

# **Craigie High School Site Local Structure Plan**

## **STRUCTURE PLAN NO. 13**

This Structure Plan is prepared under the provisions of Part 9 of the City of Joondalup District  
Planning Scheme No. 2.

REVOKED 26 JULY 2022



## DOCUMENT HISTORY AND STATUS

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This Structure Plan is prepared under Part 9 of the City of Joondalup District Planning Scheme No.2

**CERTIFICATION OF AGREED STRUCTURE PLAN  
(SCHEDULE 8)**

CERTIFIED THAT MODIFIED CRAIGIE HIGH SCHOOL SITE STRUCTURE PLAN NO. 13 WAS ADOPTED BY  
RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON 8 August 2014

.....  
being an officer of the Commission duly authorised by the Commission  
pursuant to section 24 of the *Planning and Development Act 2005*

AND

BY RESOLUTION OF THE COUNCIL OF THE CITY OF JOONDALUP, MADE 20 MAY 2014, THE COMMON  
SEAL OF THE CITY OF JOONDALUP WAS HEREUNTO AFFIXED IN THE PRESENCE OF:

.....  
TROY PICKARD  
Mayor

.....  
GARRY HUNT  
Chief Executive Officer



## Record of Amendments made to the Craigie High School Site Structure Plan

Amendment No.	Description of Amendment	Endorsed by Council	Endorsed by WAPC
1	<ul style="list-style-type: none"> <li>Modification of the R30 and R40 residential density code boundaries in the southern portion of the Structure Plan area.</li> <li>Recoding the southern end of the north-south block of R25 coded land on the eastern side of the Structure Plan area to R40.</li> <li>Text changes to Part 2, and mapping changes to reflect the coding changes.</li> </ul>	20 May 2014	



# PART ONE – STATUTORY PLANNING

## 1 STATUTORY PLANNING

### 1.1 THE STRUCTURE PLAN AREA

This Structure Plan shall apply to Lots 500 and 501 Arawa Place, Craigie, being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map (**Plan 1**).

### 1.2 STRUCTURE PLAN CONTENT

The Structure Plan comprises:

- a) Statutory Section (Part 1)
- b) Explanatory Report (Part 2)
- c) Appendices – Detailed Technical Reports

### 1.3 INTERPRETATION

Unless otherwise specified in this part, the words and expressions used in this Structure Plan shall have the respective meanings given to them in the City of Joondalup District Planning Scheme No. 2 (the Scheme) including any amendments gazetted thereto.

### 1.4 OPERATION DATE

In accordance with clause 9.8.1 of the Scheme, this Structure Plan shall come into operation when it is either certified by the Western Australian Planning Commission (WAPC) pursuant to clause 9.6.3 of the Scheme or adopted, signed and sealed by the Council pursuant to clause 9.6.5 of the Scheme, whichever is the latter.












### 1.5 RELATIONSHIP WITH THE SCHEME

Pursuant to clause 9.8 of the Scheme:

- a) The provisions standards and requirements specified under Part 1 of this Structure Plan shall have the same force and effect as if it were a provision, standard or requirement of the Scheme. In the event of there being any variations or conflict between the provisions, standards or requirements of the Scheme and the provisions, standards or requirements of this Structure Plan, then the provisions, standards or requirements of this Structure Plan shall prevail;
- b) Any other provisions, standard or requirement of Part 1 of the Structure Plan that is not otherwise contained in the Scheme, shall apply to the land as though it is incorporated into the Scheme, and shall be binding and enforceable to the same extent as if part of the Scheme; and
- c) Part 2 of this Structure Plan and the Appendices – Technical Reports are to be used as a reference only to clarify and guide interpretation and implementation of Part 1.

## 2 OBJECTIVES

The objectives for the Residential Precincts are:

-  To provide for housing diversity through a variety of single and grouped housing lot sizes at densities indicated on the Structure Plan;
-  To provide residential lots which have the correct solar orientation to facilitate passive solar access and the construction of energy efficient dwellings;
-  To provide smaller lots adjacent to public open space to derive benefit from proximity to informal recreation areas;
-  To provide lots which overlook parkland areas and streets to maximise passive surveillance opportunities and promote attractive streetscapes;
-  To maintain a high level of pedestrian connectivity, amenity and safety;
-  Provide narrow front loaded lots to maximise housing affordability;
-  Better enable two storey development to occur that without the constraints of the City of Joondalup Policy 3.19 *"Height and Scale of Buildings Within a Residential Area"*;
-  Avoid over supply of laneway product to achieve housing diversity and therefore appeal to a wider market;
-  Ensure built form activation and presentation to the streetscape and public open space;
-  Ensure the retention of significant trees onsite; and
-  Ensure private open space requirements do not compromise the opportunity for a variety of housing product and design, especially on smaller blocks and considering the provision of quality public open space amenity.

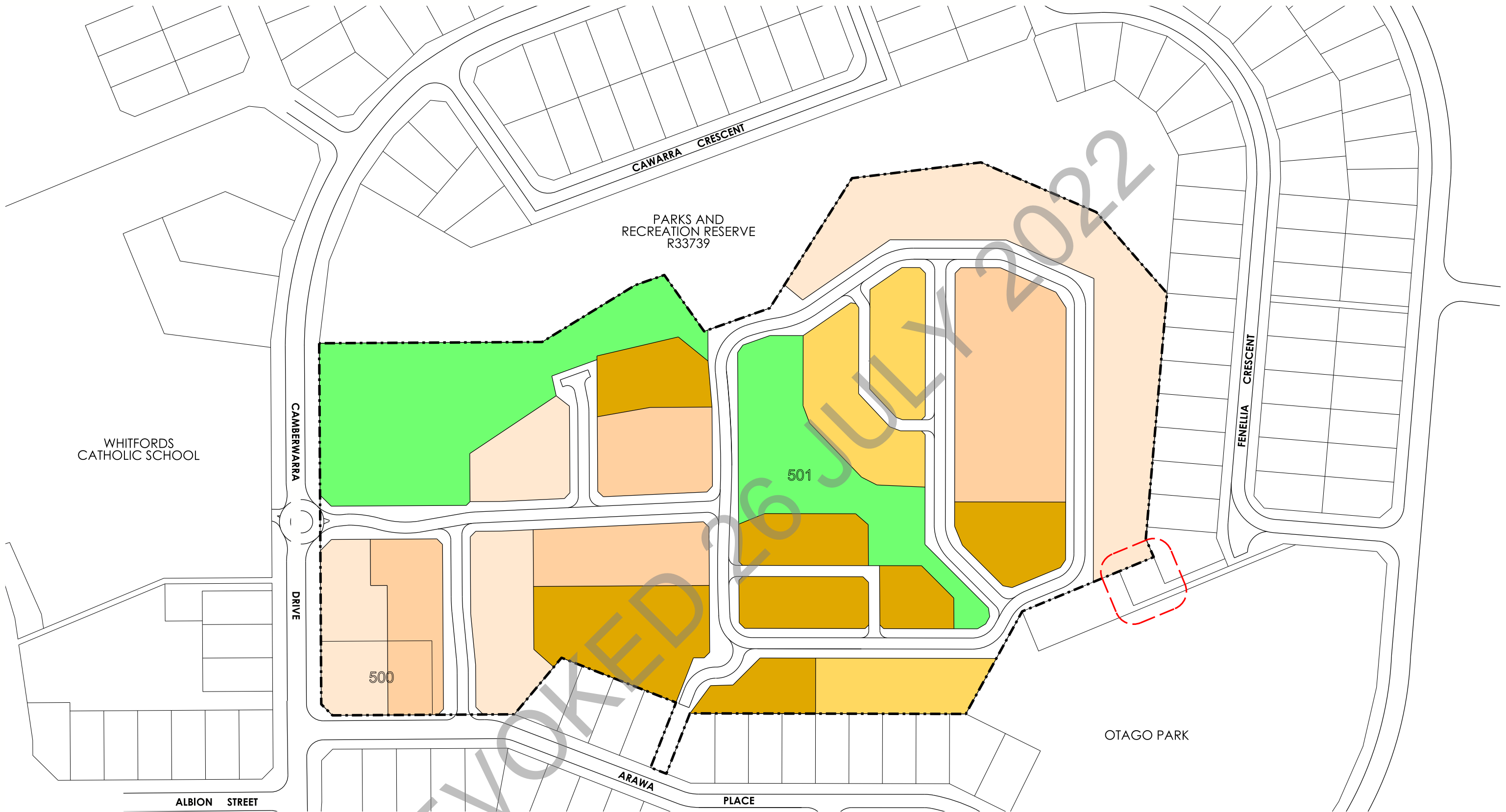
## 3 LAND USE AND SUBDIVISION

The Structure Plan Map (**Plan 1**) outlines land use, zones, reserves and the residential density codes applicable within the Structure Plan area. The zones, reserves and residential density codes designated under this Structure Plan apply to the land within it as if the zones, reserves and residential density codes were incorporated into the Scheme.

### 3.1 LAND USE PERMISSIBILITY

Land use permissibility within the Structure Plan areas shall be in accordance with the corresponding zone or reserve under the Scheme, except for the following:

- a) within 10 metres of the Water Corporation's Waste Water Pumping Station, subdivision and/or development of sensitive land uses will not be supported in accordance with the Environmental Protection Authority's Guidance for the Assessment of Environmental Factors – Separation Distances between Industrial and Sensitive Land Uses.



LEGEND	
<b>ZONES AND R-CODES</b>	<b>ZONES AND R-CODES</b>
RESIDENTIAL R20	RESIDENTIAL R40
RESIDENTIAL R25	LOCAL SCHEME RESERVES
RESIDENTIAL R30	PARKS, RECREATION AND DRAINAGE
	<b>OTHER</b>
	LOCAL STRUCTURE PLAN BOUNDARY
	10m BUFFER LINE AROUND WASTE WATER PUMP STATION

**NOTE:**

1. FURTHER DETAILED DESIGN OF THE MOVEMENT NETWORK IS REQUIRED AT THE SUBDIVISION STAGE AND SHOULD ADDRESS THE OUTCOMES OF THE REVISED MOVEMENT NETWORK POLICY.
2. THE TAKING OF INDIVIDUAL GRACEFUL SUN MOTHS, AS A RESULT OF THE CLEARING OF HABITAT SUCH AS LOMANDRA HERMAPHRODITA AND MARITIMA, REQUIRES THE PERMISSION OF THE MINISTER FOR ENVIRONMENT, OR THEIR DELEGATE, PURSUANT TO THE WILDLIFE CONSERVATION ACT 1950.

## 3.2 RESIDENTIAL

### 3.2.1 OBJECTIVES

- a) To provide for a minimum of 15 dwellings per gross Urban zoned hectare within the Structure Plan area;
- b) To provide for housing diversity through a variety of single and grouped housing lot sizes at densities indicated on the Structure Plan;
- c) To provide residential lots which have the correct solar orientation to facilitate passive solar access and the construction of energy efficient dwellings;
- d) To provide smaller lots adjacent to public open space to derive benefit from proximity to informal recreation areas;
- e) To provide lots which overlook parkland areas and streets to maximise passive surveillance opportunities and promote attractive streetscapes; and
- f) To maintain a high level of pedestrian connectivity, amenity and safety.

## 3.3 PUBLIC OPEN SPACE

The provision of a minimum of 10% public open space being provided in accordance with the WAPC's Liveable Neighbourhoods. Public open space is to be provided generally in accordance with **Plan 1**.

## 3.4 REPORTS/STRATEGIES REQUIRED PRIOR TO SUBDIVISION

Prior to the lodgement of subdivisions, the following management plans are to be prepared, as applicable, to the satisfaction of the relevant authority and provided at the time of subdivision:

- a) Dune Management Plan (City of Joondalup)

## 3.5 CONDITIONS OF SUBDIVISION APPROVAL

At the time of subdivision the City of Joondalup may recommend conditions to the WAPC, as applicable, requiring the preparation and/or implementation of the following strategies:

- a) Urban Water Management Plan (City of Joondalup/Department of Water)
- b) Geotechnical Report (City of Joondalup)
- c) Landscaping Plan (City of Joondalup)
- d) Traffic Management Plan (City of Joondalup)
- e) Dune Management Plan (City of Joondalup)

## 4 DEVELOPMENT



### 4.1 RESIDENTIAL DESIGN CODE VARIATIONS

The following sets out variations to the Residential Design Codes that are deemed to constitute Acceptable Development within the Structure Plan area and which do not therefore require neighbour consultation and planning approval.

### 4.2 GENERAL PROVISIONS

#### 4.2.1 STREETScape AND ORIENTATION REQUIREMENTS

##### 4.2.1.1 ORIENTATION

- a) Dwellings must address nominated street/s and/or public reserve in terms of main entry, major openings, articulation, materials and detailing. Dwellings directly abutting public reserve shall orientate as follows:
  -  If vehicle access is via a laneway - the public reserve is considered as the primary façade.
  -  If vehicle access is via a street, this shall be considered the primary façade, however the secondary façade overlooking the public reserve must be articulated and include at least one major opening.
- b) North-facing lots are permitted to locate outdoor living areas within the front setback area to take advantage of the northern aspect of the site and shall be constructed to maintain surveillance and activation of the adjoining streetscape.

##### 4.2.1.2 CORNER LOTS

- a) Dwellings located on corner lots shall address both streets through their design by extending the primary elevation features onto the secondary street elevation where forward of a return fence. Exposed secondary street façade must incorporate major openings.

##### 4.2.1.3 LOTS ABUTTING PUBLIC OPEN SPACE

- a) Dwellings on lots abutting public open space should be orientated such that they offer passive surveillance over the open space. Major openings and habitable rooms should, where possible, be directed to look onto the open space.

##### 4.2.1.4 ROOFS

- a) Eaves or window overhangs to a minimum dimension of 400mm are required to all habitable rooms. South facing walls, garages and walls with no major openings are excluded.

##### 4.2.1.5 GARAGES/CARPORTS

- a) The roof and design features must be consistent with the form and materials of the home.
- b) Garages shall be located on the nominated nil side setback boundary.

## Craigie High School Site Local Structure Plan

- c) Garages on corner lots, however, may be permitted on northern or eastern side boundaries for a maximum depth of 9m.
- d) A garage door and its supporting structures must not occupy more than 50% of the primary street frontage at the setback line. This may be varied to 60% where a balcony or upper floor with major openings extends 2/3 of the width of the garage (refer below figure). Note: For the purpose of Residential Design Codes Clause 6.2.8 'Garage doors', the performance criterion does not apply.



Source: City of Joondalup's Draft Dual Density Code Policy (2010)

### 4.2.1.6 BOUNDARY FENCING

- a) Fencing to a secondary street must be set back at least 4m from the corner truncation.
- b) Side and rear fencing is to be a maximum of 1.8m high and must return to the house a minimum of 1m behind the front façade of the dwelling closest to the street.
- c) For lots abutting Public Open Space, the developer will construct fencing in accordance with the requirements of the City of Joondalup. The fencing shall be designed such that it offers surveillance of the neighbouring Public Open Space.

### 4.2.2 OTHER REQUIREMENTS

#### 4.2.2.1 RETAINED TREES

- a) Trees within lots at time of purchase shall be retained, unless deemed to be a safety hazard by an approved arboricultural expert to the satisfaction of the City of Joondalup.
- b) Location of crossovers shall avoid impact on existing verge trees.

#### 4.2.2.2 OUTBUILDINGS

Outbuildings that are visible from the public domain (such as from a POS reserve) shall compliment the design and materials of the dwelling or be suitably screened from view, to the satisfaction of the City of Joondalup. Outbuildings shall not be positioned such that they obscure surveillance of public open space from a dwelling.

#### 4.2.2.3 DEVELOPER WORKS

The developer will be responsible for the construction of a footpath along the boundary of properties abutting Public Open Space. The footpath will be located within the open space, off-set from the property boundary. The distance of this off-set, and the specification of the footpath shall be determined by the City of Joondalup.

Where the developer has constructed a fence, entry statement or retaining wall, it must be maintained by the owner to the standard to which it was constructed.

#### 4.2.2.4 RETAINING WALLS

Retaining walls visible from the street or a public space must be constructed of materials matching those provided by the developer. Pre-cast concrete "panel and post" retaining walls are not permitted.

### 4.3 R20 AND R25 PROVISIONS

#### 4.3.1 BOUNDARY SETBACK REQUIREMENTS

The variations to R20 and R25 setbacks are determined by elements including solar penetration, addressing the street/Public Open Space, tree retention, accessibility, surveillance and land efficiency.

Setbacks for the development shall be in accordance with the following. Except where identified below, all boundary setbacks shall be in accordance with the R-Codes.

##### 4.3.1.1 FRONT SETBACKS

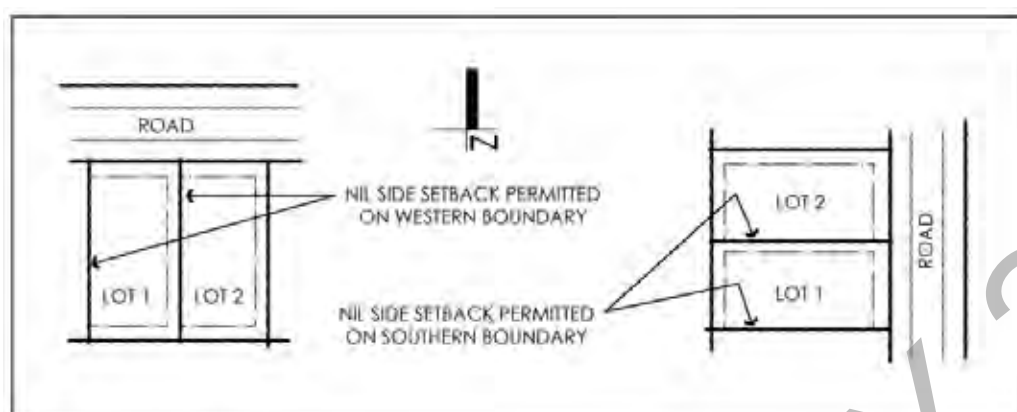
The following setback requirements shall apply to R20 and R25 front loaded lots (except where noted, all other setbacks shall be in accordance with the R-Codes):

- a) Dwellings, exclusive of carports and garages, shall be set back a minimum of 3.0 m to a maximum of 5.0 m from the primary street (no average applies).
- b) A 3.0m minimum dwelling setback is required to lots that abut public open space.
- c) Lots abutting Camberwarra Drive shall have a minimum dwelling front setback of 8m to avoid impact on existing trees.

##### 4.3.1.2 SIDE SETBACKS

- a) A nil side setback is permitted (excluding street and public open space setbacks) to the ground floor level of a dwelling to a maximum wall height of 3.2m (no average) up to 9m in length between a minimum of 1.5m behind the dwelling frontage (face of building) and rear setback. For north south lots the nil side setback shall be on the western boundary and for east west lots the nil side setback shall be on the southern boundary (refer figure below). These nominated nil side setbacks maximise solar penetration whilst facilitating solar accessible private open space.








- b) A 2.0m minimum dwelling side setback is required to a side boundary abutting public open space.

#### 4.3.1.3 GARAGE/CARPORT SETBACKS

Garages and carports shall be setback a minimum of 4.5m from the primary street or 0.5m behind dwelling frontage (face of building).

#### 4.3.2 BUILDING HEIGHT REQUIREMENTS

The provisions of the City of Joondalup Policy 3.19 *"Height and Scale of Buildings Within a Residential Area"* shall not apply.

- a) Dwellings may be constructed to a maximum height of 9.5 metres with loft areas within the roof space permitted.
- b) The maximum building height measured from natural ground level shall be:
-  Maximum wall height (with pitched roof) – 6.5 metres
  -  Maximum total height to roof ridge – 9.5 metres
  -  Maximum wall and total height (parapet wall with concealed roof) – 7.5 metres

### 4.4 R30 AND R40 PROVISIONS

#### 4.4.1 BOUNDARY SETBACK REQUIREMENTS

The variations to R-Codes setbacks are determined by elements including solar penetration, addressing the street/ Public Open Space, tree retention, accessibility, surveillance and land efficiency. Setbacks for the development shall be in accordance with the following. Except where identified below, all boundary setbacks shall be in accordance with the R-Codes.

##### 4.4.1.1 FRONT SETBACKS

- a) A 3.0m minimum to a 5.0 m maximum dwelling front setback is required to the primary street, exclusive of carports and garages (no average applies).
- b) A 3.0m minimum dwelling front setback is required to lots that abut public open space.



#### 4.4.1.2 SIDE SETBACKS




- a) A nil side setback is permitted (excluding street and public open space setbacks) to the ground floor level of a dwelling to a maximum wall height of 3.2m (no average) for two-thirds the length determined by a minimum of 1.5m behind the dwelling frontage (face of building) and rear setback. For north south lots the nil side setback shall be on the western boundary and for east west lots the nil side setback shall be on the southern boundary (refer figure below). These nominated nil side setbacks maximise solar penetration whilst facilitating solar accessible private open space.
- b) A 2.0m minimum dwelling side setback is required to a side boundary abutting public open space.

#### 4.4.1.3 REAR/GARAGE/STORE SETBACKS

- a) A 1.5m minimum garage setback is required to the laneway boundary.
- b) A 0.5m minimum store setback is required to the laneway boundary.
- c) A 1.5m minimum dwelling setback is required to the ground floor level from the laneway boundary.
- d) A nil dwelling setback is permitted to the dwelling upper floor balcony on a laneway boundary.
- e) Garages and carports shall be setback a minimum of 4.5m from the primary street or 0.5m behind dwelling frontage (face of building).

#### 4.4.2 BUILDING HEIGHT REQUIREMENTS

The provisions of the City of Joondalup Policy 3.19 *"Height and Scale of Buildings Within a Residential Area"* shall not apply.

- a) Multiple dwellings may be constructed to a maximum height of 13 metres.
- b) The maximum building height measured from natural ground level shall be:
  -  Maximum wall height (with pitched roof) - 10 metres
  -  Maximum total height to roof ridge - 13 metres
  -  Maximum wall and total height (parapet wall with concealed roof) - 11 metres





### 5 VARIANCE FROM THE STRUCTURE PLAN

Any variance from the Structure Plan at proposed subdivision and development stage shall generally be in accordance with the Structure Plan. Council will determine whether a modification is required to be subject to a formal modification to the Structure Plan.

## PART TWO – EXPLANATORY REPORT

### 1 INTRODUCTION

This Structure Plan (refer **Figure 1** – Structure Plan) and report has been prepared on behalf of LandCorp in partnership with Stockland, by Taylor Burrell Barnett in collaboration with:

-  Emerson Stewart (engineering consultants);
-  Ecoscape (environmental consultants and landscape architects);
-  Bruce Aulabaugh (traffic and transport); and
-  Professional Public Relations (Public Relations).

The Structure Plan will guide future subdivision and development within the former Craigie High School Site. It has been prepared with due regard to the requirements of the City of Joondalup District Planning Scheme No. 2 and various City of Joondalup policy documents.

Elements within the report have been the subject of specific discussions and have received, in principle, endorsement from the City of Joondalup officers.

The Structure Plan is supported by a range of technical reports including traffic, servicing, landscape, environmental and community consultation studies, undertaken to support the Craigie High School Structure Plan.

**Part One**, inclusive of sections 1-8, covers the Statutory Planning Report.

**Part Two** Covers the Explanatory Report. **Section 1** provides an introduction to the Structure Plan area. **Section 2** outlines the area over which the Structure Plan applies. **Section 3** outlines the key sustainability consideration and objectives, with **Section 4** of the report examines the statutory planning framework. The analysis of this context identifies key considerations and parameters for the Structure Plan. **Section 5** outlines the existing Craigie community. **Section 6** provides a detailed description of the existing environment. **Section 7** analyses the site identifying key considerations and parameters for the Local Structure Plan. **Section 8** describes the proposed Structure Plan. **Section 9** of the report outlines the implementation process for the Structure Plan in terms of the statutory framework which has been established for the area by the City of Joondalup. Compliance is identified, management plans explained and staging considered.

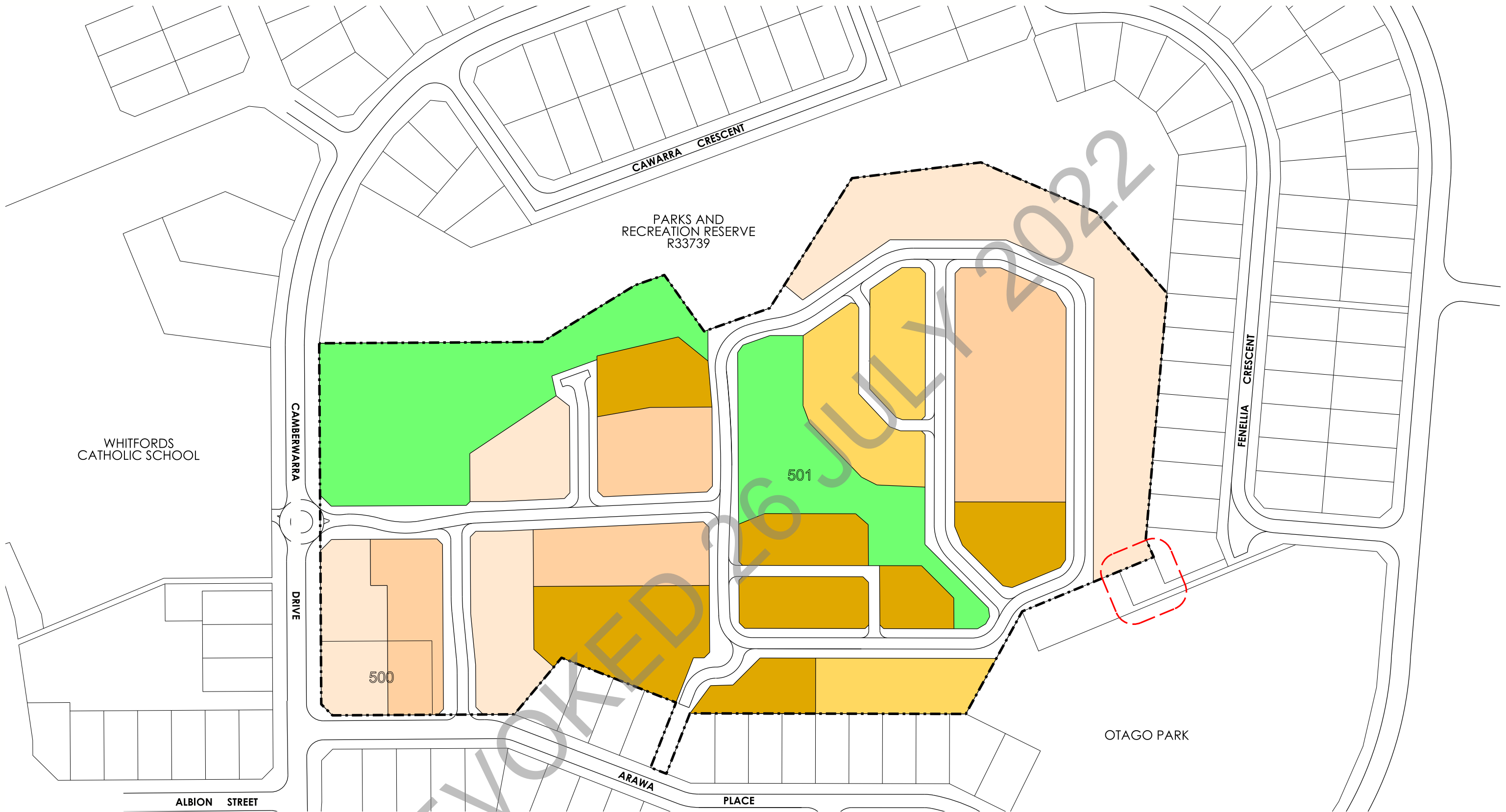
#### 1.1 PURPOSE

The Structure Plan and Report provides the rationale and framework to support future subdivision and development within the Structure Plan area.

The Structure Plan has been prepared in accordance with the City of Joondalup District Planning Scheme No. 2 and the application requirements of Liveable Neighbourhoods.

#### 1.2 BACKGROUND

In 2002, the Craigie High School was identified as surplus to Department of Environment (DoE) requirements. The State Government approved the school's closure and the facility ceased operations in 2003. In 2004 all buildings on the site were demolished.



LEGEND	
<b>ZONES AND R-CODES</b>	<b>ZONES AND R-CODES</b>
RESIDENTIAL R20	RESIDENTIAL R40
RESIDENTIAL R25	LOCAL SCHEME RESERVES
RESIDENTIAL R30	PARKS, RECREATION AND DRAINAGE
	<b>OTHER</b>
	LOCAL STRUCTURE PLAN BOUNDARY
	10m BUFFER LINE AROUND WASTE WATER PUMP STATION




**NOTE:**

- FURTHER DETAILED DESIGN OF THE MOVEMENT NETWORK IS REQUIRED AT THE SUBDIVISION STAGE AND SHOULD ADDRESS THE OUTCOMES OF THE REVISED MOVEMENT NETWORK POLICY.
- THE TAKING OF INDIVIDUAL GRACEFUL SUN MOTHS, AS A RESULT OF THE CLEARING OF HABITAT SUCH AS LOMANDRA HERMAPHRODITA AND MARITIMA, REQUIRES THE PERMISSION OF THE MINISTER FOR ENVIRONMENT, OR THEIR DELEGATE, PURSUANT TO THE WILDLIFE CONSERVATION ACT 1950.

The subject land is a C Class Crown Reserve, vested with the DoE for educational purposes. LandCorp has entered into arrangements with DoE to eventually acquire the Craigie High School site and for LandCorp to take the lead role in the development of the site. Further to these arrangements, LandCorp and Stockland have entered into a partnership to potentially develop the subject land.

Consultation began at a preliminary Strategic Directions Vision Workshop in November 2007, at the outset of the process to inform the design preparation. In addition to the Stockland/LandCorp representatives, the workshop was attended by key stakeholders including Taylor Burrell Barnett, Ecoscape and Emerson Stewart.

The objectives of the workshop were:

-  To collectively gain an appreciation of project critical issues, constraints and objectives;
-  To identify, analyse and evaluate short and long term impacts of critical issues; and
-  To initiate an Issue Response Plan as a framework for ongoing project management.









Subsequent to the workshop, various site inspections, general project meetings and meetings with Council, were undertaken by Stockland and its consultants to discuss and progress project issues.

### 1.3 COMMUNITY CONSULTATION




The development of the former Craigie High School Site and integrated residential development represents a significant brown field development opportunity for investment, which will ultimately produce a broad spectrum of community benefits. LandCorp in partnership with Stockland and the consultant team has undertaken a comprehensive synthesis of the opportunities and constraints to formulate a plan that is cognisant of the community values and expectations for the site. Specifically, this includes respecting the existing residential lots backing directly onto the site, respecting the existing dunal system immediately adjacent to the site, careful consideration for the retention/re-creation of remnant native vegetation and the historical Craigie terraces, respecting the interface with Whitfords Catholic Primary School (to the west of the site) and improving the transition into Otago Park, specifically how to treat the drainage. These sensitive issues are further discussed within the report.

Professional Public Relations (PPR) was engaged to deliver a community consultation strategy to raise awareness and encourage local community support for the Craigie High School redevelopment, and support the public comment period for the Structure Plan. A door knock was undertaken of adjacent residents as requested by Council. In February 2010, PPR with the project team held an onsite information session to re-engage with locals. The session exceeded expectations with more than 200 people attending the session held onsite next to Otago Park. Residents, businesses and stakeholders were given four fact sheets and a set of FAQs on arrival. Attendees could view the analysis plans for the site and discuss with members of the project team. More than 200 feedback forms were issued and a summary of community feedback attached.

The following is a synopsis of community consultation results achieved to date:

	Project information line established	Late 2009
	Website update	21 January 2010
	Invitation letter re home visit	21 January
	Media site visit and photos	28 January
	Personal home visits conducted	27-29 January
	Ministerial media statement	1 February
	Letter re information session invite	1 February
	E-shot re information session invite	2 February

## Craigie High School Site Local Structure Plan

	Brief school and bush care groups	4 February
	Community information session held	13 February
	Post event media release and images	24 February

To continue to build on the success of consultation to date, LandCorp and Stockland will undertake further communications activities to update residents and stakeholders. This material should provide information about additional key dates including detailed estate design, subdivision planning phases and town planning scheme amendment, civil works and expected first sales milestones.

## 2 THE SUBJECT LAND

### 2.1 LAND OWNERSHIP

The subject land (including both Lots 500 on Deposited Plan 60150 and described on Certificate of Title Volume LR3154 Folio 14 and Lot 501 on Deposited Plan 60150 and described on Certificate of Title Volume LR3154 Folio 15 (refer **Appendix 1** – Certificate of Titles) is a C Class Crown Reserve, vested with the Department of Education (DoE) for educational purposes (refer **Figure 2** – Land Ownership). LandCorp entered into arrangements with DoE to acquire the Craigie High School site, once the rezoning for the site was complete.

Lots Details	Plan No.	Landowner	Area
Lot 500 Arawa Place	P60150	Department of Education	0.2381 ha
Lot 501 Arawa Place	P60150	Department of Education	9.9089 ha
TOTAL			10.147 ha

### 2.2 LOCATION

The subject land is located on the former Craigie High School Site within the northern suburb of Craigie, located approximately 22 km north of the CBD. It is approximately 2.8 km east of the beach and 1 km north-east of the Whitfords Shopping Centre (refer **Figure 3** – Location Plan).

More specifically, the subject land extends from Camberwarra Drive to the west to the rear of the existing residential to the east; and from the Parks and Recreation Reserve (R33739) to the north to the rear of the existing residential to the south (refer **Figure 4** – Local Context).

The land comprises of Lots 500 and 501 Arawa Place and covers an approximate area of 10.147 ha.

### 2.3 EXISTING LAND USES

With all Craigie High School buildings demolished in 2004 there is no remaining school infrastructure except for the unkempt remains to the school oval over the eastern portion of the site and the existing concrete terraces to the west of the oval, towards the middle of the site. The site is generally undulating with specific areas of steep and flat terrain. The dune system encroaches into the north-western corner with steep levels grading down into the site. It is sparsely vegetated with a mixture of native and imported trees.

### 2.4 SURROUNDING LAND USES

The subject land is bounded by Whitfords Catholic Primary School to the west, Parks and Recreation Reserve (R33739) to the north, existing residential to the east and south, Otago Park to the south-east and Arawa Place to the south-west. The direct interfaces with the Dunes to the north, existing residential lots to the east and south and Otago Park to the south-east (inclusive of drainage sump) are all important interfaces requiring careful consideration during the formulation of the Structure Plan.

Whitfords Catholic Primary School is situated over Camberwarra Crescent to the west and Craigie Plaza, a local centre, is situated approximately 300m north-east of the site (refer **Figure 4** – Local Context).





## LEGEND

 SUBJECT LAND BOUNDARY

## LAND OWNERSHIP

Lot No.	Street Name	Owner	Area
500	Arawa Place	Department of Education and Training	0.2381ha
501	Arawa Place	Department of Education and Training	9.9089ha
Total			10.1407ha

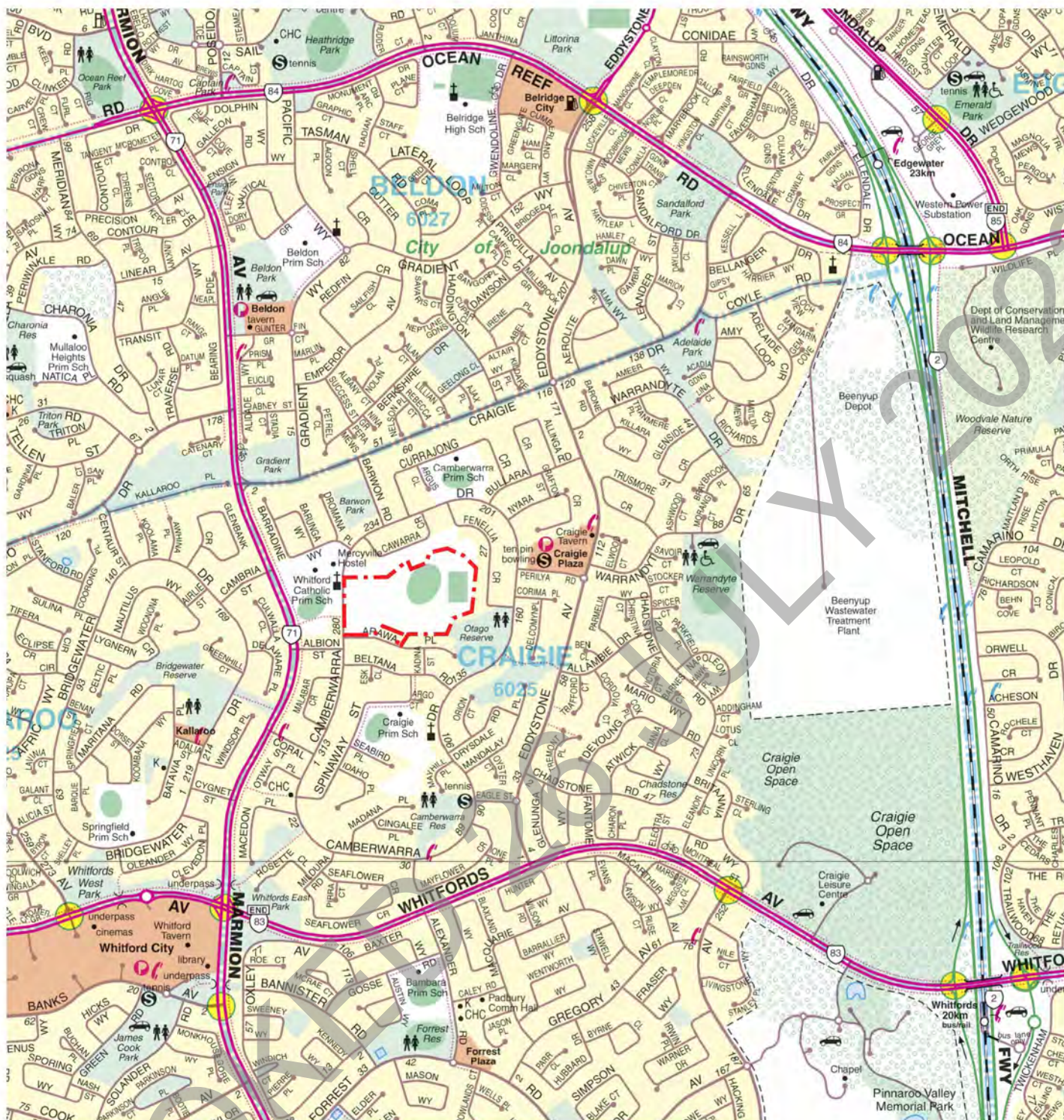
## LAND OWNERSHIP

Craigie High School Structure Plan

N 0m 20 40 60m  
 s: 1:4000@A4  
 d: Oct 2011  
 j: 07/088

figure  
02





## LEGEND

--- SUBJECT LAND BOUNDARY

## LOCATION PLAN

Craigie High School Structure Plan

0m 100 200 300m

s: 1:20,000@A4  
d: Oct 2011  
j: 07/088

figure

03





#### LEGEND

- - - SUBJECT LAND BOUNDARY
- /// SIGNIFICANT DUNAL LANDFORM WITHIN SUBJECT LAND
- /// PARKS AND RECREATION RESERVE R33739
- ★ EXISTING ACCESS POINT FROM ARAWA PLACE
- ... DIRECT INTERFACE WITH EXISTING RESIDENTIAL

#### LOCAL CONTEXT

Craigie High School Structure Plan

0m 20m 40m  
 s: 1:2500@A3  
 d: Oct 2011  
 j: 07/088



## Craigie High School Site Local Structure Plan

At a greater context, Whitfords Shopping Centre, a regional Centre, is located 1km south-west of the site. Marmion Avenue, a major north-south District Distributor Type A, is located approximately 200m west of the subject site with the Mitchell Freeway leading into the CBD, located approximately 1.5km east of the site. Various Primary Schools, 3 High Schools, a Retirement Village and a mixture of public open spaces are all found within a 2km radius of the site (refer **Figure 5** – Greater Context).



## LEGEND

- SUBJECT SITE
- SCHOOL
- SHOPPING CENTRE/RETAIL
- RESERVE
- BUSHFOREVER PROTECTION AREA
- BUS ROUTE
- RAILWAY LINE
- RAILWAY STATIONS

### SCHOOLS

- 1 MATER DIA COLLEGE
- 2 EDDYSTONE PRIMARY SCHOOL
- 3 BELBRIDGE HIGH SCHOOL
- 4 BELDON PRIMARY SCHOOL
- 5 OCEAN REEF PRIMARY SCHOOL
- 6 MULLALOO BEACH PRIMARY SCHOOL
- 7 MULLALOO HEIGHTS PRIMARY SCHOOL
- 8 WHITFORDS PRIMARY SCHOOL
- 9 WHITFORD CATHOLIC PRIMARY SCHOOL
- 10 SPRINGFIELDS PRIMARY SCHOOL
- 11 ST MARKS ANGLICAN COMMUNITY SCHOOL
- 12 BAMBARA PRIMARY SCHOOL
- 13 PADBURY PRIMARY/SENIOR HIGH SCHOOL

### SHOPPING CENTRES/RETAIL

- 14 OCEAN REEF LOCAL CENTRE
- 15 BELBRIDGE CITY
- 16 BELDON LOCAL CENTRE
- 17 MULLALOO LOCAL CENTRE
- 18 CRAIGIE PLAZA
- 19 KALLAROO LOCAL CENTRE
- 20 WHITFORD CITY
- 21 FORREST PLAZA

### OTHER

- 22 WOODVALE NATURE RESERVE
- 23 BEENYUP DEPOT
- 24 BEENYUP WASTEWATER TREATMENT PLANT
- 25 CRAIGIE OPEN SPACE
- 26 MC DONALD PARK/RECREATION CENTRE/NETBALL/BASKETBALL
- 27 PINNAROO VALLEY MEMORIAL PARK
- 28 ST. IVES NORTHSORE ESTATE (RETIREMENT VILLAGE)

## GREATER CONTEXT

Craigie High School Structure Plan

0m 500m  
 s: 1:30,000@A4  
 d: Oct 2011  
 j: 07/088

figure  
05



### **3 SUSTAINABILITY**

The vision for the development of the Craigie High School site is to create a development which is environmentally, economically and socially sustainable.

