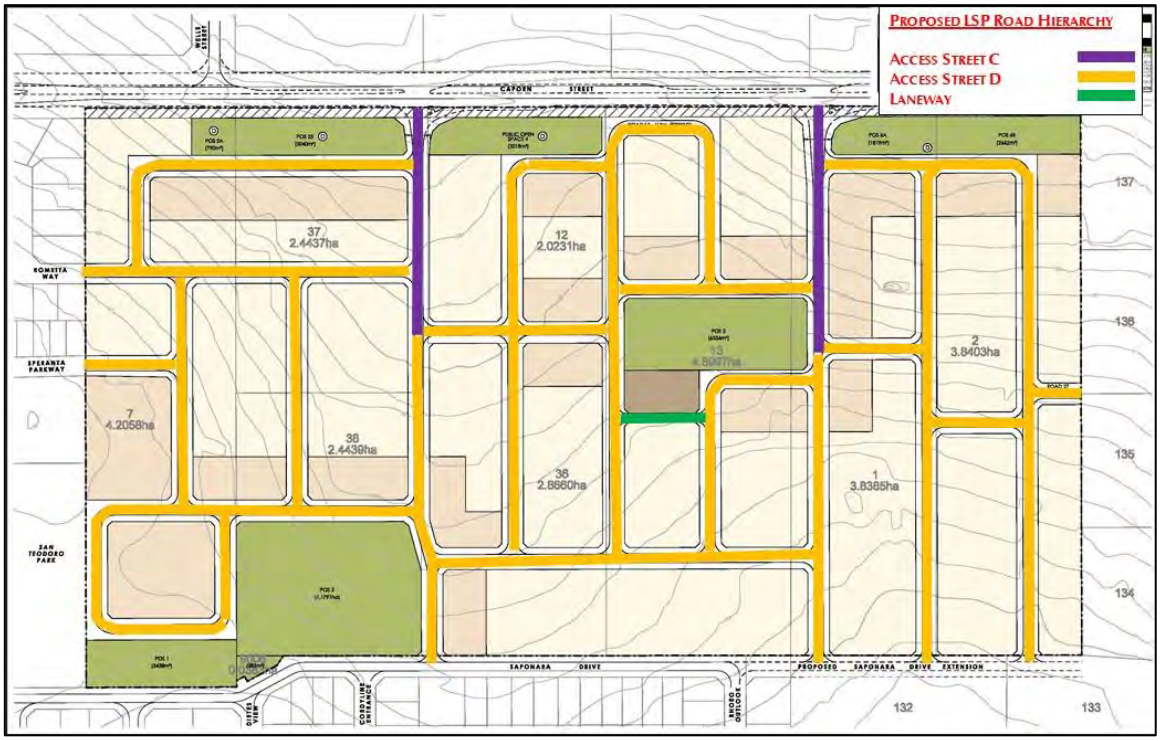


Figure 9. Proposed LSP road hierarchy

Some key characteristics of typical cross-sections, defined in *WAPC Liveable Neighbourhoods (2009)* publication, are discussed further in this section.

Access Street C is a typical residential street projected to carry up to 3,000vpd and common to areas with densities of R30/R35. It is not intended to carry buses or accommodate any bike lanes. For the subject LSP due to its relatively short length no on-street parking is proposed for section adjacent to Caporn Street intersection in order to avoid any impact on traffic operation and potential safety implications.

A typical road reserve of 15.4 with a trafficable carriageway width of 7.2m is recommended by *Liveable Neighbourhoods* for an *Access Street C*. If fronting P.O.S., access street verge adjacent to P.O.S. may be reduced by 1.0-1.2m. This is the case with the internal LSP roads abutting the P.O.S. areas where road reserve is narrowed down to 14.2m. This is consistent with the *Liveable Neighbourhoods* guidelines. Refer to **Figure 10** for typical *Access Street C* cross section.

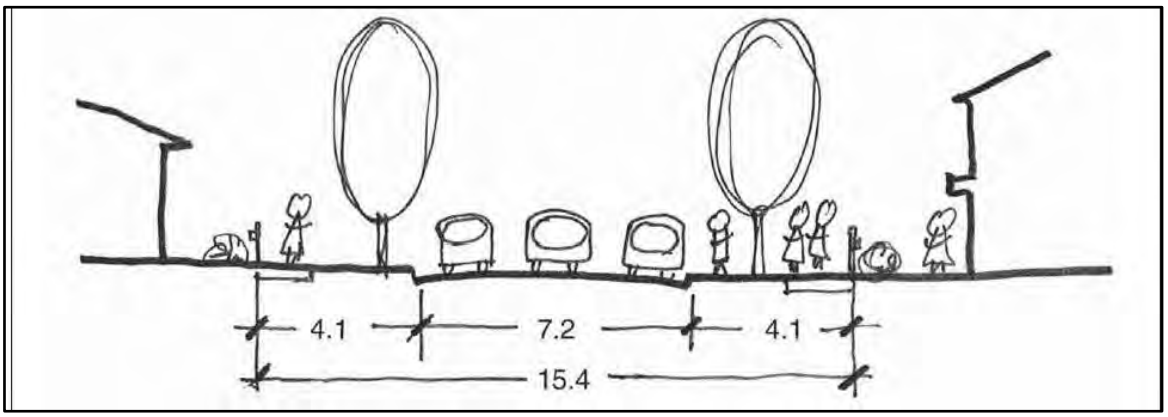


Figure 10. Access Street C – yield (or give way) street with target speed of 40km/h (<3,000vpd)

The typical road reserve for *Access Street D (narrow yield)* in Liveable Neighbourhoods entails a road reserve width of 14.2m with 6.0m wide trafficable carriageway pavement and 4.1m wide verges on both sides. This type of street is recommended throughout the subdivision road network. Current subdivision practice often provides 15.0m road reserve width and 4.5m verges for *Access Street D*.

If fronting P.O.S., access street verge adjacent to P.O.S. may be reduced. This is the case at several locations throughout the LSP area.

Maximum desirable daily traffic volume for this type of road is 1,000vpd. The typical cross-section of the *Access Street D* sourced from *"Liveable Neighbourhoods"* is illustrated in **Figure 11**.

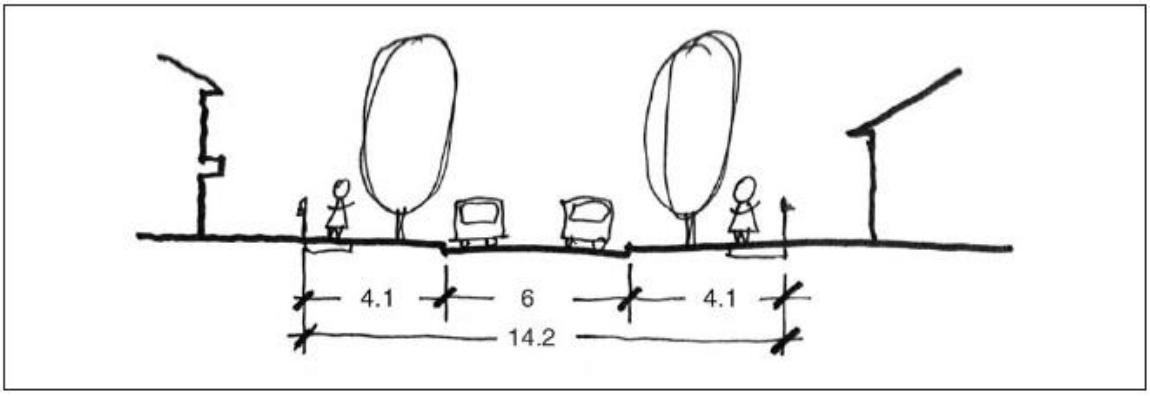


Figure 11. Access Street D (narrow yield) with target speed of 30 km/h (<1,000vpd)

The typical road reserve for *Laneways* entails a 6m wide trafficable pavement sufficient to allow two-way movements, rubbish collection and vehicle access into garages located on the rear of properties. Maximum desirable traffic volume for a laneway is 300vpd. The typical cross-section of the *Laneways* is illustrated in **Figure 12**.

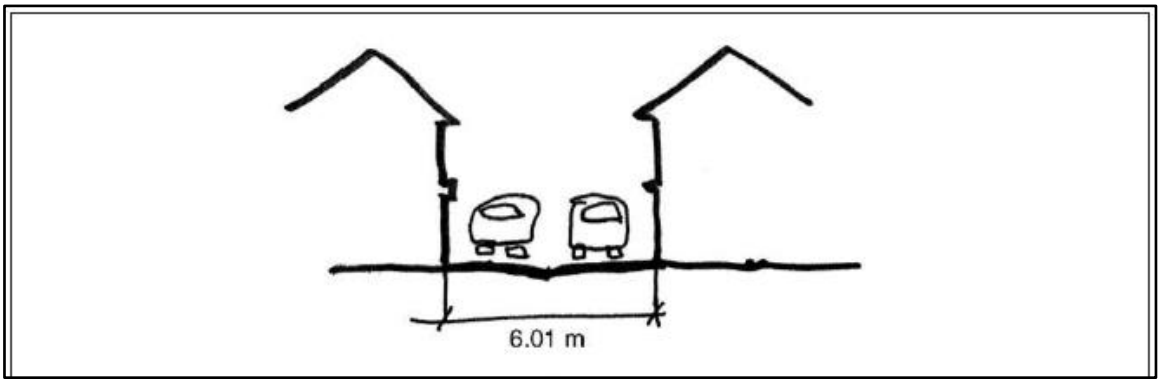


Figure 12. Laneways – for rear vehicle access with target speed of 15km/h (<300vpd)

5.2 Pedestrian and Cyclist Facilities

In accordance with the WAPC *Liveable Neighbourhoods* principles paths would be required on at least one side of all lower order access streets. Accordingly, it is proposed that 2.0m footpaths be provided on one side off all internal LSP roads (excluding the Laneway). A 2.0m wide footpath standard is selected to mirror the footpath standard already in place on lower order residential access streets to the immediate west of the LSP.

Shared paths on internal subdivision roads would not be mandatory as daily traffic forecast would be such that cyclists can safely share the carriageways with cars.

As part of the proposed subdivision it is anticipated that a shared path on southern side of Caporn Street may ultimately be constructed to tie in with the existing section of a shared path already in place between Pinjar Road and San Teodoro Avenue some 300m west of the subject site. This path would ensure important pedestrian and cyclist connection to the nearby Ashby Neighbourhood Centre which located some 500m west of the subject site. The proposed LSP pedestrian path network is shown in **Figure 13**.

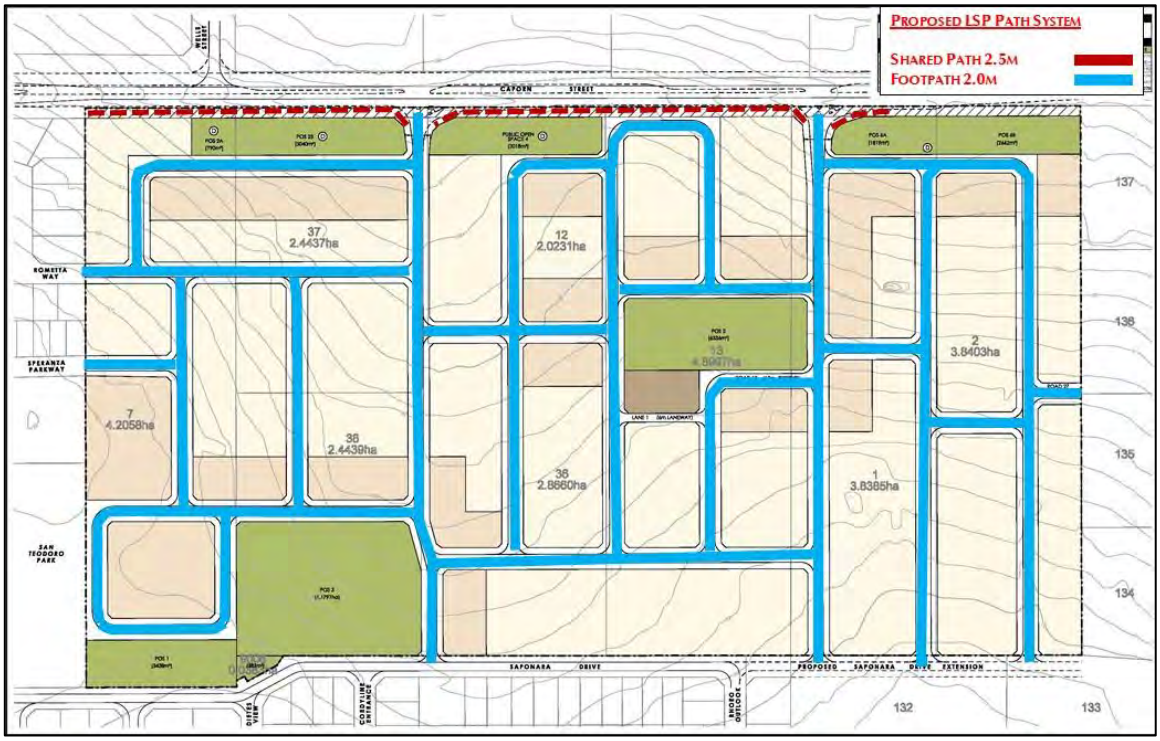


Figure 13. Proposed LSP pedestrian and cyclist facilities

5.3 Public Transport

The existing bus services at this locality are noted in section 4.4 of this report. It is expected that once the population within the locality has reached critical levels PTA will investigate public transport service for the locality. The Draft East Wanneroo DSP anticipates local bus services along Neighbourhood Connector roads.

6.0 Changes to External Transport Network

It is anticipated that Caporn Street may need to be upgraded to a four-lane standard in the near future considering the level of current traffic volume it carries. The current daily traffic volumes of over 11,000vpd (west of Franklin Road) suggest that this upgrade will probably need to eventuate in the very near future. Current traffic volumes also suggest that Caporn Street classification would need to be reviewed, as volumes far exceed desirable daily traffic volume thresholds of a typical *Local Distributor* (current Caporn Street classification) and are more akin to a *District Distributor* road class.