#### **3.1 OBJECTIVES AND INITIATIVES**

The State Sustainability Strategy was released by the Government of Western Australia in September 2003. Sustainability is defined by the Strategy as meeting the needs of current and future generations through simultaneous environmental, social and economic improvement.

#### **3.2 SOCIAL SUSTAINABILITY**

The Craigie High School Structure Plan will facilitate for development that will accommodate a range of socio-demographic groups through the creation of a range of lot sizes to cater for a variety of housing products thus encouraging social diversity.

The Craigie High School Structure Plan has been designed to encourage social interaction and the development of a healthy community. The development as proposed will facilitate the creation of a healthy and socially interactive and active community as all allotments will strongly relate to and have ready and safe access to parkland, bushland, and other areas of community focus. The development will facilitate active lifestyles through the provision of safe, quality and attractive walking and cycling trails throughout the public open space and within the residential areas. Social interaction will be encouraged through the implementation of good urban design and development of community spaces and places.

The Craigie High School Structure Plan embraces many Liveable Neighbourhood principles such as 'walkability' and 'permeability' which contribute to reducing car use, creating a greater sense of community, better access to services and using land more efficiently.

To assist in the creation of a strong sense of place and a community focal point, the Structure Plan proposes a multi-activity trail adjacent to the dunes and a high amenity public open space in the central area of the site to cater for the daily convenience needs of the future population. Vibrancy, liveability and amenity will be enhanced by these kind of land uses where people can come to socialise and enjoy their lifestyle.

The implementation of all of the above principles at Craigie High School will significantly contribute towards ensuring the socially sustainability of the project is maximised.

#### **3.3 ENVIRONMENTAL SUSTAINABILITY**

The Craigie High School Structure Plan will facilitate for a residential settlement with a modest ecological footprint as almost 18% of the site (refer Table 3, section 7.2.2) is Reserved for public open space. A Dune Management Plan will be prepared to ensure that the dune environment is protected and conservation principles are balanced with the need to provide people access and spaces along the dunal system to the north of the site.

Selected vegetation within public open spaces and along Camberwarra Drive will also be retained where possible and appropriate.

The Craigie High School design encourages and facilitates walkability and in making provision for an effective and efficient bus route along Camberwarra Drive encourages the use of public transport leading to less use of the private car. This will assist in the reduction of the consumption of non-renewable resources and reducing air pollution and waste creation. Importantly, the site is in close proximity to railway services at Edgewater and Whitfords Stations.

### 3.4 ECONOMIC SUSTAINABILITY

The Craigie High School Structure Plan will facilitate development that will create numerous jobs during its planning, design, development and construction phase. Jobs in the local government will also be created for the maintenance of public open space, garbage collection and other local authority services. The creation of employment opportunities in the local area contributes towards environmental sustainability and social sustainability by reducing travel time and distance.

The urban design incorporated in the Craigie High School Structure Plan focuses on minimising the length of road required, whilst still providing a permeable and connected residential area. This contributes to sustainable development by efficiently using resources.

Residential development at Craigie High School will introduce additional families to the area and will support existing infrastructure and community services, including the northern railway line and bus services in the area and the near-by Craigie Plaza. The development as proposed will be economically sustainable and represents an efficient use of resources and existing infrastructure.

In developing Craigie High School, key sustainability objectives and initiatives shall apply to this structure plan as follows:

Item	Objective
<b>ENVIRONMENTAL LEADERSHIP</b>	
Environmental Leadership	Leadership through the protection and management of natural systems, habitat and biodiversity, and innovation and efficient use and management of precious resources such as materials, water and energy.
<b>WATER EFFICIENCY</b>	
Water Efficiency	Landscape works to focus on utilising native water wise vegetation. Investigate the opportunity to capture & treat grey and stormwater onsite to service public, private gardens and community park. Ensure appropriate onsite retention and/or detention utilising best practice Water Sensitive Urban Design principles.
Recycling Water and Education	Water balance strategy and WSUD principles to be applied to landscaping in public domain, community park and drainage reserve. Ensure that these are integrated into the overall site water management plan and that they incorporate investigations of greywater/stormwater reuse system.
<b>MATERIALS</b>	
Use of Recycled Materials	Use of reconstituted limestone and recycled materials throughout project.

## Craigie High School Site Local Structure Plan

Item	Objective
<b>ECOLOGY</b>	
Local Biodiversity	The protection and management of natural systems, habitats and biodiversity and innovation and efficient use and management of precious resources such as materials, water and energy.
Ecological and Recreation Enhancement	Restoring and enhancing natural and biodiversity values of the Quindalup Coastal Dune. Regenerating and enhancing the quality accessibility and amenity of the Quindalup dunes within the site. Adventure trail and focal point along green spine. Landscape works to focus on utilising native plants indigenous to the area that will provide food/habitat for native wildlife.
<b>WASTE</b>	
Carbon Reduction	Retention and enhancement of mature vegetation.
<b>DESIGN EXCELLENCE</b>	
Sense of Place	To create an inspiring place for the Craigie Community by harnessing the site's key natural and historic attributes and promoting sustainable outcomes balanced with the built environment to ensure a safe, attractive accessible and adaptable place that contributes to the identity of Craigie and its revitalisation.
<b>PASSIVE DESIGN</b>	
Passive Design Features	Lot orientation. Built form requirements to facilitate passive solar gain and natural ventilation. Maximise retention and enhancement of mature native vegetation. Improved ambient temperature through retaining and enhancing trees, green shading and vegetation and through the use of locally sourced (reconstituted) light coloured paving material, thereby reducing the community cooling load.
<b>BUILT FORM</b>	
Built Form Innovation	Application of sustainability built form requirements.
<b>COMMUNITY WELLBEING</b>	
Community Wellbeing	The redevelopment will create a community that is safe, healthy and an enjoyable place to live and work and the residence will have access to affordable and appropriate housing and foster active local citizenship.
<b>SOCIAL NEEDS</b>	
Social Needs	Celebrate social and cultural history of the site through a Community Artworks Program. Improved vehicular, safety and accessibility through the provision of a dual-use pathway for both pedestrian and cyclists with improved passive surveillance and minimised vehicular impact through a human scale streetscape.

Item	Objective
<b>ECONOMIC HEALTH</b>	
Economic	Efficient use of existing infrastructure.
Capital Growth	Promotion of revitalisation of Craigie to the immediate and greater area.

## 4 STATUTORY AND POLICY FRAMEWORK

### 4.1 STATUTORY PLANNING CONTEXT

#### 4.1.1 METROPOLITAN REGION SCHEME

The subject land is currently zoned Urban under the Metropolitan Region Scheme. The land was the subject of Metropolitan Region Scheme (MRS) amendment 1150/57 which transferred the land from the Public Purposes (high school) reservation to the Urban zone. The MRS amendment was published in the Government Gazette in June 2008.

#### 4.1.2 CITY OF JOONDALUP DISTRICT PLANNING SCHEME NO. 2

Lots 500 and 501 are currently zoned 'Urban Development' under the City of Joondalup District Planning Scheme (DPS) No. 2 (refer **Figure 6** – District Planning Scheme No. 2).

### 4.2 STRATEGIC PLANNING CONTEXT

#### 4.2.1 DIRECTIONS 2031 AND BEYOND

*"Directions 2031 and beyond is a spatial framework; a high level strategic plan that establishes a vision for future growth of the Perth and Peel region, and provides a framework to guide the detailed planning and delivery of housing, infrastructure and services necessary to accommodate that growth."* (Department of Planning, 2010; 1)  
With the population expected to climb from 1.65 million currently to 2.2 million by 2031, Directions 2031 sets out a strategic framework for accommodating this expected growth.

*"Having a more compact City"* has been identified in Directions 2031 and beyond as a preferred growth scenario, which means, consolidating development in appropriate locations with an emphasis on infill development. The Craigie High School Site, is a perfect example of an appropriate location for infill development to support the growth strategies advocated by Directions 2031.

An initiative of Directions 2031 and beyond is to support housing strategies for Perth and Peel to deliver a responsive housing system that meets the changing needs, aspirations and choices of the residents of Perth and Peel taking into account affordability and equity.

*Reference: Department of Planning 2010, Directions 2031 and beyond, Western Australian Planning Commission, Perth.*

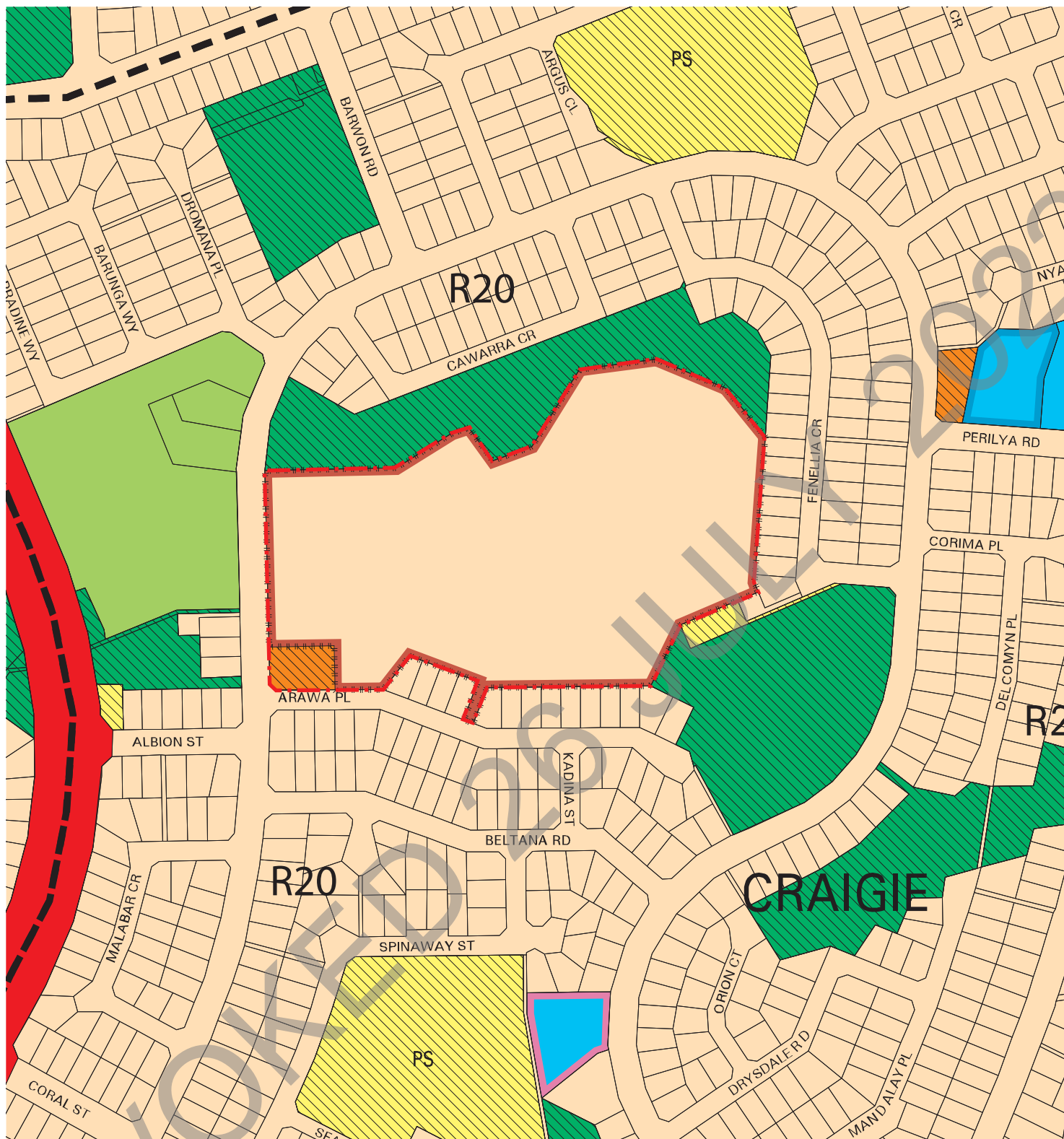
#### 4.2.2 OTHER STATE PLANNING POLICIES

*Liveable Neighbourhoods* is an operational policy for the design and assessment of structure plans and subdivision for new urban areas in the metropolitan area and country centres.

*Liveable Neighbourhoods* is applied in the City in the design and approval of urban development, structure planning and subdivision for green field sites and for the redevelopment of large brown field and urban infill sites.

The design of the Craigie High School Local Structure Plan has been formulated using the *Liveable Neighbourhoods* planning approach to development.





## LEGEND

### METROPOLITAN REGION SCHEME RESERVES

PRIMARY REGIONAL ROADS

### LOCAL SCHEME RESERVES

PARKS AND RECREATION

PUBLIC USE

PUBLIC USE  
DENOTED AS FOLLOWS  
PRIMARY SCHOOL

PS

### ZONES

RESIDENTIAL

URBAN DEVELOPMENT

COMMERCIAL

MIXED USE

CIVIC AND CULTURAL

PRIVATE CLUBS/RECREATION

### OTHER

R CODES

LOCALITY BOUNDARY

SUBJECT BOUNDARY

## DISTRICT PLANNING SCHEME No. 2

Craigie High School Structure Plan

0m 25 50 75m  
s: 1:5000@A4  
d: Oct 2011  
j: 07/088

figure  
06

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#### 4.2.3 LOCAL PLANNING STRATEGY

City of Joondalup's Local Planning Strategy (LPS), dated July 2008, is to enable Council and the community to determine the vision and strategic planning direction for the City of Joondalup for the next fifteen to twenty years.

Preparation of the LPS has included assessment of all relevant state, regional and council plans, policies and strategies. Community input into the strategy has been achieved through surveys on key planning strategies.

The strategy states, in relation to housing, that *"in strategically appropriate locations, planning will take into account the future housing needs of an aging population and changing household structures."* With this changing household structure, that is, household sizes decreasing, the City acknowledges the need for smaller lot sizes and consequently smaller houses to reflect changing lifestyles. The City realises Craigie, with ageing housing stock, is ready for regeneration. *"This is the natural process of housing renewal and presents excellent opportunities to provide more diverse housing types and at the same time, upgrade physical infrastructure and amenity."* An action of the LPS was to prepare a Local Housing Strategy aimed at identifying areas which are strategically located for infill or redevelopment. This is explained further below.

Together with housing, the environment is a key consideration, and the City plans to *"ensure that biodiversity and the natural environment values of the city are protected and preserved for the existing and future generations."*

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#### 4.2.4 CITY OF JOONDALUP DRAFT LOCAL HOUSING STRATEGY

At its meeting held on 15 February 2011, Council adopted the Draft Local Housing Strategy.

A Local Housing Strategy is a plan that identifies how future housing needs can be met within a local government area. A Strategy of this type is a requirement for local governments when preparing a new District Planning Scheme.

State government policies, in particular Directions 2031 and beyond (as previously covered), are encouraging this movement towards more efficient use of land and the City of Joondalup's draft Local Housing Strategy has been considered in this context. Research undertaken has shown that the combination of changes in household size to smaller households combined with an ageing population illustrates a need for a variety of housing options in the City of Joondalup.

Four principal objectives of the draft Local Housing Strategy, relevant to Craigie are to:

-  Encourage residential development which protects amenity and ensures that growth in the City occurs in a sustainable way;
-  Identify suitable areas for increased densities which are in need of private investment to make more effective use of existing community infrastructure;
-  Ensure that a wide range of housing can be provided to meet the social and economic needs of the changing demographics of the City; and
-  Identify mechanisms to ensure new infill development is based on good design principles thus improving the amenity of existing neighbourhoods.





The objective of increasing densities in the appropriate areas aligns to the draft Dual Density Code Policy which is further explained below.

As part of the Draft Local Housing Strategy, the City of Joondalup has identified 10 areas in the City as being suitable for higher residential densities. The subject land sits within Opportunity Area 5 (refer **Figure 7** – Draft Local Housing Strategy), where it is notated as being “*subject to further detailed planning.*”

The general future direction for Opportunity Area 5 is that it “*presents an excellent opportunity for more compact living and greater housing choices focussed around Whitfords Regional Centre and the important public transport services on Whitfords Avenue. There is an opportunity to revitalise the older part of Craigie.*”

An R20/R40 dual density code is recommended for residential properties close to Whitfords Centre and the public transport corridor for Whitfords Avenue. Elsewhere in the Housing Opportunity Area, and surrounding the former Craigie High School site, R20/30 is recommended for residential properties.

The former Craigie High School site is identified as “*subject to future planning.*” The urban design directions for the Craigie High School Site are:

-  The focus will be on good design outcomes that will improve the area and respect the amenity of current and future residents.
-  A new Dual Density Code Policy will be prepared and development at the higher densities will have to meet the requirements of the policy.
-  Enhancing/maintaining streetscapes and environmentally responsible housing designs are features of the proposed new Dual Density Code Policy.
-  The expected increase in housing diversity will build on existing neighbourhood character and sense of place.

All of these urban design directions/principles have been key considerations in the design formulation of the proposed local structure plan.

The Residential Design Codes of Western Australia (R-Codes) are a regulatory and comprehensive tool for the control of built form and density of the residential development throughout WA and are supported by the Local Housing Strategy.

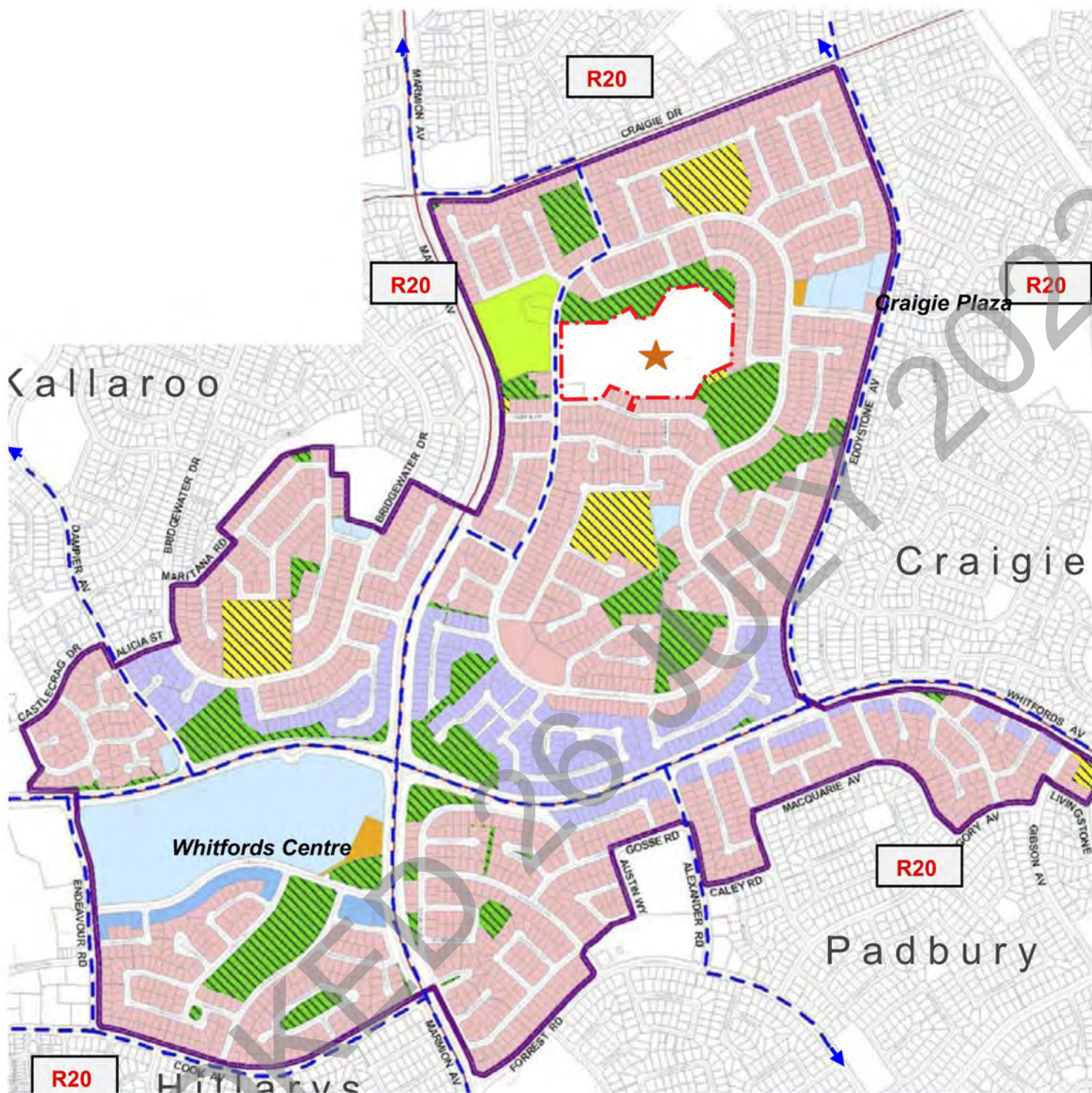
Community concerns about the impact of infill housing can be addressed by the application of additional standards (refer Part One, **Section 4** – Development).

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#### 4.2.5 CITY OF JOONDALUP LANDSCAPE MASTER PLAN

The City of Joondalup contains a diverse range of public open space that includes: bush forever sites, conservation category wetlands, regional parks, areas of passive and active recreation, a wide range of purpose-built sporting grounds, and generous road verges and medians. In 2008, the City prepared a Water Conservation Plan to demonstrate a reduction in groundwater consumption for Public Open Space irrigation, in response to limitations imposed by the State Government in 2007. This process was a major catalyst for the production of the City of Joondalup Landscape Master Plan 2009-2019. The relevance of this document to the former Craigie High School site is discussed below.





#### LEGEND

- SUBJECT LAND BOUNDARY
- HOUSING OPPORTUNITY AREA BOUNDARY
- PROPOSED R20/R30 CODING
- PROPOSED R20/R40 CODING
- PROPOSED MIXED USE ZONING
- ★ FORMER CRAIGIE SENIOR HIGH SCHOOL SITE SUBJECT TO FURTHER DETAILED PLANNING
- EXISTING COMMERCIAL/MIXED USE AREA

- EXISTING PUBLIC USES INCLUDING SCHOOLS
- EXISTING PARKS
- EXISTING CIVIC USES
- EXISTING PRIVATE SCHOOL
- RAILWAY STATION
- BUS ROUTES
- R20 NO CHANGES TO RESIDENTIAL DENSITY

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#### 4.2.5.1 LANDSCAPE VISION







The vision for landscape within the City of Joondalup *“will be innovative, distinctive, functional and appealing, and valued by residents and visitors and will evoke a sense of ownership and pride amongst its residents. This vision will be achieved through the application of sustainable principles that will underpin all landscaping practices, with a focus on environmental best practice and the preservation, enhancement and showcasing of local natural diversity.”*

Key elements of the City’s vision have been reflected in the Craigie High School Redevelopment Landscape Master Plan, these are described within the aims and principles listed below.

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#### 4.2.5.2 AIMS AND PRINCIPLES

The City’s vision is underpinned by several aims and principles. The following have been referenced due to their relevance to the Craigie site, and of the proposed landscape works:

-  provide more opportunities for passive recreational pursuits in public open space and ‘natural’ bushland ecosystems;
-  increase active and passive recreational opportunities within attractive and functional landscape incorporating expanses of irrigated turf, maintained native garden beds, and rehabilitating more natural bushland areas;
-  provide an effective response to the issue of climate change through reducing overall water consumption patterns across the City where appropriate;
-  provide attractive and functional streetscapes;
-  ensure that the City’s Town Planning Scheme and development plans for residential development reflect the principles of landscape master planning; and
-  ensure community awareness and engagement occurs during planning and implementation.

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#### 4.2.6 OTHER LOCAL PLANNING POLICIES

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##### 4.2.6.1 POLICY 3.2 HEIGHT AND SCALE OF BUILDINGS WITHIN RESIDENTIAL AREAS

Issued by the City of Joondalup in October 2005, the *Height and Scale of Buildings Within Residential Areas* policy’s primary objective is “to ensure that all development within a residential area of significant height and scale is given appropriate consideration with due regard to the protection and enhancement of the amenity and streetscape character of the surrounding area.” As part of this policy development application must comply with a building threshold envelope.

The Structure Plan’s relationship with this policy is addressed within **section 8.3 - Built Form**.

## **5 CRAIGIE COMMUNITY**

### **5.1 DEMOGRAPHICS**

In a total area of 4.6 km<sup>2</sup>, current population for the suburb of Craigie (based on 2006 Census) is 5,565 making the population density 1,210 people per km<sup>2</sup>. This population is accommodated within 2,157 dwellings with an average household size of 2.4 people. Craigie's median age is 34 with the number of people aged over 65 at 553, 9.9% of Craigie's total population. The median household income is \$52,073 per annum.

### **5.2 HOUSING**

The general housing type surrounding the Craigie High School Site is single storey dwellings/houses on approximately 700m<sup>2</sup> lots, with approximate 18m frontages and 37m depths. 2,023 of 2,302 residential lots within the suburb of Craigie are between 600-900m<sup>2</sup>.

### **5.3 FACILITIES**

The facilities available within close proximity to the Craigie High School Site include Whitfords Catholic Primary School situated over Camberwarra Crescent to the west, Craigie Plaza (local centre) situated approximately 300m north-east of the site, the dunal reserve (with tracks throughout) immediately north of the site and Otago Park to the south west of the site.



## 6 EXISTING SITE DESCRIPTION

### 6.1 SOCIAL VALUES

The site is comprised of both urban (high school land use) and natural (remnant dune) landscapes. The integrity of the dune has been compromised through human use, particularly due to vehicular traffic. The removal of the High School has created a 'social void', and consequently the value of the dune environment within the surrounding community has diminished. This is most obviously demonstrated by the evidence of vehicular access, and resultant erosion, and burn off caused by a recent fire.

The urban landscape value within the high school site has also reduced since the School closed, and was subsequently demolished. This is most evident by the widespread graffiti and scattered rubbish throughout the site. The lack of passive surveillance into the site allows anti-social behaviour to occur unnoticed. Vegetation re-growth has occurred since the demolition of the School buildings and sporting courts. This has caused a perception of neglect of a once vital urban environment.

### 6.2 LANDSCAPE CONTEXT

The site is located on the western edge of the Swan Coastal Plain. The Plain is built up from sediments, in contrast to the igneous and metamorphic rock of the Darling Scarp. The sediments occur in two broad belts that differ in origin. The belt to the west is accumulated by wind from the Ocean and the belt to the east is water-laid, deposited by rivers and streams running off the Scarp. The pattern of distribution of the sediments is striking, consisting of a series of distinct landforms roughly parallel to the coastline. The belts of aeolian sediments occur in a series of three coastal dune systems: Quindalup (youngest and most western), Spearwood (middle) and Bassendean (oldest and most eastern dune system). Each dune system has distinct geology, vegetation, topography, drainage patterns and soil characteristics. The former Craigie High School site is located at the transition between two of these dune systems: the Quindalup and the Spearwood.

#### 6.2.1 TOPOGRAPHY AND LANDFORM

The Quindalup Dune System is of relatively recent origin, it exhibits striking dune forms: parallel dunes, parabolic dunes and blow-outs, while the Spearwood Dune System is older allowing time for erosion to produce different landscapes (refer Figure 8 – Topography and Landform). The Craigie site is nestled on the edge of a parabolic dune represented by the steep sloped landform of remnant bushland to north and east. The other edge of the parabolic dune is preserved in the remnant bushland southeast of the site, beyond and parallel to Camberwarra Drive. The deflated hollow inside this parabolic dune has been developed for housing and the former High School. Land development within the Swan Coastal Plain has resulted in a significant loss of the parabolic dune formation. Thus preservation, education and rehabilitation of the remnant dune in this project are important.

An assessment of the existing landform was undertaken to demonstrate the extent of slope, flat areas and the relationship between them. The landform of the site is comprised of two primary components: a remnant dune ridge and the flat hollow, which has been modified into a series of flat benches separated by steep slopes, creating a predominantly human altered landscape. The benching was a result of the construction of an oval, building pads and ball sport courts for the High School.

## Craigie High School Site Local Structure Plan

The slopes that connect each of the large flat areas range in severity between approximately 5% and 30% grades. A series of concrete terraces, located centrally within the site, accommodate a five metre level change between the east and west of the site. The variation in ground levels across the site ranges between a low point of 30m (AHD) and a high point of 55m (AHD).

### 6.2.2 SOILS AND GEOMORPHOLOGY

A preliminary geotechnical investigation (refer **Appendix 2**) was undertaken on the site by Brown Geotechnical and Environmental in October 2009 (BGE, 2009) and comprised of a series of excavated test pits and cone penetration tests. The investigation was aimed at obtaining an understanding of the geotechnical conditions on the site.

Results of the investigation indicate a thin layer of topsoil covers the majority of the site and is underlain by medium grained light grey and light brown sand. The sand extends to at least 2.5m and represents the Safety Bay Sand Formation as indicated on the geological maps. Occasional roots were encountered to a depth of 1.0m. The relative density of the sand is generally medium dense to dense to very dense (refer **Figure 9 – Geomorphology and Climate**).

Occasional cobbles and boulders were encountered intermittently across the site. There is evidence of uncontrolled fill, primarily uncontrolled fill material from demolition of school buildings, which will require removal from the site.

The Quindalup Dune System is comprised of three soil types, all of which are present within the site: limestone, limestone sand and calcareous sand (refer **Figure 10 – Soils**). The limestone is a pale yellowish brown in colour, is weakly cemented, friable, medium grained, with sub-rounded quartz and shell debris of aeolian origin. The sand is pale and olive in colour, with medium to coarse grain, sub-angular to sub-rounded quartz, a trace of feldspar, and moderately sorted of residual origin. The calcareous sand is white in colour, fine to medium grained with sub-rounded quartz and shell debris of aeolian origin. These soils are free draining and support unique flora and fauna.

The Spearwood Dune System consists of calcareous deep sands and yellow sands, coastal aeolian sand over sedimentary rocks, coastal dunes with sand flats. There are two distinctly different landscapes, one that consists of shallow yellow brown sands and exposed limestone while the other has deep yellow brown sands.

### 6.2.3 SURFACE HYDROLOGY AND GROUNDWATER

The site is located on the Safety Bay Sands system. The geotechnical investigation revealed that the in-situ sand generally has a fines content of less than 5% (typically 1-2%) with permeability at post development compacted densities expected to be 5-6m/day. The site is well suited to the on-site disposal of stormwater runoff (refer **Figure 11 – Surface Hydrology**).

No groundwater was encountered during the geotechnical investigation. The Perth Groundwater Atlas shows the maximum historical groundwater level to be approximately 2mAHD, approximately 30m below existing ground level.

The previous earthworks associated with the High School have resulted in a local ridge that extends from the dune formation in a south easterly direction. This local ridge defines two distinct catchments within the site: one to the west, with a combination of benching and organic sloping terrain; the other to the east, with a combination of benching and steep slopes (refer **Figure 11 – Surface Hydrology**). The western catchment which occupies approximately one third of the site drains to the west onto Camberwarra Drive. The eastern catchment which occupies the remainder of the site drains to an existing sump, located outside the south western site boundary.



The porosity of the soil profile allows the stormwater to drain freely into a deep groundwater reservoir, which sits approximately 30m below ground level.

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#### 6.2.4 FLORA AND VEGETATION

A spring flora and vegetation survey was completed by Coffey Environments in 2007 (refer **Appendix 3** - Spring flora and vegetation survey). The vegetation surrounding the former high school site contains representatives of the Quindalup Dune System such as, the Rottnest Island Tea Trees and Rottnest Island Pines and the adjacent Spearwood Dune System, most notably, a stand of Tuarts adjacent Camberwarra Drive to the west of the site. The site is predominantly covered by the Cottesloe Central and South Vegetation Complex, with the southeast corner containing the Quindalup Vegetation Complex.

A total of 53 flora species were recorded, within five vegetation types. The dominant family present was Poaceae (Grasses). The condition of the vegetation ranged from completely degraded to excellent, depending on the extent of disturbance and weed species present.

A total of 16 weed species were recorded, many of which are considered aggressive. These include; Coastal Moort, Jarrah, two large Ficus trees, and several Norfolk Pines, Canary Island Palm, Japanese Pepper, River Sheoak, Candlestick Banksia, Peppermint, Sugar Gum and Lemon Scented Gum.

No Threatened Ecological Communities (TECs) were recorded within the survey area. The dunes to the north west of the survey area may be considered locally significant as they represent a good quality vegetation type which normally occurs in closer proximity to the coast.

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#### 6.2.5 FAUNA

The vegetation to the north and west of the High School Site has been identified as containing the conservation significant fauna species *Synemon gratiosa* (Graceful Sun Moth) which is listed as specially protected fauna under the *WA Wildlife Conservation Act (1950)* and listed as Endangered under the Commonwealth *Environment Protection and Conservation Act (1999)*.

Ecoscape undertook a vegetation condition and Lomandra survey of the site in April 2010 (refer **Appendix 4** – Vegetation Condition and Lomandra Survey). The presence of large numbers of Lomandra maritime within good to excellent condition bushland was found within the western portion of the dune vegetation. This is ideal habitat for the Graceful Sun Moth (GSM).

The need to protect the remnant vegetation and provide a sustainable habitat for the Graceful Sun Moth if present is acknowledged via retention and protection of the vegetation within public open space. It is for this reason that referral to DEHWA is not considered necessary. Recommendations for the management of the dunes and the fauna habitat have been provided later within this document. Additionally, the proposed development does not involve any clearing of the identified GSM habitat areas.

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#### 6.2.6 OPEN SPACE NETWORK

The site is located centrally to several public open spaces, and community gathering points, each of which are within walking distance. Bridgewater Reserve can be accessed via an under-pass beneath Marmion Avenue, Whitford Catholic Primary School is adjacent the site on Camberwarra Drive, Gradient and Barwon Park to the north west, Camberwarra Primary School to the north, the Craigie Plaza, and Warrandyte Reserve to the east, and both Otago Reserve and the Craigie Primary School to the south.

## Craigie High School Site Local Structure Plan

Most of the road network surrounding the site contains at least one footpath within the road verge, facilitating pedestrian movement between these public spaces.

### 6.2.7 CLIMATIC INFLUENCES

The site is located less than 3 km from the coast and, due to the existence of the remnant dune at the northern boundary, it is predominantly south facing. As a result of these factors, the site is expected to benefit from the "Fremantle Doctor", the summer afternoon south westerly breeze; while being partially sheltered from summer morning easterlies and winter strong westerly storms.

### 6.2.8 SIGNIFICANT LANDSCAPE FEATURES

There are many significant landscape features on the site. The former amphitheatre/grand stand made of concrete has been decorated with graffiti and provides the strongest memory of the former high school. The potential for re-creation and reuse is strong as it provides a specific connection to the past for the old and new community. Two mature fig trees, one with a swing attached create significant shady "roofed" outdoor rooms. Two stands of mature Tuarts remain to the west and north. Remnant groves of Rottnest Island Pines and Rottnest Island Tea Tree, and the dune provide the memory of the geomorphologic past.

## 6.3 MOVEMENT NETWORK

A traffic study has been completed by Bruce Aulabaugh Consulting (refer **Appendix 5** – Traffic Report).

Existing traffic counts (August 2008) were provided by the City of Joondalup for Albion Street and Camberwarra Drive. In addition, AM peak hour turn movement traffic counts were collected on 3 and 4 February 2010. This data was used for traffic modelling and to simulate the AM peak hour post development traffic. The simulation revealed the upgrade requirements to the existing road network surrounding the development and the internal road types required in the development to be discussed further in **section 8.7.1**.

The following section gives a description of the existing situation with regard to movement network in the vicinity of the subject land (refer **Figure 12** – Existing Movement Network).

### 6.3.1 REGIONAL ROADS

#### DISTRICT DISTRIBUTOR TYPE A – MARMION A

Marmion Avenue is an Other Regional Road (Blue Road) in the Metropolitan Region Scheme and is classified as a District Distributor Type A. It is constructed to a 4-lane divided arterial standard with a median.

### 6.3.2 LOCAL DISTRIBUTOR ROADS

#### ALBION STREET AND CAMBERWARRA DRIVE

Albion Street and Camberwarra Drive are Local Distributor Roads, designed to provide property access, distribute local traffic and provide connection to District Distributor Roads. These are 2-lane roads with 4m carriageways and a 2m painted median. Kerbed median islands are located at key intersections and driveways.

Camberwarra Drive provides a local traffic loop with other roads (such as Albion Street) providing the final connection to the district/ regional road network.

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### 6.3.3 LOCAL ROADS

There are local roads in the vicinity of the site that provide property access and connect to the distributor roads. These roads are not critical to the planning and traffic management.

#### ARAWA PLACE

Arawa Place is a 2-lane undivided local Access Street which provides property access and connects to Camberwarra Crescent.

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### 6.3.4 PEDESTRIANS & CYCLISTS

The existing path network is well established at the perimeter of the development site. The paths are generally in good condition, but the path on the north side of Arawa Place, near Camberwarra Drive (west loop) is in a state of poor repair and should be replaced as part of the Lot 500 & 501 development works (refer **Figure 13** – Pedestrian and Cyclist Network).

The existing dune serves as a physical barrier that limits both pedestrian and vehicular access to the north side of the site. The site also has limited street frontage to Camberwarra Drive and Arawa Place, with the majority of the boundary interfacing with the rear of residential properties or public open space.

Despite these physical constraints, several pedestrian connections into the site exist and appear to receive regular use. The current users of the site include dog walkers, members of the Friends of Craigie Bushland, four-wheel drivers within the dune and graffiti artists. Access points to the site include several locations along the length of the dune, a service track from Camberwarra Drive, a service lane from Arawa Place, and the interface with Otago Park. Fencing exists at the south western corner of the site, preventing access.

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### 6.3.5 PUBLIC TRANSPORT

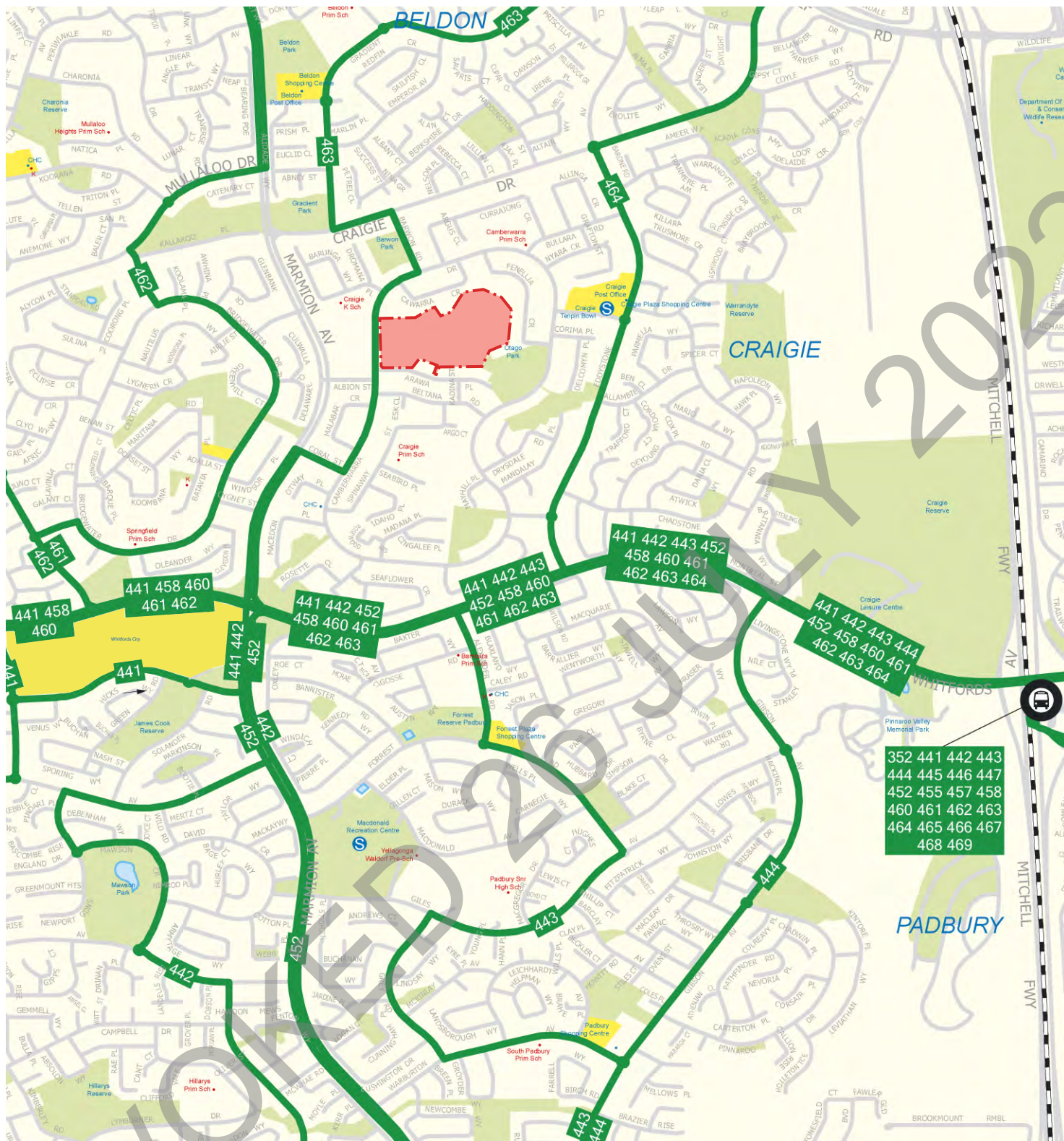
Transperth Route 463 runs along Camberwarra Drive. Route 463 operates between Joondalup Station and Whitfords Station. The Route 463 bus stop and shelter is located on Camberwarra Drive just north of Arawa Place intersection (refer **Figure 14** – Bus Routes).

## 6.4 SERVICE INFRASTRUCTURE

A service infrastructure report has been completed by Emerson Stewart (refer **Appendix 5** – Service Infrastructure Report). The report is prepared in support of the Structure Plan for the redevelopment of the Craigie High School site and sets out the major external infrastructure requirements for the project.

The following sections give a description of the existing situation with regard to the servicing infrastructure in the vicinity of the subject land.





## LEGEND

- SUBJECT LAND BOUNDARY
- BUS ROUTES
- 335 BUS ROUTE NUMBERS
- SPORTING FACILITY
- PUBLIC ROAD
- The Plaza Shopping Centre MAJOR SHOPPING CENTRE
- RAILWAY
- T TRAIN STATION WITH BUS CONNECTION

## BUS ROUTES

Craigie High School Structure Plan

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figure  
14

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#### 6.4.1 SEWERAGE SYSTEM

The Craigie area is well serviced by existing Water Corporation sewer assets with existing sewers located on the boundary of the development site. The site is located within two sewer catchments, as described below:




-  The western portion of the site is located within the catchment serviced by Whitfords Pumpstation No. 7 located south of the existing school on Camberwarra Drive.
-  The eastern portion is serviced by Whitfords Pumpstation No. 8 located off Fenellia Crescent on the south eastern boundary of the development site. The existing pump station is small, with a capacity of less than 20 L/sec. As such, the Environmental Protection Authority Guidelines requires a 10 m buffer. The Water Corporation encourage the implementation of a 30 m buffer from the centre of the wetwell to the closest building.
-  The Water Corporation advised that there is capacity within the existing system to support the current planning for the development. The actual catchment split will determine if any upgrade is required to the planned pipe sizing of the development and this will be determined at design stage.

Figure 15 shows the boundaries of the two catchments within the development site.

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#### 6.4.2 WATER SUPPLY

Several existing water mains are located in close proximity to the site, including a DN200 diameter main located on Camberwarra Drive on the western boundary of the site and a 100mm diameter on Arawa Place on the southern boundary.

Figure 16 presents the location of the existing water mains adjacent to the site.

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#### 6.4.3 DRAINAGE

An existing drainage sump is located to the south-east of the site boundary adjacent to Otago Park and receives drainage from the adjacent road drainage system. The existing drainage to the west of the site consists of a piped network which drains to an existing sump at the intersection of Marmion Road and Albion Street. Drainage from the old school buildings was retained within the site.

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#### 6.4.4 ELECTRICITY

The site is well serviced by existing Western Power infrastructure with the adjacent Gibson Avenue 22kV feeder the main High Voltage infrastructure. The feeder is supplied from the Padbury zone substation located some 3km to the south-east of the site (refer **Appendix 6 – Infrastructure Report (Appendix 'A')**).

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#### 6.4.5 GAS

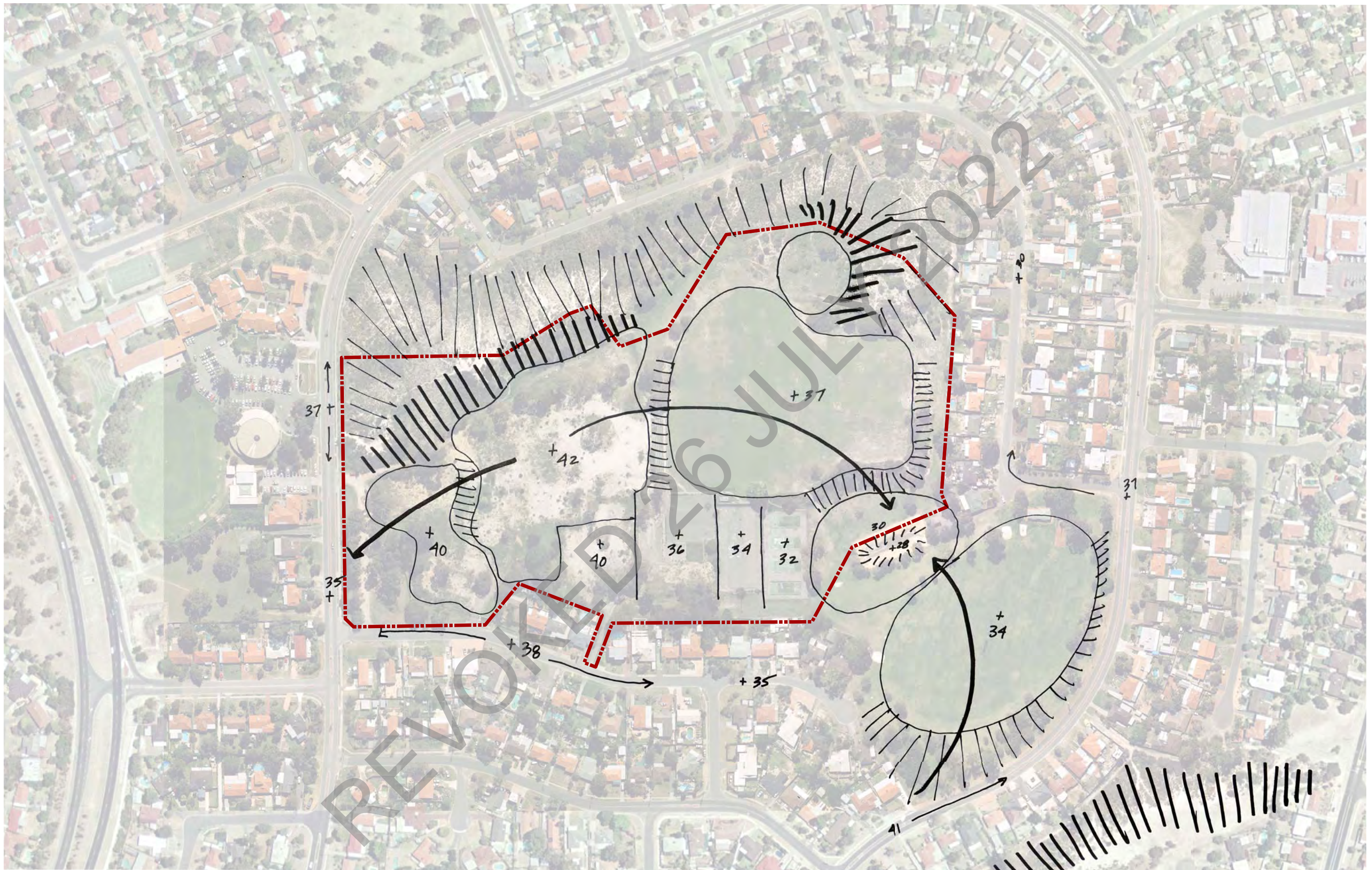
The site is sufficiently serviced by existing gas infrastructure with a gas pipeline running along Camberwarra Drive on the western boundary of the site.

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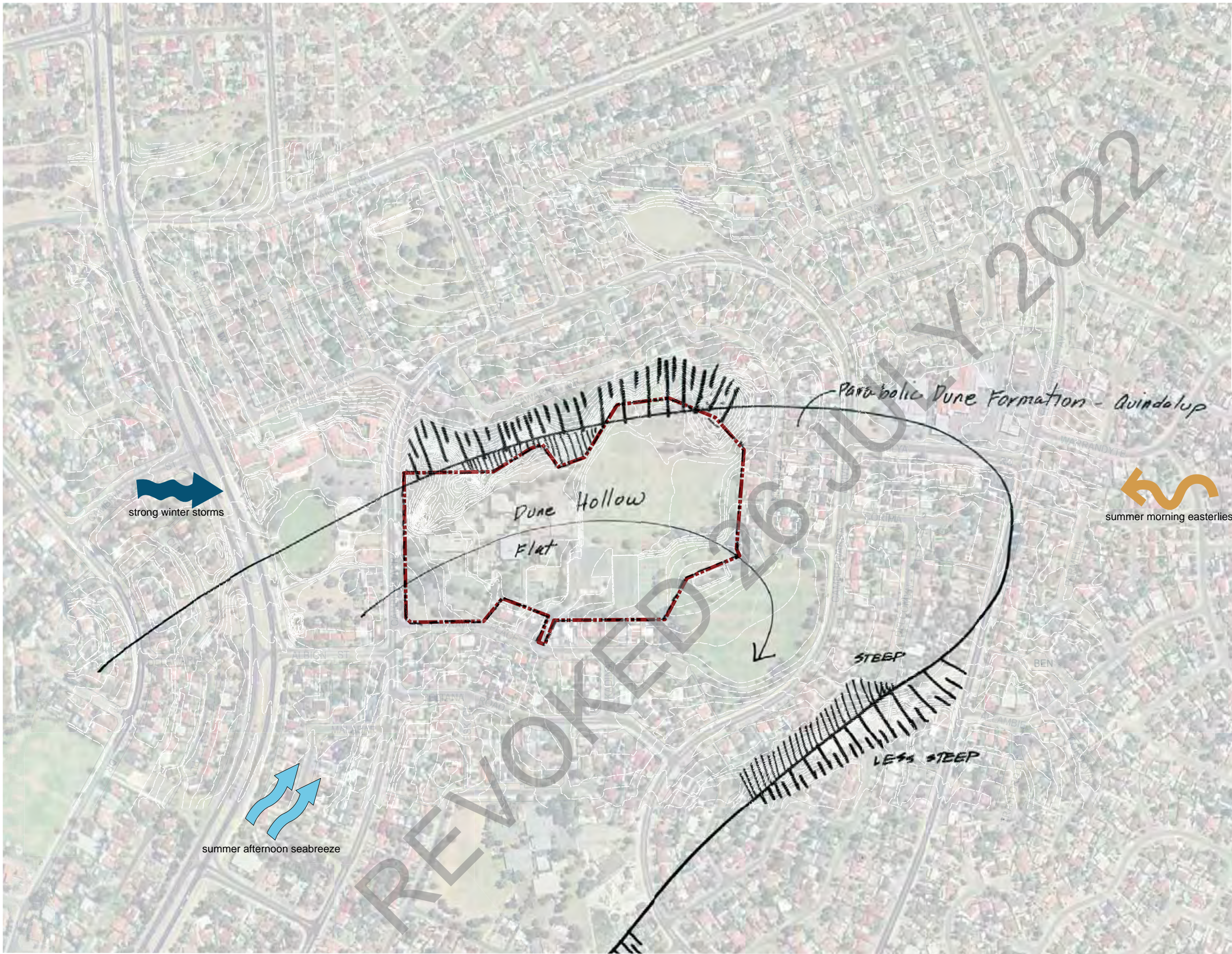
#### 6.4.6 TELECOMMUNICATIONS

The site has existing telecommunications infrastructure adjacent to the site with a major exchange building located south-west of the development site.



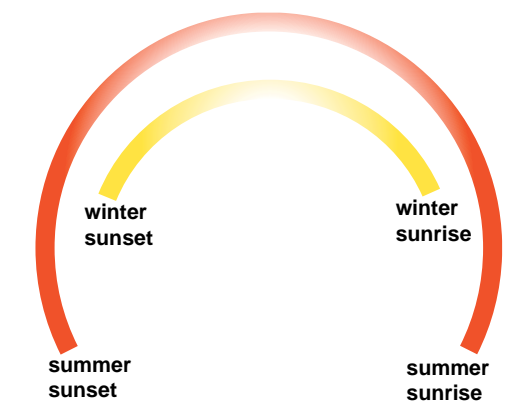






LEGEND

- GEOMORPHOLOGY**
- QUINDALUP
  - YOUNGEST
- SOIL**
- QUINDALUP SAND
  - CREAMY GALCAREOUS SAND
- VEGETATION**
- QUINDALUP VEGETATION COMPLEX
  - MYRTAGEAE, PROTEACEAE, FABACEAE
  - NO EUCALYPTUS OR BANKSIA
- TREES:**
- A. ROSTELLIFERA
  - A. CYCLOPS
  - CALLITRIS PREISII
  - M. LANCEOLATA (RESTRICTED ROTTNEST
  - AND GARDEN ISLANDS
  - SPREADWOOD
- TOPOGRAPHY**
- STEEP DUNES
  - FLAT HOLLOW
- WATER**
- WATERTABLE - DEEP >30m
-  SUBJECT LAND BOUNDARY







## LEGEND

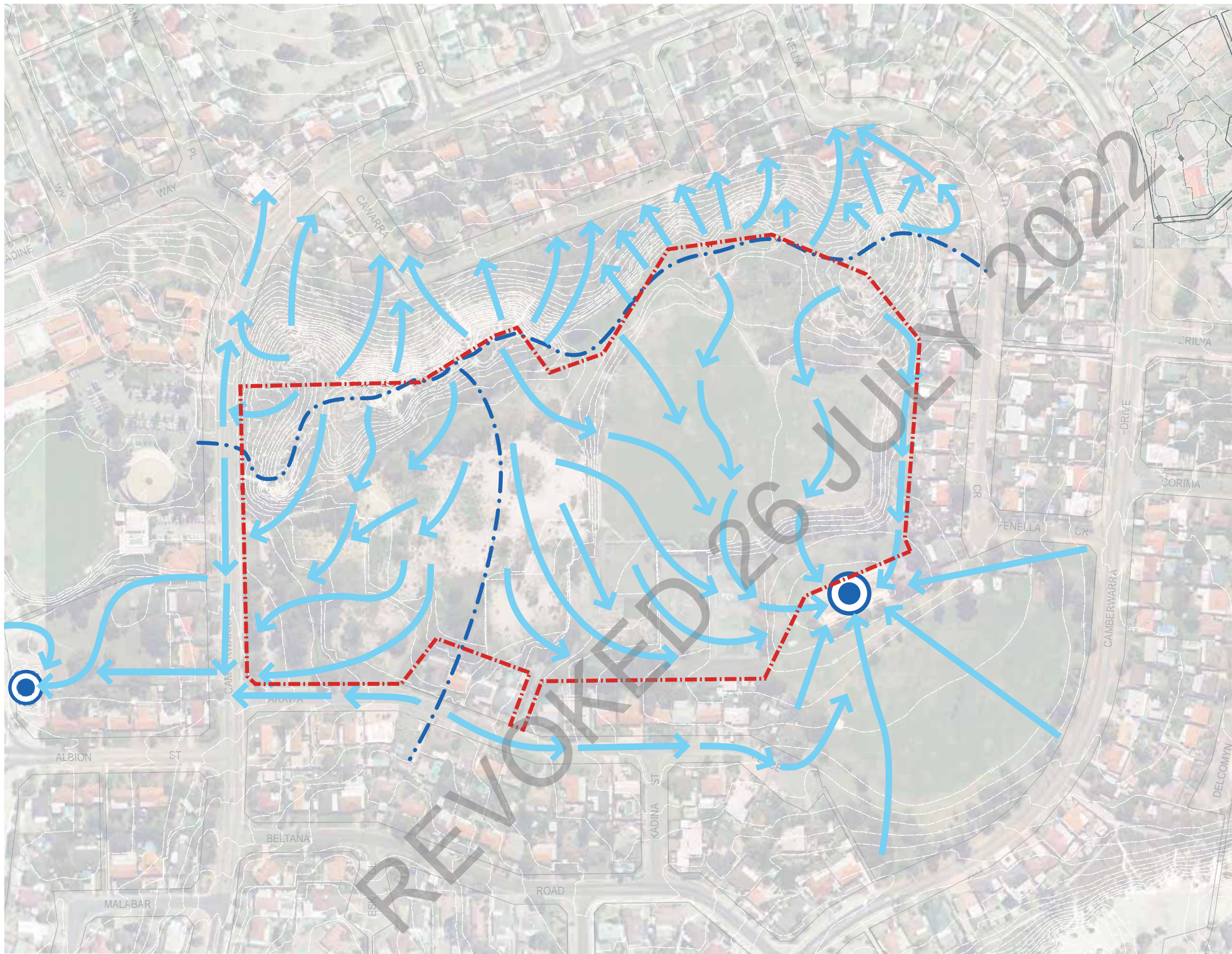
- LIMESTONE (LS4)  
Pale yellowish brown, weakly cemented, friable, medium grained, sub-rounded quartz and shell debris of eolian origin.
- SAND (S7)  
Pale and olive yellow medium to coarse grain, sub angular to sub-rounded quartz, trace of feldspar, moderately sorted of residual origin.
- CALCAREOUS SAND (S2)  
White, fine to medium grained, subrounded quartz and shell debris, of eolian origin.
- SUBJECT LAND BOUNDARY

## SOILS

Craigie High School Structure Plan

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- LEGEND**
- EXISTING DRAINAGE SUMP (FENCED)
  - WATERSHED (CATCHMENT BOUNDARY)
  - GENERAL DRAINAGE DIRECTION
  - SUBJECT LAND BOUNDARY

## SURFACE HYDROLOGY

Craigie High School Structure Plan

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LEGEND

LOCAL ROADS

LOCAL DISTRIBUTOR ROADS

REGIONAL ROADS

GREEN SPACE

PEDESTRIAN LINKS

SUBJECT LAND BOUNDARY





## LEGEND

- EXISTING CONTOURS (1m)
- EXISTING CONTOURS (0.25m)
- EXISTING LOOP ROAD
- EXISTING ROAD
- EXISTING PEDESTRIAN CONNEXION (NO PATH)
- EXISTING SHARED PATH
- EXISTING PATH
- RESIDENTIAL LOTS R20
- RESIDENTIAL LOTS R25
- RESIDENTIAL LOTS R30
- RESIDENTIAL LOTS R40
- PROPOSED ROAD
- PATH - DUP (2.0m WIDTH)
- PATH - VERGE (1.5m WIDTH)
- PROPOSED FENCING
- SUBJECT LAND BOUNDARY

## NOTE:

THE RESPONSIBILITY FOR THE PROVISION OF PATHWAYS WITHIN THE SUBJECT LAND IS WITH THE DEVELOPER. PATHWAYS SHOWN OUTSIDE OF THE SUBJECT LAND (DUNAL PATHS, BOARDWALKS, LOOKOUTS, GATES, RE-VEGETATION, ETC) IS INDICATIVE ONLY AND NOT THE RESPONSIBILITY OF THE DEVELOPER.

## PEDESTRIAN AND CYCLIST MOVEMENT NETWORK PLAN

Craigie High School Structure Plan

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**LEGEND**

- EXISTING SEWER
- EXISTING PRESSURE MAIN
- DEVELOPMENT CATCHMENT BOUNDARY
- DEVELOPMENT CATCHMENT BOUNDARY
- SUBJECT LAND BOUNDARY

**EXISTING AND PROPOSED SEWER**  
 Craigie High School Structure Plan

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**LEGEND**

— EXISTING WATER

- - - SUBJECT LAND BOUNDARY








## 7 OPPORTUNITIES, CONSTRAINTS AND ISSUES

The site is characterised by a number of factors which are relevant in the formulation of the Structure Plan and should influence the design outcome. The outcomes of an opportunities and constraints/issues analysis of the site area are illustrated in **Figures 17 and 18** respectively and discussed further below.

### 7.1 OPPORTUNITIES



#### 7.1.1 LAND USE/SURROUNDING USES

The following land use/surrounding land use opportunities are evident in the Craigie High School Site:

-  To optimise the aesthetic appearance of the development along the highly exposed external edge of Camberwarra Drive and Arawa Place through quality public realm, built form and retention of trees.
-  Potential green links through the site, specifically between the existing dunal system and Otago Park.
-  To integrate the adjoining dunal system into the design.
-  Consider the opportunities to maximise the interface with Otago Park.
-  Potential to beautify drainage basin at Otago Park interface as a wetland feature.






#### 7.1.2 EXISTING VEGETATION

The following existing vegetation opportunities are evident in the Craigie High School Site:

-  Consider the retention of the significant and standard trees on site.
-  To integrate, protect and enhance the remnant dunal reserve.



#### 7.1.3 VEHICULAR AND PEDESTRIAN MOVEMENT

The following vehicular/pedestrian movement opportunities are evident in the Craigie High School Site:

-  Protect and enhance existing accessways and view vantage points through the existing dunal system.
-  Potential linkages off existing pedestrian network.
-  Potential pedestrian pathways providing legible walkability through the site.
-  Capitalise on near-by bus route to facilitate and promote transit use.
-  Camberwarra Drive provides an opportunity for access into the site due to good exposure and connectivity to the existing street network.

#### 7.1.4 LANDFORM

The following landform opportunities are evident in the Craigie High School Site:

-  The steep dunal system landform to the north provides opportunity to capitalise on significant views in various directions.
-  The terraced topography of the site provides potential for views, specifically south-east across Otago Park.





## LEGEND

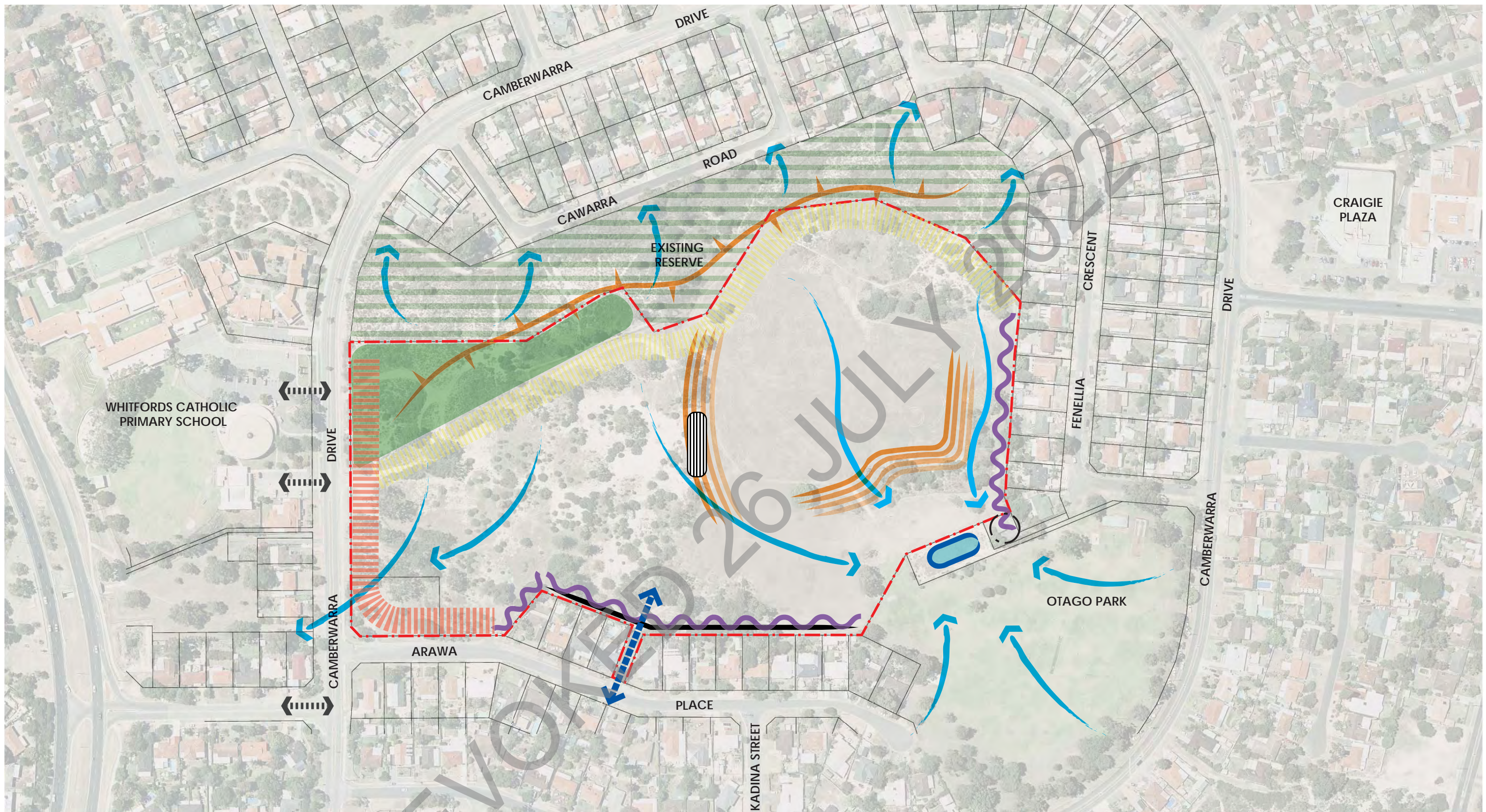
- |  |  |   |                         |
|--|--|---|-------------------------|
| SUBJECT LAND BOUNDARY  | PROTECT AND ENHANCE EXISTING ACCESSWAYS AND VANTAGE POINTS THROUGH EXISTING DUNAL SYSTEM | PROTECT AND ENHANCE REMNANT BUSHLAND RESERVE                          | EXISTING DUNAL FEATURES |
| SIGNIFICANT TREE TO BE ASSESSED FOR RETENTION  | EXISTING PEDESTRIAN LINKAGES   | OPPORTUNITY TO INTEGRATE ADJOINING DUNAL SYSTEM INTO DESIGN           | POTENTIAL ACCESS POINTS |
| OTHER TREE TO BE ASSESSED FOR RETENTION  | POTENTIAL PEDESTRIAN PATHWAYS PROVIDING LEGIBLE WALKABILITY THROUGH SITE                 | CONSIDER OPPORTUNITIES TO MAXIMISE INTERFACE TO OTAGO PARK            |                         |
| OPPORTUNITY TO CAPITALISE ON SIGNIFICANT VIEWSHEDS                                     | POTENTIAL GREENLINKS (SPECIFICALLY FROM EXISTING DUNAL SYSTEM TO OTAGO PARK)             | OPPORTUNITY TO BEAUTIFY DRAINAGE BASIN AS WETLAND FEATURE             |                         |
| OPTIMISE AESTHETIC TO HIGHLY EXPOSED EXTERNAL EDGE THROUGH QUALITY PUBLIC REALM DESIGN |  | CAPITALISE ON NEAR-BY BUS ROUTE TO FACILITATE AND PROMOTE RIDEABILITY |                         |

## OPPORTUNITIES

Craigie High School Structure Plan

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#### LEGEND

- SUBJECT LAND BOUNDARY
- |||| MINIMAL ROAD FRONTAGE CAUSING LIMITED CONNECTIONS TO SURROUNDING STREET NETWORK
- STEEPLY SLOPING SHRUBLAND
- PROMINANT RIDGELINE ADJACENT TO SITE BOUNDARY TO BE RESPECTED
- |||| STABILITY OF ADJOINING DUNAL SYSTEM AND TREATMENT OF INTERFACE TO BE CONSIDERED

- GENERAL DRAINAGE DIRECTION INFLUENCING STREET BLOCK ORIENTATION AND SLOAR ACCESS
- ~ CONSIDER TREATMENTS TO REAR/SIDE LOT INTERFACES
- (---) ENTRY/EXIT POINTS ONTO CAMBERWARRA DRIVE TO BE CONSIDERED
- TREATMENT OF EXISTING DRAINAGE SUMP TO BE CONSIDERED WITHIN SENSITIVE TRANSITION TO OTAGO PARK

- |||| TREATMENT AND ENHANCEMENT OF EXISTING TERRACES TO BE CONSIDERED
- TREATMENT OF POTENTIAL PEDESTRIAN/VEHICULAR CONNECTIONS INTO SITE TO BE CONSIDERED
- CONSIDER EXISTING LEVELS THROUGHOUT SITE
- CONSIDER EXISTING SEWER LINE

- NO RESIDENTIAL DEVELOPMENT ALLOWED WITHIN 10m BUFFER OF PUMP STATION

## CONSTRAINTS AND ISSUES

Craigie High School Structure Plan



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## 7.2 CONSTRAINTS/ISSUES





### 7.2.1 MOVEMENT

The following movement constraints/issues are evident in the Craigie High School Site:

-  Entry/Exit points onto Camberwarra Drive to be considered.
-  Treatment of potential pedestrian/vehicular connections into site to be considered.





### 7.2.2 INTERFACE

The following topography constraints/issues are evident in the Craigie High School Site:

-  Minimal road frontage causing limited connections to surrounding street network.
-  Prominent ridgeline adjacent to site boundary to be respected.
-  Stability of adjoining dunal system and treatment of interface to be considered.
-  Consider treatments to rear/side lot interfaces.




### 7.2.3 EXISTING INFRASTRUCTURE

The following infrastructure constraints/issues are evident in the Craigie High School Site:

-  Treatment of existing drainage sump to be considered within sensitive transition to Otago Park.
-  Treatment and enhancement of existing terraces to be considered.
-  Consider the treatment of the existing sewer line along the rear boundary of the existing lots fronting Arawa Place.
-  No residential development allowed within 10m buffer of the eastern pump station.

### 7.2.4 TOPOGRAPHY

The following interface constraints/issues are evident in the Craigie High School Site:

-  Steeply sloping shrubland.
-  General drainage direction influencing street block orientation and solar access.
-  Consider existing level changes throughout site.

## 8 THE PLAN









### 8.1 DESIGN PHILOSOPHY & PRINCIPLES

The design vision of the Craigie development is to create a new and inspiring residential community that embraces natural landmarks, history, and uses site-specific creativity to accentuate natural landform.

Integral to the vision, is the integration of the adjacent existing residential development with the new Craigie High School development. This has been achieved through the creation of a central green link that connects the existing dunal system to Otago Park creating communal open space areas, community focal points and promotes the site's sense of identity.




The design seeks to encourage a relaxed, healthy and social lifestyle, while complementing a new and emerging demographic through the provision of diverse housing product.

The Structure Plan embraces the following principles:

-  Integrate the existing dunal system and Otago Park with a high-amenity open space link.
-  Provide for a range of quality built form and housing product opportunities.
-  Ensure a sensitive transition and integration between the existing and new development.
-  Provide a legible movement network that enhances accessibility and way-finding.
-  Provide an interface with the dunes to protect and celebrate the natural landform asset, and enable effective land management.
-  Climate responsive and environmental design is to be incorporated into the urban design and built form outcomes.
-  Provide site response design that optimises climate and landform sensitive outcomes.
-  With regard to the adjacent Craigie residential area, the urban fabric is of a form that has minimal street interface with the subject land. However, through well connected public realm and facilities, the existing assets and sense of community are enhanced by integrating with the new development.

### 8.2 LAND USES

The Craigie High School Structure Plan (refer **Figure 1** - Structure Plan) proposes the following mix of land uses over the subject land:

-  Residential;
-  Public Open Space; and
-  Drainage.

The following sections describe the land uses proposed by the Structure Plan and provides a rationale for their location within the structure plan area.




### 8.2.1 RESIDENTIAL

The density within the Craigie High School Structure Plan has been considered within the context of the State Government's *Directions 2031* and the City's *Draft Local Housing Strategy*, which both encourage more efficient use of land. Areas of lower density have been provided where site-responsiveness has been a priority. That is, to retain trees on site, respecting the interface with the existing R20 residential areas and incorporating the dunal grades within the lots.

Densities have generally been provided for by locating the lower densities on the periphery of the site to interface with the existing lower density residential, while the density intensifies towards the Public Open Space located in the centre of the site.

Through the *Residential Design Codes*, together with the *Built Form Requirements* (refer Part One, **Section 4 - Development**) of this Structure Plan, and the *Energy Efficient and Water Sensitive Design* section of the City's *Draft Dual Density Code Policy*, the Craigie High School Development encourages residential development to occur in a sustainable way.

The location, variety and orientation of the residential densities are in accordance with Element 3 – Liveable Neighbourhoods. The Structure Plan (refer **Figure 1 - Structure Plan**) provides for the following density ranges:

-  R20 Residential
-  R25 Residential
-  R30 Residential
-  R40 Residential

Based on the densities proposed by the Local Structure Plan, approximately 181 dwellings will be achieved. **Table 1** provides an indicative dwelling yield breakdown for the Structure Plan area:

**TABLE 1: DWELLING UNIT YIELDS**

R-Code	Dwelling Yield (1)	% of Yield
R20	39	21.6%
R25	46	25.4%
R30	27	14.9%
R40 (incl. GH Sites)	69	38.1%
<b>Total</b>	<b>181</b>	<b>100%</b>

*Note: (1) The dwelling yields have been calculated at the Structure Plan stage and will be subject to detailed design refinement and are therefore subject to change. The dwelling yields have been determined based on Net Developable Area (NDA) divided by R-Code averages/unit. The yields may vary at the developer's discretion as development occurs.*

Based on the residential area proposed by the Local Structure Plan, approximately 59,830m<sup>2</sup> of Net Developable Area (NDA) will be achieved. **Table 2** provides an indicative R-Code Area breakdown for the Structure Plan area:

TABLE 2: R-CODE AREAS

R-Code	NDA (m <sup>2</sup> )	% of Area
R20	19,960	33.4%
R25	16,286	27.2%
R30	8,207	13.7%
R40 (incl. GH Sites)	15,377	25.7%
<b>Total</b>	<b>59,830</b>	<b>100%</b>

#### 8.2.1.1 R20 RESIDENTIAL

The land proposed for residential development at R20 has been generally located on the periphery of the subject land to provide a similar built form transition from the abutting R20 development to the more compact residential housing towards the centre of the site. The Structure Plan provides for these peripheral R20 zones in response to the existing residential R20 housing adjacent to the site.

Similarly, an R20 residential zone has been located adjacent to the Parks and Recreation Reserve to the north, providing a lower density transition into the site.

An R20 residential zone has been located towards the north-eastern corner for the provision of larger lots as a response to the steep topography. Additional depth has been provided to the R20 residential zone fronting Camberwarra Drive to allow, through Part One, **section 4.3.1.1(c) Front Setbacks**, for the retention of a number of significant Tuart trees along the western edge of these future lots.

#### 8.2.1.2 R25 RESIDENTIAL

The R25 residential zone provided within the subject site facilitates front-loaded housing on an affordable lot size.

The R25 residential zone is located along both the north-south and east-west entry roads leading to the central open space, as well as a pocket towards the eastern portion of the site. The R25 coding also provides for a subtle density transition from the R20 on the periphery to the R40 in the centre of the development.

#### 8.2.1.3 R30 RESIDENTIAL

An area of R30 rear-loaded laneway product is strategically located along the north-eastern interface of the high amenity central open space. This location provides the opportunity for direct Public Open Space interface with rear laneway access. This R30 residential zone promotes a more equitable urban structure and offers high accessibility to open space for smaller lots. This strategic allocation of density provides for increased accessibility and promotes a lively community nucleus by allowing for the population required to support these high amenity areas. The R30 Code allows for larger laneway lots generally between 270-350m<sup>2</sup>, with some having direct access to the central open space.

This mid-range laneway lot size and front loaded R30 housing product provide and support an additional diversity of housing and lot sizes within the Structure Plan area.

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#### 8.2.1.4 R40 RESIDENTIAL

The higher R40-density areas are provided by the Structure Plan in order to facilitate housing variety, socio-economic and demographic diversity, and to contribute to the efficient use of the land. The R40 coded zones optimise density around areas of high amenity promoting a more equitable urban structure and offering high accessibility to open space for smaller lots. This strategic allocation of density provides for increased accessibility and promotes a lively community nucleus by allowing for the population required to support these high amenity areas

The single lot sizes, located along the south-western interface of the high amenity central open space, will be in the order of between 200-300 m<sup>2</sup>. The R40 coded precincts within the Structure Plan are also capable of being developed as grouped housing sites, contributing to the diversity of housing within the development.

The R40-density areas allow for both rear-loaded, single-lot development and grouped-housing development opportunities, with a large proportion of the R40 product overlooking Public Open Space (refer Part One, **section 4** – Development for control over R40 single lot housing).

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#### 8.2.2 PUBLIC OPEN SPACE

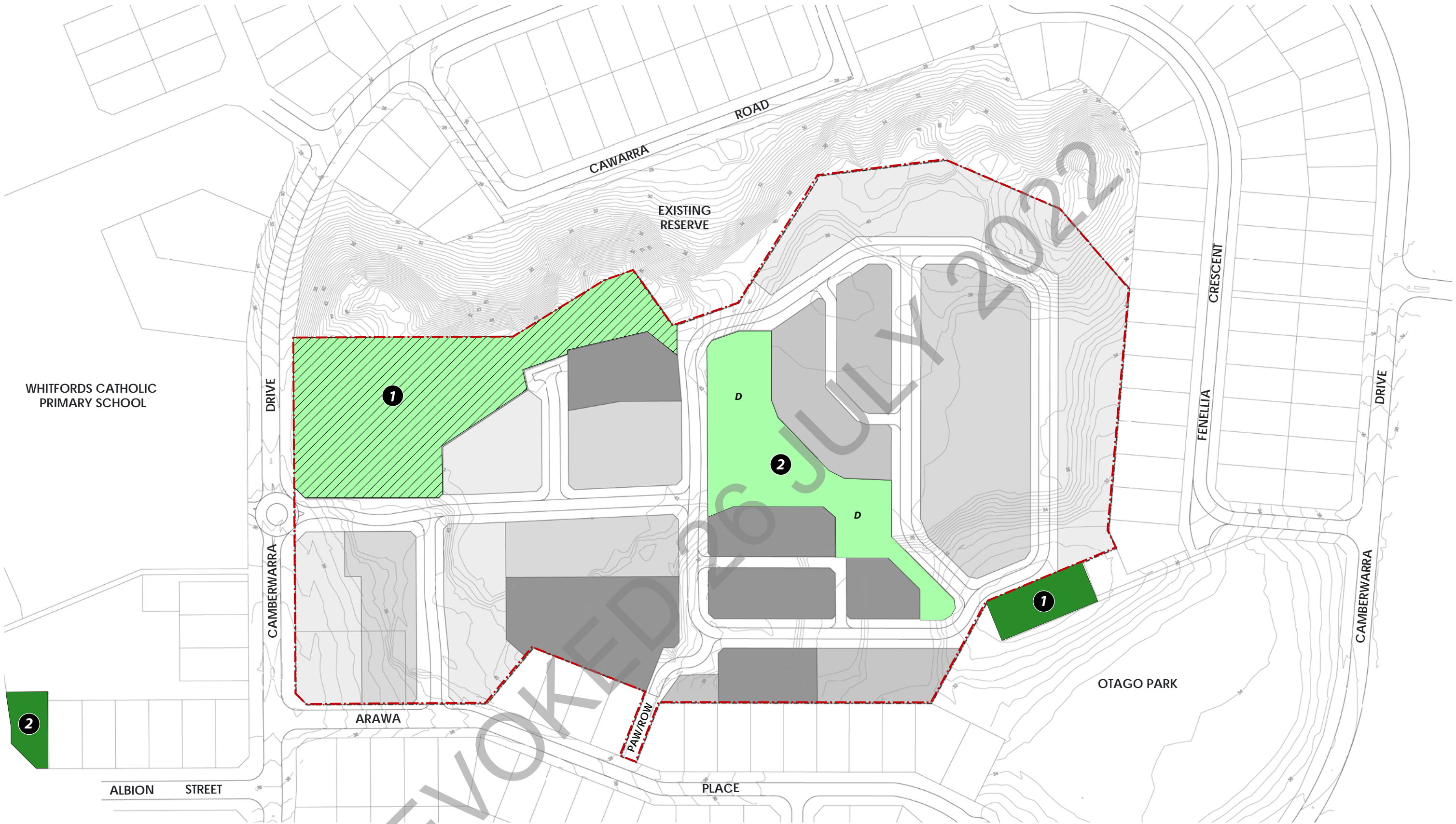
Approximately 1.7705 ha of Public Open Space (exclusive of 1 in 1 year Drainage) have been provided for within the Structure Plan (refer **Figure 19** – Public Open Space Plan) resulting in 17.91% Public Open Space provided (refer **Table 3** - Public Open Space Schedule).

The Structure Plan has been designed around an approximate 6,500m<sup>2</sup> central linear open space spine, traversing the site in a NW - SE direction. The alignment of the open space spine has been centred on a visual corridor between the existing dunal system to the NW down to the existing Otago Park in the SE. The green spine also offers a grade within the open space area of 12m over approximately 220m (i.e. 1:18).

**Public Open Space Area 1** (approximately 1.1414 ha), provided in the north-west of the site, is dedicated to retaining (part of) the existing dunal system and remnant vegetation within the subject site, whilst integrating seamlessly with the existing Parks and Recreation reserve that contains (greater portion of) the dunal system.

**Public Open Space Area 2** (approximately 6,516 m<sup>2</sup>) is the open space spine, which is to be a central focus of the Structure Plan, that links the dunal system with Otago Park. This central green spine provides for a permeable open space network incorporated within the urban fabric to be primarily utilised for passive recreation pursuits and drainage, with active recreational pursuits to take place in the larger areas of Otago Park.

The high amenity of this central open space is complemented by higher density allotments (up to R40), on its periphery, providing surveillance and high quality built form interface. The design of the central open space has been done in way to optimise view corridors to/from the dunes, to/from Otago Park and across the open space from the eastern termination of the entry road towards the R30 housing opposite.



#### LEGEND

ACTIVE LOCAL PARKS

PASSIVE DUNAL OPEN SPACE

DRAINAGE

D INTEGRATED DRAINAGE

SUBJECT LAND BOUNDARY

1 PUBLIC OPEN SPACE 1

2 PUBLIC OPEN SPACE 2

1 DRAINAGE 1

2 DRAINAGE 2

#### PUBLIC OPEN SPACE PLAN

Craigie High School Structure Plan

N  
0m 15 30m  
s: 1:2000@A3  
d: Oct 2011  
j: 07/088



## Craigie High School Site Local Structure Plan

TABLE 3: PUBLIC OPEN SPACE SCHEDULE - CRAIGIE HIGH SCHOOL STRUCTURE PLAN		
<b>Gross Site Area</b>	(m <sup>2</sup> )	(m <sup>2</sup> )
Lot 500	2,381	
Lot 501	99,089	
<b>Total Gross Site Area</b>		<b>101,470</b>
<b>Deductions</b>		
1 in 1 year drainage (within Public Open Space 2) (*)	225	
<b>Total Deductions</b>	<b>225</b>	
Net Subdivisible Area/ Public Open Space Contribution Area		101,245
<b>Required Public Open Space (10%)</b>		<b>10,124</b>
<b>Public Open Space Requirements</b>		
Unrestricted public open space – minimum 80%	8,100	
Restricted public open space – maximum 20%	2,024	
<b>Total</b>		<b>10,124</b>
<b>PUBLIC OPEN SPACE PROVISION</b>		
<b>Unrestricted Public Open Space</b>		
Public Open Space 1	11,414	
Public Open Space 2	6,032	
1 in 100 year drainage (within Public Open Space 2) (*)	160	
<b>Total Unrestricted Public Open Space</b>		<b>17,606</b>
<b>Restricted Public Open Space</b>		
1 in 5 year drainage (within Public Open Space 2) (*)	99	
<b>Total Restricted Public Open Space</b>		<b>99</b>
<b>Total Public Open Space Provided</b>		<b>17,705</b>
<b>Percentage of Public Open Space Provided</b>		<b>17.48%</b>
(Unrestricted and Restricted PUBLIC OPEN SPACE Contribution)		
<b>Surplus Restricted Public Open Space</b>		<b>n/a</b>

1. Detailed drainage calculations are subject to detailed calculation at the Subdivision stage
  2. Assumes no drainage into potential drainage 1 and/or potential drainage 2 (Schedule requires modification if the drainage requires changes).
- (\*) Detailed drainage calculations are subject to detailed calculation at the Subdivision stage.