However, it is acknowledged that Caporn Street is still contemplated as a connector road in Draft East Wanneroo DSP: *"Dundebar Road, Caporn Street and Coogee Road are not intended to become integrator arterials; however, they will function as important connections from the EWDSP area to the existing road network in the west"*.

The proposed residential subdivision design allows for the potential future Caporn Street reserve widening on the southern side which is required to accommodate the ultimate road duplication.

7.0 Integration with Surrounding Area

The proposed LSP is in accordance with the existing land uses to the immediate west and south. The proposed internal LSP road network is designed to integrate with the existing road system bordering the site and take main access from Caporn Street which is a local distributor road.

A primary school is proposed centrally within the EWC2 ASP No.4 area, some 600m to the southwest of the subject site. The location of the future primary school is optimal to serve the subject site. Routes to and from the school would be via internal subdivision roads without the need to use or cross any district-level roads to travel between the subject site and the school.

Ashby Village Neighbourhood Centre, located about 500m west of the subject site, would represent a convenient and easily accessible retail/commercial node to service the LSP area.

8.0 Traffic Assessment

8.1 Assessment Period

The year 2031 has been selected as the assessment year for the proposed LSP. It is anticipated that by this time the LSP area can be fully developed and activated. Year 2031 has been adopted as the assessment year in accordance with WAPC *Transport Impact Assessment Guidelines*.

The appropriate periods for assessment of the proposed residential development are typical weekday AM and PM peak periods. Accordingly, and for the purpose of intersection capacity analysis the typical morning and afternoon commuter peak hours of 7:00-8:00AM and 5:00-6:00PM have been adopted as assessment periods.

8.2 Trip Generation and Distribution

The traffic volume expected to be generated by the proposed LSP has been estimated using trip generation rates recommended in the WAPC *Transport Impact Assessment Guidelines Volume 2 (August 2016)*. Accordingly, the daily traffic generation rate of 8 vehicle trips per day (vpd) and peak hour trip rate of 0.8 per hour per dwelling was used in this case.

Accordingly, it is estimated that the proposed LSP would generate approximately 3,750 total weekday trips (both inbound and outbound) with approximately 375 trips both inbound and outbound (approximately 10% of total daily trip production), during the morning and afternoon peak hour periods. As the proposed land uses for the subject site are exclusively residential it is anticipated that the vast majority of trips would be external to the structure plan area.

The assumed distribution of trips from the LSP area is based on the layout of adjacent local and district-level road network as well as major education, retail, recreational, employment and social attractors. The external distribution of trips is summarised in **Table 3**.

Table 3: Trip distribution of traffic generated by proposed LSP

Direction	Proportion (%)
Caporn Street (west)	70%
Caporn Street (east)	6%
Rometta Way (west)	2%
Speranza Parkway (west)	2%
Saponara Drive (south)	20%
Total	**100%**

8.3 Traffic Flow Forecasts

The forecast total daily traffic volume plan for the internal LSP road system is illustrated in **Figure 14.**

All traffic volume figures represent total daily vehicular trips. All minor internal LSP roads not showing traffic volumes will have daily traffic volumes of significantly less than 1,000vpd.

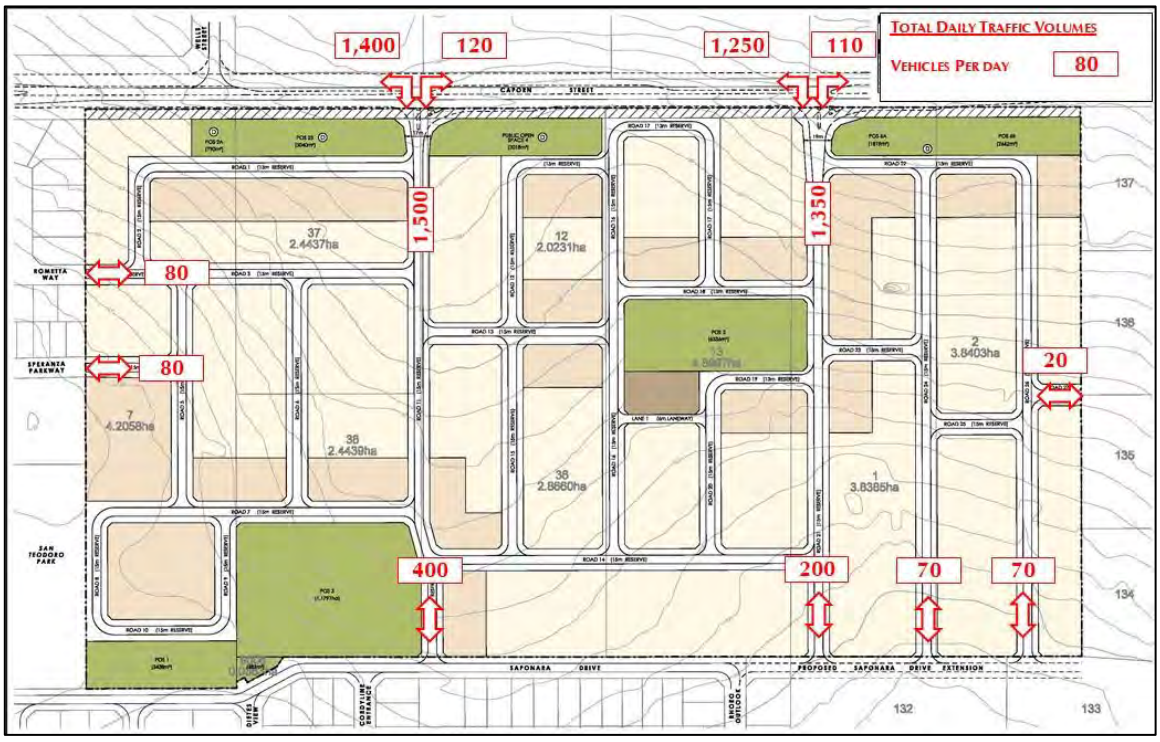


Figure 14: Daily traffic flows forecast for the proposed LSP

The daily traffic forecast indicates that most of the traffic generated by the LSP would be taking Caporn Street route (about 76% of total daily trip production) whilst traffic using (combined) southern and western routes would be in order of 900vpd. This traffic would be distributed over six routes/roads thereby reducing any impact from the subdivision traffic on adjacent residential areas.

The AM and PM peak traffic volumes generated by the proposed LSP and expected to pass through the two external LSP access intersections on Caporn Street are illustrated in **Figure 15**.

The anticipated peak hour traffic volumes on LSP access intersections on Saponara Drive are estimated to be significantly lower that those on Caporn Street and as such are considered to not be significant enough to warrant detialed assessment.

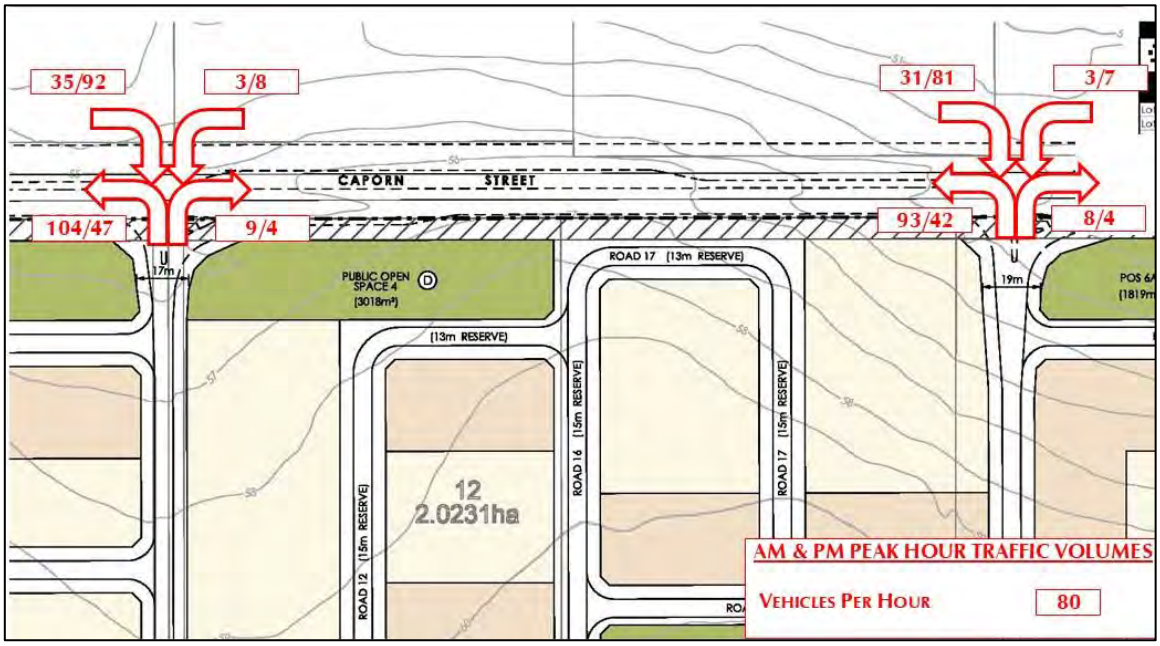


Figure 15. Projected AM and PM peak hour traffic flows at external LSP access intersections on Caporn Street

8.4 Internal LSP Roads and Intersections

8.4.1 Road Assessment

The LSP internal road network proposed to accommodate the projected traffic volumes, including the details of the proposed road hierarchy and indicative cross sections have been detailed in section 5.1 of this transport assessment.

The desirable daily volume thresholds for Access Street C and D are 3,000vpd and 1,000vpd, respectively. As such it is expected that the anticipated road hierarchy for the LSP would have more than sufficient capacity to accommodate the forecast daily traffic flows on internal structure plan roads.

As previously discussed, the LSP's internal road network is designed to integrate with the existing road network serving the residential areas to the immediate west and south. The level of traffic expected to flow from the LSP area to the surrounding road network is expected to be relatively low and distributed in four directions thus reducing the level of impact on each individual road.

The expected additional traffic as a result of the proposed LSP on surrounding residential roads is low and would not have a practical impact on their current operations.

8.4.2 Intersection Assessment

Table 2.4 from AUSTROADS *"Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings (2007)"*, although not featuring in recent editions, still

provides reasonably good indication of traffic volume thresholds for detailed intersection assessment warrants. This table illustrates the traffic volume thresholds above which a detailed intersection capacity assessment is required.

It is typically assumed that regular peak hour traffic generally represents approximately 10% of the total daily traffic volume. As hourly traffic volumes through intersections are well below the indicative thresholds shown in **Table 4,** it is confirmed that uninterrupted traffic flow conditions can be expected at all key internal structure plan intersections.

Table 4: Traffic volume thresholds for detailed intersection analysis

Major Road type	Major Road Flow (vph[1])	Minor Road Flow (vph)
Two-lane	400 500 650	250 200 100
Four-lane	1,000 1,500 2,000	100 50 25

All but one internal LSP intersections are designed as priority-controlled T-intersections. The internal LSP Roads 12, 13 and 15 intersect forming a four-way priority-controlled intersection. Typically, a roundabout treatment is contemplated for such intersections; however, in this particular instance due to anticipated traffic flows involved (well below 2,000vpd threshold), good geometry and likely available sightlines, it is recommended that a threshold treatments and give-way signs on both Road 12 and Road 15 approaches be implemented to ensure appropriate traffic control at this location.

8.5 Pedestrian/Bicycle Networks

The proposed network of footpaths for pedestrians is described in section 5.2 of this report. This network of paths will provide sufficient level of accessibility and connectivity for pedestrians within the structure plan area. As previously discussed, it is anticipated that, due to the relatively low level of traffic forecast for internal LSP roads, cyclists and vehicles can be expected to safely share the internal LSP roads and as such no particular cyclist facilities are proposed for the LSP.

The WAPC *Transport Impact Assessment Guidelines Volume 2 – Planning Schemes, Structure Plans and Activity Centres (2016)* provides guidance on the levels of traffic volumes that are likely to affect the ability for pedestrians to cross various types of roads. Accordingly, an undivided two-lane road should be acceptable for pedestrians crossing traffic volumes of up to approximately 1,100vph and this threshold can be increased to around 2,800vpd by adding a central median or pedestrian refuge islands. On a four-lane road, because of its greater carriageway

[1] *vph – vehicles per hour, typically represent 10% of total daily traffic volume*

width, this threshold is lower; even with a median island the threshold is only around 1,600vpd.

Since the forecast traffic volumes on internal LSP roads are nowhere near these levels, no particular pedestrian and cyclist crossing facility would be required.

It is recommended that a shared path on southern side of the Caporn Street and along the LSP area frontage be constructed to ultimately be linked with the exiting path on Caporn Street which currently terminates at San Teodoro Avenue, some 450m west of the LSP. It is anticipated that this shared path will ultimately form part of a continuous shared path along the entire length of Caporn Street.

8.6 Access to Schools

At present, no schools are proposed for the LSP and there are no existing schools within the 800m radius of the LSP area either. However, a primary school is proposed centrally within the EWC2 ASP No.4 area, which would be located some 450m to the south of the LSP area. It is anticipated that the future primary school catchment would also serve the LSP area. As such, the most convenient routes to and from the school would be taken via internal structure plan roads and adjacent access roads that presently record low level of traffic activity. This would also mean that there will be no need to take or cross district-level roads to travel between the LSP area and the school. The students would need to cross Vincent Road which is classified as a *Local Distributor*. Pedestrian crossings with refuge island are already in place on this road at intersections with Cordyline Entrance and Rhoeo Outlook.

The rule of thumb previously used by the Department of Education WA was 0.35 primary students per dwelling but we can assume this is reduced to 0.3 students per dwelling due to Year 7 students being relocated to high schools. That would indicate up to about 140 primary school students from the LSP area in the future (some students may attend private school instead). The Metro average from the Census is only about 0.25 primary students per dwelling, so the Education Department figure reflects the higher number of children in new suburban areas.