### 8.3 BUILT FORM

In promoting a Structure Plan objective to facilitate quality built form and diverse housing, it is important that achieving the required outcomes is not restricted by the City's Policy 3.2 *Height and Scale of Buildings Within Residential Areas*. For this reason, Part 1 (refer Part One, **Section 4 – Development**) proposes a variation to this Policy to allow more development scope for the lots within the Structure Plan area.

The *Height and Scale of Buildings Within Residential Areas* Policy effectively negates any two-storey development on lots less than 17-18m wide due to the wide 5m side setback on each side of a lot that creates the building envelope for the 8.5m height limit. The majority of the Structure Plan contains a density coding between R25-R40, giving those lots a frontage of under 17-18m. On these smaller R25-R40 lots, desirable two-storey development would not be allowed by the building threshold envelope limitations within the *Height and Scale of Buildings within Residential Areas* Policy.

Current building industry experience indicates that two-storey development is often higher than 8.5m, often close to 10m high at the ridge.

## 8.4 LANDSCAPE MASTERPLAN

Landscape is the cultural construction of nature. So in order to understand the former Craigie High School site landscape, it is necessary to understand the site's specific social and environmental histories. This site reading provides a strong conceptual beginning for a design response. By engaging with the particulars of site, the design solution makes the landscape visible and legible and contributes to areas larger than its own physical context. Site analysis is the critical and creative component of design. The following describes the landscape vision and key focus areas identified by the City of Joondalup, particulars of the landscape context, the site and the design response. (Refer **Figure 20** – Landscape Masterplan and **Figure 21** – Landscape Site Details)

### 8.4.1 LANDSCAPE THEME

The landscape vision will be achieved through the creation of a central open space that connects the development to its larger parabolic dune landscape. The open space is centred along an axis that connects the highest elevation of the remnant parabolic dune to the north, through the lowest point of the hollow at Otago Park and back to the remnant parabolic dune beyond. This creates a linear open space system that is characterised by a series of “gateways” and “openings” that step up the terraced landform. The largest opening or place occurs at the highest terrace and focuses on the reconstructed grand stand from the High School. The grand stand provides informal seating overlooking two “stages”: a small decked platform and a large geometric wetland and basin. The terracing of the grand stand ends in a shady bank as a transition to the dune beyond. Observing nature and “seeing and being seen” are the primary activities as the memory of the former High School is transformed into a new interpretation of the modified place.

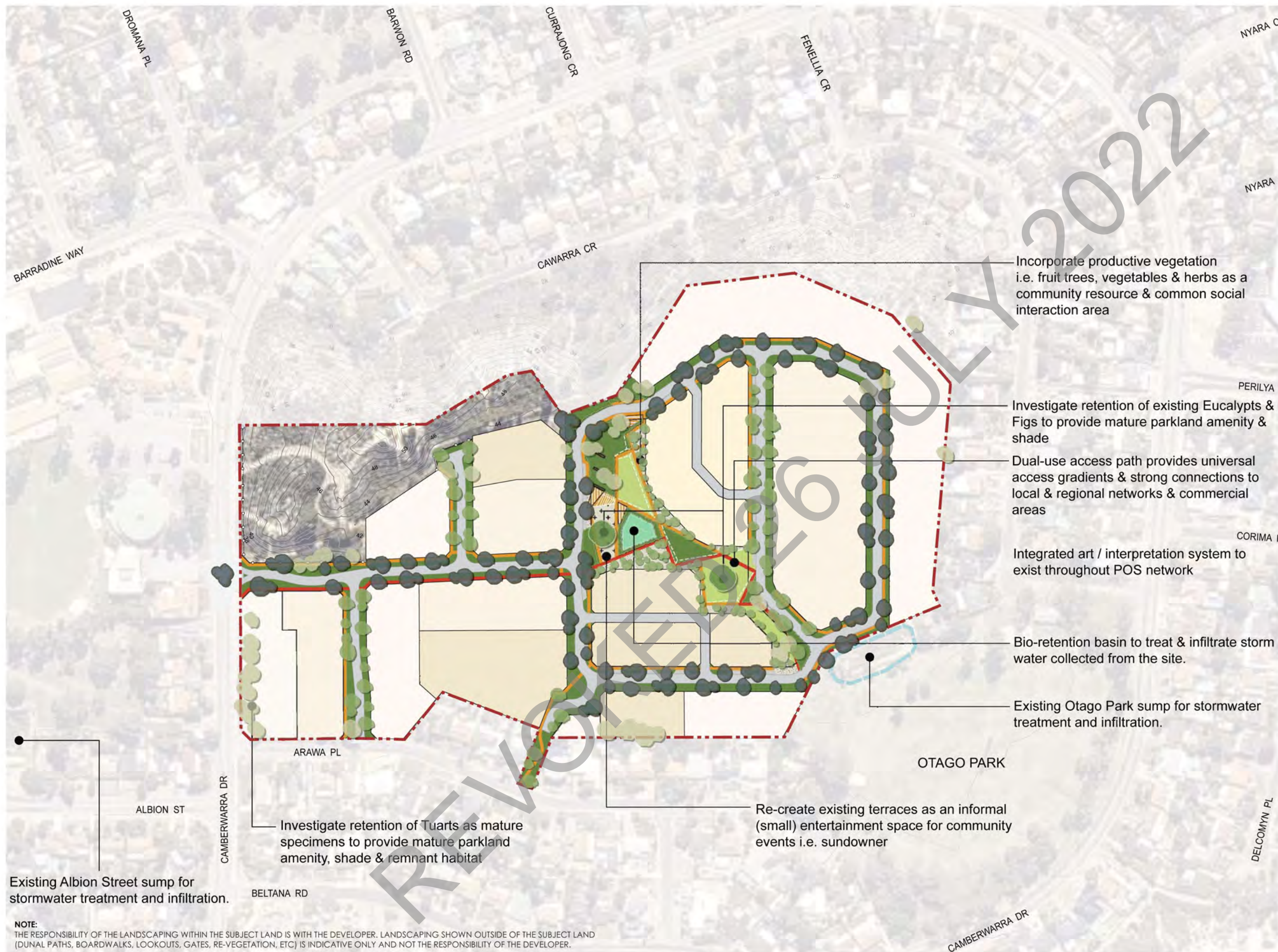
### 8.4.2 DESIGN ARTICULATION

The axial open space system is organised around trapezoidal spaces that exist as tilted planes which open out and close down to create a series of gateways and openings that step up the landform (refer **Figure 21** – Landscape Site Details). Between the central spaces and the residences, is a semi-public space in the form of a paved informal grove of trees. The paving provides flexible connections between the central open space and the residential lots and the trees provide a transparent psychological barrier between public and private. The broad verge at the southern end provides an entry environment to the axial open space.

### 8.4.3 SUSTAINABLE LANDSCAPE INITIATIVES

The substantial number of mature existing trees on the site provides valuable green infrastructure that has the inherent capacity to enhance and regenerate natural resources. These existing trees provide the benefits of climate change adaptation and mitigation by:





**NOTE:**  
THE RESPONSIBILITY OF THE LANDSCAPING WITHIN THE SUBJECT LAND IS WITH THE DEVELOPER. LANDSCAPING SHOWN OUTSIDE OF THE SUBJECT LAND (DUNAL PATHS, BOARDWALKS, LOOKOUTS, GATES, RE-VEGETATION, ETC) IS INDICATIVE ONLY AND NOT THE RESPONSIBILITY OF THE DEVELOPER.

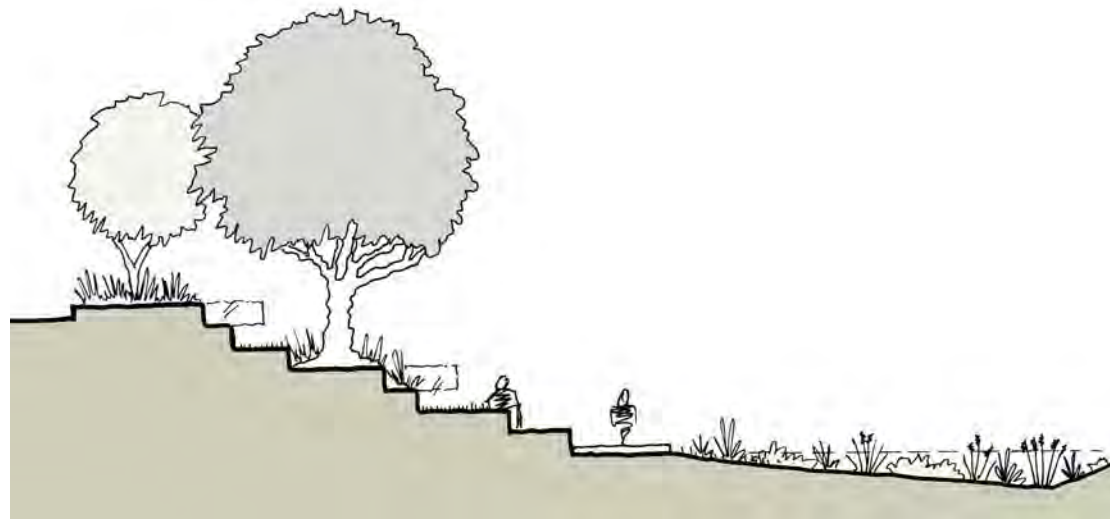
## LANDSCAPE MASTER PLAN

Craigie High School Structure Plan

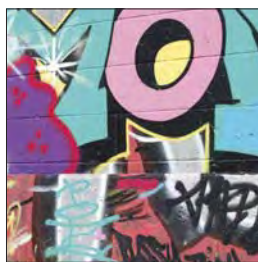
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s: 1:2500@A3  
d: Oct 2011  
j: 07/088



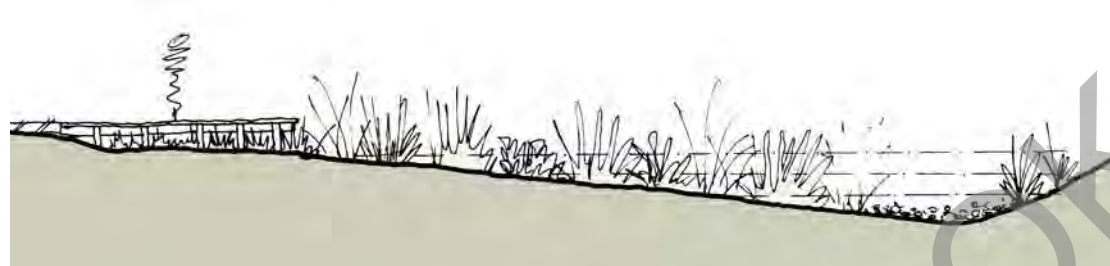
## ① recycling



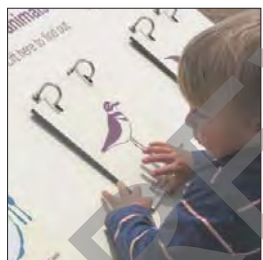
The former terraces are an important and useful remnant. The terraces are proposed to be recreated as an amphitheatre. The amphitheatre allows for the creation of a flat interior space and provides an elevated space for gathering, resting and observing. The rearranging of the graffiti images creates a new contemporary image that is respectful of the past.



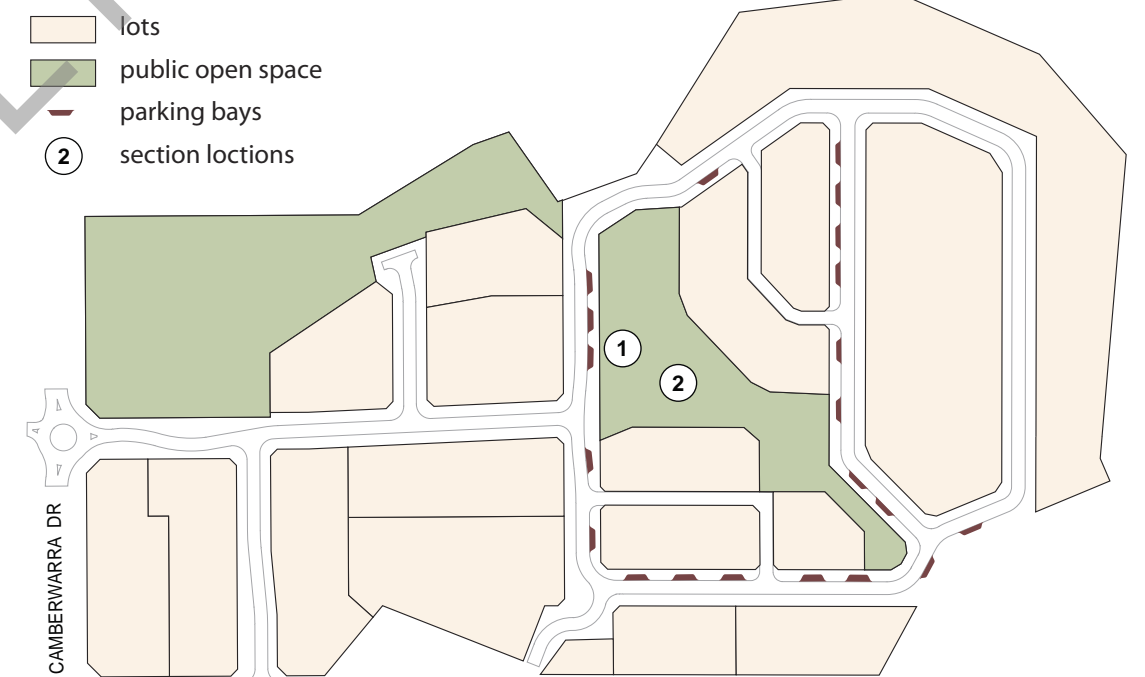
## ② bio-retention basin



The open space spine accommodates a basin that provides both an environmental and aesthetic function. The basin is a geometric trapezoidal shaped supporting the language of the series of spaces. The planting of ephemeral wetland sedges is low and formal providing a natural 'canvas' to be viewed from above on the terraces and from a deck stage. The whole water cycle is a possible theme for interpretation.










## key plan (Not to Scale)





## Craigie High School Site Local Structure Plan

-  moderating the urban heat island effect that impacts water and energy use, infrastructure economics, biodiversity and human health
-  improving air quality
-  providing buffers and refuges in extreme weather events
-  reducing green house gas via carbon sequestration
-  increased local distinctiveness that supports cultural identity
-  enhances biodiversity by providing connectivity, corridors and linkages
-  adding value to water sensitive urban design through soil infiltration that reduces flooding and pollution from run-off.

While not all trees can be saved on site, early identification and protection of important trees is essential from the outset and will minimize the problems of retaining inappropriate trees (refer **Figure 22** – Tree retention plan). Assessment and protection of important trees according to AS 4970-2009 is required in order to accrue the gains and benefits of retaining trees. An arborist has carried out a tree assessment, prepared the report, consulted with the design team, specified tree protection measures, and monitored and certified construction and maintenance (refer **Appendix 8** – Arboricultural Assessment).

### 8.5 STREETSCAPE

The streetscape is the interface between home, community and nature. Designed correctly, it provides the setting for social interaction and connection to nature. The key to this success is establishing human scale and preference for people over cars.

The broad street verges provide the best opportunity for people. The major entry road and circular road is a 16 metre road reserve (refer **Figure 23** – Streetscape Sections). Tuarts as the street tree provide continuity with the Tuarts surrounding the site. The minor roads will have a mixture of local trees that currently thrive on the site: Rottneest Island Tea Trees used within the minor roads near the dune interface, River Sheoaks and Paperbarks for the verges near the low lying drainage basin and sump, Peppermints and Sheoaks for the remaining minor streets.

Footpaths are provided on one side of every street, and at the property boundary where ever possible.

Trees and lighting are to be provided in laneways with provisions for rubbish trucks and crossovers, which is subject to detailed design.

### 8.6 SITE FEATURES

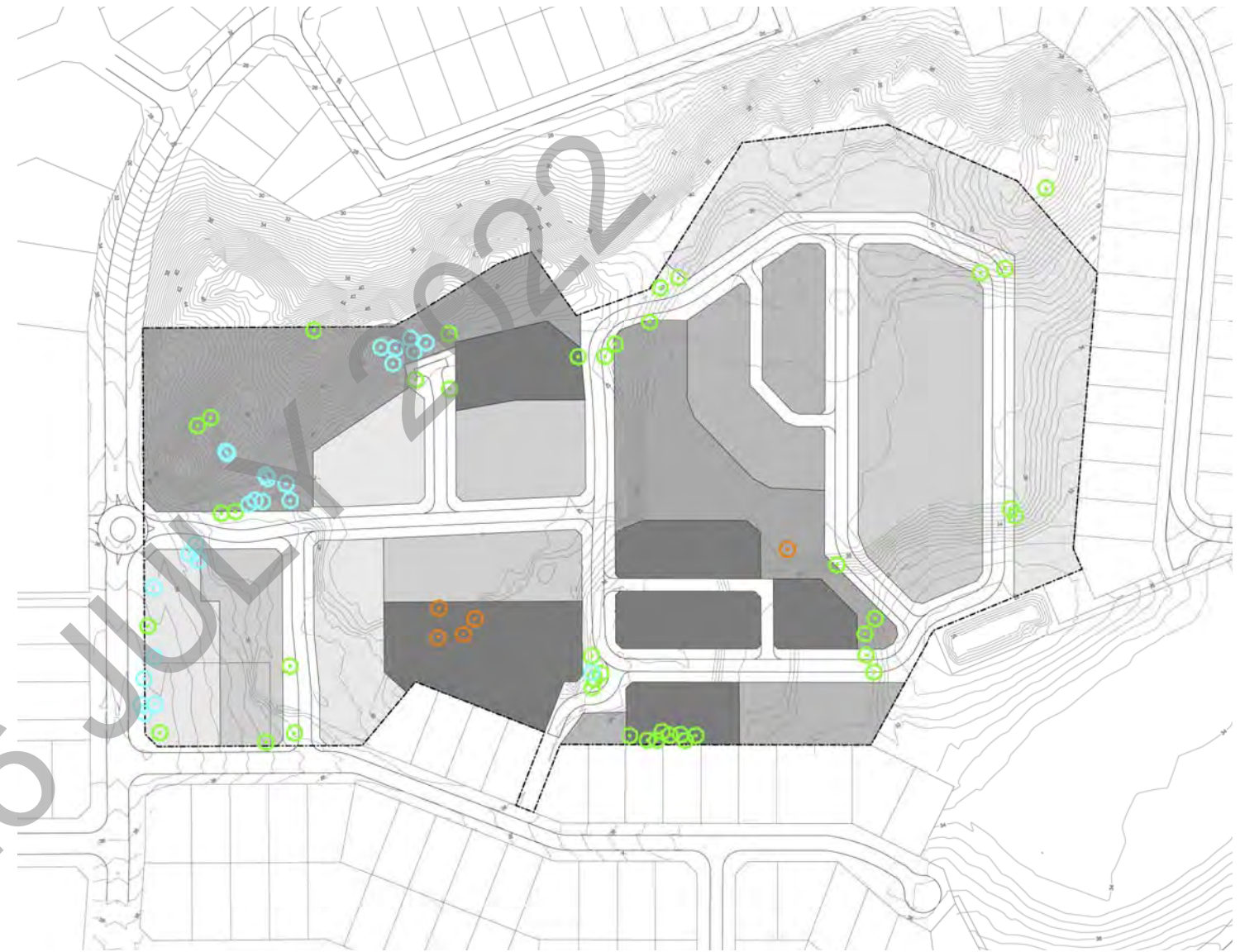
#### 8.6.1 DUNE, TRAILS AND LOOKOUTS

Preservation, education and rehabilitation of the remnant parabolic dune are important to the creation of a sustainable landscape. The many informal pathways that have been created are an indication of the importance of the dune in cross-site access, and the desire to mount the summit and survey the surrounds (refer **Figure 21** – Landscape Site Details). Defining the most desirable connections, weeding, brushing and intensive rehabilitation of the eroded areas will preserve the environment and the social use. The dune rehabilitation within the subject land should be in partnership with the local community groups, schools and Landcare organisations to promote stewardship and education.



#### EXISTING TREES

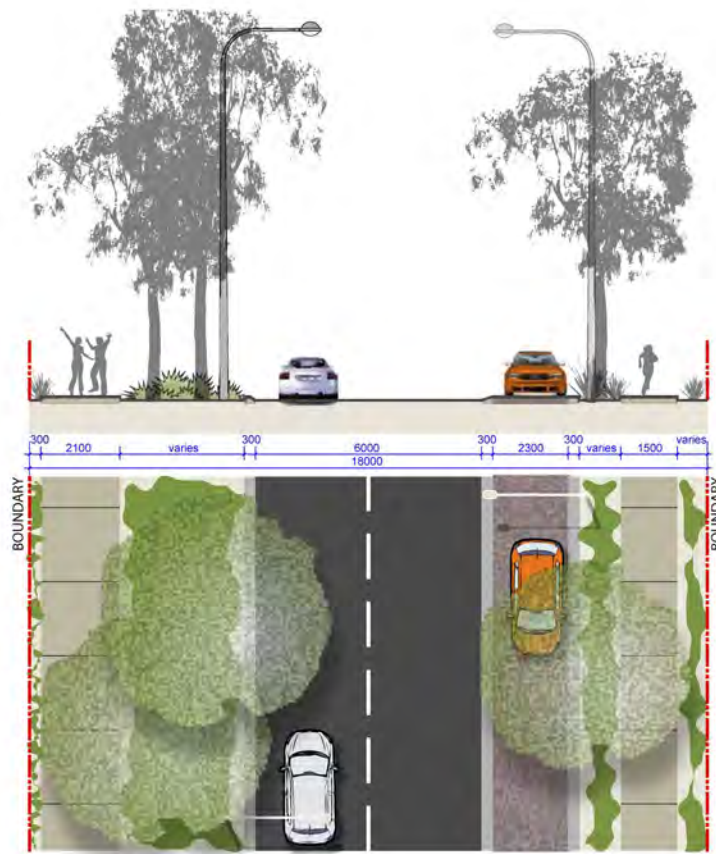
- SIGNIFICANT TREES TO BE CONSIDERED FOR RETENTION
- TREES TO BE CONSIDERED FOR RETENTION
- SIGNIFICANT TREES TO BE CONSIDERED FOR RELOCATION ON-SITE
- SIGNIFICANT TREES TO BE REMOVED



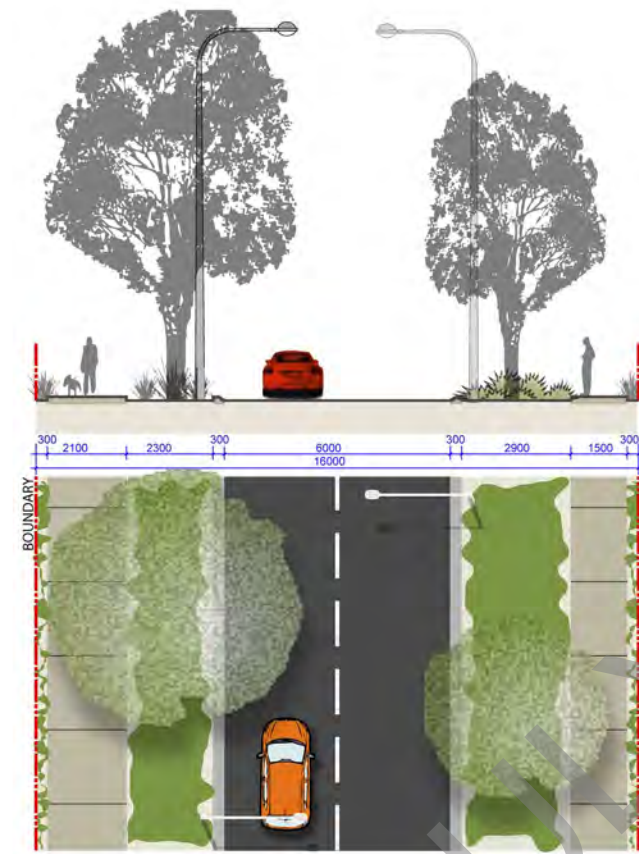
#### PROPOSED TREE RETENTION AND RELOCATION

- SIGNIFICANT TREES TO BE CONSIDERED FOR RETENTION
- TREES TO BE CONSIDERED FOR RETENTION
- SIGNIFICANT TREES TO BE CONSIDERED FOR RELOCATION ON-SITE

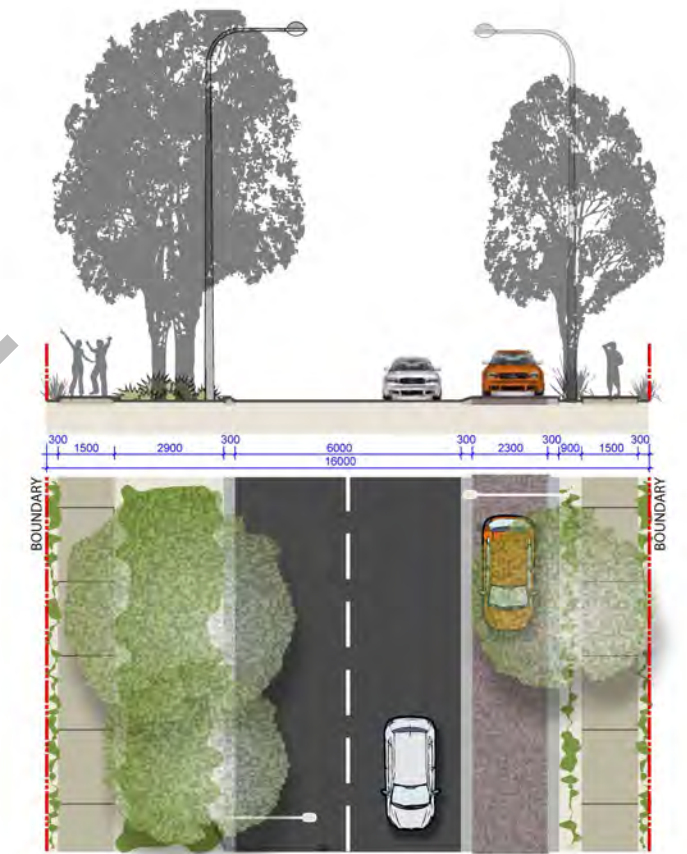




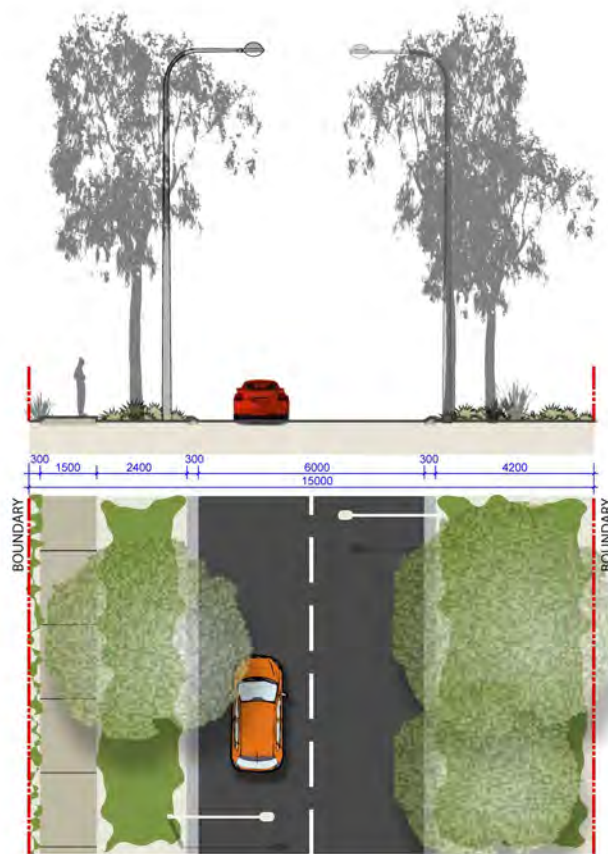
18m Road Reserve (Meandering)



16m Road Reserve (Entry Road)



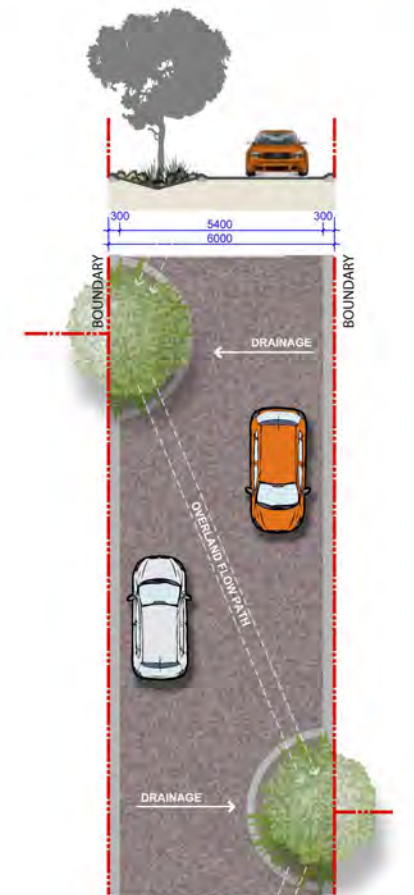
16m Road Reserve



15m Road Reserve



14m Road Reserve



6m Road Reserve (Laneway)

**NOTE:**  
LANDSCAPING ADJACENT TO ON-STREET PARKING EMBAYMENTS IS NOT TO INCLUDE SHRUBS. APPROPRIATE LANDSCAPE TREATMENTS INCLUDE PAVING, GROUND COVER AND FORMAL TREE WELLS. A 1.8 METER STREET WELL DIAMETER IS REQUIRED FOR STREET TREE PLANTING.



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### 8.6.2 INTEGRATED ART/INTERPRETATION

Artworks which are integrated into the site furnishings such as walls, paving, seats, light, fixtures, drink fountains and signage will be investigated to provide education of the site's history and function.

---

### 8.6.3 HIGH SCHOOL TERRACES

The former High School amphitheatre/grandstand that displays colourful graffiti is an important and useful remanent. It is proposed to demolish the existing terraces, rebuild and utilise the existing materials where possible. This is to ensure this asset is integrated into the subdivision and mitigate earthwork level issues that would make the interface into the existing community harder.

It is proposed to recreate the amphitheatre oriented towards the artificial wetland basin that allows for the creation of a flat useable interior space and provides an elevated space for gathering, resting, sunning and overlooking the basin, deck and lawn area below. The rearranging of the graffiti images creates a new contemporary image that is respectful of the past.

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### 8.6.4 EXISTING TREES

The substantial number of mature existing trees on the site provides valuable green infrastructure that has the inherent capacity to enhance and regenerate natural resources.

Arborlogic provided a tree assessment (refer **Appendix 7** – Arboricultural Assessment) to identify, early in the planning process, trees worthy of retention and to minimize problems of retaining inappropriate trees such as unhealthy or weed trees. Approximately 90 healthy trees have been identified to be further investigated for future retention or relocation.

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### 8.6.5 URBAN AGRICULTURE

Incorporation of productive vegetation in the vegetation plan within the public open space spine provides a community resource and a place for social interaction. Fruit trees and herbs will be planted and can be cared for by interested residents.

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### 8.6.6 BIO-RETENTION BASINS

**Public Open Space Area 2** (refer **Figure 19** – Public Open Space Plan) accommodates a basin that provides both an environmental and aesthetic function (refer **Figure 20** – Landscape Masterplan, and **Figure 21** – Landscape Site Details). The basin is a geometric trapezoidal shape supporting the language of the series of spaces. The planting of ephemeral wetland sedges is low and formal providing a natural 'canvas' to be viewed from above on the terraces.

An existing drainage basin (Drainage 2) located on the intersection of Marmion Avenue and Albion Street (refer **Figure 19** – Public Open Space Plan) will accommodate the drainage within catchment 1 (refer **Figure 28** – Preliminary Drainage Plan), whilst catchment 2 will utilise the existing Otago Park sump (Drainage 1 – refer **Figure 19** – Public Open Space Plan).

A developer contribution will be required as a condition of subdivision. This will facilitate upgrade and redesign of the existing sumps to improve the amenity of these facilities and accommodate additional drainage generated from the Structure Plan area.

## 8.7 MOVEMENT NETWORK

### 8.7.1 PROPOSED ROAD NETWORK

#### 8.7.1.1 ANALYSIS OF INTERNAL ROAD NETWORK

The traffic modelling indicates the maximum traffic loading on the internal road of the development. From this the road types were determined. **Figure 24** – Road Classification Plan – shows the proposed allocation of street types in the development and **Figure 25** - Typical Road Cross Sections - shows the proposed cross sections for the street types.

#### 8.7.1.2 INTERNAL CROSS SECTIONS AND RESERVATIONS

Throughout the Structure Plan, varying street types and cross sections have been used. These designs provide a flexible range of options to suit the different traffic, parking, pedestrian and cycling needs for the proposed Structure Plan road network and land use.

These streets are derived from Liveable Neighbourhoods Policy (WAPC, 2009 update). The streets are all categorized as Access Streets due to the very localised residential area served.

The streets have been designed with 6m paved travel way within road reserve widths which vary according to the specific parking, path, services and landscaping requirements throughout the Structure Plan area. For further detail refer **Appendix 5** Traffic Report.

See **Figure 25** for proposed road reserve cross sections.

#### 8.7.1.3 PROPOSED EXTENSION/MODIFICATION TO EXISTING ROAD NETWORK

##### CAMBERWARRA DRIVE ROUNDABOUT

Based on traffic modelling post development results, a roundabout is proposed on Camberwarra Drive at the intersection of the entry point to the proposed development and opposite the Catholic Church Car Park. Due to the limited road reserve existing on Camberwarra Drive a reduced size roundabout with predeflection and median breaks for existing property access is proposed. **Figure 27** – Future/Proposed Intersection Control and Traffic Treatment Plan – provides a preliminary design for the roundabout.

Traffic modelling indicates the roundabout will perform well, with low delays and moderate queues. However observations on site suggest vehicles entering the Catholic Church will require a 'turnaround' type facility in the event that the car park is full and vehicles flow back into Camberwarra Drive. A solution will be required in consultation with the Catholic Church and the City of Joondalup.

##### T-JUNCTION ON ARAWA PLACE

A second local road access to the development is proposed on Arawa Place, west of existing north side residential properties. This access will help spread site traffic and more importantly offer an alternative route to the Camberwarra Drive access point during busy school opening/closing times.

Traffic modelling indicates the intersection of the development entry road and Arawa Place intersection, along with Arawa Place and Camberwarra Drive intersection, perform well in post-development traffic simulation.

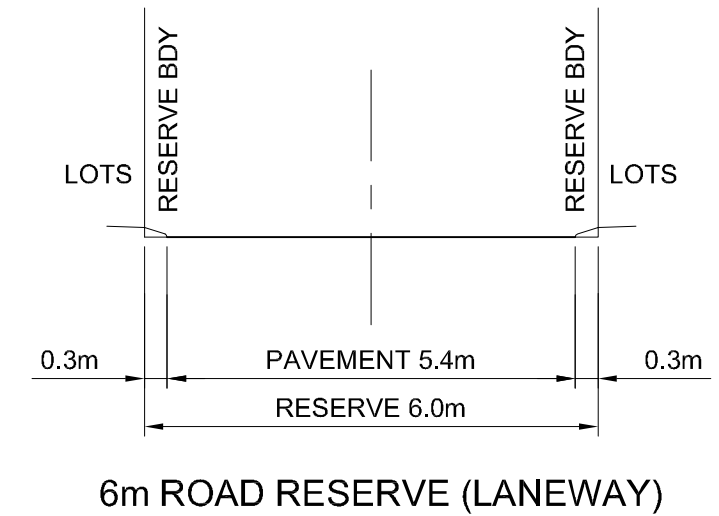
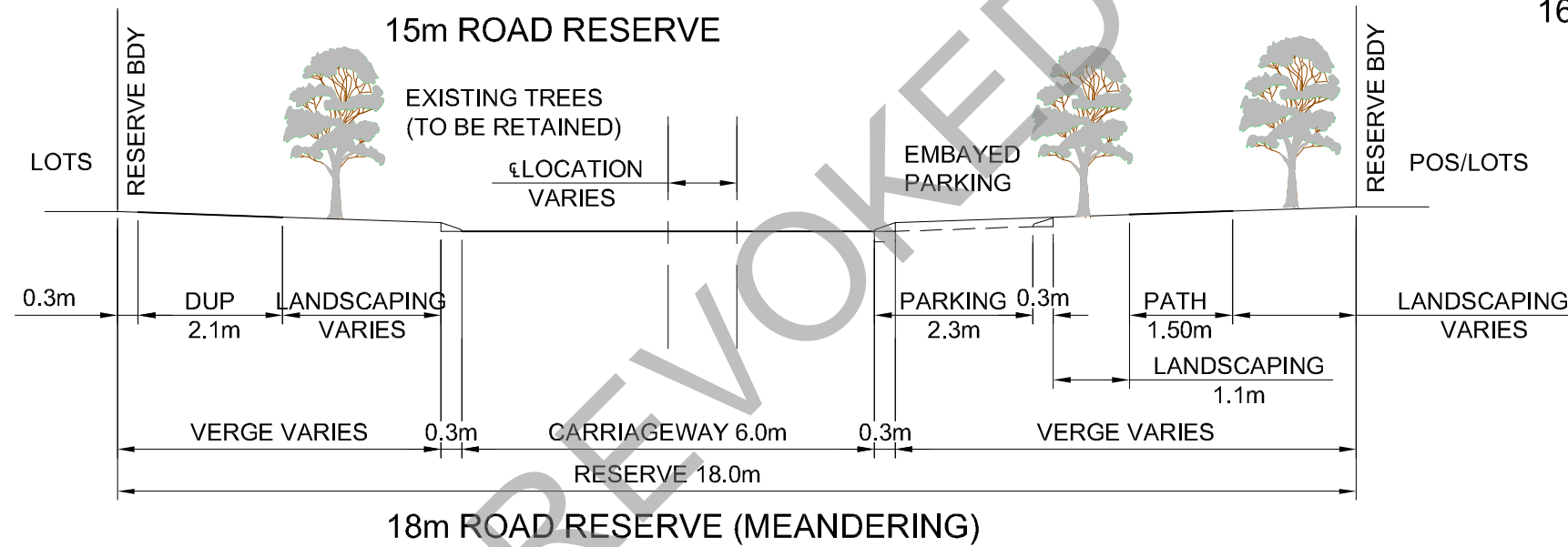
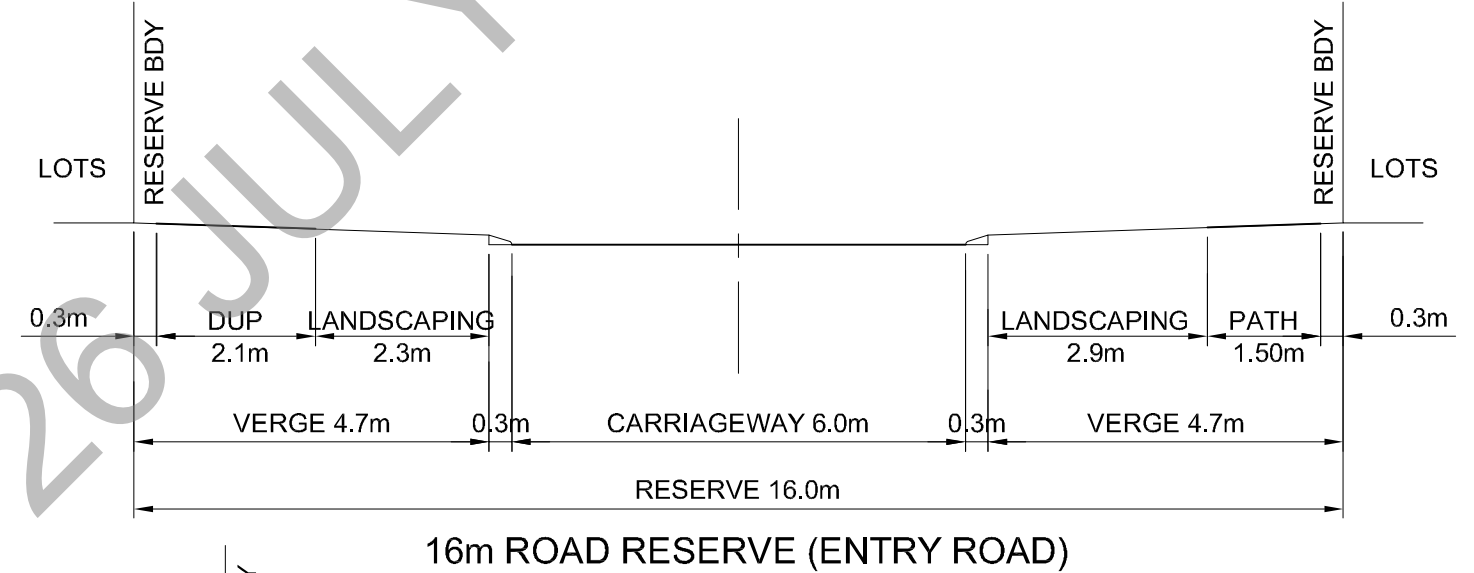
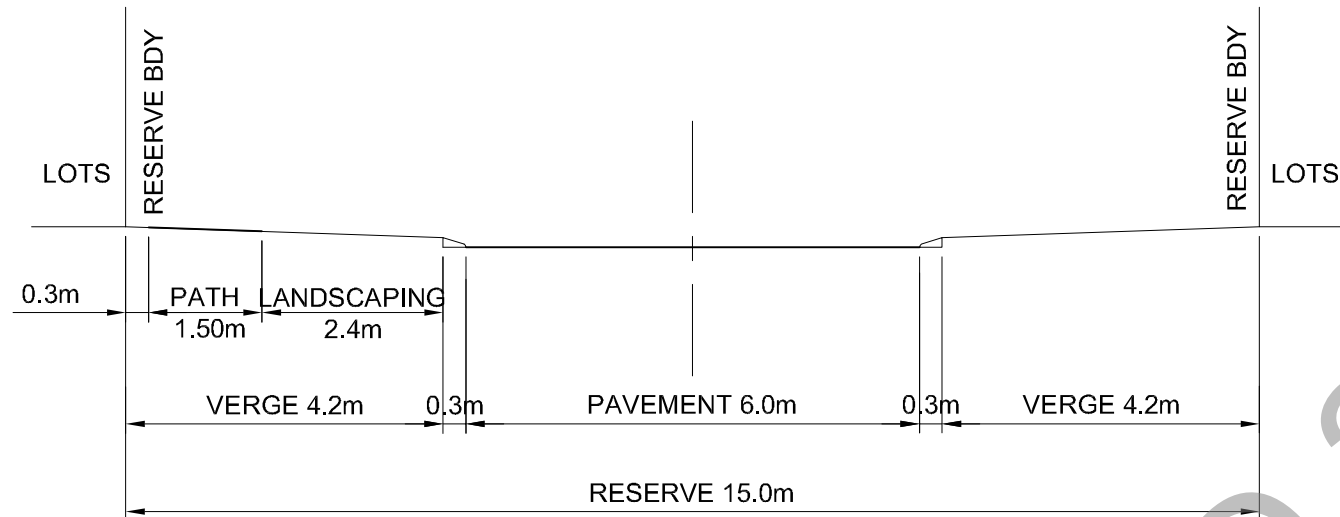
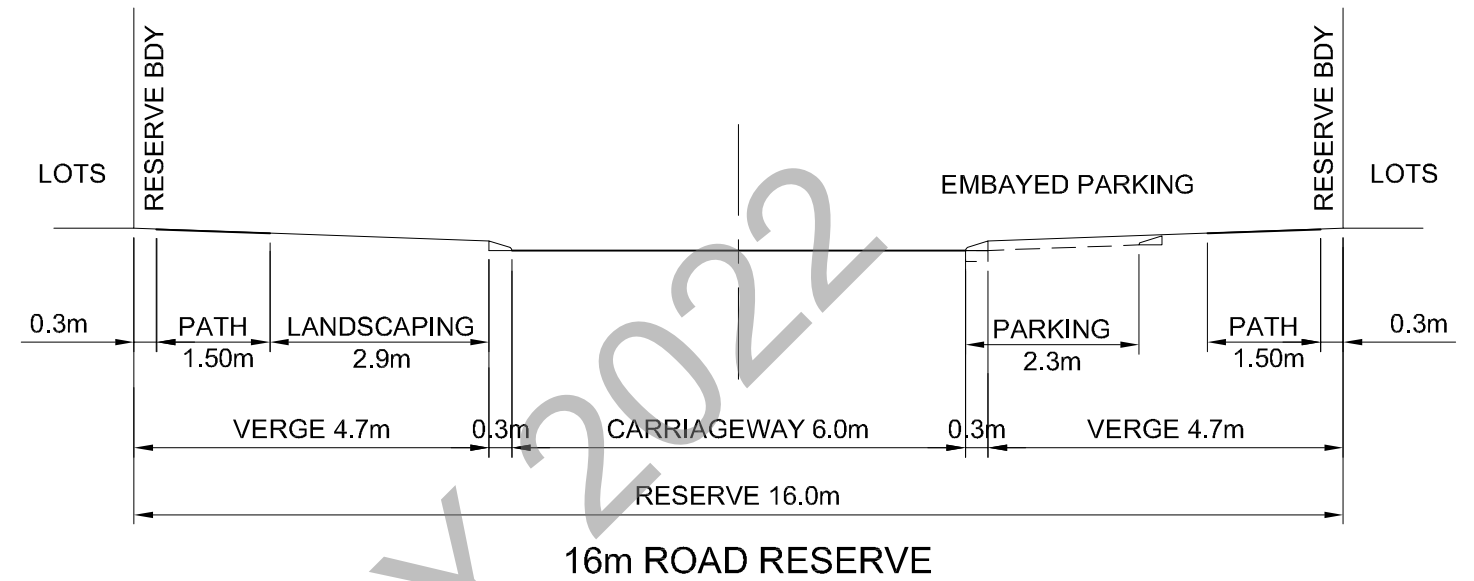
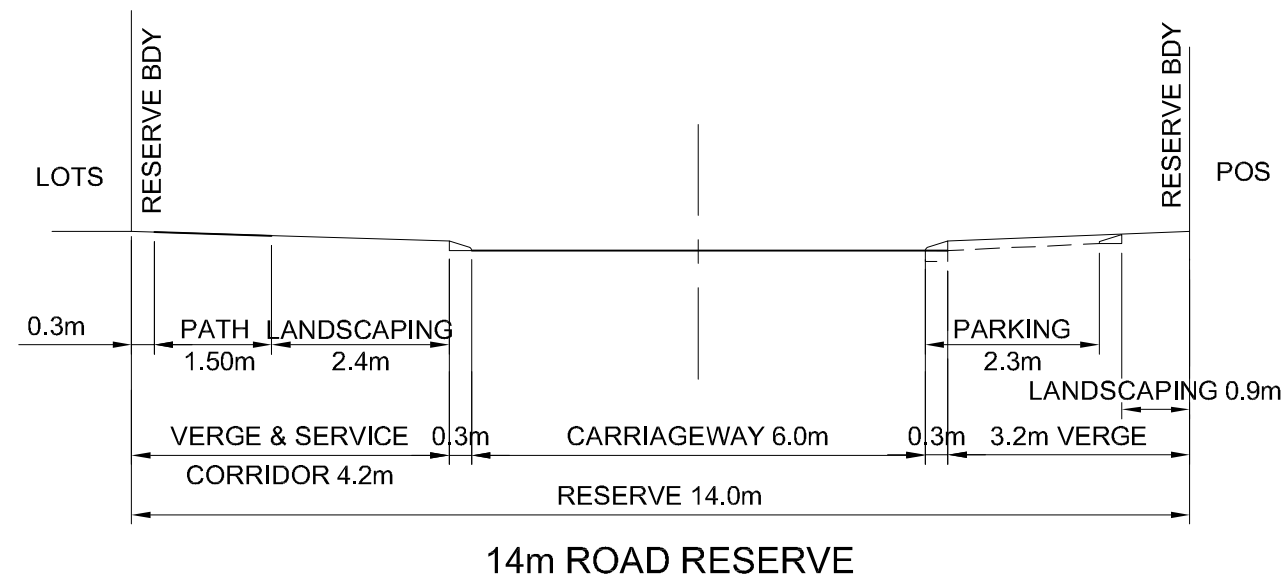