Information from the 2002-2006 Perth & Regions Travel Survey (PARTS) indicated that 25.4% of primary school students walk or cycle to school and 26.7% walk or cycle home from school. Therefore, it is estimated that a maximum of about 36 primary school students would walk or cycle across Vincent Road when the LSP area is fully developed.

Maximum desirable traffic volumes threshold for a Local Distributor within the urbanised area is 6,000vpd. It is therefore concluded that maximum likely future traffic volumes on Vincent Road would not affect the ability of pedestrians to cross this road so there is no need for treatments such as grade-separated crossings or signalised crossing points.

Based on the estimated primary school student movements across Vincent Road the proposed mid-block pedestrian crossing may qualify for a warden-controlled school crossing facility to assist primary school students to cross this road. Warrant criteria

provided on the WA Police website indicate that a *Type A Children's Crossing* may be provided where a minimum of 20 students and 200 vehicle movements occur within the hour immediately before and immediately after school, for a primary school. The warrants are lower for a *Type B Children's Crossing* at 10 students and 100 vehicle movements.

Such facilities can only be applied for by a School Principal or the President/ Secretary of the relevant school/parent organisation (eg. P&C or P&F). The anticipated numbers of students crossing this *Local Distributor* road would potentially meet these warrants so it would be expected that the school could apply for this type of facility when future student numbers and movements meet those warrants.

8.7 Access to Public Transport

The WAPC *Transport Impact Assessment Guidelines Volume 2 (2016)* suggest that it is desirable for at least 90% of dwellings to be within 400m distance of a bus route.

The existing bus services at this locality are noted in section 4.4 of this report. It is concluded that at present the proposed LSP is not covered by the public transport services and thus the 90% LSP coverage guideline is not met. It is however expected that once the population within the locality reaches critical levels PTA will investigate public transport service for the locality.

9.0 Analysis of External Transport Network

9.1 Traffic Volumes on External Road Network

Presently, Caporn Street is constructed as a two-lane 7.4m wide single-carriageway road widening to a four-lane dual-carriageway standard west of San Teodoro Avenue and on its approach to Pinjar Road intersection.

Based on latest available traffic counts for Caporn Street sourced from City of Wanneroo, Caporn Street (west of Franklin Road carried approximately 11,380vpd.

Due to various economic factors and population growth data as well as available traffic counts from across Perth metro area it is widely accepted that traffic volumes in general have not recorded net growth over the past few years. In fact, at many locations traffic counts have confirmed notable reduction in traffic activity. Accordingly, it is assumed that no changes in traffic volumes will occur in the 2017-2021 period.

For the purpose of this assessment a rather conservative growth in background traffic of 2% p.a. (20% cumulative growth) is assumed for the 2021-2031 period. Accordingly, estimation of 2031 traffic volumes on Caporn Street without and with the additional traffic from the LSP area is illustrated in **Table 5**.

Table 5: Caporn Street traffic volume forecast

Road section	W of LSP	E of LSP
2017 – 2021	11,380vpd	11,380vpd
2031 (no LSP)	13,656vpd	13,656vpd
2031 (with LSP)	16,280vpd	13,880vpd

It is apparent that Caporn Street presently carries traffic volumes in excess of its current *Local Distributor* status.

It is therefore assumed that by the full LSP build-out Caporn Street will be duplicated to mirror its current standard west of San Teodoro Avenue intersection. It is assumed that four-lane with median cross-section will be constructed between the Pinjar Road and Franklin Road intersections as a minimum.

Accordingly, for the purpose of this assessment, the future 2031 LSP access intersections on Caporn Street are modelled to include two through lanes on Caporn Street with left and right-turning lanes for safe and efficient operational conditions.

9.2 External Intersections

The traffic impact from the proposed LSP on the intersections along Saponara Drive, Romettas Way and Speranza Parkway is estimated to be moderate and as such detailed intersection analysis is deemed unnecessary in this case. The major traffic impact from the LSP will be experienced at the two main LSP access intersections on Caporn Street and as such detailed capacity assessment is warranted for these intersections.

Accordingly, a capacity assessment of main access intersections on Caporn Street during the typical weekday morning and afternoon peak hour was undertaken using the SIDRA intersection-modelling software for assumed post-development stage (year 2031) to determine the expected operational characteristics of these intersections under full development scenario.

The estimated traffic volumes generated by the fully build-out LSP were added to the estimated 2031 background traffic on Caporn Street in order to provide for a robust assessment. Caporn Street was modelled in accordance with its ultimate four-lane standard.

Capacity analysis was undertaken using the SIDRA computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.
- **Level of Service**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of services, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection.
- **95% Queue**: is the queue length below which 95% of all observed queue lengths fall.

The results of the relevant intersection SIDRA analysis are summarised in **Appendix C** and discussed in the following paragraphs.

Western LSP Access Intersection (on Caporn Street)

This intersection was modelled as a priority-controlled T-intersection with left-turn slip-lane and right-turn pocket on Caporn Street. Caporn Street was modelled as four-lane plus median cross-section similar to the existing section immediately west of San Teodoro Avenue. Refer **Figure 16** in **Appendix C** for more details on intersection layout plan.

The result of capacity assessments confirms that good operational conditions can be expected for both AM and PM peak hours in 2031. The analysis reports overall intersection LoS A for the morning peak period and LoS A to C for the afternoon peak period. No notable queues are recorded on either approach to the intersection. Ample spare capacity remains available in both scenarios. Refer **Table 6** and **Table 8** in **Appendix C**.

Western LSP Access Intersection (on Caporn Street)

This intersection was also modelled as a priority-controlled T-intersection with left-turn slip-lane and right-turn pocket on Caporn Street with four-lane and median cross-section of Caporn Street. Similar to western LSP access intersection the capacity assessment shows very good operational characteristics in both morning and afternoon scenarios with no notable delays or queues and with ample spare capacity. Refer **Table 7** and **Table 9** in **Appendix C**.

Based on the results of intersection capacity assessment it can be concluded that the proposed layout for the LSP Caporn Street access intersections provides for good operational conditions under full development build-out of the proposed LSP in 2031.

10.0 Conclusions

This Transport Impact Assessment has been prepared for the proposed Local Structure Plan over a number of lots located at the southern side of Caporn Street in Wanneroo, City of Wanneroo. The subject LSP comprises a number of lots including Lots 1, 2, 7, 12, 13, 36 to 38 and 9006 Caporn Street.

The proposed LSP yields a total of about 469 residential lots. The proposed LSP road system is designed with the intention to integrate with the adjacent East Wanneroo Cell 2 – Adopted Structure Plan No.4 and existing surrounding road network and have principal access intersections on Caporn Street. The internal LSP road system consists of *Access Streets C, Access Street D and Laneways,* designed to facilitate inter-LSP vehicular, cyclist and pedestrian movements.

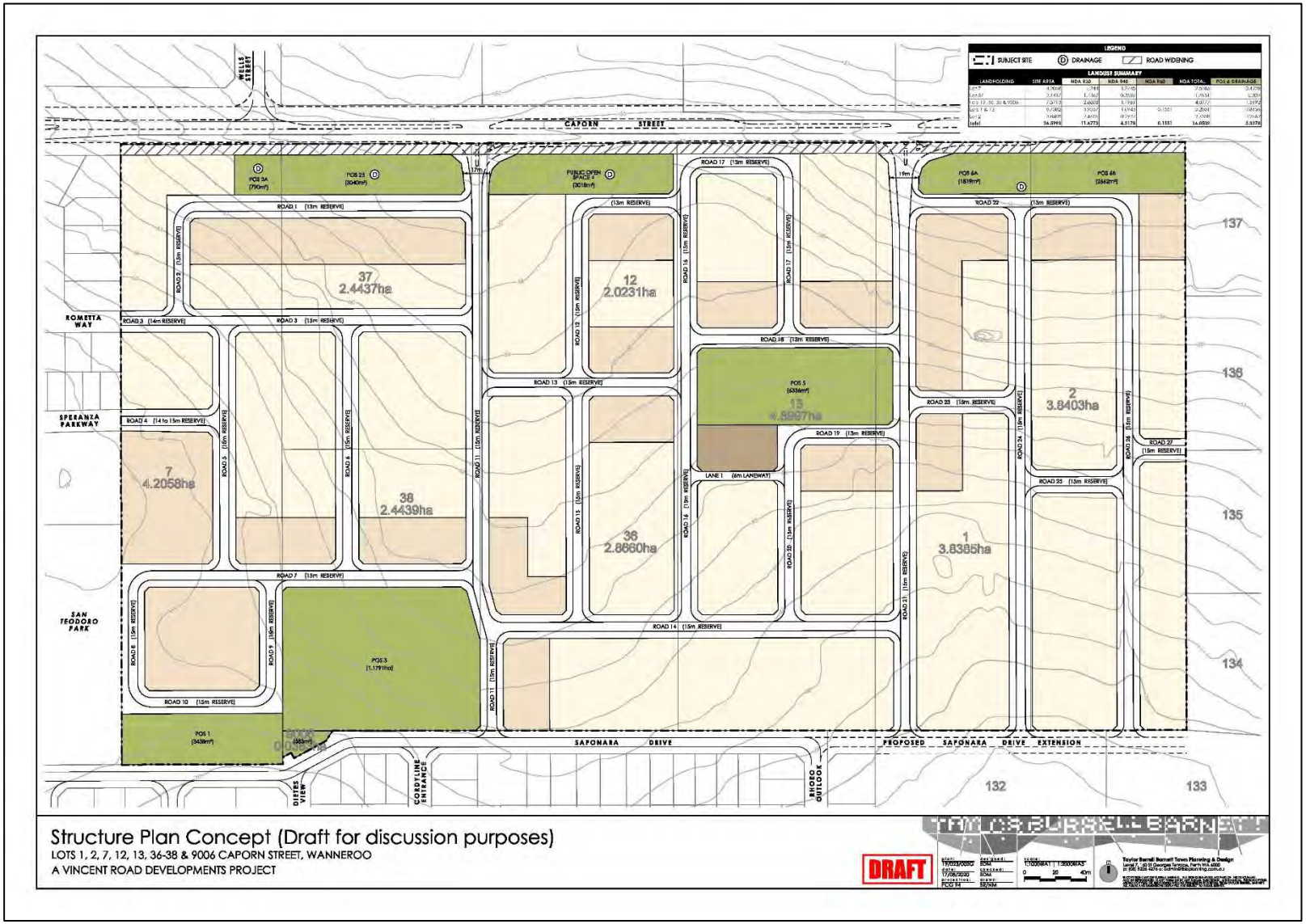
The LSP is estimated to generate approximately 3,750 total daily inbound and outbound vehicular trips with approximately 375 external trips during AM and PM peak weekday periods.

The capacity assessments undertaken for the adjacent roads and intersections indicates that the proposed LSP will not have an adverse impact on the traffic operations of the surrounding road network which has more than sufficient capacity to accommodate the anticipated LSP-generated traffic, considering the anticipated upgrading of Capron Street occurs.

Although at present there are no plans to provide public transport service for the locality and the subject site, it is however expected that, once the population within the locality has reached critical levels, PTA could potentially investigate provision of public transport service for the locality.

Appendix A

CAPORN STREET LOCAL STRUCTURE PLAN - CONCEPT



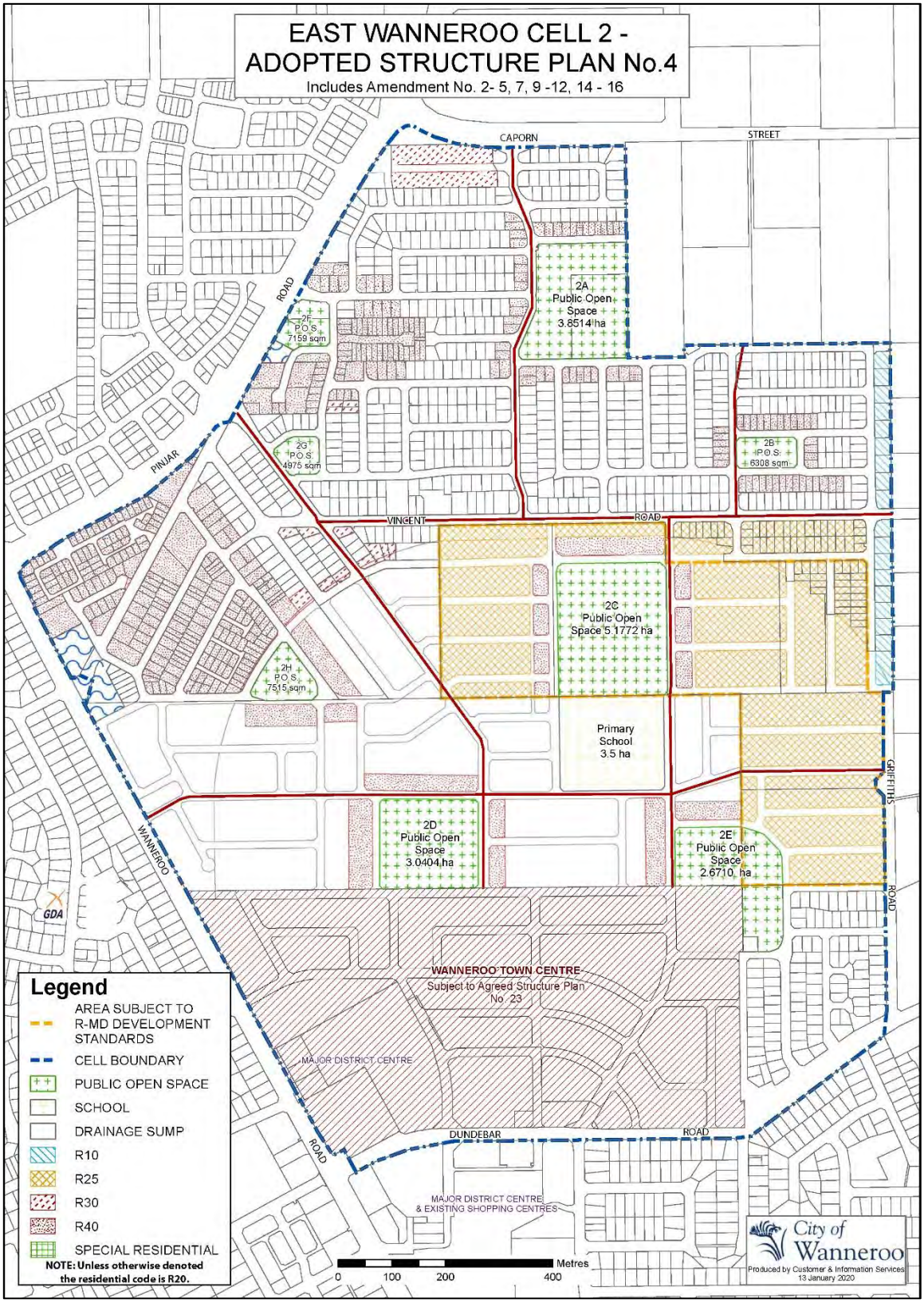
Structure Plan Concept (Draft for discussion purposes)

LOTS 1, 2, 7, 12, 13, 36-38 & 9006 CAPORN STREET, WANNEROO

A VINCENT ROAD DEVELOPMENTS PROJECT

Appendix B

EAST WANNEROO CELL 2 – AGREED STRUCTURE PLAN No. 4


EAST WANNEROO CELL 2 -
ADOPTED STRUCTURE PLAN No.4
Includes Amendment No. 2- 5, 7, 9 -12, 14 - 16
CAPORN
STREET
ROAD
2A
Public Open
Space
3.8514 ha
2F
P.O.S.
7159 sqm
2G
P.O.S.
4975 sqm
2B
P.O.S.
6308 sqm
PINJAR
VINCENT
ROAD
2C
Public Open
Space 5.1772 ha
2H
P.O.S.
7515 sqm
Primary
School
3.5 ha
GRIFFITHS
2D
Public Open
Space
3.0404 ha
2E
Public Open
Space
2.6710 ha
WANNEROO
ROAD
GDA
WANNEROO TOWN CENTRE
Subject to Agreed Structure Plan
No. 23
MAJOR DISTRICT CENTRE
DUNDEBAR
ROAD
ROAD
MAJOR DISTRICT CENTRE
& EXISTING SHOPPING CENTRES
Legend
AREA SUBJECT TO
R-MD DEVELOPMENT
STANDARDS
CELL BOUNDARY
PUBLIC OPEN SPACE
SCHOOL
DRAINAGE SUMP
R10
R25
R30
R40
SPECIAL RESIDENTIAL
NOTE: Unless otherwise denoted
the residential code is R20.
Metres
0
100
200
400
City of
Wanneroo
Produced by Customer & Information Services
13 January 2020

Appendix C

SIDRA RESULTS

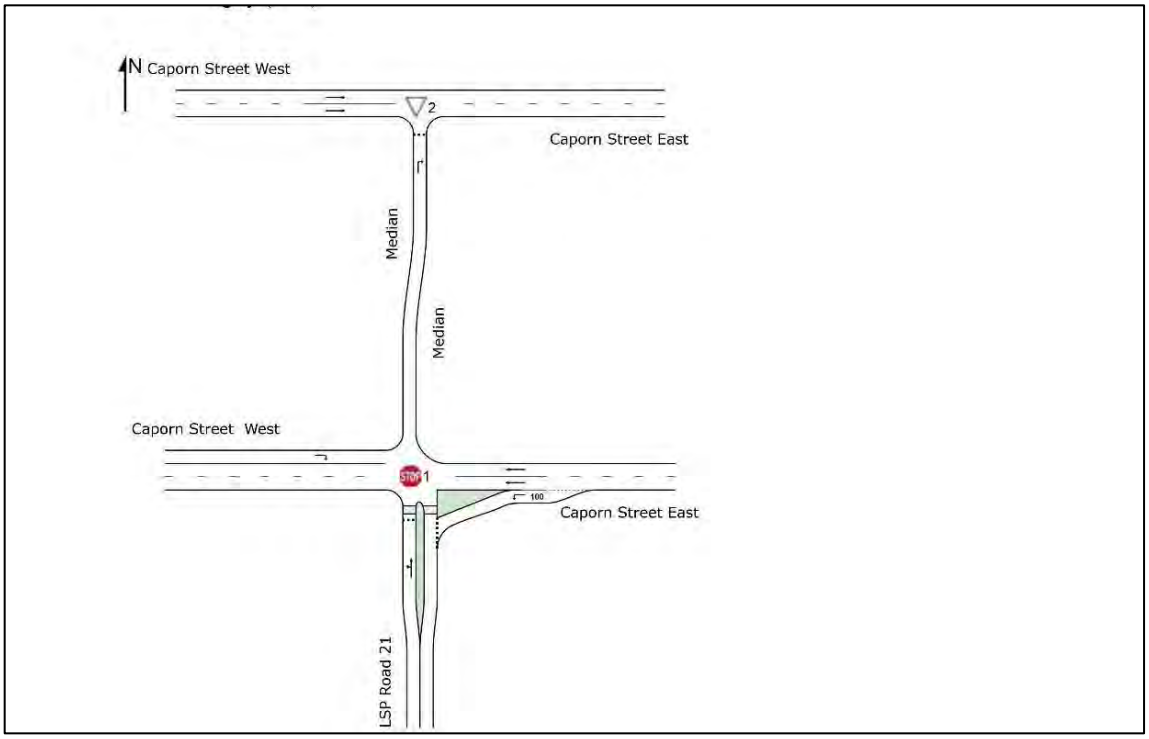


Figure 16: LSP Access intersection – concept layout as modelled

Table 6: SIDRA result for Western LSP Access intersection AM peak (year 2031)

Movement Performance - Vehicles														
Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: LSP Road 11														
1	L2	109	2.0	109	2.0	0.103	1.0	LOS A	0.4	3.0	0.38	0.26	0.38	29.6
2	T1	9	2.0	9	2.0	0.103	4.4	LOS A	0.4	3.0	0.38	0.26	0.38	19.7
Approach		119	2.0	119	2.0	0.103	1.3	LOS A	0.4	3.0	0.38	0.26	0.38	29.0
East: Caporn Street East														
4	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.11	0.60	0.11	25.2
5	T1	560	7.8	560	7.8	0.151	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	70.0
Approach		563	7.8	563	7.8	0.151	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	69.3
West: Caporn Street West														
12	R2	37	2.0	37	2.0	0.048	9.2	LOS A	0.2	1.3	0.52	0.72	0.52	29.6
Approach		37	2.0	37	2.0	0.048	9.2	NA	0.2	1.3	0.52	0.72	0.52	29.6
All Vehicles		719	6.5	719	6.5	0.151	0.7	NA	0.4	3.0	0.09	0.08	0.09	51.0
South: Median														
3	R2	9	2.0	9	2.0	0.013	2.8	LOS A	0.0	0.2	0.49	0.39	0.49	44.9
Approach		9	2.0	9	2.0	0.013	2.8	LOS A	0.0	0.2	0.49	0.39	0.49	44.9
West: Caporn Street West														
11	T1	726	7.8	726	7.8	0.196	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		726	7.8	726	7.8	0.196	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		736	7.7	736	7.7	0.196	0.1	NA	0.0	0.2	0.01	0.01	0.01	69.8

Table 7: SIDRA result for Eastern LSP Access intersection AM peak (year 2031)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: LSP Road 21														
1	L2	98	2.0	98	2.0	0.087	0.8	LOS A	0.4	2.5	0.34	0.21	0.34	25.4
2	T1	8	2.0	8	2.0	0.087	3.3	LOS A	0.4	2.5	0.34	0.21	0.34	19.7
Approach		106	2.0	106	2.0	0.087	1.0	LOS A	0.4	2.5	0.34	0.21	0.34	25.0
East: Caporn Street East														
4	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.10	0.60	0.10	29.5
5	T1	465	7.8	465	7.8	0.125	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	70.0
Approach		468	7.8	468	7.8	0.125	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	69.1
West: Caporn Street West														
12	R2	33	2.0	33	2.0	0.038	8.5	LOS A	0.1	1.0	0.48	0.68	0.48	25.4
Approach		33	2.0	33	2.0	0.038	8.5	NA	0.1	1.0	0.48	0.68	0.48	25.4
All Vehicles		607	6.4	607	6.4	0.125	0.7	NA	0.4	2.5	0.09	0.08	0.09	49.5
South: Median														
3	R2	8	2.0	8	2.0	0.011	2.6	LOS A	0.0	0.2	0.48	0.37	0.48	53.4
Approach		8	2.0	8	2.0	0.011	2.6	LOS A	0.0	0.2	0.48	0.37	0.48	53.4
West: Caporn Street West														
11	T1	703	7.8	703	7.8	0.189	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		703	7.8	703	7.8	0.189	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		712	7.7	712	7.7	0.189	0.0	NA	0.0	0.2	0.01	0.00	0.01	69.8

Table 8: SIDRA result for Western LSP Access intersection PM peak (year 2031)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: LSP Road 11														
1	L2	49	2.0	49	2.0	0.068	2.2	LOS A	0.3	1.8	0.53	0.44	0.53	29.3
2	T1	4	2.0	4	2.0	0.068	13.2	LOS B	0.3	1.8	0.53	0.44	0.53	19.4
Approach		54	2.0	54	2.0	0.068	3.1	LOS A	0.3	1.8	0.53	0.44	0.53	28.7
East: Caporn Street East														
4	L2	8	2.0	8	2.0	0.006	7.8	LOS A	0.0	0.2	0.19	0.59	0.19	25.1
5	T1	1034	7.8	1034	7.8	0.278	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		1042	7.8	1042	7.8	0.278	0.1	LOS A	0.0	0.2	0.00	0.00	0.00	68.9
West: Caporn Street West														
12	R2	97	2.0	97	2.0	0.251	16.1	LOS C	1.0	6.8	0.78	0.94	0.87	28.0
Approach		97	2.0	97	2.0	0.251	16.1	NA	1.0	6.8	0.78	0.94	0.87	28.0
All Vehicles		1193	7.0	1193	7.0	0.278	1.5	NA	1.0	6.8	0.09	0.10	0.10	56.2
South: Median														
3	R2	4	2.0	4	2.0	0.006	2.8	LOS A	0.0	0.1	0.50	0.37	0.50	44.8
Approach		4	2.0	4	2.0	0.006	2.8	LOS A	0.0	0.1	0.50	0.37	0.50	44.8
West: Caporn Street West														
11	T1	745	7.8	745	7.8	0.201	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		745	7.8	745	7.8	0.201	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		749	7.8	749	7.8	0.201	0.0	NA	0.0	0.1	0.00	0.00	0.00	69.9

Table 9: SIDRA result for Eastern LSP Access intersection PM peak (year 2031)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: LSP Road 21														
1	L2	44	2.0	44	2.0	0.060	2.1	LOS A	0.2	1.6	0.52	0.43	0.52	25.0
2	T1	4	2.0	4	2.0	0.060	11.9	LOS B	0.2	1.6	0.52	0.43	0.52	19.4
Approach		48	2.0	48	2.0	0.060	2.9	LOS A	0.2	1.6	0.52	0.43	0.52	24.6
East: Caporn Street East														
4	L2	7	2.0	7	2.0	0.006	7.7	LOS A	0.0	0.2	0.18	0.59	0.18	29.5
5	T1	998	7.8	998	7.8	0.269	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		1005	7.8	1005	7.8	0.269	0.1	LOS A	0.0	0.2	0.00	0.00	0.00	69.0
West: Caporn Street West														
12	R2	85	2.0	85	2.0	0.208	14.9	LOS B	0.8	5.4	0.76	0.92	0.79	24.0
Approach		85	2.0	85	2.0	0.208	14.9	NA	0.8	5.4	0.76	0.92	0.79	24.0
All Vehicles		1139	7.1	1139	7.1	0.269	1.3	NA	0.8	5.4	0.08	0.09	0.08	56.8
South: Median														
3	R2	4	2.0	4	2.0	0.005	2.4	LOS A	0.0	0.1	0.47	0.33	0.47	53.8
Approach		4	2.0	4	2.0	0.005	2.4	LOS A	0.0	0.1	0.47	0.33	0.47	53.8
West: Caporn Street West														
11	T1	664	7.8	664	7.8	0.179	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		664	7.8	664	7.8	0.179	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		668	7.8	668	7.8	0.179	0.0	NA	0.0	0.1	0.00	0.00	0.00	69.9

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Technical Note: No. 1a Date: 18/01/2021
Project No: t19.051
Project: **PROPOSED LSP, MULTIPLE LOTS CAPORN STREET, WANNEROO**
Subject: **PROPOSED SCHEME MODIFICATIONS**

INTRODUCTION

In August 2020 Transcore prepared a Transport Impact Assessment report (hereafter TIA) for the Local Structure Plan (LSP) over several lots located at the southern side of Caporn Street in Wanneroo, City of Wanneroo. The proposed LSP contemplates creation of approximately 470 residential lots over the subject site.

The subject site occupies an area of approximately 26.6ha situated between Caporn Street and Saponara Drive, extending some 600m east of Wells Street. The subject site comprises a number of lots including Lots 1, 2, 7, 12, 13, 36 to 38 and 9006 Caporn Street, most of which are currently undeveloped (refer **Figure 1**).

Figure 1: Subject site

The subject site is situated immediately northwest of the *East Wanneroo Cell 2 – Adopted Structure Plan No.4* (*EWC2 ASP*). The LSP is designed to integrate with the existing EWC2 ASP road network and take principal access from Caporn Street with additional links to the west and south.