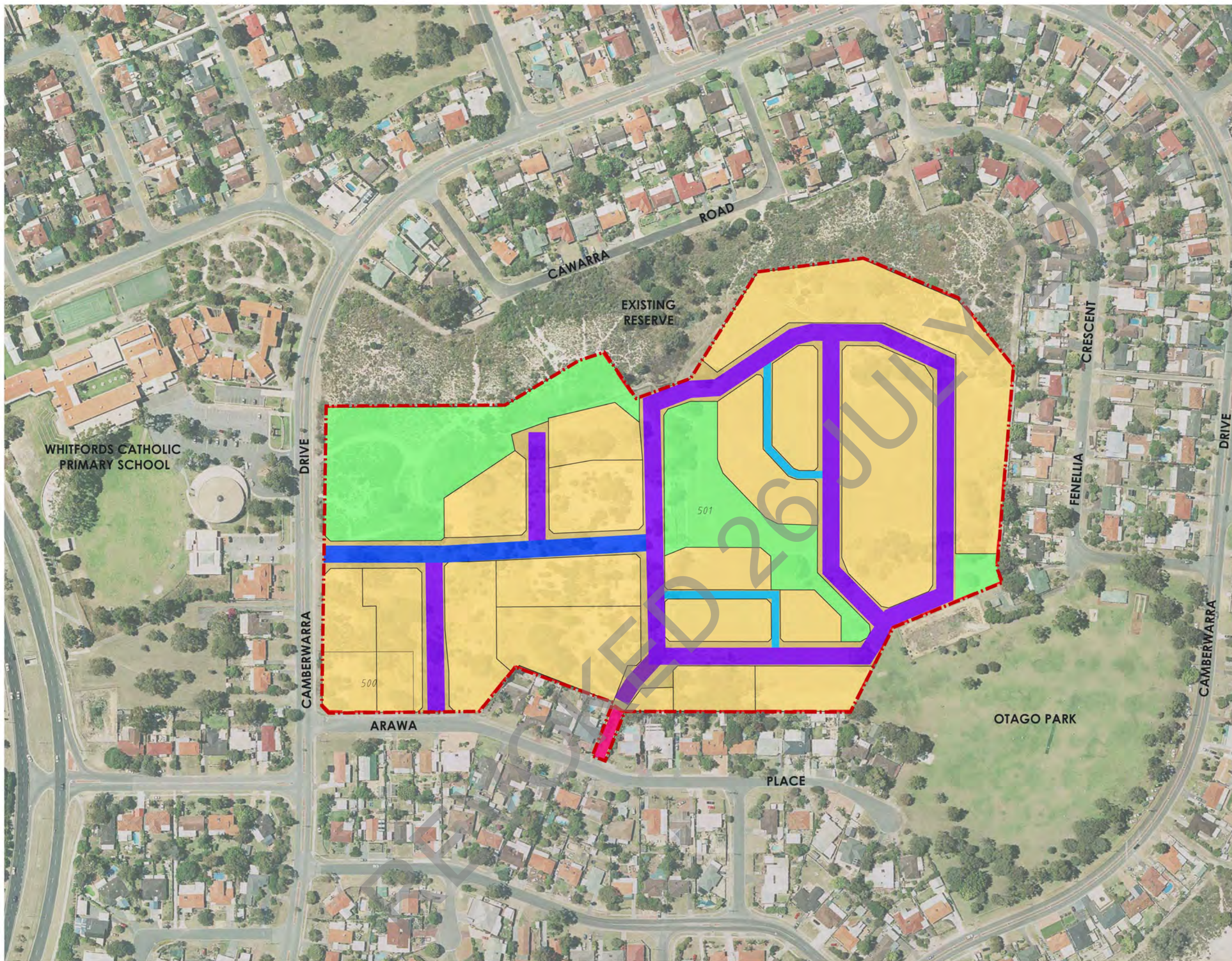
# LEGEND

- 6m RIGHT OF WAY
- 9m PUBLIC ACCESS WAY/RIGHT OF WAY
- 14m ROAD RESERVE
- 15m ROAD RESERVE
- 16m ROAD RESERVE
- 16m ROAD RESERVE (ENTRY ROAD)
- 18m ROAD RESERVE (MEANDERING ROAD)
- PROPOSED RESIDENTIAL ZONING
- PROPOSED POS AREA
- SUBJECT LAND BOUNDARY









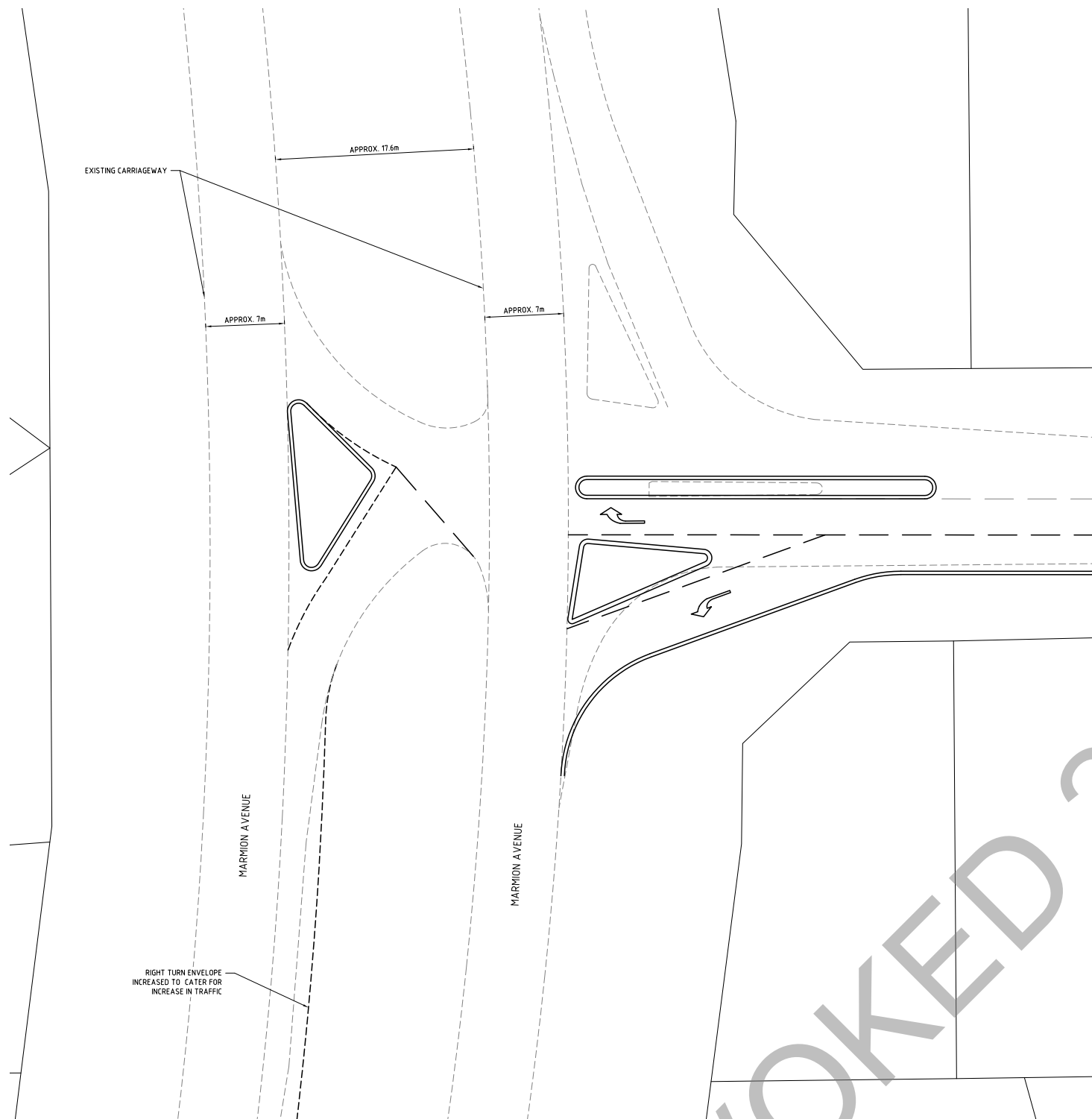
- LEGEND**
- LIVEABLE NEIGHBOURHOODS ACCESS STREET B
  - LIVEABLE NEIGHBOURHOODS ACCESS STREET C
  - PUBLIC ACCESS WAY / RIGHT OF WAY WITH DUAL USE PATH/EMERGENCY ENTRY & EXIT
  - PROPOSED PUBLIC OPEN SPACE/DRAINAGE
  - PROPOSED RESIDENTIAL ZONING
  - SUBJECT LAND BOUNDARY

## ROAD HIERARCHY PLAN

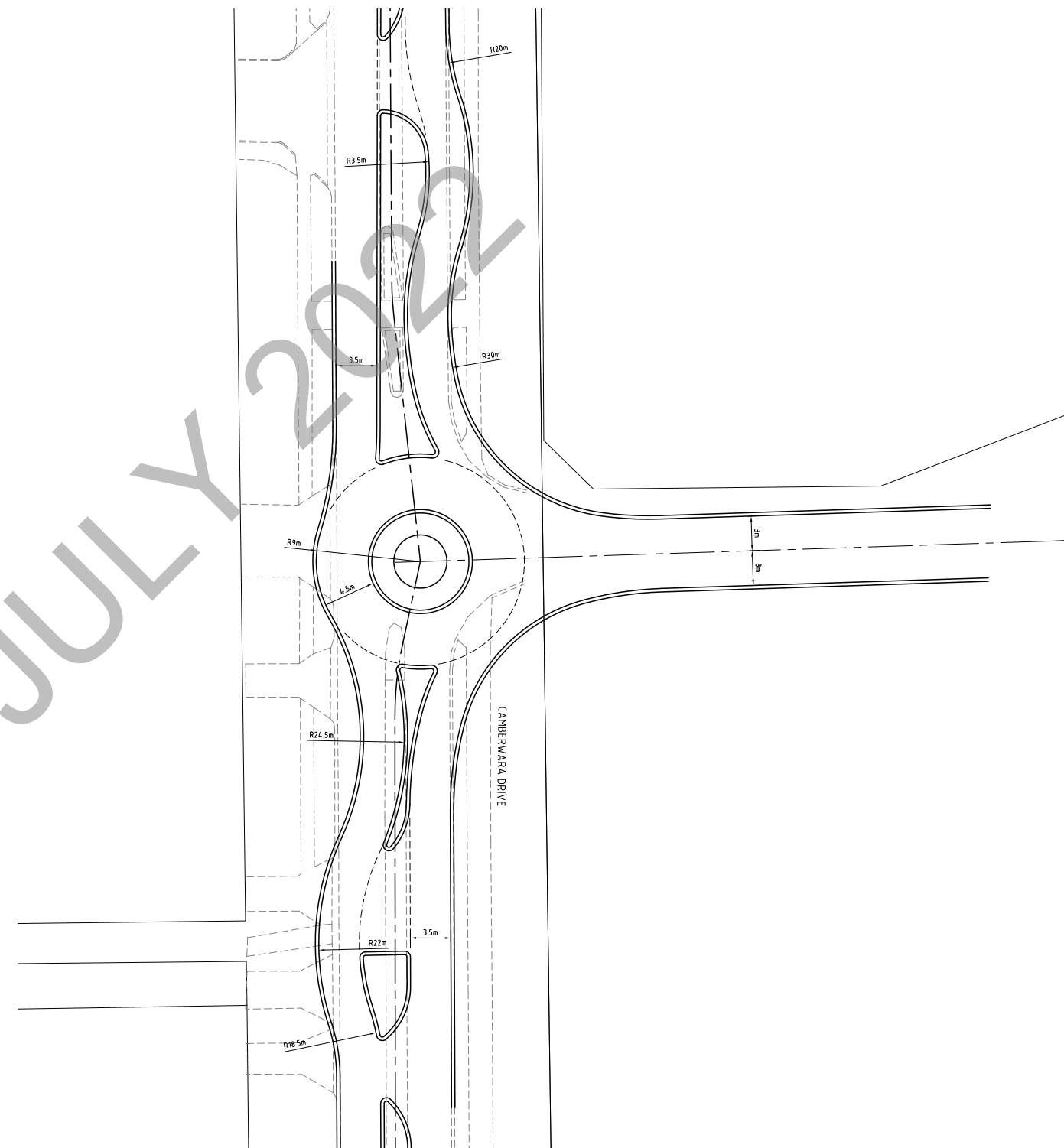
Craigie High School Structure Plan

0m 20 40m  
 s: 1:2500@A3  
 d: Oct 2011  
 j: 07/088





ALBION / MARMION INTERSECTION



CAMBERWARRA ROUNDABOUT



## EMERGENCY ACCESS FROM ARAWA PLACE

The Camberwarra Drive and Arawa Place access points have a common origin with the development. At this junction they combine to form a single gateway to the site.

An alternative access point is required for emergency service vehicles. This is accomplished by using the existing reserve linking the development to Arawa Place. It is proposed that this reserve be used only for pedestrian/cyclist and emergency service vehicles. The access will have a 3m carriageway with removable bollards at either end.

## CARRIAGEWAY WIDENING ON ALBION STREET

Post development traffic modelling indicates that vehicle queuing increases on Albion Street at the intersection of Albion Street and Marmion Avenue (refer **Figure 27** for Intersection Control and Traffic Treatment Plans). In order to provide separate traffic lanes for right and left turning vehicles onto Marmion Avenue, it is proposed that the westbound carriageway on Albion Street is widened over a distance of 50m.

A developer contribution will be required as a condition of subdivision. This will facilitate the Albion Street carriageway widening to accommodate additional traffic generated from the Structure Plan area.

---

### 8.7.2 PARKING

The pedestrian and cyclist movement network plan (refer **Figure 13**) shows the proposed locations for on street parking. The road reserve cross sections also provide a profile of the parking areas (refer **Figure 23** – Streetscape Sections). The locations have been chosen for their proximity to Public Open Space and laneway cottage style residences.

---

### 8.7.3 PEDESTRIANS AND CYCLISTS

The Pedestrian and Cyclist Network Plan (refer **Figure 13** – Pedestrian and Cyclist Movement Network)) shows dual use paths and footpaths proposed for the development and how the proposed network integrates with the existing pedestrian and cyclist network.

The dual use path provided connects the entry drive, the linear open space and Otago Park. The dual use path provides universal access gradients and connections to local and regional networks and commercial areas.

The number of lots surrounding the central Public Open Space area would require approximately seven or eight visitor bays. These bays would be provided in the streets so that the maximum distance between on-street visitor car parking and residential lots that abut Public Open Space is no greater than 50-60 metres. Visitors to the POS-frontage lots will have direct access via the footpaths through the Public Open Space to the lots that abut the open space. The proponent and the City have agreed that the direct interface between Public Open Space and residential lots can be successfully managed.

---

### 8.7.4 PUBLIC TRANSPORT

The existing bus route network (refer **Figure 14** – Bus Routes) services the subject site sufficiently with the 463 bus route travelling along Camberwarra Drive past the western boundary of the subject site.

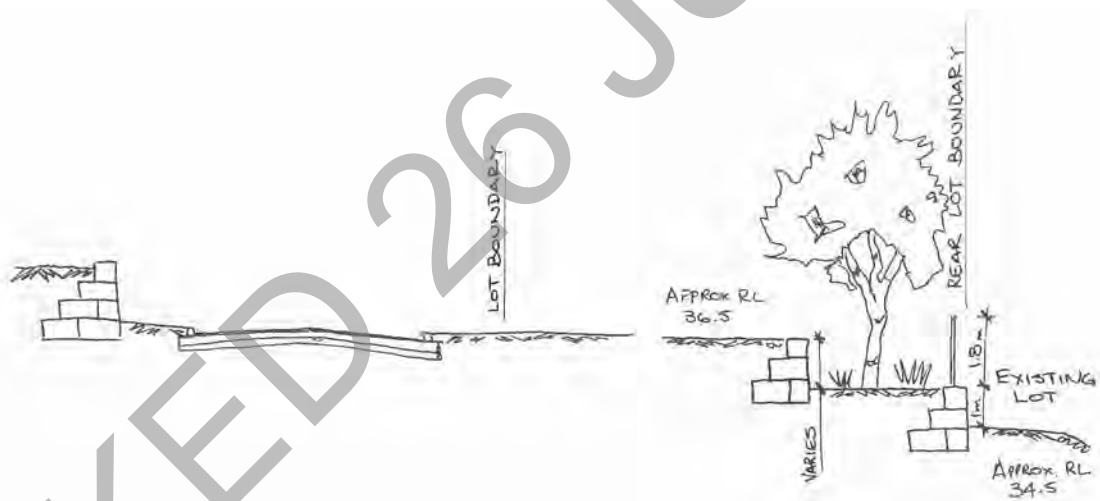
## 8.8 SERVICING INFRASTRUCTURE

### 8.8.1 EARTHWORKS

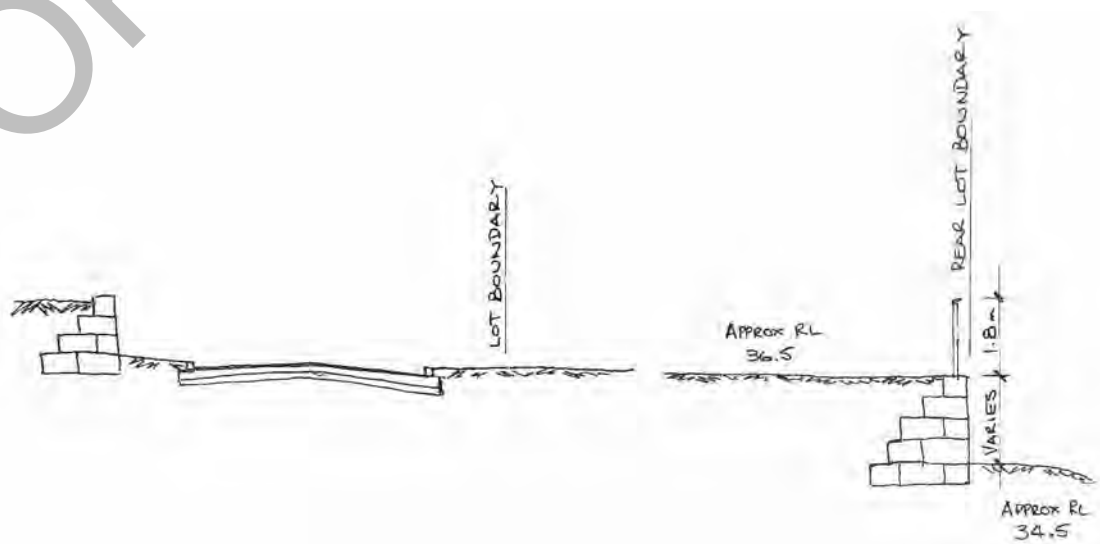
Earthworks for the site form a critical part of the proposed development. The key factors associated with the earthworks will be the various interfaces with the dune area to the north, the existing lots to the east and south and integrating the existing steep terraces into the proposed development. This will require a combination of sloping lots and retaining structures to ensure an optimum design and effective servicing strategy is achieved.

Generally, retaining wall structures will be designed to 1m in height where possible subject to detailed design. Higher walls will however be required in order to integrate the steep terraces into the development.

Two options exist for the interface along the eastern boundary interface. Option 1 (refer below) provides for a terraced planting strip adjacent to the boundary thus providing for a 1m maximum wall on the boundary and the remaining height difference taken up in the internal wall. Option 2 (refer below) is to take up the full height differential on the property boundary. Option 1 provides for a maximum height combination of wall and fence of 2.8m, but impacts on the usable space of the proposed development lots.



Eastern Boundary Interface - Option 1



Eastern Boundary Interface - Option 2





Indicative photo of a retaining wall screened by landscaped planting

### 8.8.2 STORMWATER MANAGEMENT


Due to the permeability of the in-situ sand, the site is well suited to the on-site disposal of stormwater. There are potentially two options for disposal of stormwater drainage. Stormwater can be retained on site and infiltrated through drainage basins within the central POS. Stormwater drainage will be integrated into the public open space in accordance with the requirements of Liveable Neighbourhoods and the local authority through the application of water sensitive urban design principles.

The proposed development will have two catchment areas (refer **Figure 28** – Preliminary Drainage Plan). Most of the site is within the eastern catchment and there is much potential for infiltration in public open space. Stormwater can also be discharged into the existing Otago Park sump. The western catchment is reasonably small, but lacks public open space areas suitable for infiltration. Drainage for this catchment will require a piped system directing flow to the existing Albion Street drainage sump. These options require further investigation which will be undertaken during the subdivision stage of the development.

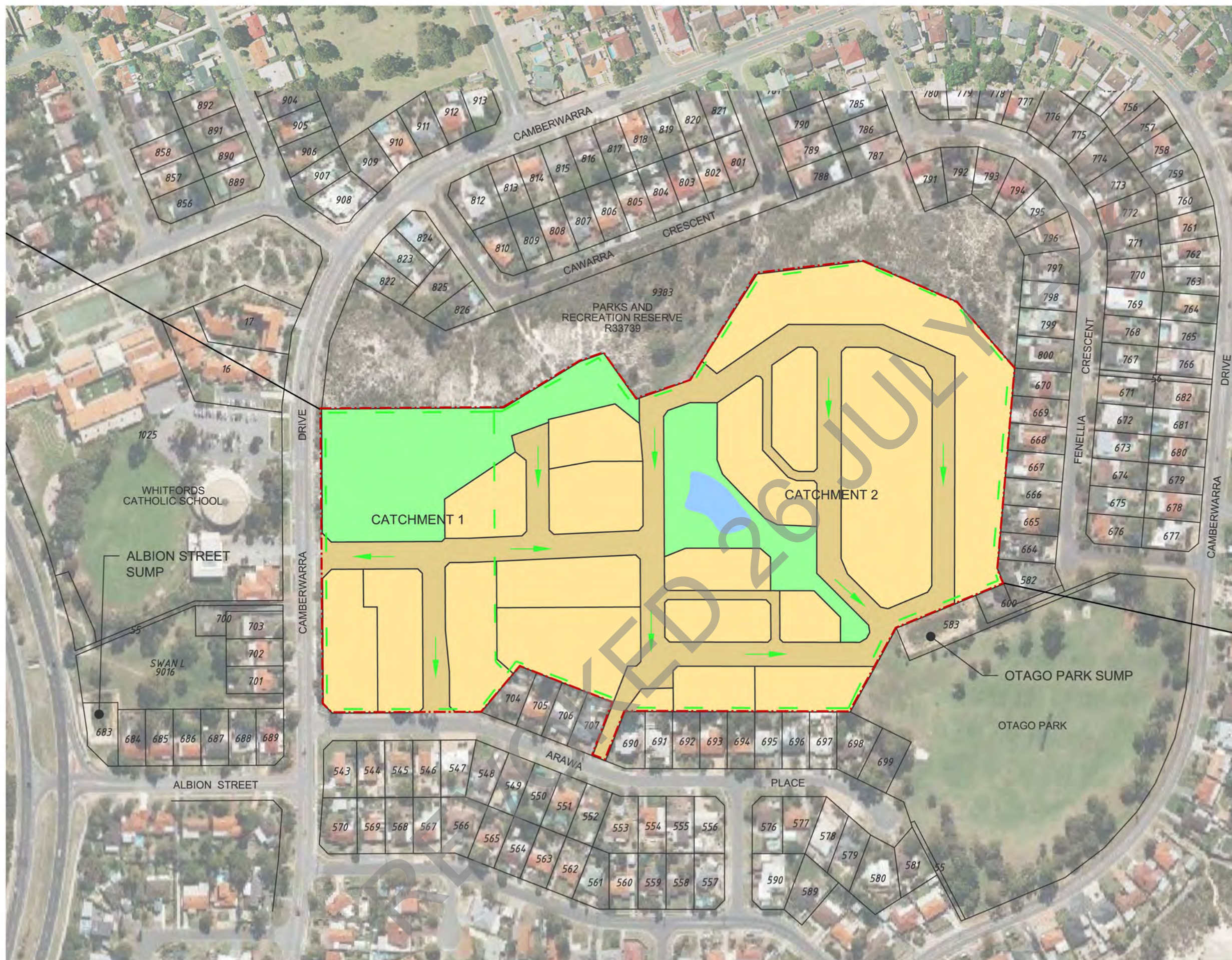
Refer **section 9.2.1** for Urban Water Management Plan requirements.

### 8.8.3 ROADWORKS

Traffic modelling have provided preliminary traffic and intersection requirements. The following requirements were identified:

-  Camberwarra Drive – This road will serve as the main access to the site and a new roundabout will be required to provide access to the site and to safely integrate the existing access point into the school parking/drop-off area on the western side of the road.







- LEGEND**
- DRAINAGE CATCHMENT BOUNDARY
  - PROPOSED DRAINAGE BASIN
  - PROPOSED RESIDENTIAL ZONING
  - PROPOSED PUBLIC OPEN SPACE/DRAINAGE AREA
  - SUBJECT LAND BOUNDARY



## Craigie High School Site Local Structure Plan

-  Albion Street – Modification to the intersection of Marmion Avenue and Albion Street will be required to allow for the increased traffic volume to accommodate the future growth in the area which this development contributes towards during peak periods. The upgrade will provide a left and right turning lane onto Marmion Avenue with a 50m queuing capacity for right turners from Albion Street.
-  Fenellia Crescent – A link with Fenellia Crescent to the east of the development site is not being considered. Traffic modelling indicates that access to the new development will be primarily from Camberwarra Drive on the western boundary of the site. Also a new road linking with Fenellia will require the relocation of exiting sewer pressure mains and electrical equipment located to the west of Fenellia Crescent, within the development site.

**Figure 26** indicates the road hierarchy internally in the development. The entrance to the development from Camberwarra Drive will have a typical cross section similar to Access Street B from Liveable Neighbourhoods. The remainder of the roads will be Access Street C and 6m laneways from Liveable Neighbourhoods. **Figure 25** provides the typical cross section for Access Street B, Access Street C and Laneways.

The treatment of the Pedestrian Access Way (PAW)/Right of Way (ROW) to the north of Arawa Place is subject to further stakeholder discussion.

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### 8.8.4 WATER SUPPLY

No significant upgrading to the existing water supply infrastructure will be required. Minor upgrading of the DN100 main located in Arawa Place to a DN150 may be required if the internal water reticulation network is to be connected to it. Road crossings will be required under Cambewarra Drive and Arawa Place to connect into the existing water mains.

The proposed water infrastructure requirements for the site are shown in **Figure 29**.

---

### 8.8.5 POWER SUPPLY

A feasibility study (refer **Appendix 6 – Infrastructure Report (Appendix 'A')**) was prepared by Western Power to assess the capacity of the existing high voltage (HV) infrastructure to supply the proposed development and any upgrading works that may be required. The Western Power feasibility study concluded that the Gibson Avenue feeder will have sufficient capacity to supply the proposed development, via looping in and out of the HV distribution backbone located in Cambewarra Drive or Arawa Place to a new ring main unit (RMU) located within the development site.

Some HV switching may be required to finalise network configuration to improve the reliability of supply to the development.

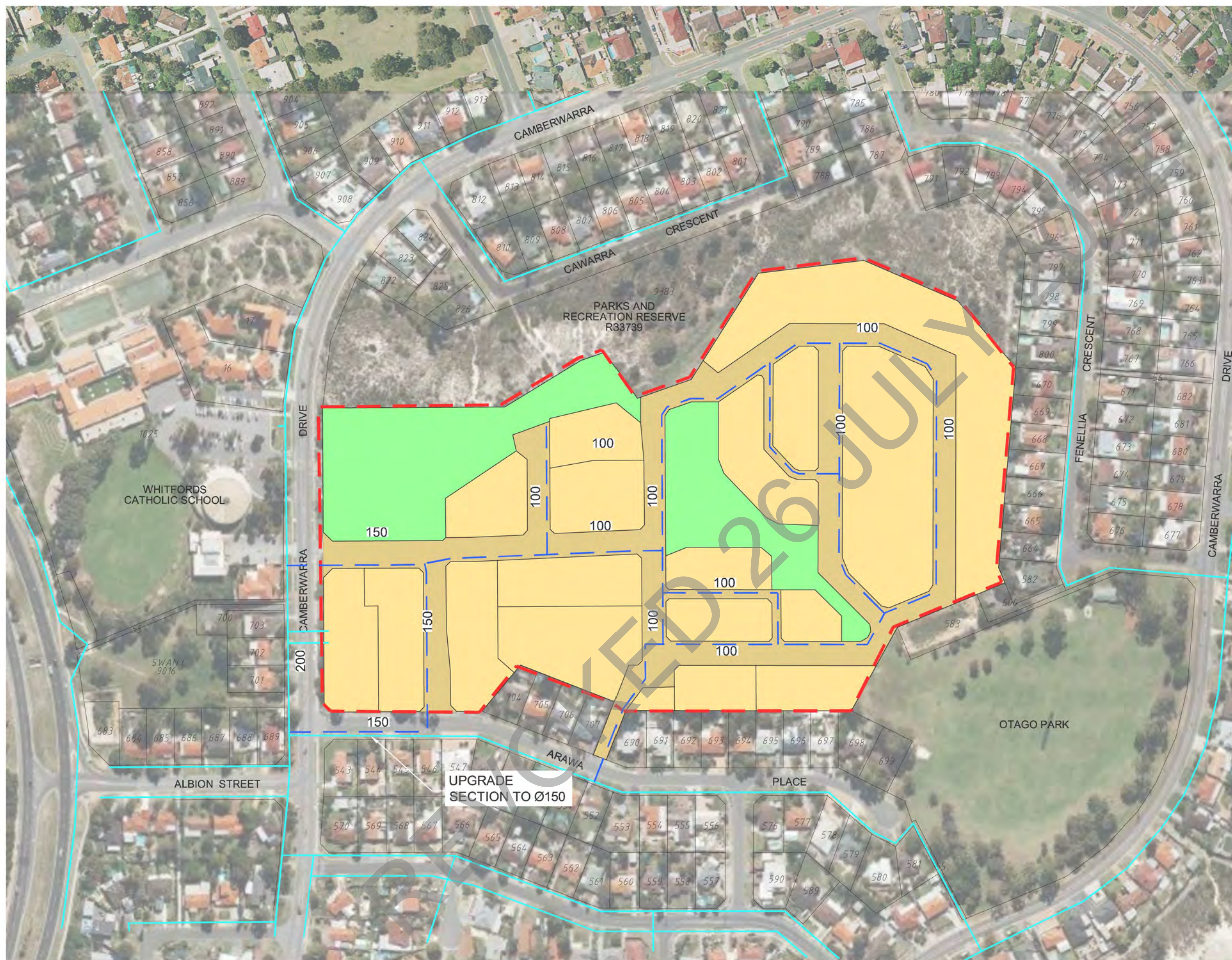
---

### 8.8.6 TELECOMMUNICATIONS

Communications infrastructure can be readily provided to the proposed development with a major exchange building located south-west of the development site.

The Commonwealth has released draft legislation in 2009 that will require optical fibre cables to be installed as part of any new development after July 2010.





- LEGEND**
- EXISTING WATER
  - - - 100 PROPOSED WATER WITH DIAMETER
  - PROPOSED RESIDENTIAL ZONING
  - PROPOSED POS AREA
  - SUBJECT LAND BOUNDARY



An update to the 2009 legislation indicates that from 1 January 2011 developers will only be required to fund the cost of pit and pipes for fibre connections and NBN Co (National Broadband Network) will be responsible for all other costs for fibre deployment including backhaul.

---

#### 8.8.7 GAS SUPPLY

The developer will be required to provide a bore under the road to connect to the existing gas network. This developer funded bore will be located under Camberwarra Drive just north of Arawa Place junction which has capacity to supply the proposed development.

**Figure 30** shows the approximate location of the bore to connect to the existing gas infrastructure.

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#### 8.8.8 FIRE MANAGEMENT

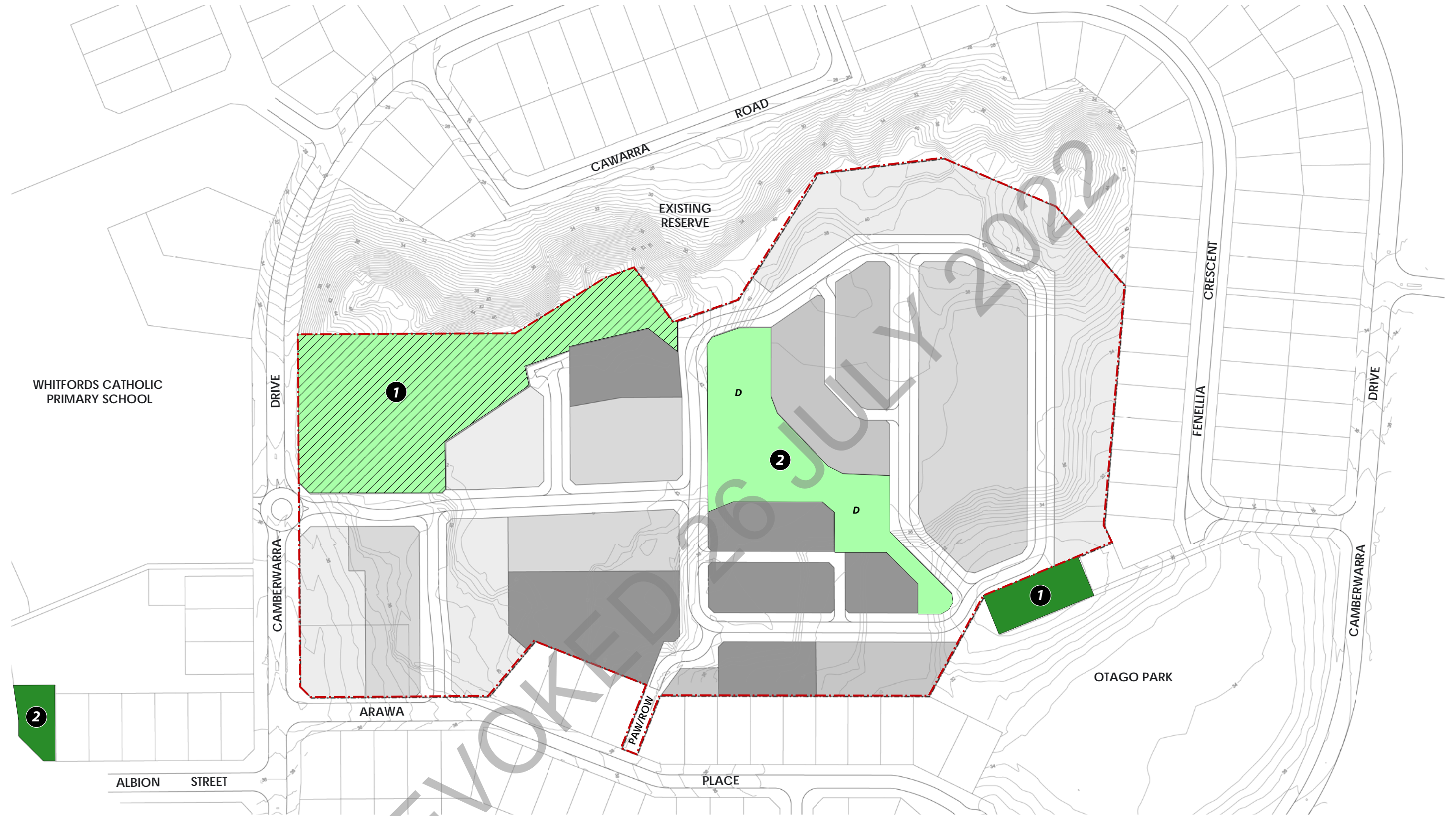
As specified by Fire and Emergency Services Authority of Western Australia (FESA), hydrants will be spaced 200m apart with no obstructions. A PAW/ROW with removable bollards is proposed to provide additional access for emergency vehicles. The PAW/ROW provides a second access point for emergency services from Arawa Place.