The proposed LSP internal road system connects to perimeter roads via several access/egress intersections. The proposed access/egress system for the LSP is detailed as follows:

- **Western LSP Caporn Street Access Intersection** is proposed as Road 11/Caporn Street intersection approximately 135m east of the existing Wells Street intersection and is proposed to operate as a full-movement T-intersection;
- **Eastern LSP Caporn Street Access Intersection** is proposed as Road 21/Caporn Street approximately 390m east of the existing Wells Street intersection and is proposed to operate as a full-movement T-intersection;
- **Road 21 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 24 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 26 Saponara Drive Extension Access** is proposed as a T-intersection at the SE corner of the LSP area (initially will be cul-de-saced at southern end);
- **Road 27 Extension Access** is proposed as an extension of Road 27 into the future residential areas to the east (initially will be cul-de-saced at eastern end);
- **Road 11 Saponara Drive Access** is proposed as a T-intersection at the SW end of the LSP area;
- **Rometta Way (Road 3) Access** is proposed as an extension of Rometta Way directly into the LSP at the northwest corner of the LSP area; and,
- **Speranza Parkway (Road 4) Access** is proposed as an extension of Speranza Parkway directly into the LSP at the southwest corner of the LSP area.

Refer to **Appendix A** for the proposed concept LSP plan.

BACKGROUND

As part of the LSP external access system assessment scope, the capacity assessment of the two, key external LSP access intersections on Caporn Street (western and eastern LSP accesses), was undertaken and presented in the TIA report.

According to conservative daily traffic projections, Caporn Street (in the vicinity of the LSP) is anticipated to reach almost 14,000vpd by 2031, without the traffic

contribution from the future LSP. This level of daily traffic typically requires a four-lane road profile for efficient and safe operation.

However, the traffic section of the City of Wanneroo has indicated that Caporn Street features as a single-carriageway, two-lane road in the *East Wanneroo District Structure Plan* (*EWDSP*) and as such may not be upgraded to the four-lane standard even with the full development of the subject locality. Accordingly, the City has requested that a new capacity assessment be undertaken for the two LSP access intersections on Caporn Street modelling Caporn Street as a single-carriageway two-lane road in the 2031 post-development period.

Hence, a new capacity assessment was undertaken and presented in this Technical Note which investigates the future operation of the two LSP access intersections on Caporn Street in 2031 assuming this road remains a two-lane road in the future. The following section provides comparison of Caporn Street four-lane option (as per TIA) and two-lane option (as per latest City of Wanneroo instructions).

SENSITIVITY ANALYSIS - CAPORN STREET FOUR-LANE VS TWO-LANE OPTION

The TIA capacity assessment of the LSP's Western and Eastern Access Intersection was undertaken for the nominal 2031 year assumed to be the year of full LSP build-out. For the purpose of this assessment a growth in background traffic of 2% p.a. was assumed for the 2021-2031 period.

The estimated AM and PM peak hour traffic volumes generated by the proposed LSP and expected to pass through the two external LSP access intersections on Caporn Street are illustrated in **Figure 2**.

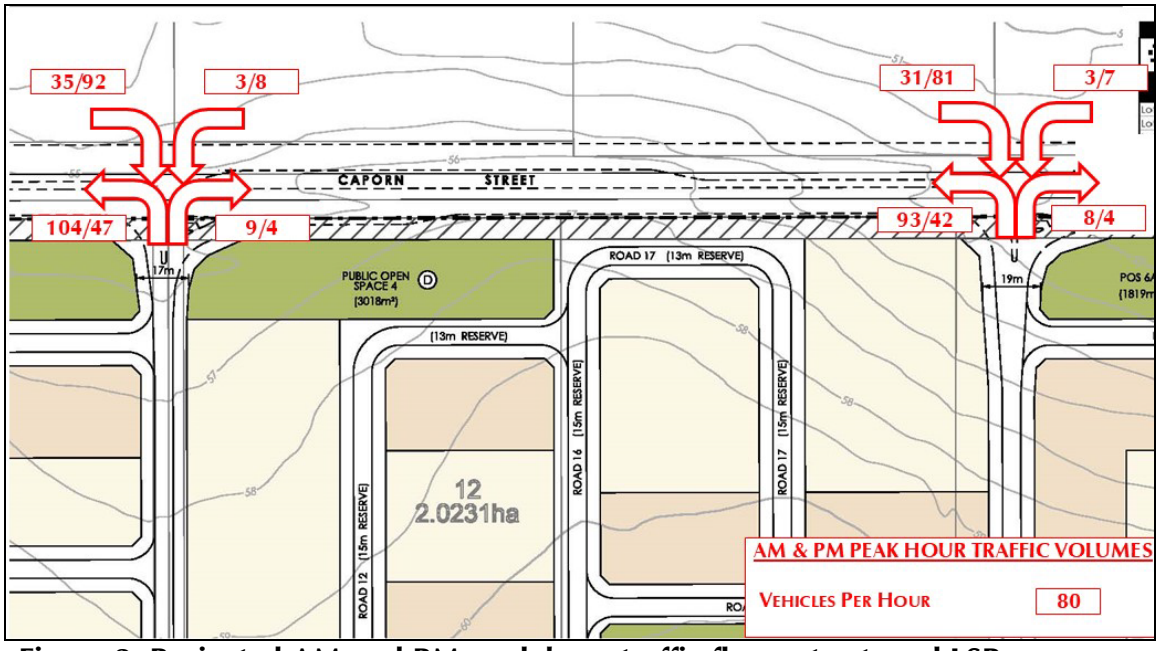


Figure 2. Projected AM and PM peak hour traffic flows at external LSP access intersections on Caporn Street

The capacity analysis was undertaken using the latest SIDRA 9 computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.
- **Level of Service**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of services, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection.
- **95% Queue**: is the queue length below which 95% of all observed queue lengths fall.

CAPACITY ASSESSMENT – FOUR-LANE CAPORN STREET OPTION

The outcome of the SIDRA 9 capacity assessment shows that very good operational characteristics in both morning and afternoon peak hour scenarios with no notable delays or queues and with ample spare capacity can be expected at both LSP access intersections on Caporn Street.

Both intersections were modelled as priority-controlled T-intersections with left-turn slip-lanes and right-turn pockets on Caporn Street. Accordingly, Caporn Street was modelled as four-lane road with a 7.0m wide median cross-section, similar to the existing section immediately west of San Teodoro Avenue. The results of the SIDRA assessment are presented in the following tables (refer **Table 1** to **Table 4**).

It should be noted that, for the purpose of this Technical Note, SIDRA 8 outputs presented in TIA report are updated/converted to SIDRA 9 version following the latest software upgrade. No other changes to the original assessment were made for consistency.

Table 1: SIDRA result for Western LSP Access intersection AM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 11														
1	L2	109	2.0	109	2.0	0.103	1.0	LOS A	0.4	3.0	0.38	0.26	0.38	29.6
2	T1	9	2.0	9	2.0	0.103	4.4	LOS A	0.4	3.0	0.38	0.26	0.38	19.7
Approach		119	2.0	119	2.0	0.103	1.3	LOS A	0.4	3.0	0.38	0.26	0.38	29.0
East: Caporn Street East														
4	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.11	0.60	0.11	25.2
5	T1	560	7.8	560	7.8	0.151	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		563	7.8	563	7.8	0.151	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	69.2
West: Caporn Street West														
12	R2	37	2.0	37	2.0	0.048	9.2	LOS A	0.2	1.3	0.52	0.72	0.52	29.6
Approach		37	2.0	37	2.0	0.048	9.2	NA	0.2	1.3	0.52	0.72	0.52	29.6
All Vehicles		719	6.5	719	6.5	0.151	0.7	NA	0.4	3.0	0.09	0.08	0.09	51.0
South: Median														
3	R2	9	2.0	9	2.0	0.013	2.8	LOS A	0.0	0.2	0.49	0.39	0.49	44.9
Approach		9	2.0	9	2.0	0.013	2.8	LOS A	0.0	0.2	0.49	0.39	0.49	44.9
West: Caporn Street West														
11	T1	726	7.8	726	7.8	0.196	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		726	7.8	726	7.8	0.196	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		736	7.7	736	7.7	0.196	0.1	NA	0.0	0.2	0.01	0.01	0.01	69.7

Table 2: SIDRA result for Eastern LSP Access intersection AM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 21														
1	L2	98	2.0	98	2.0	0.087	0.8	LOS A	0.4	2.5	0.34	0.21	0.34	25.4
2	T1	8	2.0	8	2.0	0.087	3.3	LOS A	0.4	2.5	0.34	0.21	0.34	19.7
Approach		106	2.0	106	2.0	0.087	1.0	LOS A	0.4	2.5	0.34	0.21	0.34	25.0
East: Caporn Street East														
4	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.10	0.60	0.10	29.5
5	T1	465	7.8	465	7.8	0.125	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		468	7.8	468	7.8	0.125	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	69.1
West: Caporn Street West														
12	R2	33	2.0	33	2.0	0.038	8.5	LOS A	0.1	1.0	0.48	0.68	0.48	25.4
Approach		33	2.0	33	2.0	0.038	8.5	NA	0.1	1.0	0.48	0.68	0.48	25.4
All Vehicles		607	6.4	607	6.4	0.125	0.7	NA	0.4	2.5	0.09	0.08	0.09	49.5
South: Median														
3	R2	8	2.0	8	2.0	0.011	2.6	LOS A	0.0	0.2	0.48	0.37	0.48	53.4
Approach		8	2.0	8	2.0	0.011	2.6	LOS A	0.0	0.2	0.48	0.37	0.48	53.4
West: Caporn Street West														
11	T1	703	7.8	703	7.8	0.189	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		703	7.8	703	7.8	0.189	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		712	7.7	712	7.7	0.189	0.1	NA	0.0	0.2	0.01	0.00	0.01	69.7

Table 3: SIDRA result for Western LSP Access intersection PM peak (year 2031)

Vehicle Movement Performance

Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 11														
1	L2	49	2.0	49	2.0	0.068	2.2	LOS A	0.3	1.8	0.53	0.44	0.53	29.3
2	T1	4	2.0	4	2.0	0.068	13.2	LOS B	0.3	1.8	0.53	0.44	0.53	19.4
Approach		54	2.0	54	2.0	0.068	3.1	LOS A	0.3	1.8	0.53	0.44	0.53	28.7
East: Caporn Street East														
4	L2	8	2.0	8	2.0	0.006	7.8	LOS A	0.0	0.2	0.19	0.59	0.19	25.1
5	T1	1034	7.8	1034	7.8	0.278	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		1042	7.8	1042	7.8	0.278	0.1	LOS A	0.0	0.2	0.00	0.00	0.00	68.8
West: Caporn Street West														
12	R2	97	2.0	97	2.0	0.251	16.1	LOS C	1.0	6.8	0.78	0.94	0.87	28.0
Approach		97	2.0	97	2.0	0.251	16.1	NA	1.0	6.8	0.78	0.94	0.87	28.0
All Vehicles		1193	7.0	1193	7.0	0.278	1.5	NA	1.0	6.8	0.09	0.10	0.10	56.2
South: Median														
3	R2	4	2.0	4	2.0	0.006	2.8	LOS A	0.0	0.1	0.50	0.37	0.50	44.8
Approach		4	2.0	4	2.0	0.006	2.8	LOS A	0.0	0.1	0.50	0.37	0.50	44.8
West: Caporn Street West														
11	T1	745	7.8	745	7.8	0.201	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		745	7.8	745	7.8	0.201	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		749	7.8	749	7.8	0.201	0.1	NA	0.0	0.1	0.00	0.00	0.00	69.8

Table 4: SIDRA result for Eastern LSP Access intersection PM peak (year 2031)

Vehicle Movement Performance

Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 21														
1	L2	44	2.0	44	2.0	0.060	2.1	LOS A	0.2	1.6	0.52	0.43	0.52	25.0
2	T1	4	2.0	4	2.0	0.060	11.9	LOS B	0.2	1.6	0.52	0.43	0.52	19.4
Approach		48	2.0	48	2.0	0.060	2.9	LOS A	0.2	1.6	0.52	0.43	0.52	24.6
East: Caporn Street East														
4	L2	7	2.0	7	2.0	0.006	7.7	LOS A	0.0	0.2	0.18	0.59	0.18	29.5
5	T1	998	7.8	998	7.8	0.269	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		1005	7.8	1005	7.8	0.269	0.1	LOS A	0.0	0.2	0.00	0.00	0.00	68.9
West: Caporn Street West														
12	R2	85	2.0	85	2.0	0.208	14.9	LOS B	0.8	5.4	0.76	0.92	0.79	24.0
Approach		85	2.0	85	2.0	0.208	14.9	NA	0.8	5.4	0.76	0.92	0.79	24.0
All Vehicles		1139	7.1	1139	7.1	0.269	1.3	NA	0.8	5.4	0.08	0.09	0.08	56.7
South: Median														
3	R2	4	2.0	4	2.0	0.005	2.4	LOS A	0.0	0.1	0.47	0.33	0.47	53.8
Approach		4	2.0	4	2.0	0.005	2.4	LOS A	0.0	0.1	0.47	0.33	0.47	53.8
West: Caporn Street West														
11	T1	664	7.8	664	7.8	0.179	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.9
Approach		664	7.8	664	7.8	0.179	0.0	NA	0.0	0.0	0.00	0.00	0.00	69.9
All Vehicles		668	7.8	668	7.8	0.179	0.0	NA	0.0	0.1	0.00	0.00	0.00	69.8

CAPACITY ASSESSMENT – TWO-LANE CAPORN STREET OPTION

A capacity assessment of two LSP access intersections on Caporn Street for the scenario where Caporn Street features a single-carriageway, two-lane cross-section was undertaken using SIDRA 9 software. The aim of such assessment was to investigate the operation of the two intersections under the scenario where Caporn Street effectively retains its current form.

Accordingly, for the purpose of this scenario, Caporn Street was modelled as a single-carriageway, two-lane road with a localised widening along the frontage of the LSP which would see the introduction of a 7.0m wide median strip in the road cross-section. This is proposed so to facilitate two-stage right-turn in and out movements from the structure plan access roads (Road 11 at the western and Road 21 at the eastern LSP access intersection). Similar to the original scenario, a left-turn sliplane and right-turn pocket are proposed at both LSP access intersections. A concept plan of such Caporn Street road profile modelled in this scenario is shown below. The existing Caporn Street road reserve, at a minimum of 20m, plus the additional 7m of road widening as proposed in the LSP, will provide the sufficient road reserve width for this profile to be accommodated.

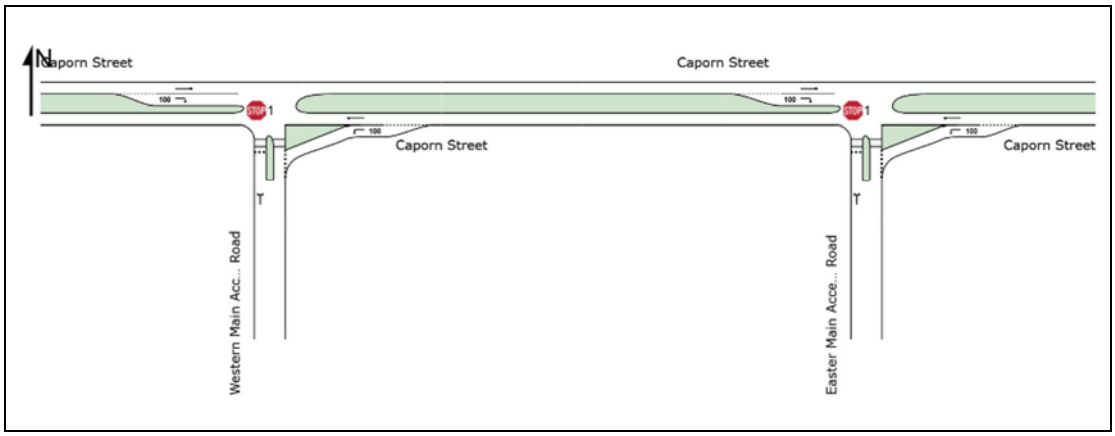


Figure 3. Indicative Caporn Street profile along the LSP frontage

The results of the SIDRA 9 assessment for the two-lane Caporn Street scenario are presented in the following tables (refer **Table 5** to **Table 8**).

As can be seen, the result of the SIDRA 9 assessment confirms that the two LSP intersections will operate at the very good overall intersection Level of Service A (LoS A) with negligible queues and delays during both AM and PM peak hour periods.

Although, compared to the four-lane Caporn Street option, the two LSP access intersections will record higher level of capacity, still ample spare capacity remains available for further traffic growth.

Accordingly, it is concluded that the operation of the two LSP access intersections will not be compromised should Caporn Street remain in its current form.

Table 5: SIDRA result for Western LSP Access intersection AM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 11														
1	L2	109	2.0	109	2.0	0.135	2.7	LOS A	0.5	3.6	0.53	0.49	0.53	29.4
2	T1	9	2.0	9	2.0	0.135	2.7	LOS A	0.5	3.6	0.53	0.49	0.53	19.4
Approach		119	2.0	119	2.0	0.135	2.7	LOS A	0.5	3.6	0.53	0.49	0.53	28.8
East: Caporn Street														
3	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.11	0.60	0.11	25.2
4	T1	560	7.8	560	7.8	0.302	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		563	7.8	563	7.8	0.302	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	69.1
North: Median Storage														
5	T1	37	2.0	37	2.0	0.045	2.5	LOS A	0.1	1.1	0.49	0.41	0.49	43.6
Approach		37	2.0	37	2.0	0.045	2.5	LOS A	0.1	1.1	0.49	0.41	0.49	43.6
All Vehicles		719	6.5	719	6.5	0.302	0.6	NA	0.5	3.6	0.11	0.10	0.11	53.0
South: Median Storage														
1	R2	9	2.0	9	2.0	0.015	4.1	LOS A	0.0	0.3	0.55	0.57	0.55	8.5
Approach		9	2.0	9	2.0	0.015	4.1	LOS A	0.0	0.3	0.55	0.57	0.55	8.5
West: Caporn Street														
2	T1	726	7.8	726	7.8	0.391	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
3	R2	37	2.0	37	2.0	0.020	6.4	LOS A	0.0	0.0	0.00	0.66	0.00	56.4
Approach		763	7.5	763	7.5	0.391	0.4	NA	0.0	0.0	0.00	0.03	0.00	68.9
All Vehicles		773	7.5	773	7.5	0.391	0.5	NA	0.0	0.3	0.01	0.04	0.01	68.7

Table 6: SIDRA result for Eastern LSP Access intersection AM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 21														
1	L2	98	2.0	98	2.0	0.107	2.0	LOS A	0.4	2.9	0.48	0.40	0.48	19.6
2	T1	8	2.0	8	2.0	0.107	2.0	LOS A	0.4	2.9	0.48	0.40	0.48	19.6
Approach		106	2.0	106	2.0	0.107	2.0	LOS A	0.4	2.9	0.48	0.40	0.48	19.6
East: Caporn Street														
3	L2	3	2.0	3	2.0	0.002	7.5	LOS A	0.0	0.1	0.10	0.60	0.10	29.5
4	T1	465	7.8	465	7.8	0.251	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		468	7.8	468	7.8	0.251	0.1	LOS A	0.0	0.1	0.00	0.00	0.00	68.6
North: Median Storage														
5	T1	33	2.0	33	2.0	0.035	1.8	LOS A	0.1	0.8	0.44	0.34	0.44	44.2
Approach		33	2.0	33	2.0	0.035	1.8	LOS A	0.1	0.8	0.44	0.34	0.44	44.2
All Vehicles		607	6.4	607	6.4	0.251	0.5	NA	0.4	2.9	0.11	0.09	0.11	46.7
South: Median Storage														
1	R2	8	2.0	8	2.0	0.012	3.9	LOS A	0.0	0.3	0.53	0.54	0.53	50.9
Approach		8	2.0	8	2.0	0.012	3.9	LOS A	0.0	0.3	0.53	0.54	0.53	50.9
West: Caporn Street														
2	T1	703	7.8	703	7.8	0.379	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
3	R2	33	2.0	33	2.0	0.018	6.4	LOS A	0.0	0.0	0.00	0.66	0.00	48.4
Approach		736	7.5	736	7.5	0.379	0.3	NA	0.0	0.0	0.00	0.03	0.00	69.2
All Vehicles		744	7.5	744	7.5	0.379	0.4	NA	0.0	0.3	0.01	0.03	0.01	69.0

Table 7: SIDRA result for Western LSP Access intersection PM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 11														
1	L2	49	2.0	49	2.0	0.146	9.1	LOS A	0.5	3.4	0.80	0.80	0.80	27.9
2	T1	4	2.0	4	2.0	0.146	8.8	LOS A	0.5	3.4	0.80	0.80	0.80	18.2
Approach		54	2.0	54	2.0	0.146	9.1	LOS A	0.5	3.4	0.80	0.80	0.80	27.3
East: Caporn Street														
3	L2	8	2.0	8	2.0	0.006	7.8	LOS A	0.0	0.2	0.19	0.59	0.19	25.1
4	T1	1034	7.8	1034	7.8	0.557	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.4
Approach		1042	7.8	1042	7.8	0.557	0.2	LOS A	0.0	0.2	0.00	0.00	0.00	68.4
North: Median Storage														
5	T1	97	2.0	97	2.0	0.278	10.5	LOS B	0.9	6.7	0.82	0.90	0.94	36.7
Approach		97	2.0	97	2.0	0.278	10.5	LOS B	0.9	6.7	0.82	0.90	0.94	36.7
All Vehicles		1193	7.0	1193	7.0	0.557	1.4	NA	0.9	6.7	0.10	0.11	0.11	60.3
South: Median Storage														
1	R2	4	2.0	4	2.0	0.007	4.6	LOS A	0.0	0.1	0.59	0.57	0.59	8.0
Approach		4	2.0	4	2.0	0.007	4.6	LOS A	0.0	0.1	0.59	0.57	0.59	8.0
West: Caporn Street														
2	T1	745	7.8	745	7.8	0.402	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
3	R2	97	2.0	97	2.0	0.055	6.4	LOS A	0.0	0.0	0.00	0.66	0.00	56.4
Approach		842	7.1	842	7.1	0.402	0.8	NA	0.0	0.0	0.00	0.08	0.00	67.8
All Vehicles		846	7.1	846	7.1	0.402	0.9	NA	0.0	0.1	0.00	0.08	0.00	67.8

Table 8: SIDRA result for Eastern LSP Access intersection PM peak (year 2031)

Vehicle Movement Performance														
Mov ID	Turn	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: LSP Road 21														
1	L2	44	2.0	44	2.0	0.121	8.2	LOS A	0.4	2.8	0.77	0.77	0.77	18.4
2	T1	4	2.0	4	2.0	0.121	7.9	LOS A	0.4	2.8	0.77	0.77	0.77	18.4
Approach		48	2.0	48	2.0	0.121	8.2	LOS A	0.4	2.8	0.77	0.77	0.77	18.4
East: Caporn Street														
3	L2	7	2.0	7	2.0	0.006	7.7	LOS A	0.0	0.2	0.18	0.59	0.18	29.5
4	T1	998	7.8	998	7.8	0.538	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	69.4
Approach		1005	7.8	1005	7.8	0.538	0.3	LOS A	0.0	0.2	0.00	0.00	0.00	68.1
North: Median Storage														
5	T1	85	2.0	85	2.0	0.225	9.0	LOS A	0.7	5.2	0.79	0.83	0.86	37.8
Approach		85	2.0	85	2.0	0.225	9.0	LOS A	0.7	5.2	0.79	0.83	0.86	37.8
All Vehicles		1139	7.1	1139	7.1	0.538	1.3	NA	0.7	5.2	0.09	0.10	0.10	57.9
South: Median Storage														
1	R2	4	2.0	4	2.0	0.006	3.9	LOS A	0.0	0.1	0.53	0.51	0.53	50.9
Approach		4	2.0	4	2.0	0.006	3.9	LOS A	0.0	0.1	0.53	0.51	0.53	50.9
West: Caporn Street														
2	T1	664	7.8	664	7.8	0.358	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
3	R2	85	2.0	85	2.0	0.047	6.4	LOS A	0.0	0.0	0.00	0.66	0.00	48.4
Approach		749	7.1	749	7.1	0.358	0.8	NA	0.0	0.0	0.00	0.07	0.00	68.4
All Vehicles		754	7.1	754	7.1	0.358	0.8	NA	0.0	0.1	0.00	0.08	0.00	68.3

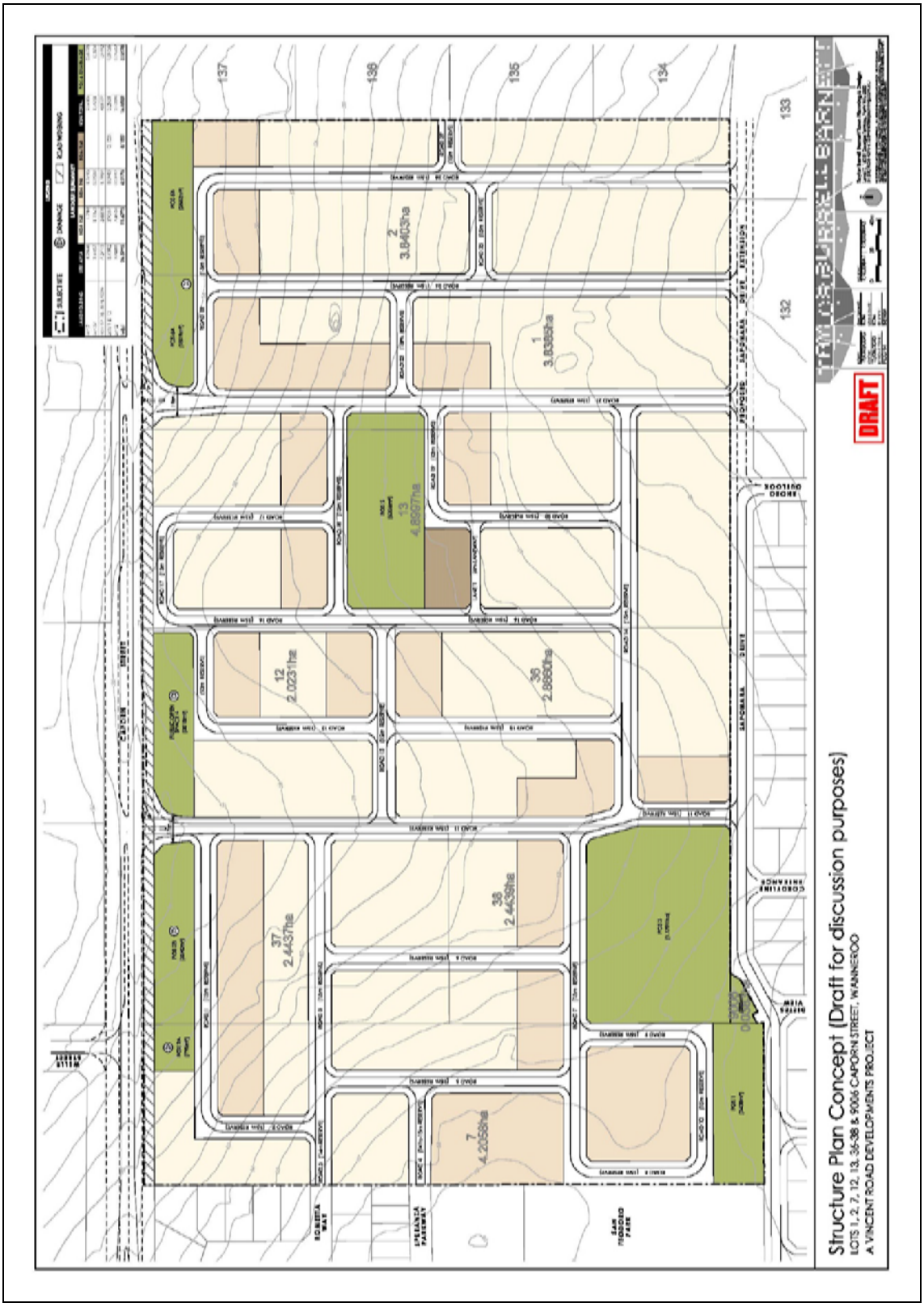
CONCLUSION

The result of the SIDRA capacity analysis confirms that, should Caporn Street retain its single-carriageway, two-lane cross-section in the future the operation of the two LSP access intersections will not be compromised. The two LSP access intersection on Caporn Street are expected to operate satisfactorily and without significant delays or extensive queues.