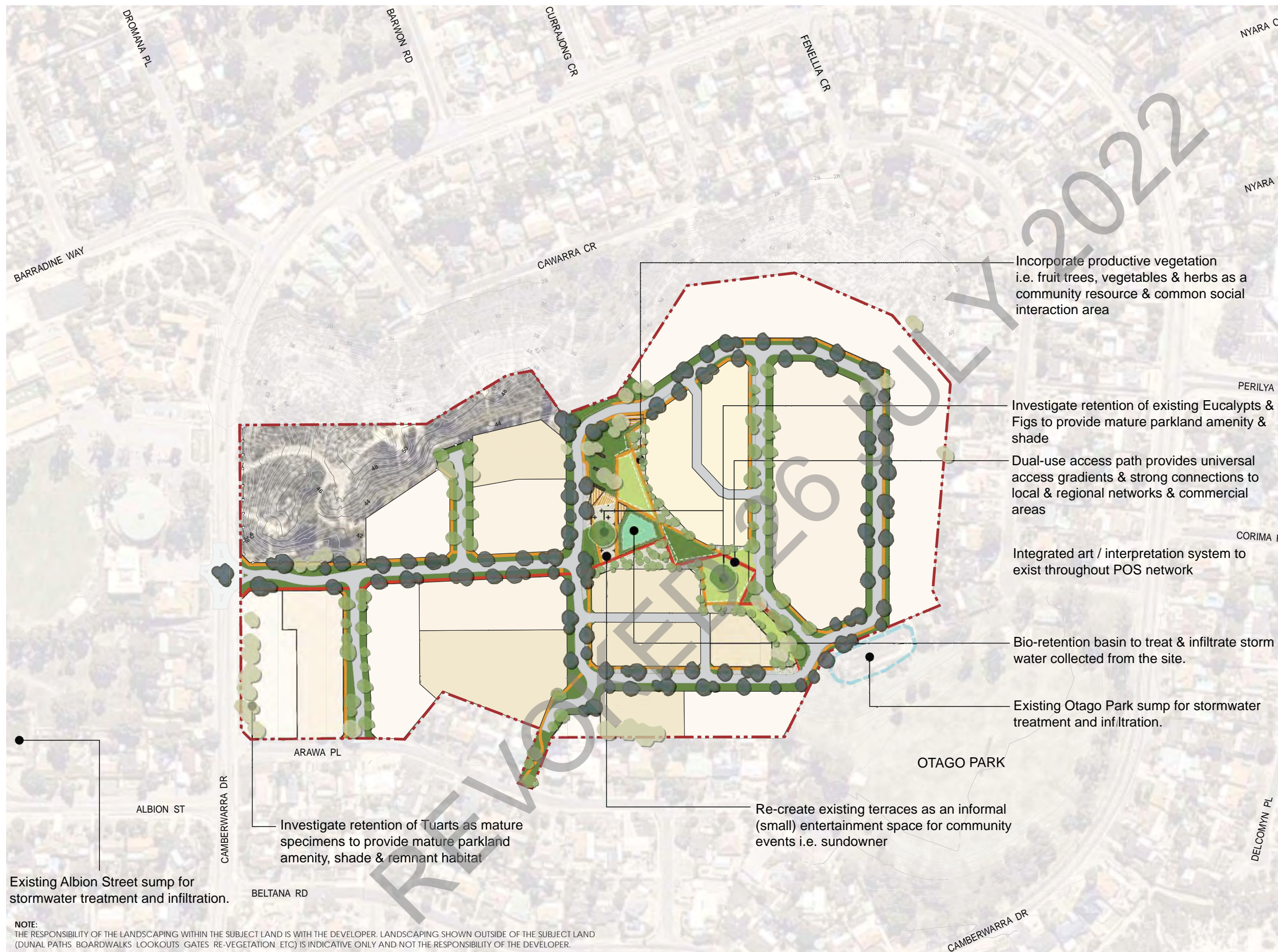
- LEGEND**
- EXISTING GAS NETWORK
  - PROPOSED GAS NETWORK
  - - - SUBJECT LAND BOUNDARY





<b>LEGEND</b>		
<span style="display:inline-block; width:15px; height:10px; background-color:lightgreen; border:1px solid black;"></span> ACTIVE LOCAL PARKS	<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black;"></span> INTEGRATED DRAINAGE	<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black; border-radius:50%;"></span> PUBLIC OPEN SPACE 1
<span style="display:inline-block; width:15px; height:10px; background-color:lightgreen; border:1px solid black; border-style:dashed;"></span> PASSIVE DUNAL OPEN SPACE	<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black; border-style:dashed;"></span> SUBJECT LAND BOUNDARY	<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black; border-radius:50%;"></span> PUBLIC OPEN SPACE 2
<span style="display:inline-block; width:15px; height:10px; background-color:darkgreen; border:1px solid black;"></span> DRAINAGE		<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black; border-radius:50%;"></span> DRAINAGE 1
		<span style="display:inline-block; width:10px; height:10px; background-color:lightgrey; border:1px solid black; border-radius:50%;"></span> DRAINAGE 2

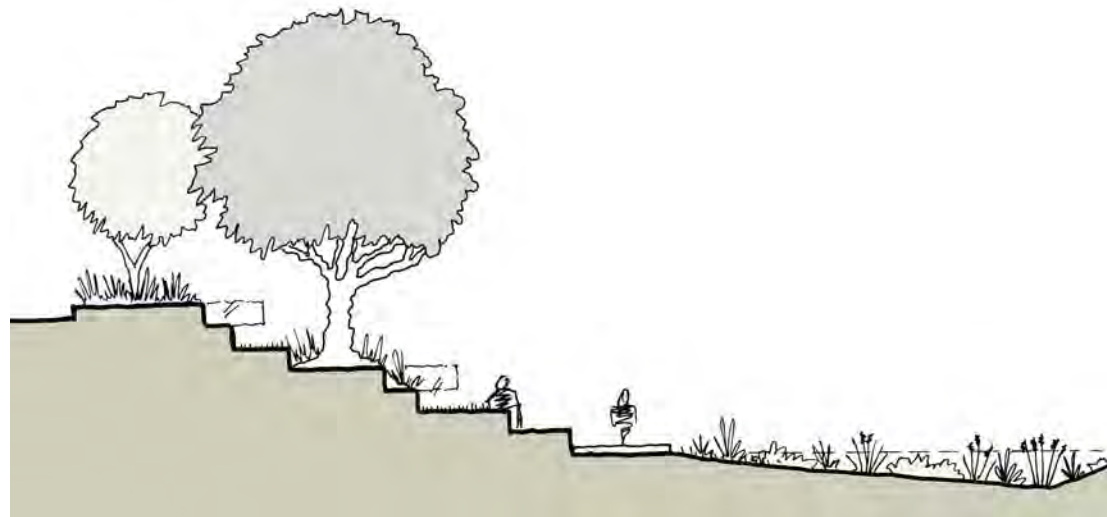




- ### LEGEND
- EXISTING CONTOURS (1m)
  - EXISTING CONTOURS (0.25m)
  - TREES EXISTING TO BE CONSIDERED FOR RETENTION
  - TREES PROPOSED - MAIN STREET
  - TREES PROPOSED - SECONDARY STREETS
  - TREES TRANSPLANTED
  - RESIDENTIAL R20
  - RESIDENTIAL R25
  - RESIDENTIAL R30
  - RESIDENTIAL R40
  - ROAD
  - CONCRETE STEPS
  - GRAVEL PAVING - COMPACTED
  - PATH - DUP (2.0m WIDTH)
  - PATH - VERGE (1.5m WIDTH)
  - RE-VEGETATION
  - PLANTING - SHRUB / GROUND-COVER
  - TURFED AREA
  - BIO-RETENTION BASIN
  - WALL ART
  - DECKING
  - RINGLOCK FENCE
  - SUBJECT LAND BOUNDARY



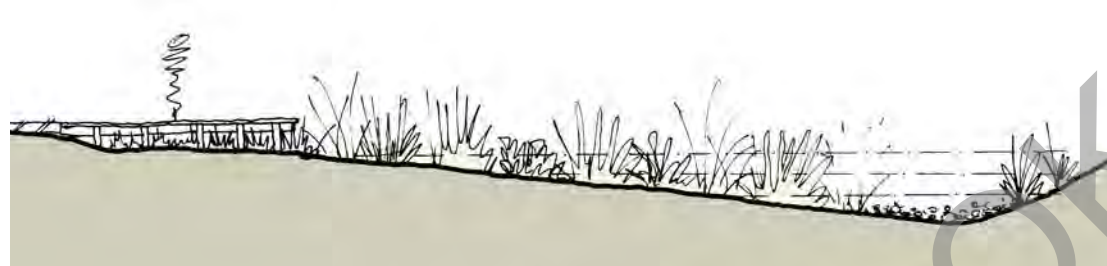
## ① recycling



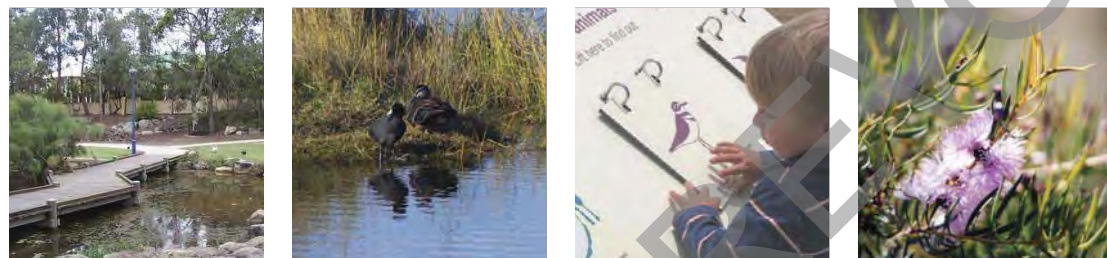
The former terraces are an important and useful remnant. The terraces are proposed to be recreated as an amphitheatre. The amphitheatre allows for the creation of a flat interior space and provides an elevated space for gathering, resting and observing. The rearranging of the graffiti images creates a new contemporary image that is respectful of the past.



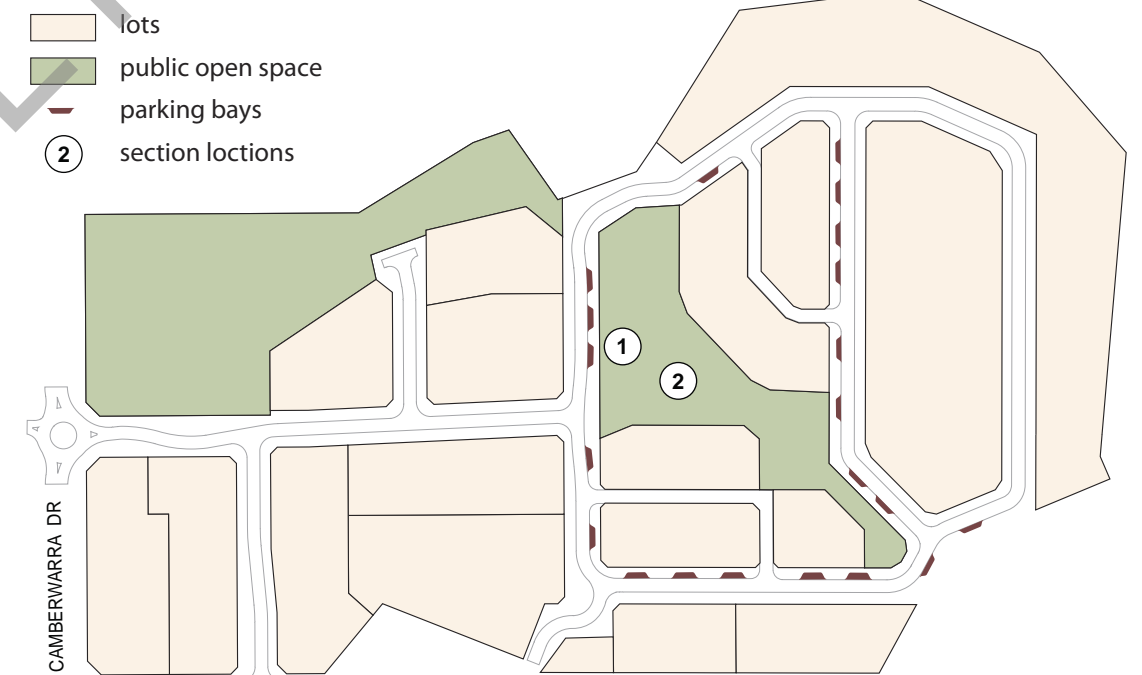
## ② bio-retention basin



The open space spine accommodates a basin that provides both an environmental and aesthetic function. The basin is a geometric trapezoidal shaped supporting the language of the series of spaces. The planting of ephemeral wetland sedges is low and formal providing a natural 'canvas' to be viewed from above on the terraces and from a deck stage. The whole water cycle is a possible theme for interpretation.



## key plan (Not to Scale)

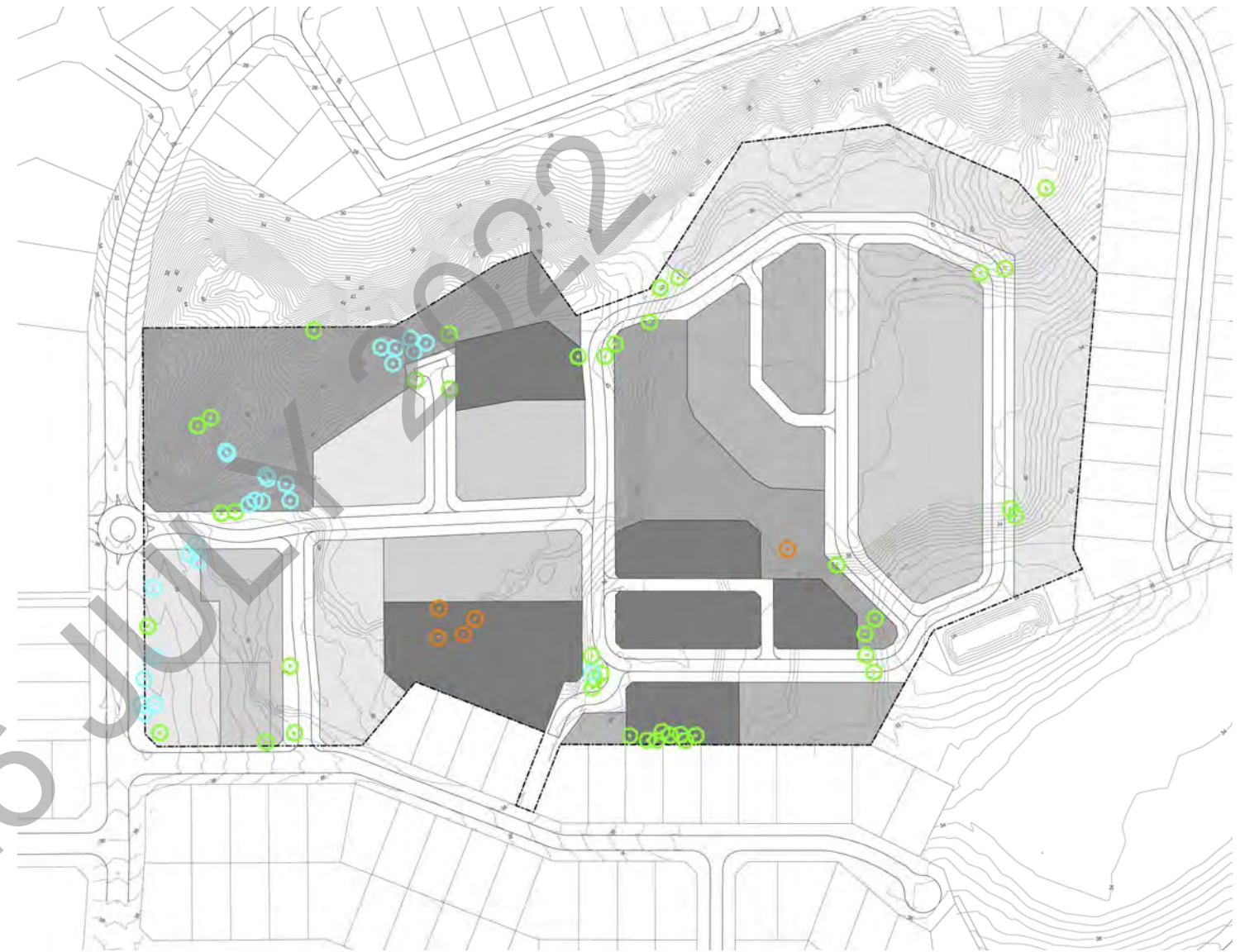






#### EXISTING TREES

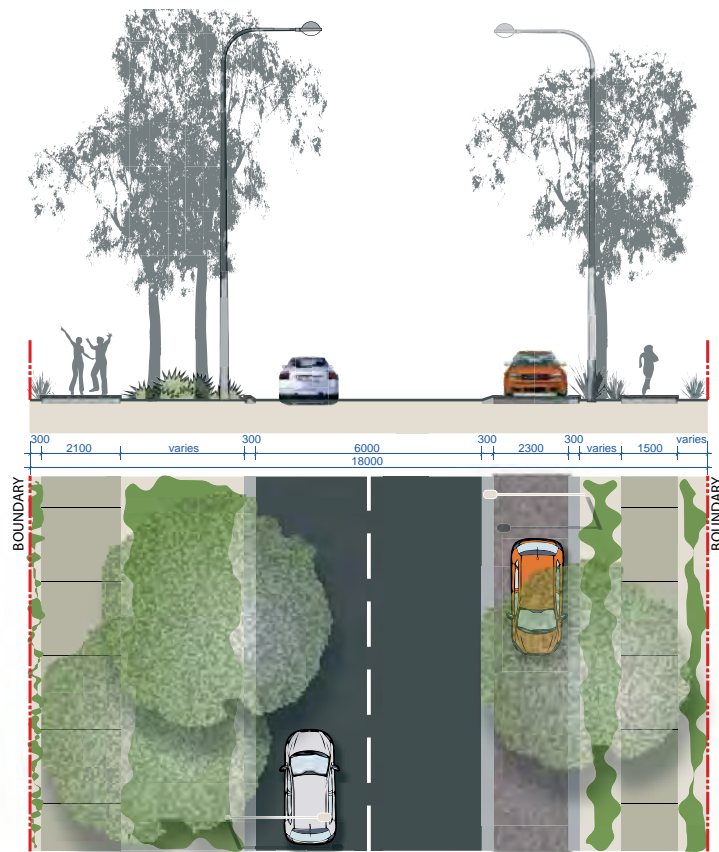
- SIGNIFICANT TREES TO BE CONSIDERED FOR RETENTION
- TREES TO BE CONSIDERED FOR RETENTION
- SIGNIFICANT TREES TO BE CONSIDERED FOR RELOCATION ON-SITE
- SIGNIFICANT TREES TO BE REMOVED



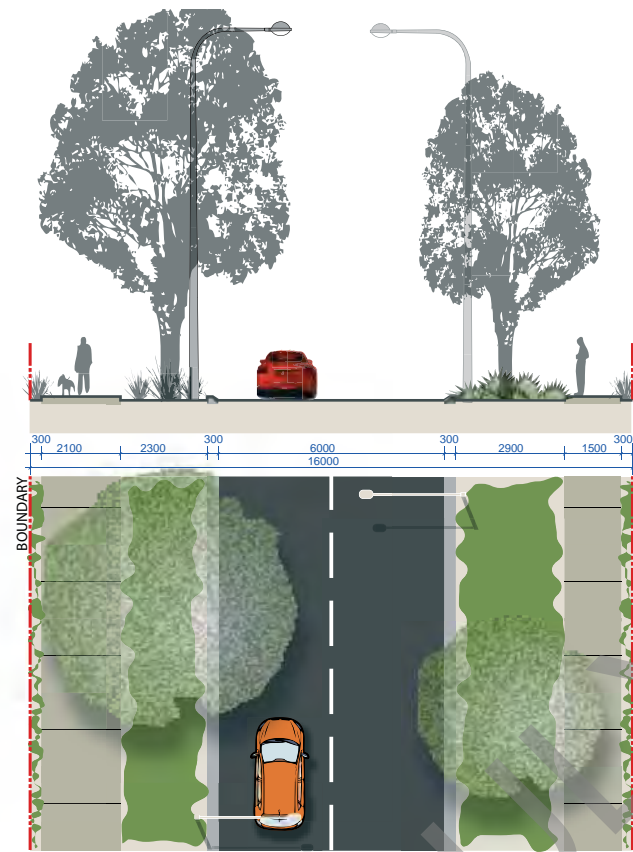
#### PROPOSED TREE RETENTION AND RELOCATION

- SIGNIFICANT TREES TO BE CONSIDERED FOR RETENTION
- TREES TO BE CONSIDERED FOR RETENTION
- SIGNIFICANT TREES TO BE CONSIDERED FOR RELOCATION ON-SITE

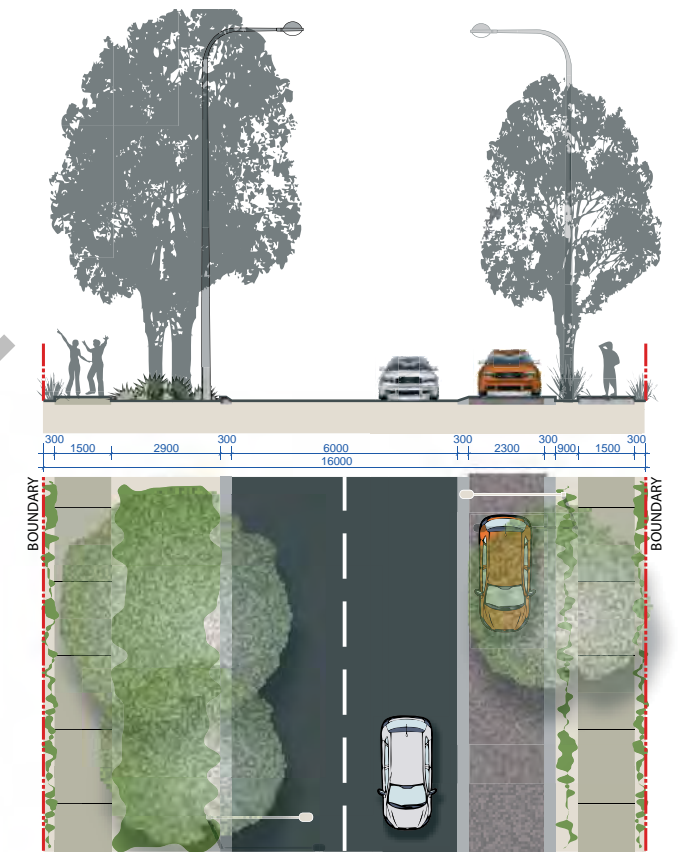




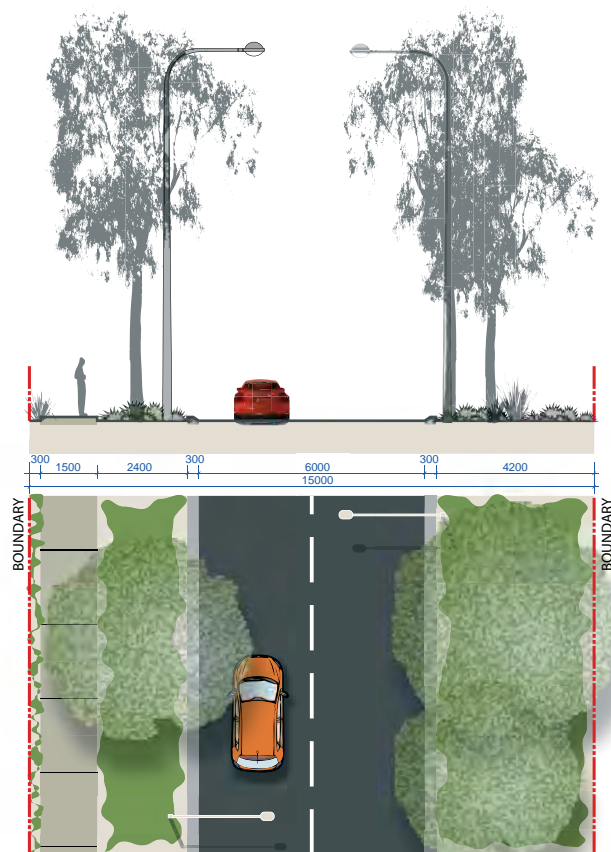
18m Road Reserve (Meandering)



16m Road Reserve (Entry Road)



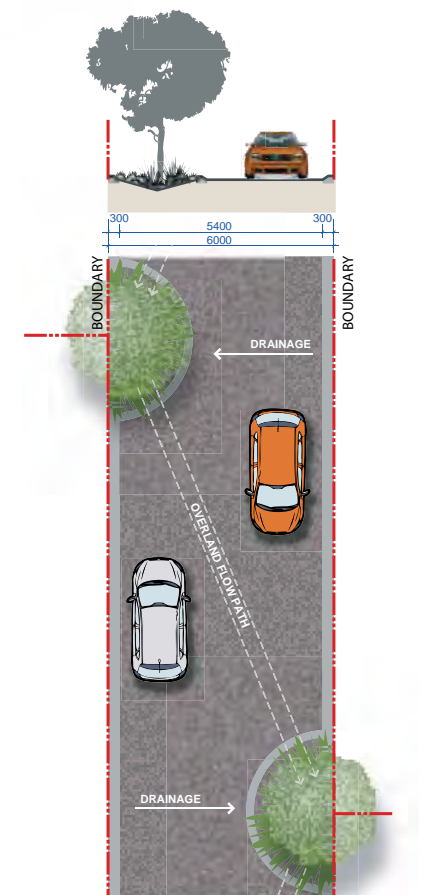
16m Road Reserve



15m Road Reserve



14m Road Reserve



6m Road Reserve (Laneway)

**NOTE:**  
LANDSCAPING ADJACENT TO ON-STREET PARKING EMBAYMENTS IS NOT TO INCLUDE SHRUBS. APPROPRIATE LANDSCAPE TREATMENTS INCLUDE PAVING, GROUNDCOVER AND FORMAL TREE WELLS. A 1.8 METER STREET WELL DIAMETER IS REQUIRED FOR STREET TREE PLANTING.

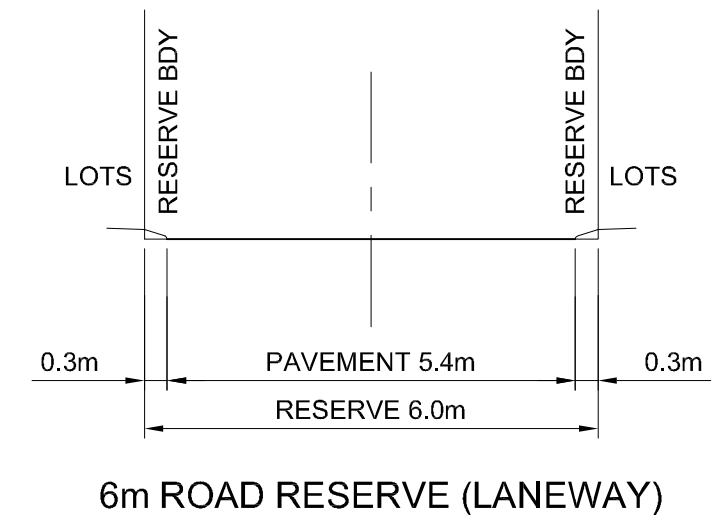
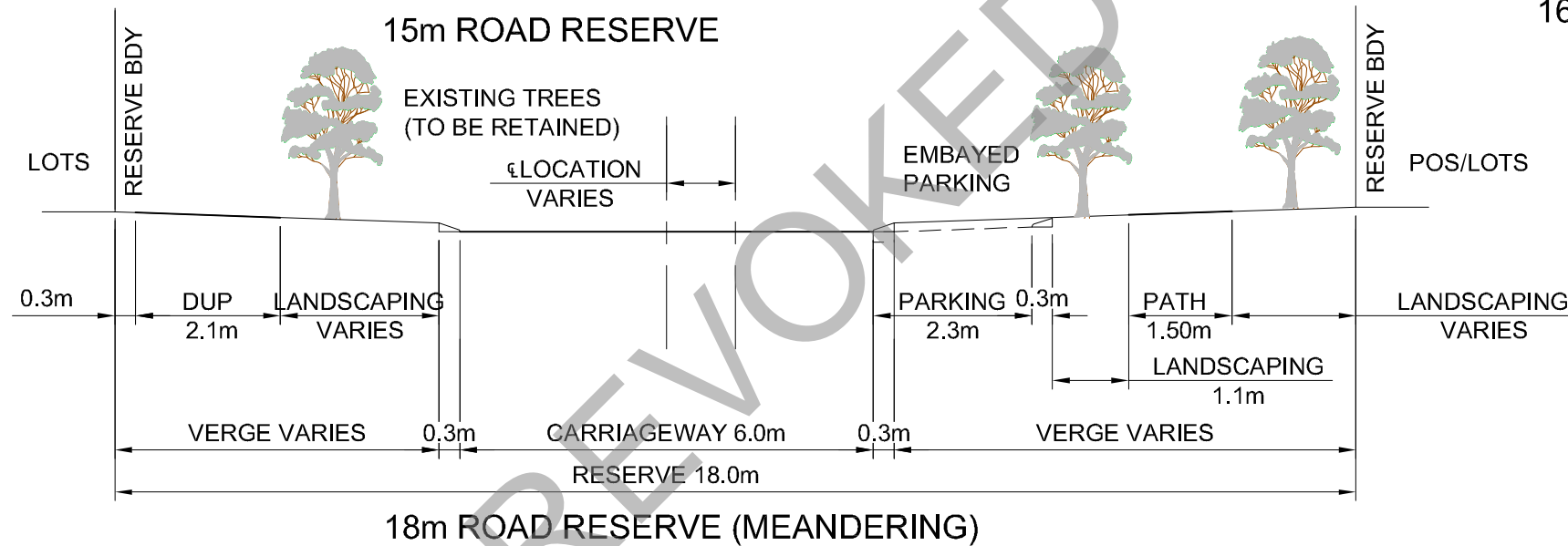
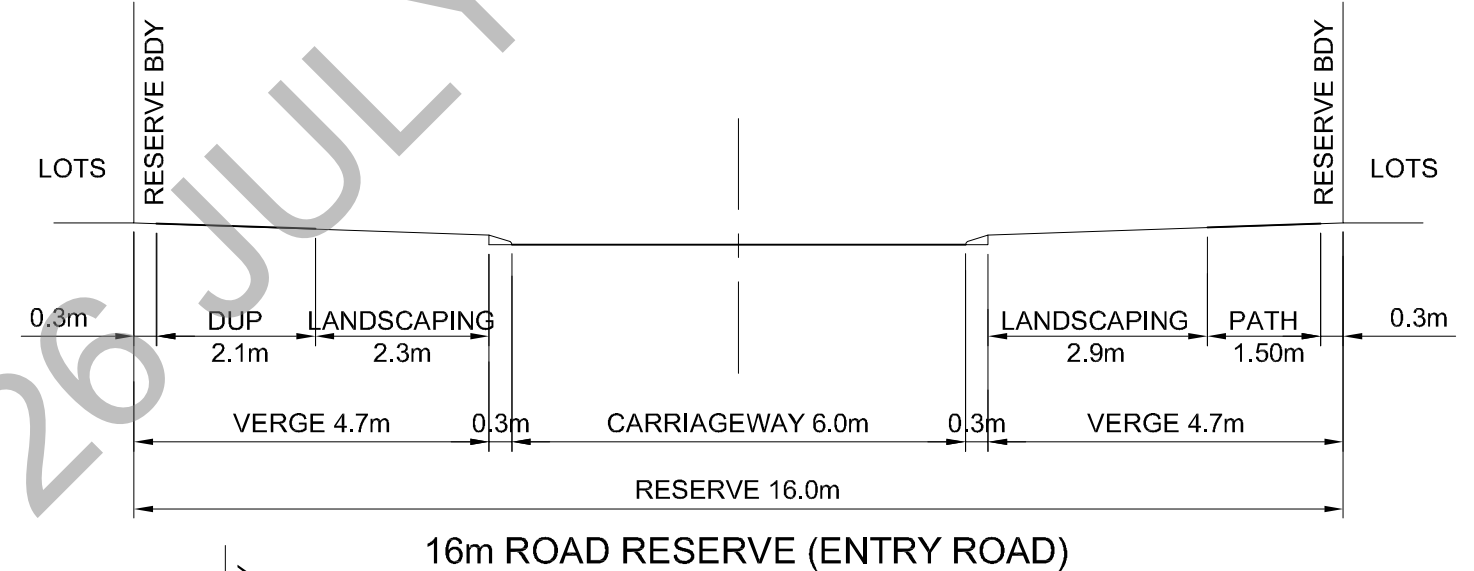
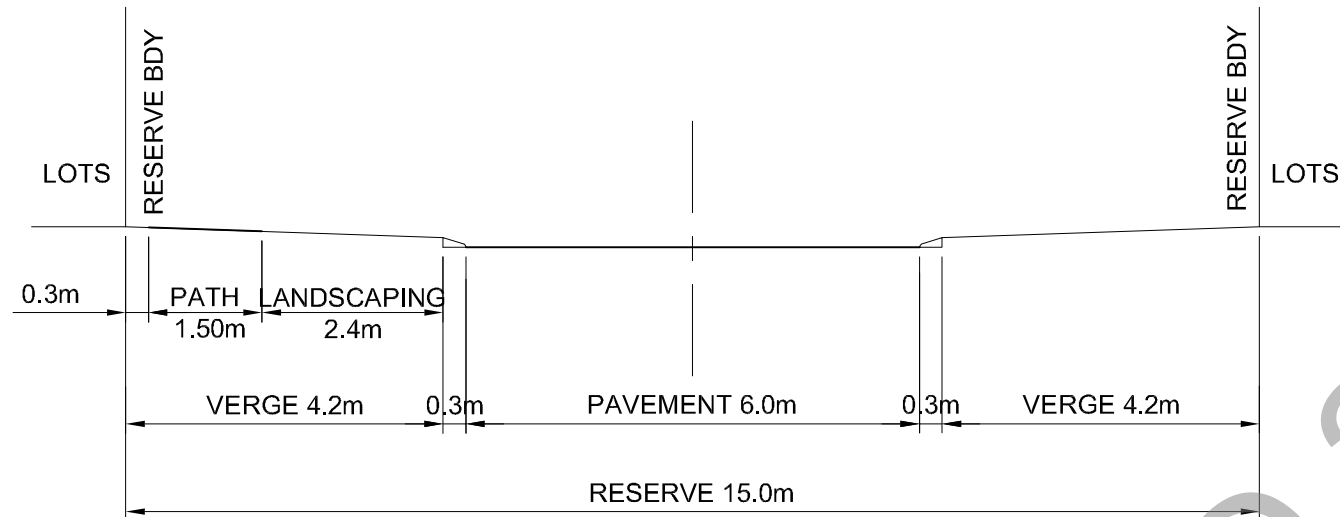
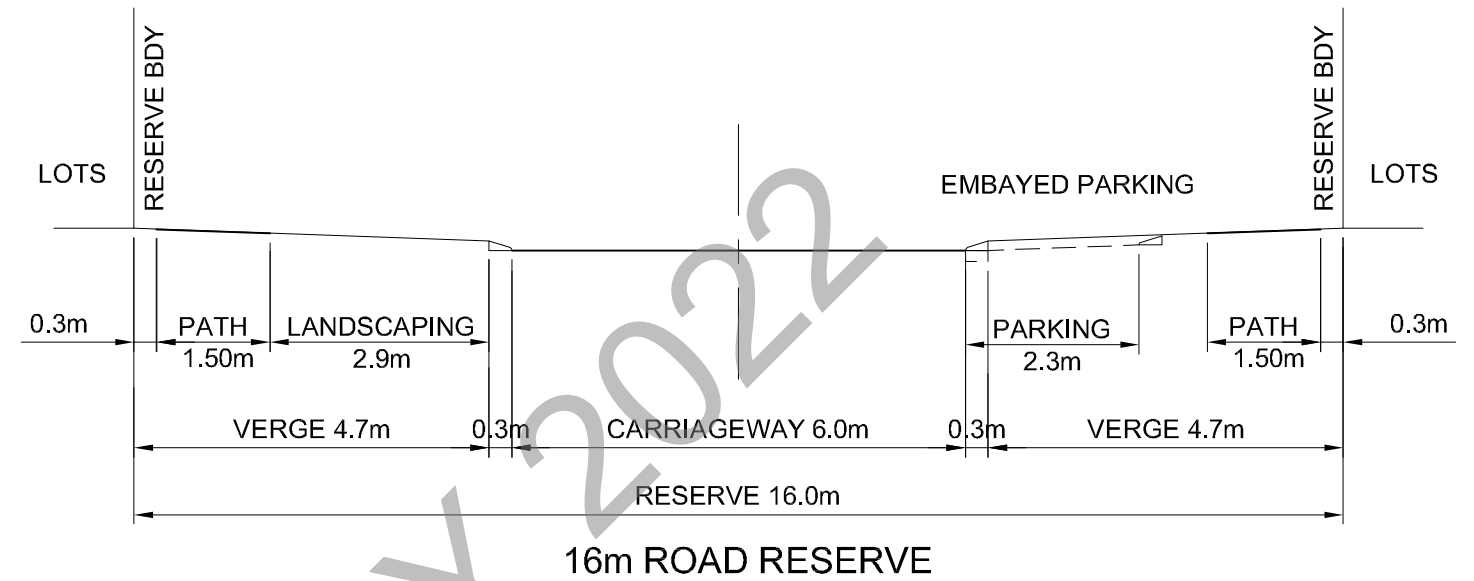
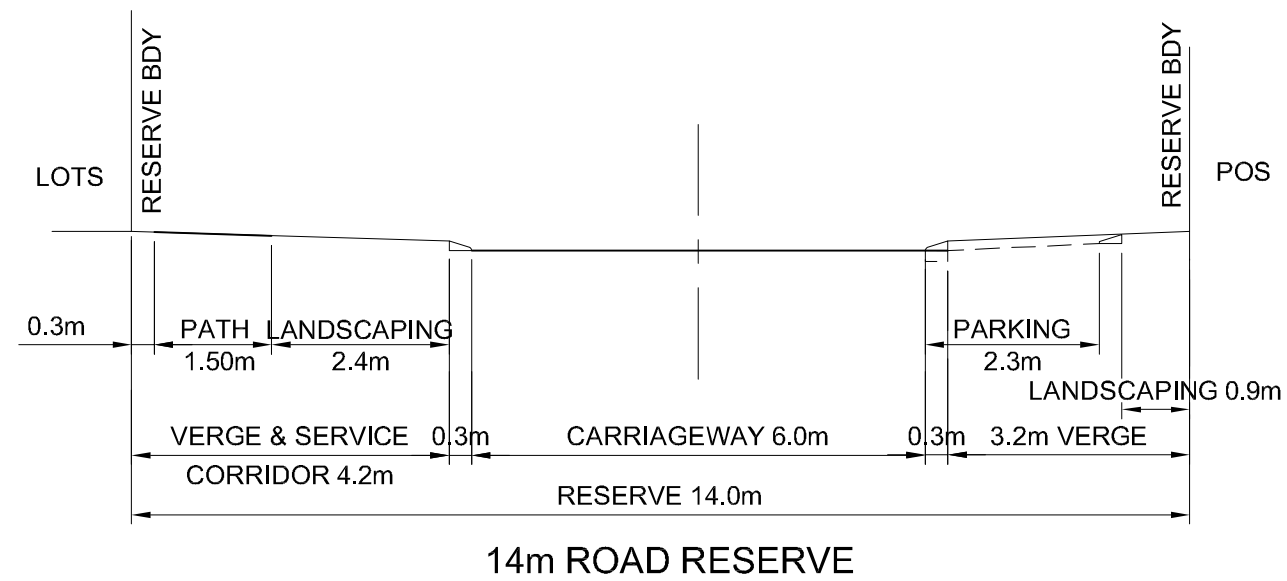