The development of the LSP is therefore not incumbent on the duplication of Caporn Street.

Appendix A

CAPORN STREET LOCAL STRUCTURE PLAN - CONCEPT


Structure Plan Concept (Draft for discussion purposes)
LOTS 1, 2, 7, 12, 13, 35-38 & 9006 CAPORN STREET, WANNEROO
A VINCENT ROAD DEVELOPMENTS PROJECT
DRAFT

APPENDIX E

Engineering Infrastructure Report

TABEC
Civil Engineering Consultants

CAPORN STREET LOCAL STRUCTURE PLAN

Engineering Infrastructure Report

AUGUST 2020

CLIENT: ACUMEN DEVELOPMENT SOLUTIONS

PROJECT: 2419 – CAPORN STREET LOCAL STRUCTURE PLAN

TITLE: LSP ENGINEERING INFRASTRUCTURE REPORT

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
0	18 August 2020	CB	CB	CB

TABLE OF CONTENTS

1 INTRODUCTION

The Caporn Street Local Structure Plan area comprises lots 1, 2, 7, 12, 13, 36- 37 and 38 Caporn Street and lot 9006 Saponara Drive Wanneroo in the City of Wanneroo (the site). The nine lots making up the site are represented by six different landowners. The landowners have expressed a desire to progress development of the site and have appointed Acumen Development Solutions to prepare a Local Structure Plan (LSP) for the site. This Engineering Infrastructure Report which provides a broad overview of the existing conditions and engineering advice on the capability and possible future infrastructure requirements of the proposed development has been prepared to support the LSP and associated local rezoning of the site.

The site is zoned Urban in the Metropolitan Region Scheme and Rural Resource in City of Wanneroo District Planning Scheme No. 2. The site and it's context with respect to the surrounding area is shown in the image below.

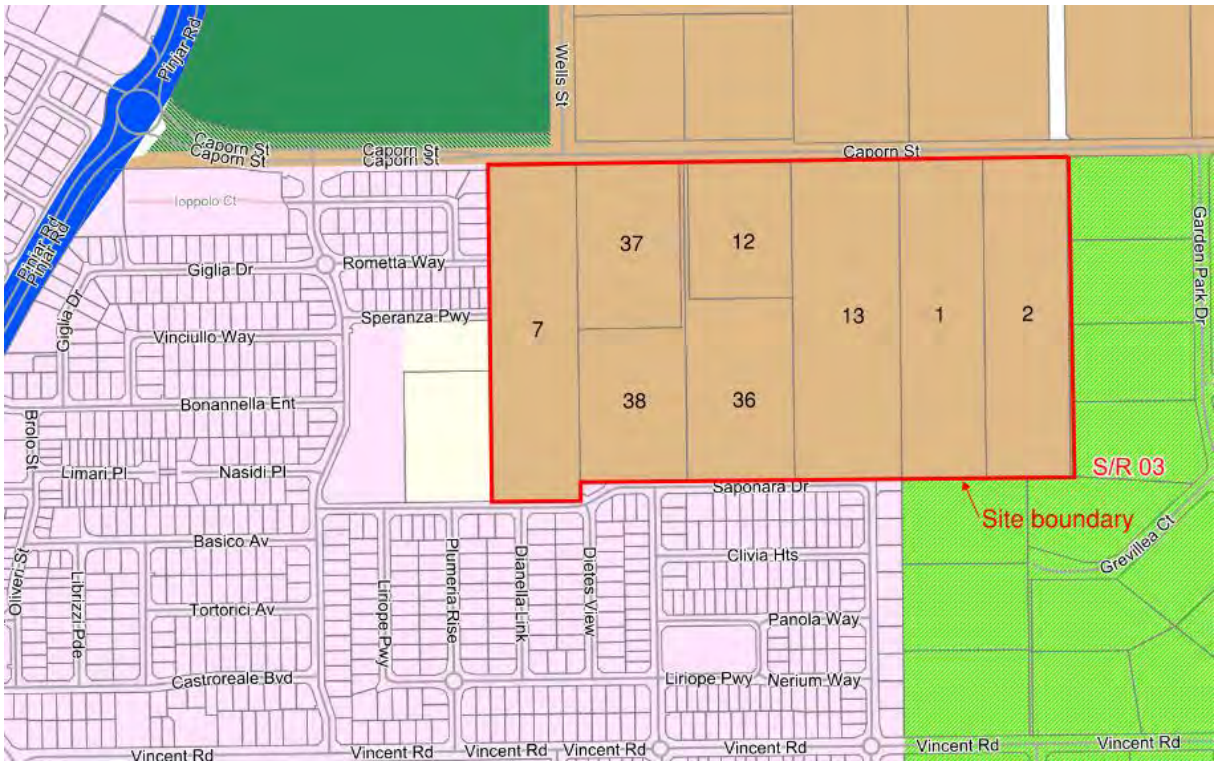


Figure 1 – Site boundary (base source City of Wanneroo Intramaps, August 2020)

The investigation and preparation of the report is primarily based on preliminary advice from the various service authorities. The information is current as of August 2020 and is subject to change as development proceeds around the site.

2 THE SITE

2.1 Site Description

The approximately 27.2ha total site is located between Caporn Street and Saponara Drive in the suburb of Wanneroo about 2km northeast of the Wanneroo townsite CBD within the City of Wanneroo.

Portions of the land have progressively been cleared of native vegetation since the early 1970's and while there are some isolated stands of native vegetation that remain on the site, the vast majority of vegetation that currently exists is regrowth. The various lots within the site currently sustain different land uses including market garden, orchard and rural residential lifestyle lots.

The site is bounded by residential development along the majority of the western and southern boundaries and rural residential to the east and north. All existing lots have legal frontage to Caporn Street, albeit lots 36 and 38 each have 5.0m battleaxe width only, and lots 7, 6, 36 and 38 have frontage onto Saponara Drive at their respective southern boundaries.

Vegetation located within the southern portion of Lot 38 has been identified for retention and the proposed structure plan accommodates this requirement.

2.2 Landform / Topography

Despite the various historical land uses across the site, the topography is largely unmodified from its natural state, except for isolated areas where residences and outbuildings have been constructed.

Site gradients vary from 1 in 35 (3.5%) to 1 in 16 (6.2%). Figure 2 below shows the natural topographic contours of the site that generally have a south to north downhill gradient. The contours indicate that lots 1 and 2 are generally steeper than the remainder of the site.

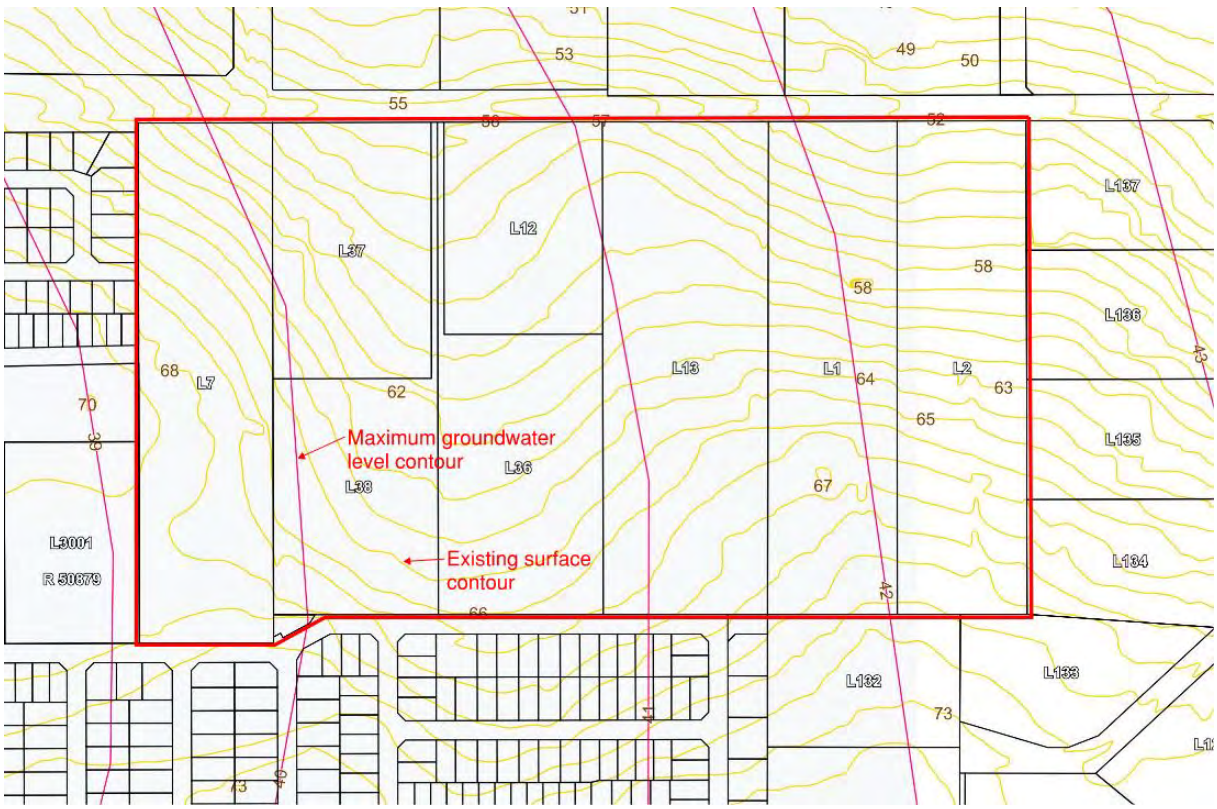


Figure 2 – Site Topography (MNG, August 2020)

Site levels vary from a minimum of 52.0m Australian Height Datum (AHD) in the north-east corner up to 71.0mAHD near the south east corner of the site. Levels along the southern boundary adjacent to Saponara Drive vary between 66.0mAHD and 71.0mAHD and at the northern boundary along Caporn Street the levels vary from 53.0mAHD to 61.0mAHD. Along Caporn Street, there is a shallow crest located near the intersection of lots 12 and 13, and a well defined low point near lots 1 and 2.

2.3 Ground Conditions

Geological mapping provided by online resource GeoVIEW WA indicates that the site comprises sand described as pale and olive-yellow medium to course grained sub-angular quartz moderately sorted of residual origin modified by marine inundation.

Based on a surface observations of the site, along with permeability testing undertaken at various locations around the site, it appears as though the actual site conditions are consistent with the GeoVIEW WA mapping.

In areas where market gardening activities are being undertaken there has been some shallow soil amendment, presumably to increase the soil moisture retention properties. This observation is consistent with permeability tests carried out on site by Hyd2o.

Overall, the site ground conditions are considered to be consistent with the ground conditions encountered in the surrounding residential development which typically produce lots classified as 'A' in AS2870 – Residential Slabs and Footings.

More detailed site geotechnical investigations will be required as part of future detailed design.

2.4 Groundwater

MNG Access groundwater mapping indicates that the maximum groundwater levels beneath the site ranges from 39.2mAHD to 42.7mAHD, with groundwater flow generally in a westerly direction. This indicates a minimum depth to groundwater near the north-east corner of the site of 9.3m and a depth to groundwater of 30.8m near the south-west corner.

Based on the ground conditions and clearance to maximum groundwater level, the site readily lends itself to infiltration of stormwater on-site.

Groundwater modelling undertaken as part of the East Wanneroo District Structure Plan has predicted a groundwater level rise in the area however, given the current clearance to groundwater, there would be no impact on the development.

2.5 Acid Sulphate Soils

A review of the DWER Acid Sulphate Soils (ASS) mapping indicates that the site is located in an area as having "no known risk" of ASS occurring within 3.0m of the natural surface.

3 SITEWORKS AND EARTHWORKS

Siteworks to support residential urban development will generally comprise the demolition and removal of improvements within the site, clearing of existing vegetation that has not been identified for retention, stripping of topsoil, earthworking of the existing ground surface as a cut to fill exercise and construction of retaining walls to create level building lots.

The predominant north south alignment of roads within the proposed LSP provides for a development that has opportunity to minimise the height of retaining walls. Notwithstanding that the proposed road layout allows for the most conservative approach to retaining walls, it is expected that some areas of

the site will have side boundary retaining walls up to 1.1m in height and rear of lot retaining up to about 2.8m in height, if existing common boundary levels are to be respected.

At the time of development, a collaborative approach between adjacent landowners has the potential to further minimise height of retaining across the LSP. As an example, this approach could occur to remove the ridge between lots 12 and 13, while filling the valley between lots 37 and 12.

The bulk earthworks design will also need to take account of any vegetation that is identified for retention within some of the identified Public Open Space areas.

With the site sloping downwards in a northerly direction, the provision of retaining walls on lot side boundaries will act to minimise shading from properties to the immediate north of a subject property which will assist in the pursuit of passive solar design for future residences.

4 ROADS AND TRAFFIC

The site is well connected to the surrounding road network as it has 690m of frontage to Caporn Street and 420m of frontage to Saponara Drive.

Transcore have undertaken a transport assessment for the Local Structure Plan which has forecast traffic generation from the LSP area along with the impact on the surrounding road network. The traffic assessment suggests there is capacity in the existing road network to support the proposed development.

Within the proposed road network, there are two new intersections proposed along Caporn Street and one ne intersection on Saponara Drive. All three proposed intersections appear to have adequate horizontal and vertical sight distance however this will need to be checked and confirmed as part of future detailed designs for the intersections.