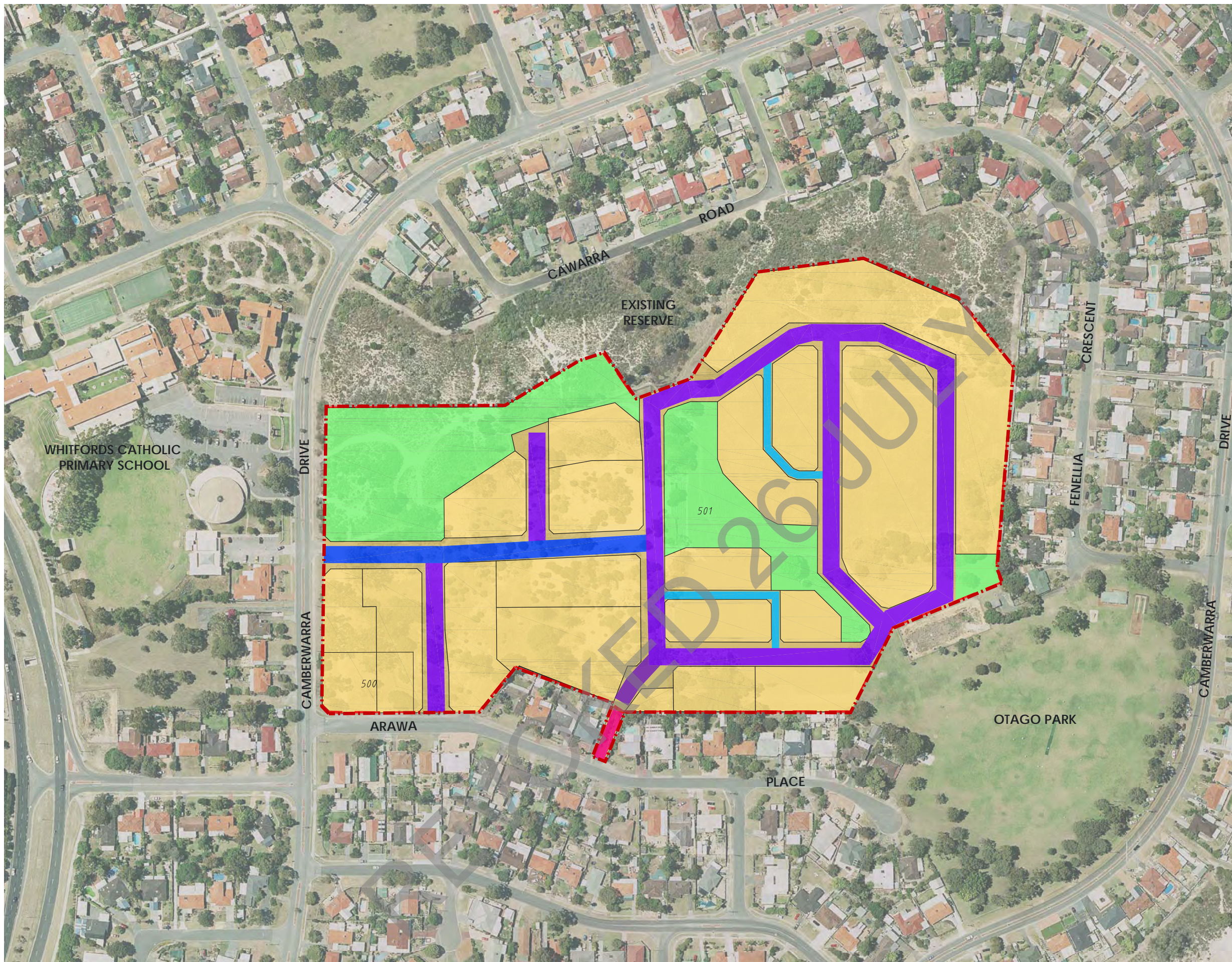
# LEGEND

- 6m RIGHT OF WAY
- 9m PUBLIC ACCESS WAY/RIGHT OF WAY
- 14m ROAD RESERVE
- 15m ROAD RESERVE
- 16m ROAD RESERVE
- 16m ROAD RESERVE (ENTRY ROAD)
- 18m ROAD RESERVE (MEANDERING ROAD)
- PROPOSED RESIDENTIAL ZONING
- PROPOSED POS AREA
- SUBJECT LAND BOUNDARY









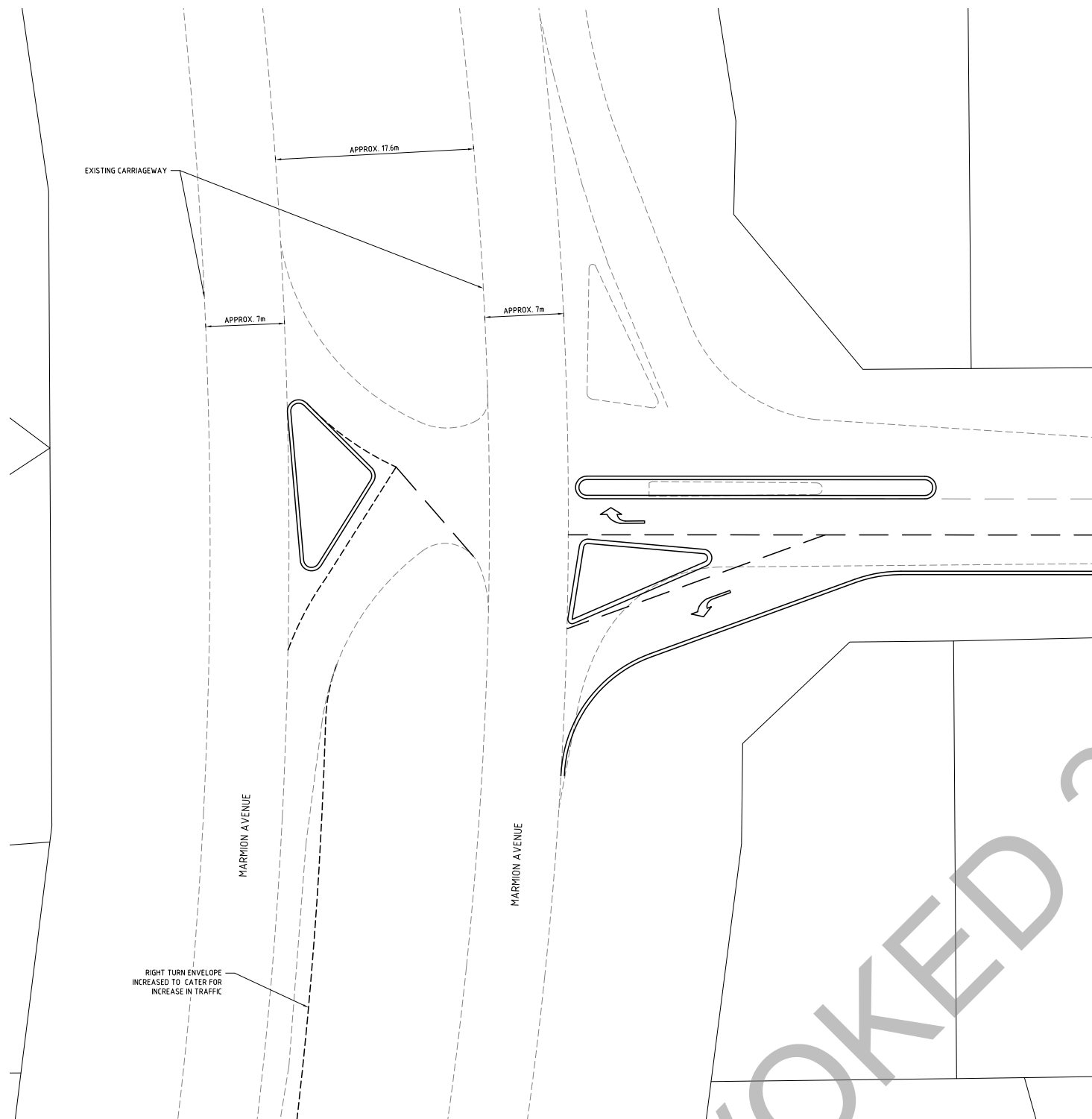
- LEGEND**
- LIVEABLE NEIGHBOURHOODS ACCESS STREET B
  - LIVEABLE NEIGHBOURHOODS ACCESS STREET C
  - PUBLIC ACCESS WAY / RIGHT OF WAY WITH DUAL USE PATH/EMERGENCY ENTRY & EXIT
  - PROPOSED PUBLIC OPEN SPACE/DRAINAGE
  - PROPOSED RESIDENTIAL ZONING
  - SUBJECT LAND BOUNDARY

## ROAD HIERARCHY PLAN

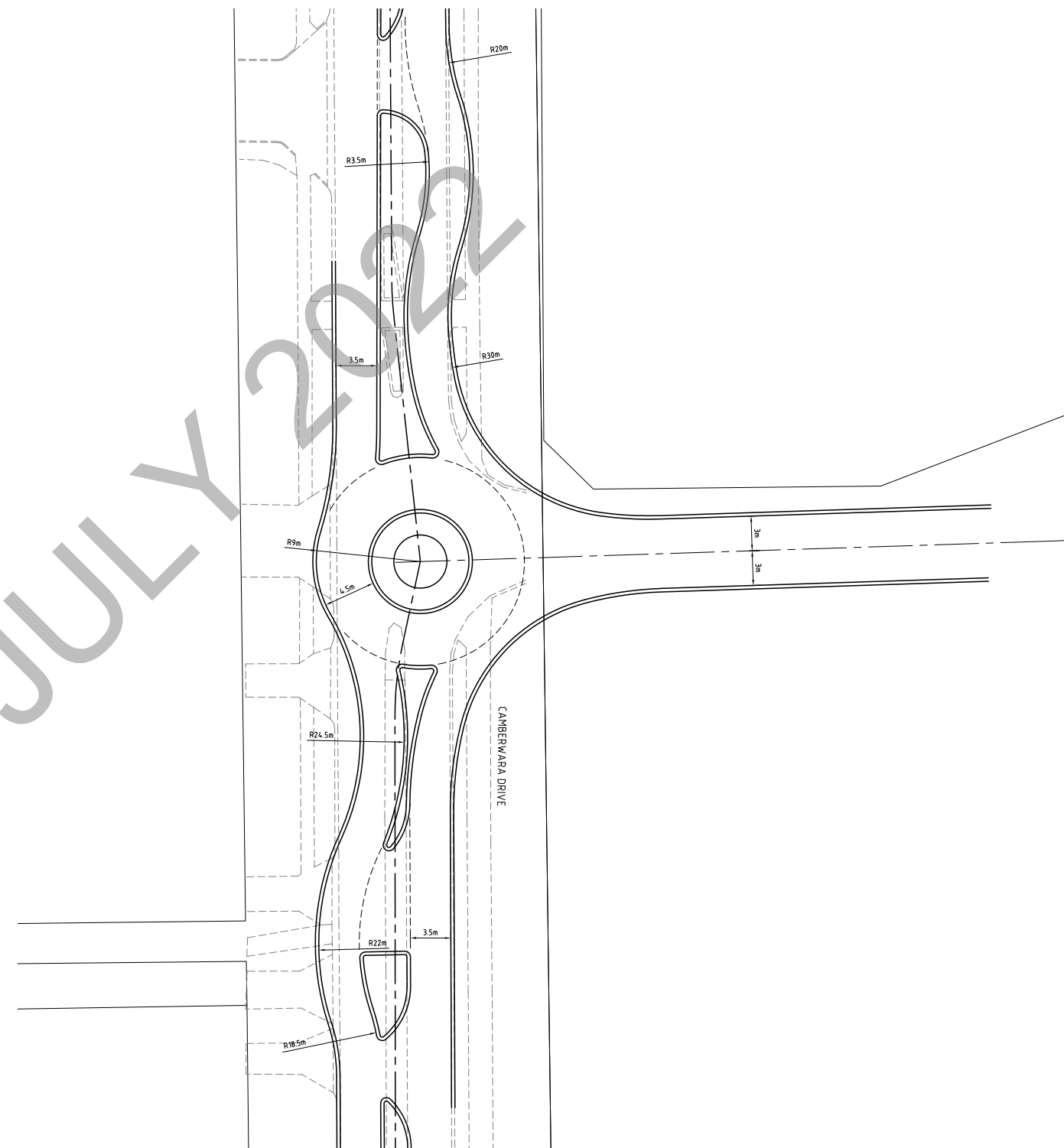
Craigie High School Structure Plan

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 s: 1:2500@A3  
 d: Oct 2011  
 j: 07/088





ALBION / MARMION INTERSECTION

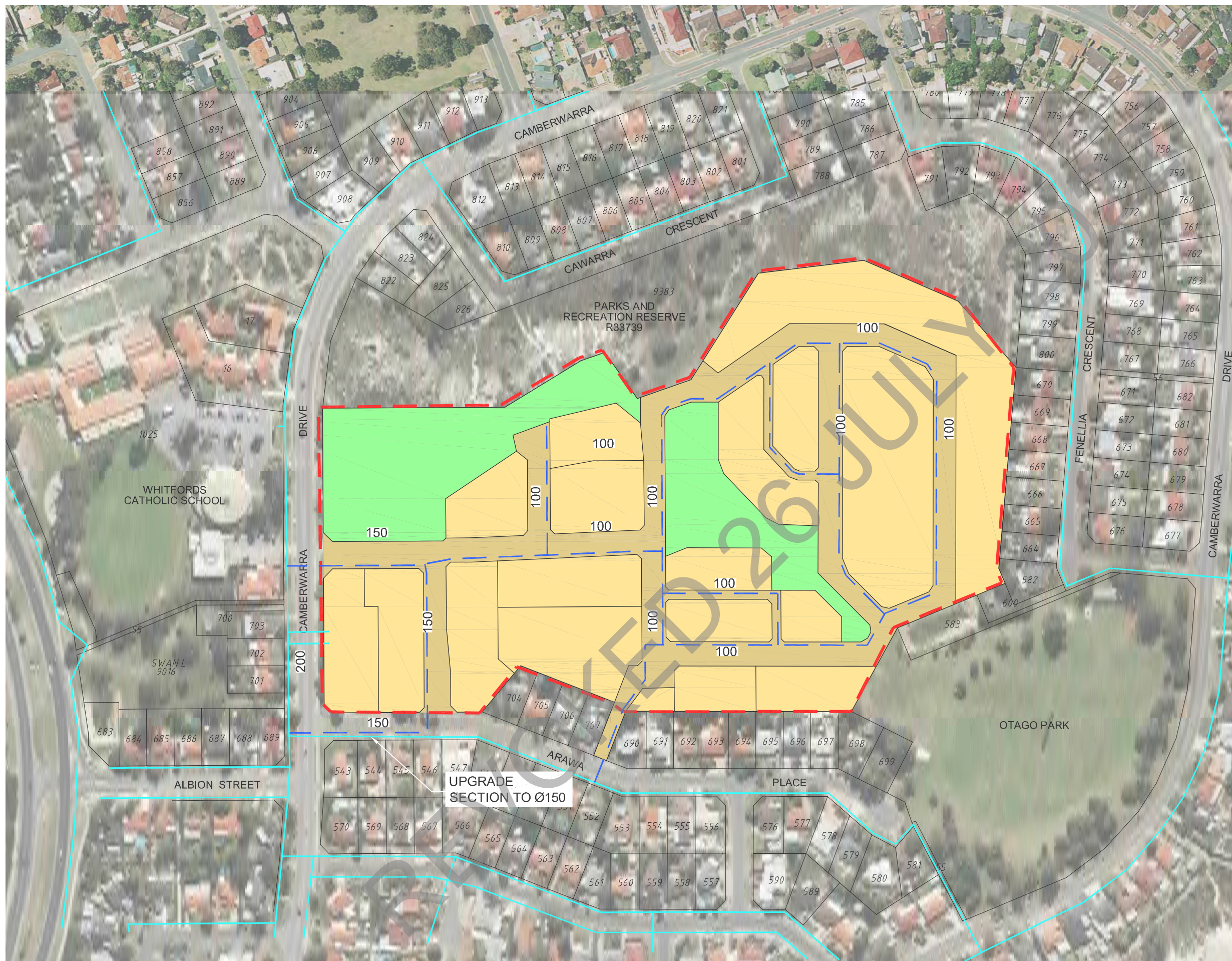


CAMBERWARRA ROUNDABOUT









- LEGEND**
- EXISTING WATER
  - 100 PROPOSED WATER WITH DIAMETER
  - PROPOSED RESIDENTIAL ZONING
  - PROPOSED POS AREA
  - SUBJECT LAND BOUNDARY

## PROPOSED WATER SERVICE

Craigie High School Structure Plan

0m 20 40m  
 s: 1:2500@A3  
 d: Oct 2011  
 j: 07/088





**LEGEND**

- EXISTING GAS NETWORK
- PROPOSED GAS NETWORK
- - - SUBJECT LAND BOUNDARY

**PROPOSED GAS CONNECTION**  
 Craigie High School Structure Plan

0m 20 40m  
 s: 1:2500@A3  
 d: Oct 2011  
 j: 07/088



## **9 IMPLEMENTATION**

### **9.1 ADOPTION OF LOCAL STRUCTURE PLAN**

The Structure Plan should be formally adopted under Clause 9.6.1 of the City of Joondalup District Planning Scheme No. 2. Once adopted, the Structure Plan will provide the basis for guiding subdivision and development within the former Craigie High School Site.

### **9.2 MANAGEMENT PLANS**

To ensure the successful implementation of the project, it is necessary for the works and ongoing project responsibilities to be clearly defined at the outset. The following management plans have been identified as integral to this process.




The following management plans over the Craigie High School Structure Plan area are the responsibility of, and to be provided by the developer.

#### **9.2.1 URBAN WATER MANAGEMENT PLAN**

For the effective management of the stormwater collection, filtration and distribution, an Urban Water Management Plan will be required. The following highlights the issues to be addressed for effective management:




##### **9.2.1.1 WATER COLLECTION**

For effective management of stormwater collection there is a need to:

-  model the volume storage requirements of 1:1, 1:5, 1:10 and 1:100 storm events
-  design basins to accommodate occupational health and safety requirements
-  ensure best practice design principles apply for the drainage infrastructure network.





##### **9.2.1.2 WATER FILTRATION**






For effective management of water quality there is a need to:

-  accommodate City of Joondalup standards for stormwater basins
-  ensure surface treatments are conducive to nutrient stripping and water filtration
-  ensure plant species selection are appropriate for debris collection, erosion control, nutrient stripping and periodic submersion.

#### **9.2.2 DUNE MANAGEMENT PLAN**

For the effective management of the dunes within the subject land, a management plan will be required. The following highlights the issues to be addressed:

-  Weed control.
-  Revegetation of the remnant vegetation.
-  Management of native fauna, specifically the Graceful Sun Moth.
-  Management of feral fauna.

-  Access and infrastructure to minimise dune damage.
-  Educate the public of the importance of the dunes and associated restrictions.
-  Fire management regime (to minimise disturbance of GSM territories during breeding season).
-  Chemical management (pesticides, herbicides and fertilisers).
-  Investigate methods to rehabilitate and improve GSM habitat, including options to increase numbers of food plants.

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#### 9.2.3 TRAFFIC MANAGEMENT PLAN

The Traffic Report (refer **Appendix 4**) is appended for Council's consideration.

### 9.3 STAGING/SUBDIVISION

The proposed Structure Plan is to be approved by early to mid 2011. Accordingly, subdivision of the subject land is expected to commence thereafter, with the subject site to be developed as a staged practical completion of works.

### 9.4 DESIGN GUIDELINES

The Structure Plan establishes the framework and themes for development within the former Craigie High School site. These are applied through Part One, **Section 4 - Development**. In addition to the built form requirements, specific development controls and design guidance may be implemented at a later date at the developer's discretion.



WESTERN



AUSTRALIA

REGISTER NUMBER <b>500/DP60150</b>	
DUPLICATE EDITION <b>N/A</b>	DATE DUPLICATE ISSUED <b>N/A</b>

VOLUME  
**LR3154**

FOLIO  
**14**

**RECORD OF CERTIFICATE  
OF  
CROWN LAND TITLE**

UNDER THE TRANSFER OF LAND ACT 1893  
AND THE LAND ADMINISTRATION ACT 1997

**NO DUPLICATE CREATED**

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

*B. Roberts*  
REGISTRAR OF TITLES



**LAND DESCRIPTION:**

LOT 500 ON DEPOSITED PLAN 60150

**STATUS ORDER AND PRIMARY INTEREST HOLDER:  
(FIRST SCHEDULE)**

**STATUS ORDER/INTEREST:** RESERVE WITHOUT MANAGEMENT ORDER

**PRIMARY INTEREST HOLDER:** STATE OF WESTERN AUSTRALIA

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:  
(SECOND SCHEDULE)**

1. L143685 PART RESERVE 35310 FOR THE PURPOSE OF HIGH SCHOOL SITE REGISTERED  
18.11.2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.  
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

**STATEMENTS:**

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: DP60150 [SHEET 1].  
PREVIOUS TITLE: THIS TITLE.  
PROPERTY STREET ADDRESS: 1 ARAWA PL, CRAIGIE.  
LOCAL GOVERNMENT AREA: CITY OF JOONDALUP.  
RESPONSIBLE AGENCY: DEPARTMENT OF EDUCATION.

NOTE 1: L143685 CORRESPONDENCE FILE 01572-1978-02RO.

WESTERN



AUSTRALIA

REGISTER NUMBER <b>501/DP60150</b>	
DUPLICATE EDITION <b>N/A</b>	DATE DUPLICATE ISSUED <b>N/A</b>

RECORD OF CERTIFICATE  
OF  
CROWN LAND TITLE

UNDER THE TRANSFER OF LAND ACT 1893  
AND THE LAND ADMINISTRATION ACT 1997

VOLUME  
**LR3154**

FOLIO  
**15**

**NO DUPLICATE CREATED**

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

*B. Roberts*  
REGISTRAR OF TITLES



**LAND DESCRIPTION:**

LOT 501 ON DEPOSITED PLAN 60150

**STATUS ORDER AND PRIMARY INTEREST HOLDER:**  
(FIRST SCHEDULE)

**STATUS ORDER/INTEREST:** RESERVE WITHOUT MANAGEMENT ORDER

**PRIMARY INTEREST HOLDER:** STATE OF WESTERN AUSTRALIA

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:**  
(SECOND SCHEDULE)

1. L143685 PART RESERVE 35310 FOR THE PURPOSE OF HIGH SCHOOL SITE REGISTERED  
18.11.2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.  
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

**STATEMENTS:**

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: DP60150 [SHEET 1].  
PREVIOUS TITLE: THIS TITLE.  
PROPERTY STREET ADDRESS: 7 ARAWA PL, CRAIGIE.  
LOCAL GOVERNMENT AREA: CITY OF JOONDALUP.  
RESPONSIBLE AGENCY: DEPARTMENT OF EDUCATION.

NOTE 1: K589665 CORRESPONDENCE FILE 01572-1978-02RO



LOTS 500 & 501 CAMBERWARRA DRIVE  
CRAIGIE

WESTERN AUSTRALIA

GEOTECHNICAL INVESTIGATION

DECEMBER 2009  
Ref: J09060

FOR  
EMERSON STEWART



Brown Geotechnical & Environmental Pty Ltd  
Suite 4, 47 Monash Avenue  
Como WA 6152  
Tel (08) 9368 2615

## CONDITIONS RELATING TO THIS REPORT

1. This report has been prepared for the sole use of Emerson Stewart. It has been issued in accordance with the agreed terms and scope detailed in the proposal for the investigation. No responsibility or liability to any third party is accepted for any damages arising out of the use of this report.
2. This report has been prepared by suitably qualified and experienced personnel for the purposes stated herein. Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussion of findings and recommendations given. No responsibility for the consequences of extrapolation by others is accepted by the company.
3. Findings and conclusions produced in the report are based on the investigation of the sub-surface through isolated locations. Conditions between investigated sites are based on extrapolation, interpretation and professional estimates. Unexpected variations in ground conditions often occur which cannot always be anticipated. The conclusions and recommendations in the report were considered accurate at the time of issue and based on certain assumptions at the time. Conditions and assumptions change with time and may affect the accuracy of the report.
4. Certain content within this report is based on information provided by the client and/or other parties and the accuracy of this information cannot be guaranteed.
5. These conditions must be read as part of the report and must be reproduced with all future copies.
6. The recommendations of this report should be considered a starting point. Recommendations should be continuously reviewed during the earthworks stage as sub-surface information and results from monitoring become available. It is strongly recommended that the Company be retained to provide consultancy and/or inspections during the earthwork stages.



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## **1 Introduction**

It is proposed to develop Lots 500 & 501 Camberwarra Drive, Craigie (the site) for residential use. This report presents the results of the geotechnical investigation for the development.

Brown Geotechnical & Environmental were retained to undertake the investigation. The terms of reference for the investigation were outlined in Brown Geotechnical and Environmental's proposal dated 12 June 2008. Instructions to proceed with the investigation were received from the client – Emerson Stewart on 25 September 2009.

Details of the proposed development and pre-cal plans were supplied by Emerson Stewart.

## **2 Objectives**

The objectives of this investigation were as follows:

- To determine the subsurface conditions.
- To determine the presence of uncontrolled fill.
- To determine the site classification in accordance with AS 2870-1996 [1].
- To recommend earthwork requirements to obtain a site classification suitable for development.
- To assess the suitability of soil as engineering fill.
- To recommend CBR for road pavement design.
- To recommend retaining wall parameters
- To address site permeability and drainage issues.
- To analyse the slope stability of adjacent sand dunes.

## **3 Site Details**

The site is located at Lots 500 & 501 Camberwarra Drive, Craigie (refer Figure 1). The general area can be characterised as low density residential properties being replaced by new high density residential development.

The site area is approximately 10ha and survey data shows the ground level at approximately 54m to 30m AHD NW to SE.

The area under investigation was grass covered, with some mature trees and occasional vacant buildings. The northern portion of the site comprised grass covered sand dunes. The site is bounded by Camberwarra Drive to the west, Fenellia Crescent to the east and residential houses to the north and south.

## **4 Geology and Environmental Studies**

The Environmental Geology sheet [2] for the area shows the site to be underlain by the Safety Bay Sand.

The Perth Groundwater Atlas [3] shows the maximum historical groundwater level to be approximately 2m AHD.

## **5 Fieldwork and Laboratory Testing**

### **5.1 Investigation Fieldwork**

The fieldwork was carried out in October 2009. Thirty five test pits were excavated to a maximum depth of 2.5m using a 5 tonne excavator. Perth Sand Penetrometer (PSP) tests were carried out adjacent to each test pit to determine the relative density of the soil. Soil samples were obtained for geotechnical laboratory testing and field descriptions.

Eight Cone Penetration Test (CPT) were carried out on the natural sand dunes at critical slope sections in the northern part of the site as directed by Emerson Stewart (refer Figure 2).

Test locations are shown on Figure 2, with test pit logs enclosed in Appendix A, PSP plots in Appendix B and CPT result in Appendix C.

### **5.2 Laboratory Testing**

Soil samples were delivered to NATA accredited SGS Australia laboratories for the following geotechnical test: percent fines, particle size distributions determinations and standard compactions tests. The laboratory test certificates are presented in Appendix D.

## **6 Results**

### **6.1 Geology and Groundwater**

Subsurface conditions encountered in the test pits and inferred from PSP tests and laboratory testing results are described as follows:

#### **6.1.1 Topsoil**

Fine to medium grained, brown sandy topsoil with rootlets was encountered over the majority of the site from 0.1m to 0.2m depth.

#### **6.1.2 Sand**

Fine to medium grained light brown and light grey sand was encountered below the surface layer and extended to the base of all excavations. TP01, 02, 13, 24, 25, and 34 contained occasional of tree roots. Occasional of cobbles and boulders were observed in TP03, 04, 05, 10, 16, 17, 18, and 28 from approximately 0.5m to 1.5m depth.

The relative density of the sand was generally medium dense and dense to very dense.



## 6.2 Groundwater

No groundwater was encountered during the investigation.

## 6.3 Laboratory Test Results

Laboratory test results are summarised in Table 1.

**Table 1 - Laboratory Test Results**

Test Pit No.	Depth (m)	Particle Size Distribution				OMC (%)	MMD (t/m <sup>2</sup> )	USC
		Fines (%)	Sand					
			Fines (%)	Medium (%)	Course (%)			
TP01	0.5 – 0.8	1	27	71	1	-	-	SP
TP05	0.5 – 1.0	-	-	-	-	22	1.52	SP
TP10	0.8 – 1.0	5	21	68	6	-	-	SP
TP13	0.5 – 0.8	1	25	73	1	-	-	SP
TP14	0.5 – 1.0	-	-	-	-	22	1.53	SP
TP19	1.0 – 1.2	1	15	81	3	-	-	SP
TP21	0.7 – 1.2	-	-	-	-	20	1.54	SP
TP23	0.8 – 1.0	1	23	76	0	-	-	SP
TP29	0.5 – 1.0	5	9	72	14	-	-	SP
TP31	0.5 – 1.0	-	-	-	-	18	1.57	SP
TP35	0.6 – 1.0	5	9	67	19	-	-	SP

The sand is poorly graded with a low fines content.

#### 6.4 CPT Results

CPT results and correlation are summarised in Table 2

**Table 2 - CPT Results**

CPT No.	Depth (m)	q <sub>c</sub> <sub>avg</sub> (Mpa)	Density	Angle of Internal Friction φ (degrees)	USC
CPT01	0.0 – 2.0	12	Dense	40	SP
	2.0 – 6.0	14	Dense	40	
CPT02	0.0 – 2.0	5	Medium dense	30	SP
	2.0 – 9.0	11	Dense	35	
	9.0 – 12.0	15	Dense	40	
CPT03	0.0 – 5.0	10	Medium Dense	35	SP
	5.0 – 15.0	15	Dense	40	
CPT04	0.0 – 2.0	10	Medium Dense	35	SP
	2.0 – 5.5	15	Dense	40	
CPT05	0.0 – 5.0	7	Medium Dense	30	SP
	5.0 – 10.5	12	Dense	40	
CPT06	0.0 – 3.0	8	Medium Dense	30	SP
	3.0 – 15.0	15	Dense	40	
CPT07	0.0 – 5.0	6	Medium Dense	30	SP
	5.0 – 5.2	15	Dense	40	
CPT08	0.0 – 5.0	7	Medium Dense	30	SP
	5.0 – 6.0	12	Dense	40	



## 7 Analysis and Conclusions

### 7.1 Subsurface Conditions

A thin layer of topsoil covers the majority of the site.

The topsoil is underlain by medium grained light grey and light brown sand. The sand extends to at least 2.5m and represents the Safety Bay Sands Formation as indicated on the geological maps. Occasional roots were encountered to a depth of 1.0m. The relative density of the sand was generally medium dense or dense to very dense.

Occasional cobbles and boulders were encountered intermittently below 0.5m to 1.5m depth locally across the site. An old soak well was encountered in TP14 below 0.5m depth.

### 7.2 Groundwater

No groundwater was encountered during the investigation. The Perth Groundwater Atlas indicates the maximum historical groundwater level to be approximately 2m AHD, approximately 30m below existing ground level.

### 7.3 Site Classification

The site classification in accordance with AS 2870 – 1996 [1] will be Class ‘A’ (refer Table 3), subject to requirements stated in Section 7.4.

**Table 3 – Definition of Site Classifications (Australian Standard AS2870-1996)**

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement for moisture changes ( $y_s < 20\text{mm}$ ).
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes ( $y_s$ 20-40mm).
H	Highly reactive clay site, which can experience high ground movement from moisture changes ( $y_s$ 40-70mm)
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes ( $y_s > 70\text{mm}$ )
A to P	Filled sites
P	Sites which include: soft soils, such as soft clays or silts or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

$y_s$ : Characteristic Surface Movement

## **7.4 Site Remediation Measures**

All earthworks should be undertaken in accordance with AS3798-1996 [4].

### **7.4.1 Topsoil and Fill Management**

Topsoil is not suitable for foundation support. The material should be screened to remove root material and stockpiled for later re-use in landscaping. Roots identified in the top 1m of the in-situ sand should be removed. All permanent building, foundation, soakwells should also be removed.

A geotechnical inspection will be required at this stage to confirm the removal of topsoil, roots, uncontrolled fill, buildings and associated foundations not to be retained, and to confirm subsurface conditions identified in the test pits are consistent across the site.

### **7.4.2 Proof Rolling and Site Compaction**

The sub-surface should then be proof rolled to achieve at least 95% SMDD. This approximates to at least 8 blows per 300mm using a Perth Sand Penetrometer (PSP) to a depth of 750mm. Moisture conditioning (wetting) of the sand may to be required to optimise compaction. The material should be prepared so that moisture content is within  $\pm 2\%$  of optimum. Compaction parameters are shown in Table 1.

### **7.4.3 Imported Fill Material**

The screened fill sand and any additional sand fill imported to obtain site formation levels should be compacted in layers not more than 300mm thick to at least 95% SMDD. This approximates to at least 8 blows per 300mm using a PSP in the depth range 150mm to 450mm below the compacted layer surface. If the required blow counts can not be achieved, in-situ density tests should be carried out to calibrate the PSP to specific densities of the compacted material. Moisture conditioning (wetting) of the sand may to be required to optimise compaction.

Following excavation for foundations, the bases of strip footings should also be compacted to achieve at least 95% SMDD.

### **7.4.4 Earthwork Inspections**

It is recommended that a geotechnical engineer inspects the site after the removal of topsoil, roots, uncontrolled fill, buildings and associated foundations not to be retained, and to confirm the compaction of subsurface sands following proof rolling. Inspections and auditing of the earthworks should be carried out by a geotechnical consultant to enable confirmation of the final site classification.



### 7.5 Suitability of Soils as Engineering Fill

The in-situ sand is medium grained, with low non-plastic fines content. The material will be suitable for use as engineering fill.

### 7.6 CBR for Road Pavement Design

The in-situ sands encountered on site have been identified as the Safety Bay Sands Formation. A minimum design CBR of 18% should be used when compacted to a minimum of 96% MMDD at optimum moisture content [5].

### 7.7 Retaining Wall Parameters

The following parameters may be used for retaining wall design – Table 4.

**Table 4 – Retaining Wall Parameters**

Design Parameter	Value
$\gamma$	18 kN/m <sup>3</sup>
$\phi'$	36°
$K_o$	0.41

The parameters detailed in the table above assume design of the retaining structure and compaction of the foundations is in accordance with AS 4678-2002 [6] and that backfill material is composed of clean cohesionless sand.

### 7.8 Site Drainage Recommendations

No groundwater was encountered during the investigation. The Perth Groundwater Atlas shows the maximum historical groundwater level to be approximately 2m AHD, approximately 30m below existing ground level.

Shallow soakwells will be suitable for the disposal of storm water. A permeability of  $1 \times 10^{-4}$  m/s would be appropriate for soakwell design within the in-situ sand and any imported clean sand fill.

### 7.9 Slope Stability

Four critical sections in northern part of the site were assessed for slope stability analysis using Morgenstern-Price method in SlopeW software. Critical section profiles were produced from the feature survey supplied by the client. Soil parameters were obtained from CPT correlation (refer Table 2). Critical failure surfaces are shown on sections enclosed in Appendix E. 1.5 was taken as the minimum safety factor for the stability analysis.

Current plans indicate proposed developments close to the crest in the northern dune area. Analysis at sections C-C' and D-D' were therefore carried out both with and without loading at the crest of the dune profile. It has been assumed that one or two storey residential structures with Class 'A' footing may be placed close to the crest in these locations. 250kPa was taken as the maximum load for one to two storey Class 'A' structures.

Results have shown all sections have a safety factor greater than 1.5 where no loading is present at the crest of the dune (refer to Table 5). The natural slopes in these areas are therefore in a stable condition.

A load of 250kPa was then placed at the immediate crest of the dunes at sections C-C' and D-D'. The safety factor for section C-C' was 1.3 with loading at the crest of the slope i.e. unstable; and 1.6 with loading 10m from the crest indicating marginal stability.

Stability at section D-D' was acceptable at 2.6.

It is therefore recommended that building envelope should be at least 10 meters from the crest in the vicinity of section C-C'.

In the event that cut to fill work is to be carried out on the slope, further investigation and slope stability analysis will be required.

**Table 5 – Slope Safety Factor**

Section	Crest Load (kPa)	Safety Factor
A – A'	n/a	1.959
B – B'	n/a	1.944
C – C'	250	1.320
C – C'	250 (10m from crest)	1.603
D – D'	2.568	2.568

**BROWN GEOTECHNICAL & ENVIRONMENTAL**

**Ferry Haryono**  
Geotechnical Engineer

**Reviewed by**  
**Ken Brown**  
Senior Geotechnical Engineer

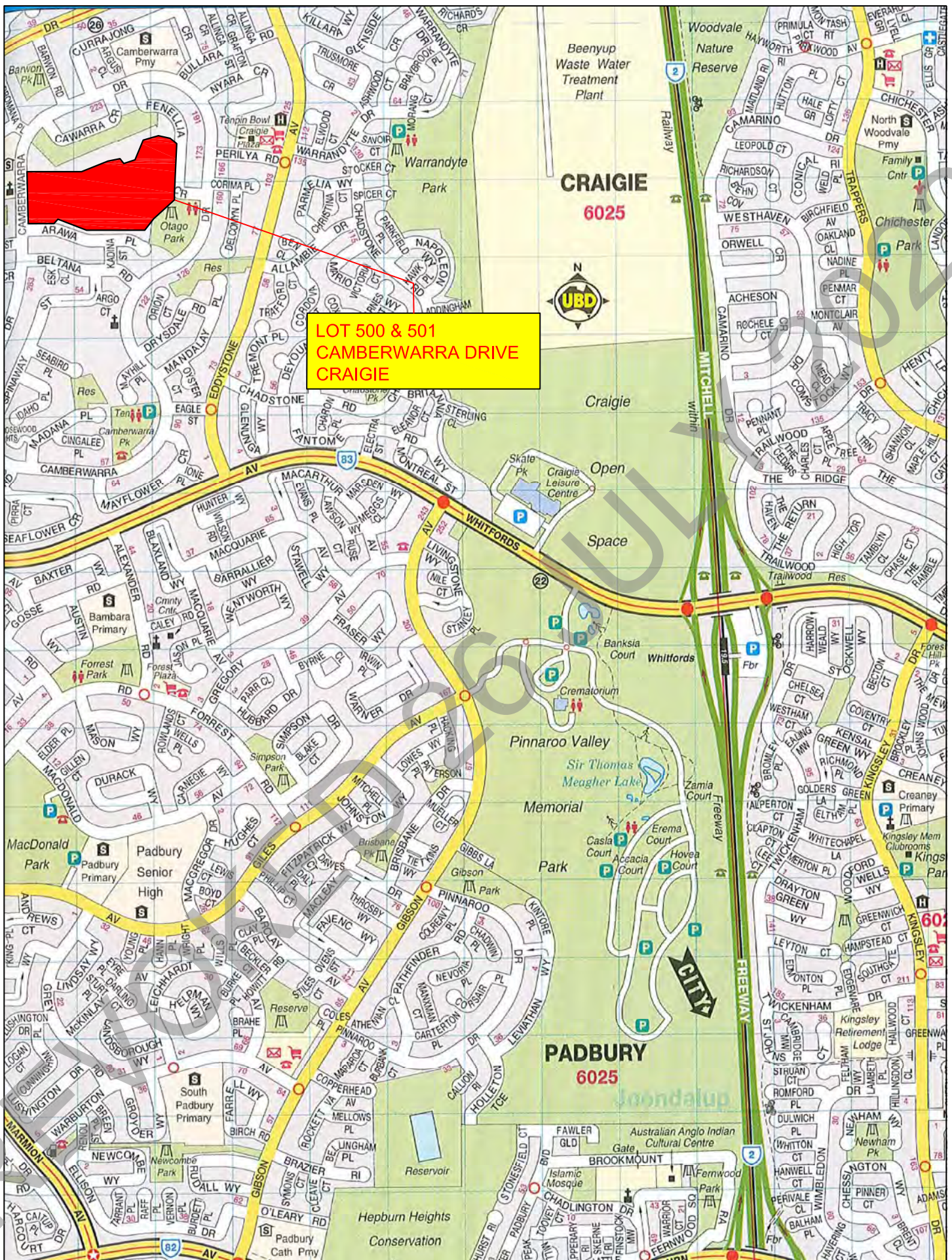


## REFERENCES

- [1] Standards Australia AS 2870 (1996). Residential Slabs and Footings – Construction.
- [2] Geological Survey of Western Australia. 1:50,000 Environmental Geology Series, Perth.
- [3] Perth Groundwater Atlas, Department of Water: [www.environment.wa.gov.au](http://www.environment.wa.gov.au).
- [4] Standards Australia AS 3798-1996. Guidelines on earthworks for commercial and residential developments.
- [5] Main Roads Western Australia (April 2004); Engineering Road Note No 9. Procedure for Thickness Design of Flexible Pavements.
- [6] Earth Retaining Structures. Standards Australia AS 4678-2002.