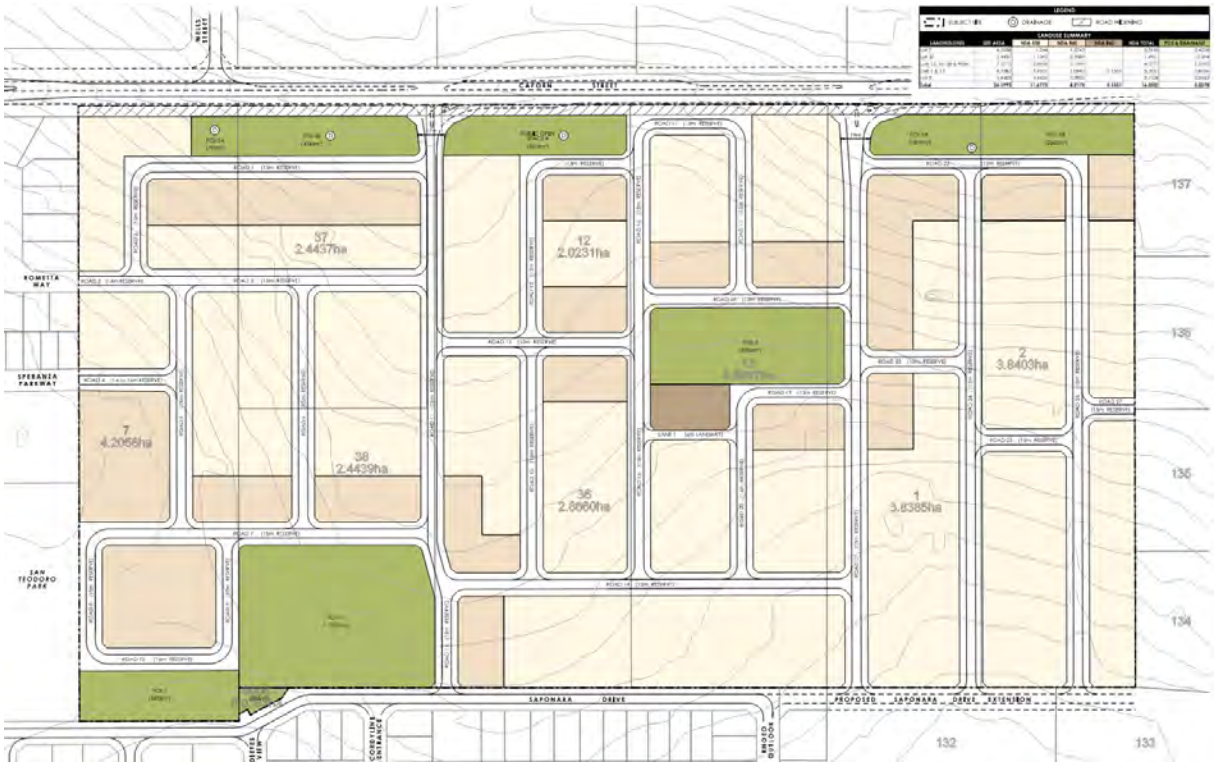


Figure 3 – Proposed LSP road network (Taylor Burrell Barnett, August 2020)

Proposed subdivision frontage to Caporn Street allows for a widening to accommodate future dual carriageway construction along Caporn Street. The future Caporn Street intersections will accommodate both left and right turn pockets into the proposed LSP area.

Saponara Drive, abutting lots 7, 38, 36 and 13 was constructed in stages over the period from 2011 to 2015, therefore there are no expected upgrades of Saponara Drive resulting from the proposed LSP other than intersections and works associated with service installation. Saponara Drive is proposed to be extended to abut the southern boundary of lots 1 and 2 however that is contingent on future subdivision of lots 132 and 133 Grevillea Court, Wanneroo.

The subdivision road network has sought to give consideration to the various existing lot boundaries where possible to ensure that subdivision of individual lots can be progressed without unnecessary reliance on abutting lots.

Within the subdivision road network, there is a predominance of T intersections, all of which have in excess of 20m centreline offset distance to opposing intersections. There is a single four way intersection proposed at the interface between lots 12 and 36, however it is noted that both intersecting roads have an Access Street D classification with corresponding very low traffic volumes.

The internal road network and upgrade of Caporn Street will be undertaken in accordance with the City of Wanneroo standards. Roadworks will generally consist of asphalt wearing course pavement with mountable and semi-mountable kerbing as required.

A network of pedestrian paths will also be required as part of the subdivision to facilitate pedestrian movement throughout the development. Like the roadworks, all footpaths will be designed and constructed in accordance with City of Wanneroo requirements.

From a roads and footpath perspective the proposed LSP represents a logical extension to the abutting residential development areas.

5 STORMWATER MANAGEMENT

Hyd2o, on behalf of Acumen Development Solutions, has prepared a Local Water Management Strategy (LWMS) for the site to support the proposed LSP and associated local rezoning.

The LWMS has been prepared in accordance with the principles and objectives of Better Urban Water Management (WAPC, 2008) and following on site investigations and discussions with key agencies. Implementation of the strategies will be undertaken through the development and implementation of an Urban Water Management Plan(s) for stages of subdivision development within the site.

The key premise within the LWMS is to maintain the existing (pre-development) hydrological regime of the site once the site is developed. Although the site has gradients ranging from 3.5% to 6.2%, there is no visual evidence of any streams or runoff from the site. This is due to the permeability of the soils on site having the capacity to infiltrate all stormwater. Notwithstanding that there is no visual evidence of runoff, it can be expected that some runoff from significant events does make it's way to Caporn Street at the downstream end of the site.

Urbanisation of the site will result in the creation of impermeable areas, primarily road pavements and crossovers, therefore the proposed strategy will be to collect stormwater generated from these areas and discharge it to one of a number of infiltration basins located within proposed Public Open Space areas. The LWMS prepared by Hyd2o provides detailed calculations showing proposed catchment areas and infiltration basin locations. These calculations are based on infiltration rates measured on site, with appropriate allowance for clogging and safety factors.

Broadly, there are 5 drainage catchments within the LSP area and where possible the catchments are reflective of existing land ownership to minimise the occurrence of temporary drainage infiltration

infrastructure. The is a private landowner agreement in place for lots 12, 36 and 38 to receive drainage from an external catchment to the south and the proposed drainage infiltration areas make allowance for this catchment.

The below plan depicts the proposed drainage catchments and infiltration basin locations.

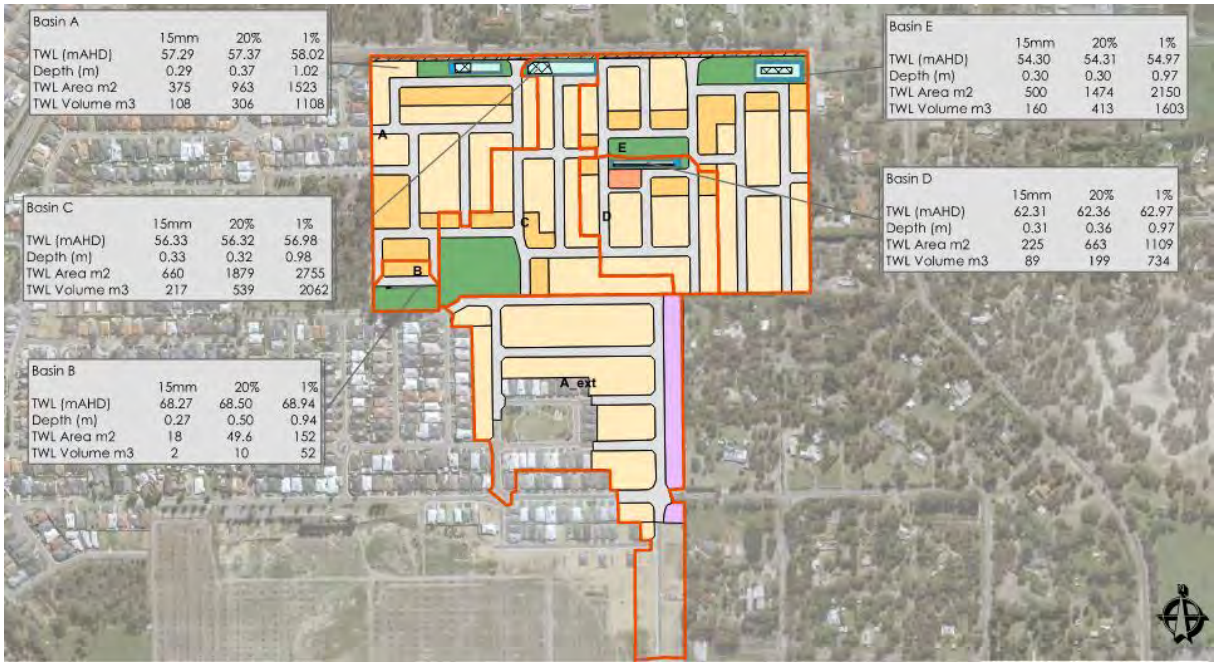


Figure 4 – Proposed drainage catchments and basins (Hyd2o, August 2020)

Proposed future residences within the LSP area will infiltrate stormwater within each lot via soakwells or the like. There is between 9.2m and 30.8m clearance above Maximum Groundwater Level, along with soils that have good permeability therefore the use of soakwells in this scenario is considered to be sound development practice.

Overall, the drainage system for the LSP can be readily accommodated through orderly and sound engineering and landscape design.

6 WASTEWATER

The proposed development is within the Water Corporation license area and all lots created will be connected to the Water Corporation sewer.

The abutting residential developments to the west and south of the LSP area are connected into Water Corporation's gravity sewer network, however as the subject land slopes away from these existing areas, there is little, if any capacity to extend the gravity system into the LSP area. The exception to this may be future residential lots that have direct frontage to Saponara Drive which, subject to future detailed design, should be able to connect into the existing gravity sewer via either pipe crossings under Saponara Drive, or through a parallel sewer constructed in the northern verge of Saponara Drive.

The majority of future lots within the LSP area will need to connect to a new sewer pumping station located in the Jandabup Sewer District to the north-east of the site, likely near reserve R46711 between lots 1 and 11 Caporn Street. At the time of writing, Water Corporation are conducting a review of sewer planning in the immediate area in order to provide for short to medium term development requirements in and around Caporn Street. This review is expected to result in revised sewer planning

that provides for servicing of the LSP area in addition to other areas to the immediate north and north-east.

It is understood that a proposed new sewer pumping station would discharge effluent to water Corporation's existing 375mm diameter network in Joondalup Drive, near Keanefield Drive as the sewer network east of this location has limited capacity to receive additional flows.

From a development perspective, providing the site with a reticulated sewer system will be achieved through the orderly development of the site. Wastewater infrastructure will be designed and constructed in accordance with Water Corporation standards and requirements. Standard Water Corporation wastewater headworks are applicable in this area.

7 WATER SUPPLY

The site is within the Water Corporation license area and is at the interface of two different reticulation systems. The two systems are the result of undulating topography in the area and the effect this has on water pressure in the system. Ultimately, Water Corporation planners will determine where the interface between the two systems is located, however it is expected that only a small portion of the LSP area will be serviced from the high level system that exists in Saponara Drive.

The majority of the water supply system will be connected to the existing 375/450mm diameter system in Pinjar Road and this will be facilitated via an extension along Caporn Street, from Pinjar Road to the site. Subject to future detailed design, there is approximately 220m of 200mm diameter main in Caporn Street that could be used for at least a portion of this link.

In the northern verge of Caporn Street, east of Wells Street, a 1000mm diameter steel water distribution main exists which acts as conveyance between Wanneroo Reservoir on Belgrade Road and 500mm diameter steel water mains crossing Pinjar Road, just south of Yandella Promenade.

While there is detail to be worked through as part of the future detailed design, Water Corporation have advised that the site can be adequately serviced with water supply.

8 POWER SUPPLY

There is currently capacity within Western Power's (WP) broader network to service the development with their network mapping tool indicating that there 10-15MVa capacity in the area which is serviced from Wanneroo substation WP-012.

Fronting the site along Caporn Street is overhead High Voltage (HV) and Low Voltage (LV) lines. As part of development that has occurred to the west of the site, the overhead lines in Caporn Street have been converted to below ground cables. As the LSP are is progressively developed, the existing overhead lines will need to be converted to underground.

At the southern end of the site, there is a HV cabling located in Saponara Drive along with ground mounted switchgear and transformer located near the intersection of Saponara and Dietes View.

The presence of HV cabling and lines surrounding the site along with spare system capacity allows for a logical extension of the power network in order to service the development.

Due to the presence of the 1000mm diameter steel water main in Caporn street, the provision of new HV equipment to service the site will require Earth Potential Rise studies to be completed as part of the power design process.

Street lighting will also be required as part of the development in accordance with Western Power and City of Wanneroo guidelines.

9 TELECOMMUNICATIONS

The site is within the NBN fibre fixed line footprint and therefore can be serviced.

Each landowner within the site would enter into an agreement with NBN (or other service provider). NBN is required to recover part of the cost of deploying the NBN network infrastructure by applying a Developer contribution charge per premise.

10 GAS SUPPLY

An Atco gas supply network exists within the existing residential subdivisions located to the west and south of the site.

At the time of development each landowner will apply to Atco to provide their design for the gas network to service proposed lots. Atco will generally install the gas pipe network at no cost to the developer, provided that the developer provides a trench in which to install the gas pipe.

The nature of the gas network is such that it does not affect proposed road or lot layout within a subdivision.

11 SUMMARY

All required utilities are available and can be extended to service the proposed development.

Based on the engineering servicing review which included a review of available mapping and, where appropriate, meetings and discussions with service authorities, there would appear to be no engineering or servicing constraints to the development of the site that cannot be resolved through orderly standard engineering design and construction. Significant planning has already been undertaken by the relevant authorities to support existing developments within the vicinity of the site.