## FIGURES





**LOT 500 & 501  
CAMBERWARRA DRIVE  
CRAIGIE**

**Brown Geotechnical  
& Environmental**

Suite 4 47 Monash Avenue  
Como WA 6152  
Tel : (08) 93682615  
Email: bge@acidss.com.au

Date	Description	Drawn	Checked	Approved
12.10.09	Site Location Plan	FH	KB	

LOCATION PLAN

CLIENT

Drawing No. 09060.01

Scale: NTS

LOTS 500 & 501 CAMBERWARRA  
DRIVE, CRAIGIE

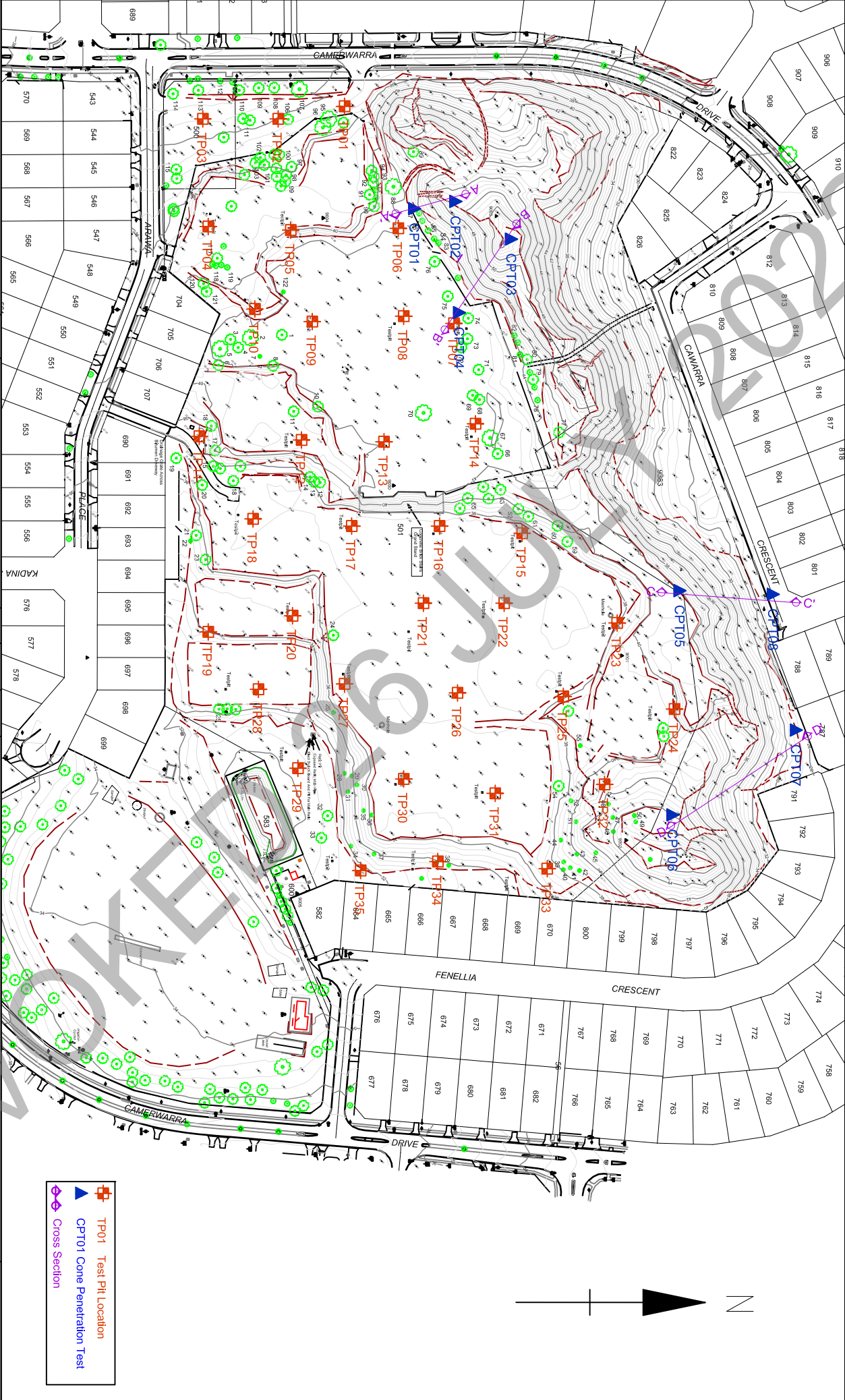
EMERSON STEWART

Sheet Size: A4

Job No. 09060

FIGURE 1





<div>Brown Geotechnical &amp; Environmental</div> <div>Suite 4, 47 Monash Avenue Como WA6152 Tel: 08 9368 2615 Email: bge@adacss.com.au</div>					Date	Description	Drawn	Checked	Approved	TEST LOCATION PLAN		CLIENT	Drawing No. 9060.02
					11.09.09	Test Location Plan	FH	KB					Scale: NTS
										CAMBERWARRA DRIVE CRAIGIE	EMERSON STEWART	Sheet Size: A4	
												Job No. J9060	
												FIGURE 2	



## APPENDIX A

# SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	
		CH			INORGANIC CLAYS OF HIGH PLASTICITY
		OH			ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
	HIGHLY ORGANIC SOILS				


NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 36.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382496E 6482606N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine, brown, with rootlets, sand, trace gravel, dry.		
		36.0	0.5		SP	SAND: Dense, medium, light brown, trace gravel and tree root, dry.		
						collapse from 0.7m.	Fines=1% Sand = 99%	
		35.5	1.0			very dense below 0.9m.		
		35.0	1.5					
		34.5	2.0			brown below 2.0m.		
		34.0	2.5			Borehole TP 01 terminated at 2.5m		
		33.5	3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 36 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382503E 6482569N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine, dark brown, with rootlets, sand, dry.		
						SAND: Dense, medium, light grey, trace tree root, dry.		
		35.5	0.5			collapse from 0.5m.		
		35.0	1.0			very dense below 0.9m.		
						brown below 1.1m.		
		34.5	1.5					
		34.0	2.0					
		33.5	2.5			Borehole TP 02 terminated at 2.5m		
		33.0	3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 35.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382503E 6482527N  
TEST PIT SIZE 1 x 2.1m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine, dark brown, with rootlets, sand, trace gravel, dry.		
						SAND: Dense, medium, light brown, dry.		
		35.0	0.5					
						brown below 0.7m.		
		34.5	1.0					
						very dense below 1.2m.		
		34.0	1.5					
		33.5	2.0					
						Refusal, boulder below 2.0m.		
						Borehole TP 03 terminated at 2.1m		
		33.0	2.5					
		32.5	3.0					

## NOTES


Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, light brown, with rootlets, sand, dry.		
					SP	SAND: Medium dense, fine, light brown, dry.		
	Not encountered	38.5	0.5			brown, medium, with boulder below 0.7m.		
		38.0	1.0			very dense below 0.9m.		
		37.5	1.5			Refusal boulder below 1.5m.		
						Borehole TP 04 terminated at 1.5m		
		37.0	2.0					
		36.5	2.5					
		36.0	3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 40 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382565E 6482576N  
TEST PIT SIZE 1 x 1.0m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine, with rootlets, sand, dry.		
					SP	SAND: Very dense, medium, light grey, dry.		
		39.5	0.5					
		39.0	1.0					
		38.5	1.5			brown, trace cobbles and boulder below 1.5m.		
		38.0	2.0					
		37.5	2.5			Borehole TP 05 terminated at 2.5m		
		37.0	3.0					

OMC=23%  
MDD=1.52Mg/m<sup>3</sup>

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 42.1 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382564E 6482636N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		42.0			SP	SAND: Dense, medium, light brown, dry.		
			0.5					
		41.5				very dense below 0.6m.		
			1.0			grey below 0.8m		
		41.0				mottled light grey below 1.0m.		
			1.5					
		40.5						
			2.0					
		40.0						
			2.5					
						Borehole TP 06 terminated at 2.5m		
		39.5						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 42.2 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382617E 6482667N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		42.0			SP	SAND: Dense, medium, light brown, dry.		
			0.5			grey below 0.5m		
						trace tree root at 0.6 - 1.2m and very dense below 0.6m.		
		41.5						
			1.0					
		41.0						
			1.5					
		40.5						
			2.0					
		40.0						
			2.5			Borehole TP 07 terminated at 2.5m		
		39.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 42.3 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382613E 6482639N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, light brown, with rootlets, sand, dry.		
					SP	SAND: Medium dense, medium, light brown, dry.		
		42.0						
			0.5					
		41.5						
			1.0					
		41.0				dense below 1.2m.		
			1.5			very dense below 1.5m.		
		40.5						
			2.0					
		40.0						
			2.5			Borehole TP 08 terminated at 2.5m		
		39.5						
			3.0					





CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 40.8 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382609E 6482556N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Very dense, fine to medium, light brown, with silt, dry.		
	Not encountered	40.5						
			0.5					
		40.0				brown, with boulder, refusal below 1.0m		
			1.0				Fines=5% Sand = 95%	
						Borehole TP 10 terminated at 1m		
		39.5						
			1.5					
		39.0						
			2.0					
		38.5						
			2.5					
		38.0						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.7 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382680E 6482525N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, light brown, with rootlets, sand, dry.		
					SP	SAND: Medium dense, fine to medium, light grey mottled light brown, dry.		
		37.5						
			0.5					
		37.0						
			1.0					
		36.5						
			1.5					
		36.0						
			2.0			dense below 1.8m.		
		35.5				white below 2.0m.		
			2.5			Borehole TP 11 terminated at 2.5m		
		35.0						
			3.0					



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# TEST PIT NUMBER TP 12

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CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 40.7 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382682E 6482582N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

## NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
					SP	SAND: Medium dense, medium, light grey, dry, trace tree roots until 0.3m.		
		40.5						
			0.5					
		40.0						
			1.0					
		39.5						
			1.5					
		39.0						
			2.0					
		38.5						
			2.5					
						Borehole TP 12 terminated at 2.5m		
		38.0						
			3.0					

BOREHOLE / TEST PIT 09327 CRAIGIE.GPJ GINT AUSTRALIA.GDT 04/12/09



**CLIENT** Emerson Stewart

**PROJECT NAME**    LOTS 500 & 501

**PROJECT NUMBER** J09060

**PROJECT LOCATION** Camberwarra Drive, Craigie

DATE STARTED 15/10/09

**COMPLETED** 15/10/09

R.L. SURFACE 42.03

**DATUM**      m AHD

**EXCAVATION CONTRACTOR** Universal Digger

**SLOPE** ---

BEARING ---

**EQUIPMENT** 5 tonne excavator

**TEST PIT LOCATION** 382683E

6482628N

**TEST PIT SIZE** 1 x 2.5m

LOGGED BY FH

**CHECKED BY** KB

## NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		42.0			SP	SAND: Dense, medium, light grey, dry.		
						trace tree root at 0.2m.		
						light brown below 0.3m.		
						collapse from 0.4m.		
		41.5	0.5				Fines=1% Sand = 99%	
		41.0	1.0					
		40.5	1.5					
		40.0	2.0					
			2.5			Borehole TP 13 terminated at 2.5m		
		39.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 42.2 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382673E 6482679N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, light brown, with rootlets, sand, dry.		
		42.0			SP	SAND: Dense, medium, light brown, dry.		
			0.5			soakwell found around this area at 0.5m.		
		41.5					OMC=22% MDD=1.53Mg/m <sup>3</sup>	
			1.0					
		41.0						
			1.5					
		40.5						
			2.0					
		40.0						
			2.5			Borehole TP 14 terminated at 2.5m		
		39.5						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382734E 6482705N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Very dense, medium, light brown, dry.		
		37.0	0.5					
		36.5	1.0					
		36.0	1.5					
		35.5	2.0					
		35.0	2.5					
						Borehole TP 15 terminated at 2.5m		
		34.5	3.0					





CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.2 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382730E 6482610N  
TEST PIT SIZE 1 x 2.0m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
					SP	SAND: Very dense, medium, white and grey, dry.		
		37.0						
			0.5			brown, with cobbles		
		36.5						
			1.0					
		36.0						
			1.5					
		35.5						
			2.0			Refusal, boulder below 2.0m.		
						Borehole TP 17 terminated at 2m		
		35.0						
			2.5					
		34.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.1 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382726E 6482555N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		37.0			SP	SAND: Very dense, fine to medium, light grey, dry.		
			0.5			brown, trace gravel and boulder at 0.5 - 0.9m.		
		36.5						
			1.0			light brown below 0.9m.		
		36.0						
			1.5					
		35.5						
			2.0					
		35.0				mottled dark grey below 1.8m.		
			2.5					
		34.5				Borehole TP 18 terminated at 2.5m		
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 34.05 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382789E 6482530N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		34.0			SP	SAND: Very dense, medium, light brown, dry.		
			0.5					
		33.5						
			1.0			dark grey at 0.9 - 1.0m. collapse from 1.0m		
		33.0					Fines=1% Sand = 99%	
			1.5					
		32.5						
			2.0					
		32.0						
			2.5			Borehole TP 19 terminated at 2.5m		
		31.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 34.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382780E 6482577N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
					SP	SAND: Very dense, medium, light grey, dry.		
						light brown below 0.2m.		
						collapse from 0.4m.		
		34.0	0.5					
		33.5	1.0					
		33.0	1.5					
		32.5	2.0					
						dark brown and moist below 2.2m		
		32.0	2.5					
						Borehole TP 20 terminated at 2.5m		
		31.5	3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.2 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382773E 6482650N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB


### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		37.0			SP	SAND: Dense, fine to medium, light grey, dry.		
			0.5					
		36.5						
			1.0			light brown below 1.0m.	OMC=20% MDD=1.54Mg/m <sup>3</sup>	
		36.0						
			1.5			very dense below 1.5m.		
		35.5						
			2.0					
		35.0						
			2.5			Borehole TP 21 terminated at 2.5m		
		34.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382773E 6482695N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Dense, fine to medium, light brown, dry.		
		37.0	0.5					
		36.5	1.0					
						collapse from 1.3m.		
		36.0	1.5					
						mottled dark grey below 1.3m.		
		35.5	2.0					
		35.0	2.5					
						Borehole TP 22 terminated at 2.5m		
		34.5	3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 37.9 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382784E 6482758N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
						SP SAND: Dense, medium, light brown, dry.		
		37.5	0.5			collapse from 0.5m.		
		37.0	1.0				Fines=1% Sand = 99%	
	Not encountered	36.5	1.5					
		36.0	2.0					
		35.5	2.5			Borehole TP 23 terminated at 2.5m		
		35.0	3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 15/10/09 COMPLETED 15/10/09 R.L. SURFACE 39.2 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382832E 6482790N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES


Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		39.0			SP	SAND: Medium dense, medium, light brown, dry.		
						trace tree roots at 0.3m.		
			0.5			collapse from 0.5m.		
						medium dense below 0.6m.		
		38.5						
			1.0					
		38.0						
			1.5					
		37.5						
			2.0					
		37.0						
			2.5			Borehole TP 24 terminated at 2.5m		
		36.5						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 37.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382825E 6482728N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		37.0	0.5		SP	SAND: Very dense, medium, yellowish brown, dry. trace tree roots at 0.3m.  collapse from 0.4m.		
		36.5	1.0					
		36.0	1.5					
		35.5	2.0					
		35.0	2.5			Borehole TP 25 terminated at 2.5m		
		34.5	3.0					



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
# TEST PIT NUMBER TP 26

PAGE 1 OF 1

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 37.3 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382823E 6482669N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

## NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		37.0			SP	SAND: Very dense, medium, yellowish brown, dry.		
			0.5					
		36.5						
			1.0					
	Not encountered	36.0				mottled grey below 1.3m.		
			1.5					
		35.5						
			2.0					
		35.0						
			2.5			Borehole TP 26 terminated at 2.5m		
		34.5						
			3.0					



**CLIENT** Emerson Stewart **PROJECT NAME** LOTS 500 & 501  
**PROJECT NUMBER** J09060 **PROJECT LOCATION** Camberwarra Drive, Craigie

**DATE STARTED** 16/10/09 **COMPLETED** 16/10/09 **R.L. SURFACE** 37 **DATUM** m AHD  
**EXCAVATION CONTRACTOR** Universal Digger **SLOPE** --- **BEARING** ---  
**EQUIPMENT** 5 tonne excavator **TEST PIT LOCATION** 382818E 6482606N  
**TEST PIT SIZE** 1 x 2.5m **LOGGED BY** FH **CHECKED BY** KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Very dense, medium, yellowish brown, dry. collapse from 0.3m.		
		36.5	0.5					
		36.0	1.0					
		35.5	1.5					
						mottled brown below 1.6m.		
		35.0	2.0					
		34.5	2.5					
						Borehole TP 27 terminated at 2.5m		
		34.0	3.0					





CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 30.3 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382865E 6482580N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		30.0						
			0.5		SP	SAND: Dense, fine to medium, grey to dark grey, dry.		
						brown, medium, below 0.5m.		
		29.5					Fines=5% Sand = 95%	
			1.0					
	Not encountered	29.0						
			1.5					
		28.5						
			2.0					
		28.0						
			2.5			Borehole TP 29 terminated at 2.5m		
		27.5						
			3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 36.6 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382871E 6482639N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, grey, with rootlets, sand, dry.		
		36.5			SP	SAND: Dense, fine to medium, yellowish brown, dry.		
						collapse from 0.3m.		
			0.5					
		36.0						
			1.0			very dense below 0.9m.		
		35.5						
			1.5					
		35.0						
			2.0					
		34.5						
			2.5			Borehole TP 30 terminated at 2.5m		
		34.0						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 36.8 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382879E 6482690N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB


### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
		36.5	0.5		SP	SAND: Dense, fine to medium, yellowish brown, dry.		
		36.0	1.0				OMC=18% MDD=1.57Mg/m <sup>3</sup>	
	Not encountered	35.5	1.5					
		35.0	2.0					
		34.5	2.5			Borehole TP 31 terminated at 2.5m		
		34.0						
		3.0						

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 41 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382874E 6482751N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						<p>TOPSOIL: Fine to medium, grey, with rootlets, sand, dry.</p> <p>SP SAND: Dense, fine to medium, yellowish brown, dry.</p> <p>collapse from surface.</p> <p>very dense below 0.6m.</p>		
	Not encountered	40.5	0.5					
		40.0	1.0					
		39.5	1.5					
		39.0	2.0					
		38.5	2.5			Borehole TP 32 terminated at 2.5m		
		38.0	3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 37.5 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382921E 6482719N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
						SP SAND: Dense, fine to medium, grey, dry.		
		37.0	0.5			collapse from 0.5m.		
		36.5	1.0			light brown below 1.1m.		
		36.0	1.5			brown below 1.8m.		
		35.5	2.0					
		35.0	2.5			Borehole TP 33 terminated at 2.5m		
		34.5	3.0					

CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 34.1 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382917E 6482658N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		34.0				TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Medium dense, fine to medium, light grey, trace with roots, dry.		
			0.5			dark grey below 0.4m.		
		33.5						
			1.0			brown below 0.8m.		
		33.0						
	Not encountered		1.5					
		32.5						
			2.0					
		32.0						
			2.5					
						Borehole TP 34 terminated at 2.5m		
		31.5						
			3.0					



CLIENT Emerson Stewart PROJECT NAME LOTS 500 & 501  
PROJECT NUMBER J09060 PROJECT LOCATION Camberwarra Drive, Craigie

DATE STARTED 16/10/09 COMPLETED 16/10/09 R.L. SURFACE 31.65 DATUM m AHD  
EXCAVATION CONTRACTOR Universal Digger SLOPE --- BEARING ---  
EQUIPMENT 5 tonne excavator TEST PIT LOCATION 382922E 6482615N  
TEST PIT SIZE 1 x 2.5m LOGGED BY FH CHECKED BY KB

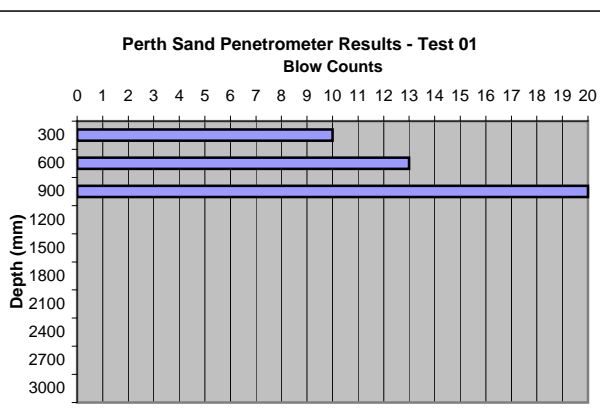
### NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		31.5				TOPSOIL: Fine to medium, dark grey, with rootlets, sand, dry.		
					SP	SAND: Medium dense, fine to medium, grey, dry.		
		31.0	0.5			brown below 0.6m.		
							Fines=5% Sand = 95%	
		30.5	1.0					
		30.0	1.5					
		29.5	2.0					
		29.0	2.5			Borehole TP 35 terminated at 2.5m		
		29.0						
		3.0						

## APPENDIX B

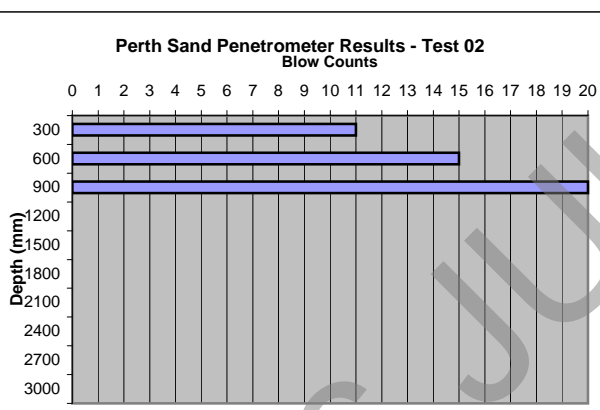


Depth (mm)	Blow Counts
300	10
600	13
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



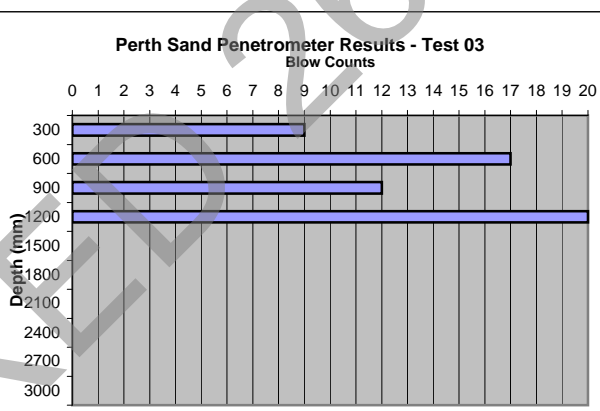
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP01

Depth (mm)	Blow Counts
300	11
600	15
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



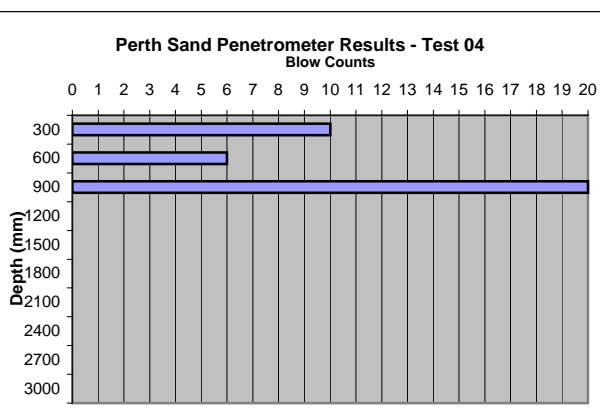
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP02

Depth (mm)	Blow Counts
300	9
600	17
900	12
1200	20
1500	
1800	
2100	
2400	
2700	
3000	



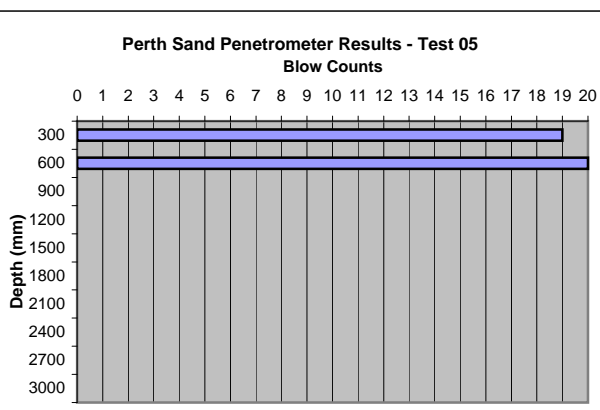
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP03

Depth (mm)	Blow Counts
300	10
600	6
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



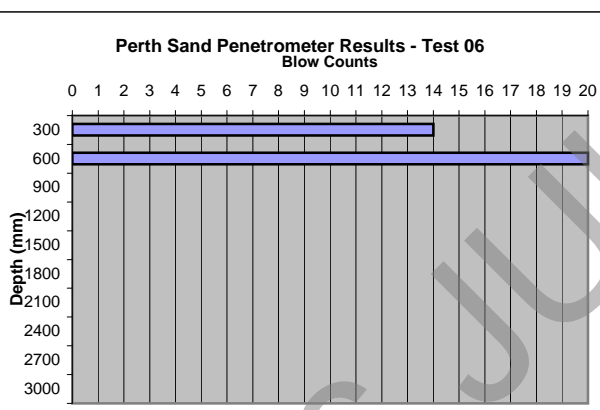
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP04

Depth (mm)	Blow Counts
300	19
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



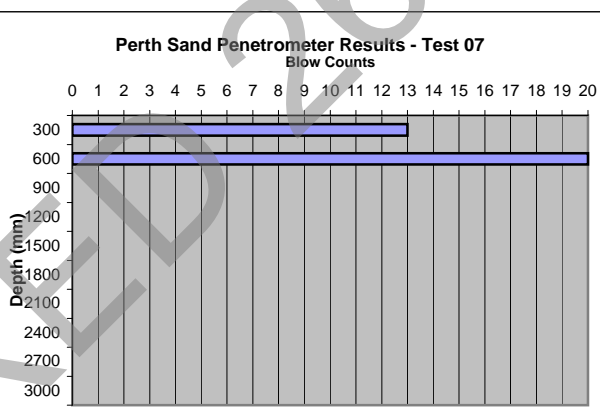
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP05

Depth (mm)	Blow Counts
300	14
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



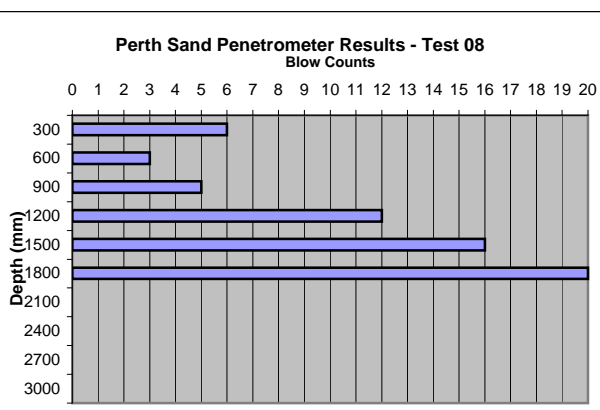
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP06

Depth (mm)	Blow Counts
300	13
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP07

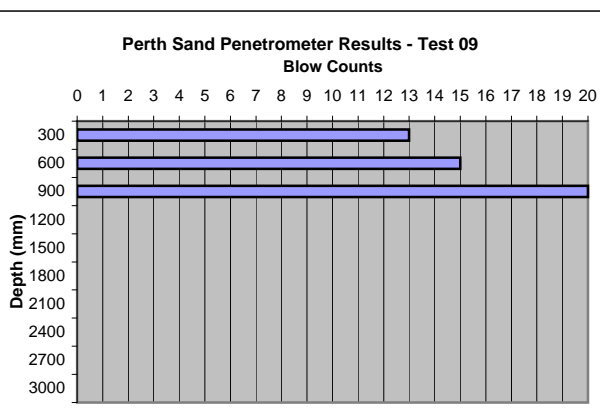
Depth (mm)	Blow Counts
300	6
600	3
900	5
1200	12
1500	16
1800	20
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP08

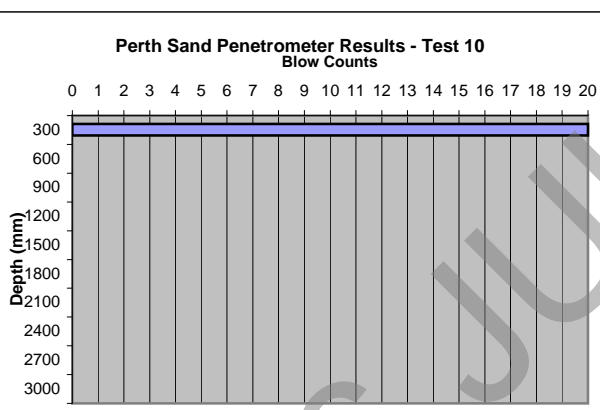


Depth (mm)	Blow Counts
300	13
600	15
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



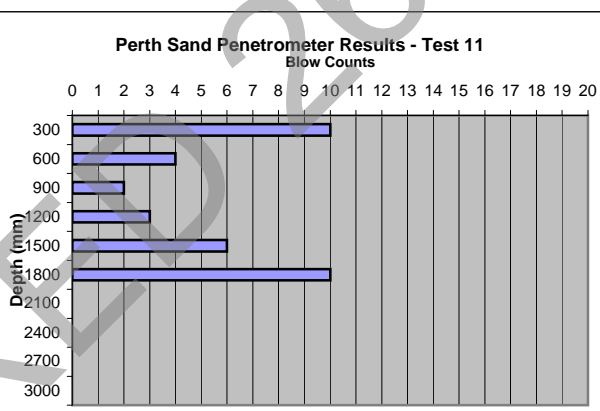
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP09

Depth (mm)	Blow Counts
300	20
600	
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



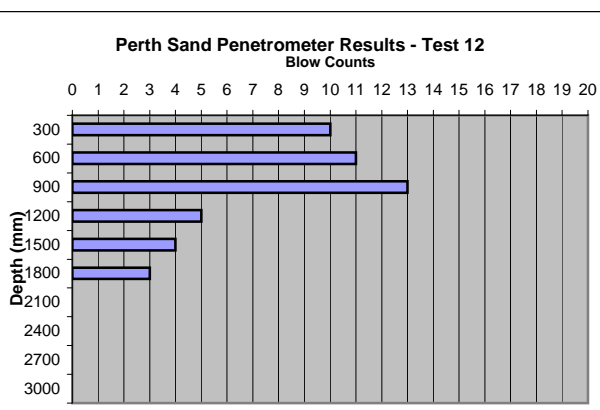
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP10

Depth (mm)	Blow Counts
300	10
600	4
900	2
1200	3
1500	6
1800	10
2100	
2400	
2700	
3000	



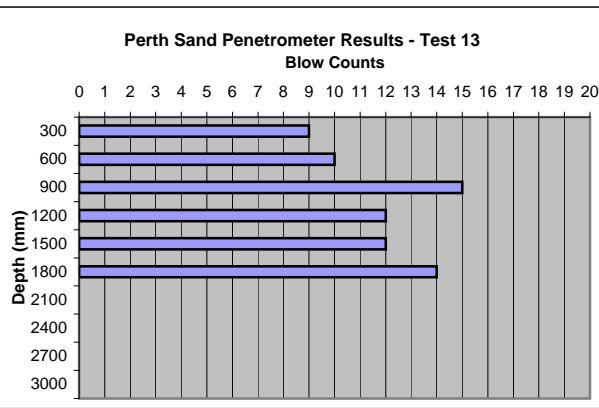
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP11

Depth (mm)	Blow Counts
300	10
600	11
900	13
1200	5
1500	4
1800	3
2100	
2400	
2700	
3000	



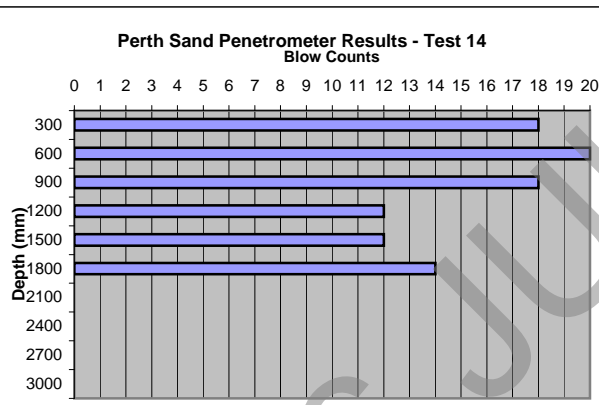
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP12

Depth (mm)	Blow Counts
300	9
600	10
900	15
1200	12
1500	12
1800	14
2100	
2400	
2700	
3000	



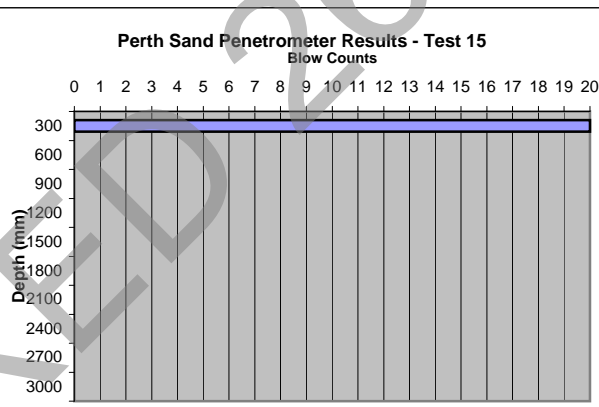
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP13

Depth (mm)	Blow Counts
300	18
600	20
900	18
1200	12
1500	12
1800	14
2100	
2400	
2700	
3000	



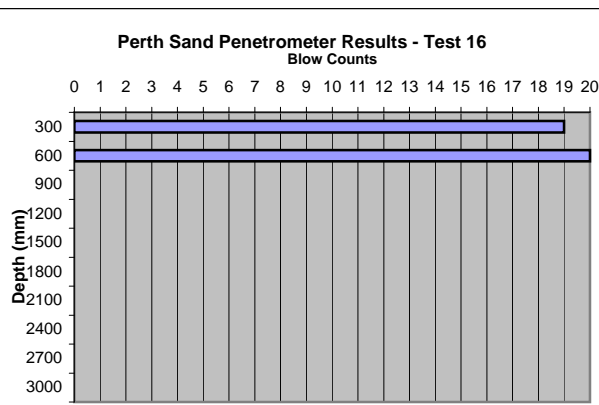
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP14

Depth (mm)	Blow Counts
300	20
600	
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP15

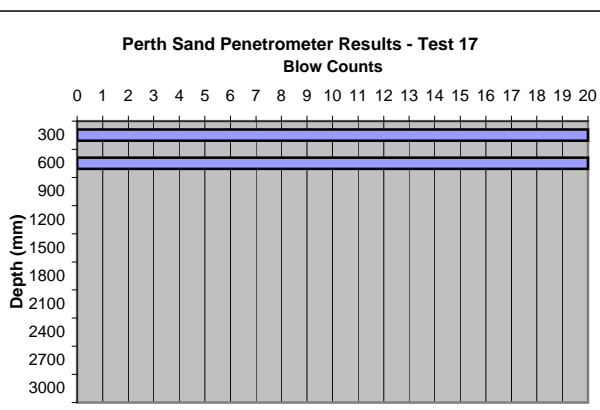
Depth (mm)	Blow Counts
300	19
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP16

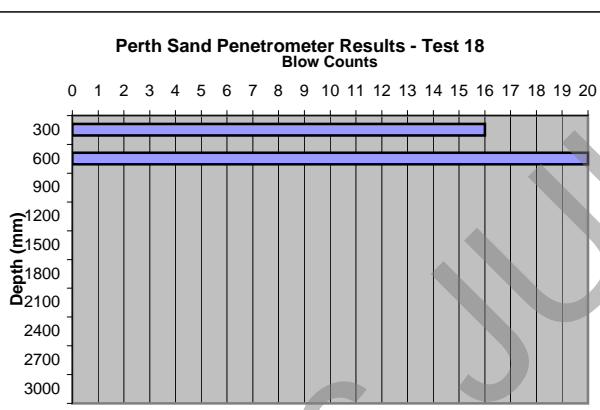


Depth (mm)	Blow Counts
300	20
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



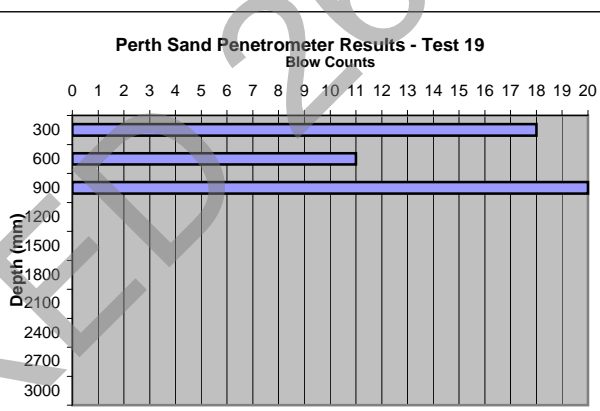
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP17

Depth (mm)	Blow Counts
300	16
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



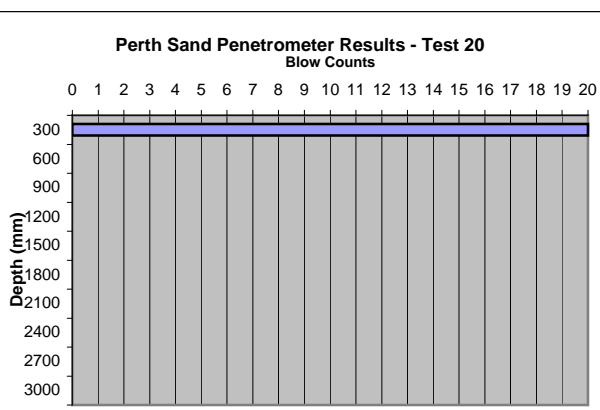
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP18

Depth (mm)	Blow Counts
300	18
600	11
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



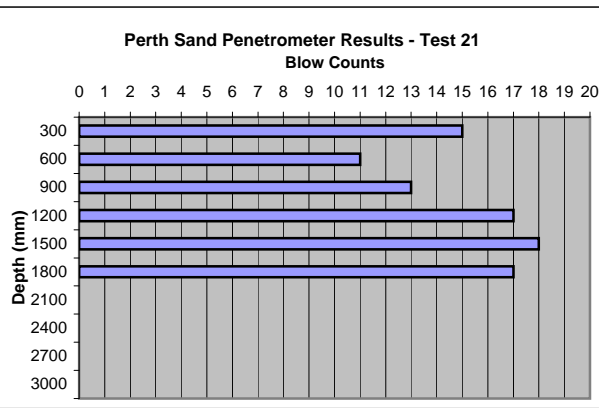
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP19

Depth (mm)	Blow Counts
300	20
600	
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



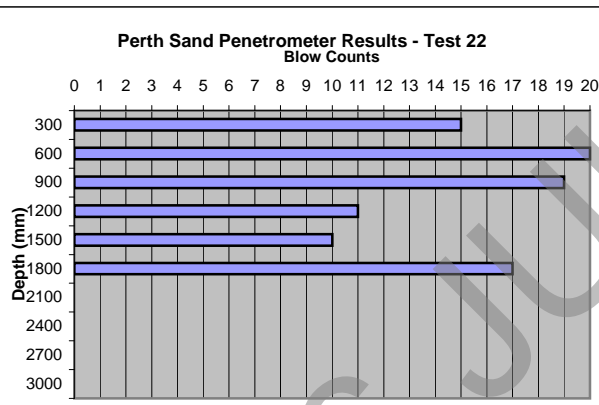
**Job Name:** Lot 500 & 501  
Lots 1202  
Oakleigh Dr  
**Job No:** Erskine  
**Date:** 09346G  
**Location:** TP20

Depth (mm)	Blow Counts
300	15
600	11
900	13
1200	17
1500	18
1800	17
2100	
2400	
2700	
3000	



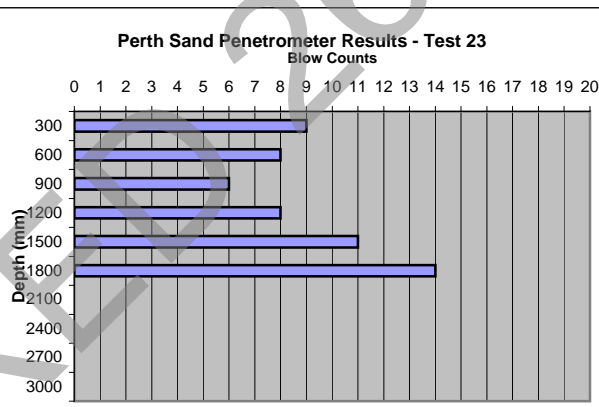
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP21

Depth (mm)	Blow Counts
300	15
600	20
900	19
1200	11
1500	10
1800	17
2100	
2400	
2700	
3000	



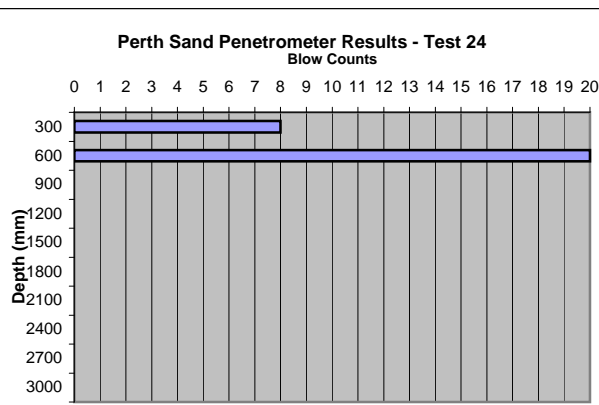
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP22

Depth (mm)	Blow Counts
300	9
600	8
900	6
1200	8
1500	11
1800	14
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP23

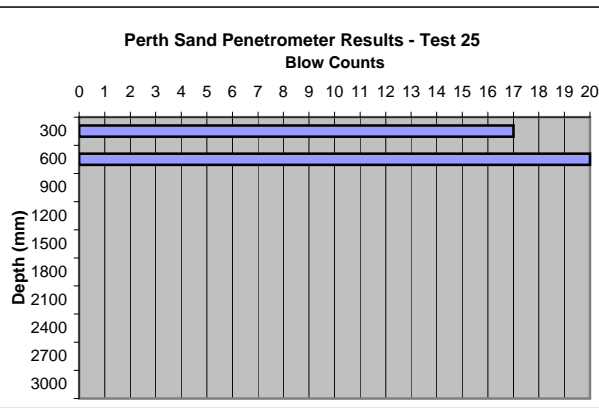
Depth (mm)	Blow Counts
300	8
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP24

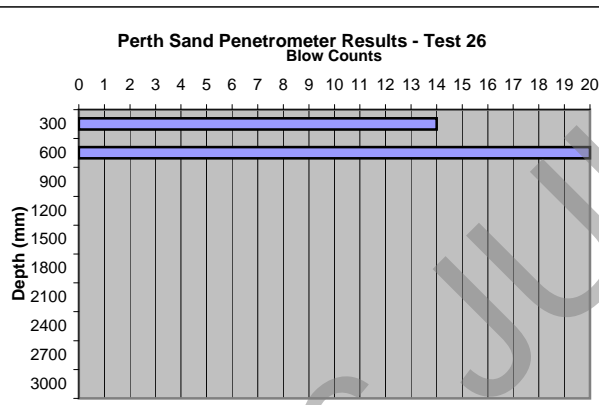


Depth (mm)	Blow Counts
300	17
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



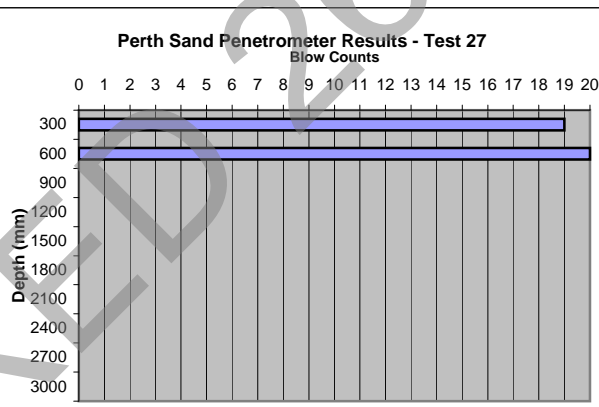
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP25

Depth (mm)	Blow Counts
300	14
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



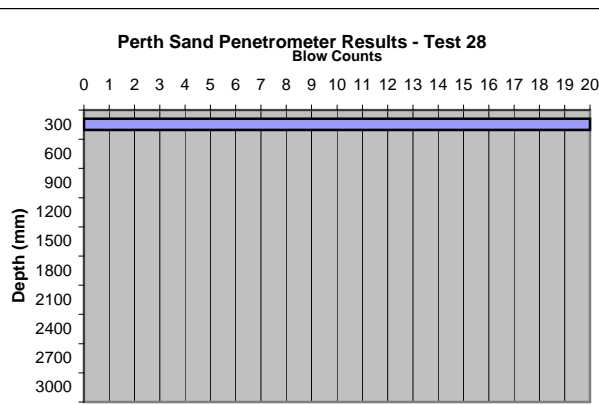
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP26

Depth (mm)	Blow Counts
300	19
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



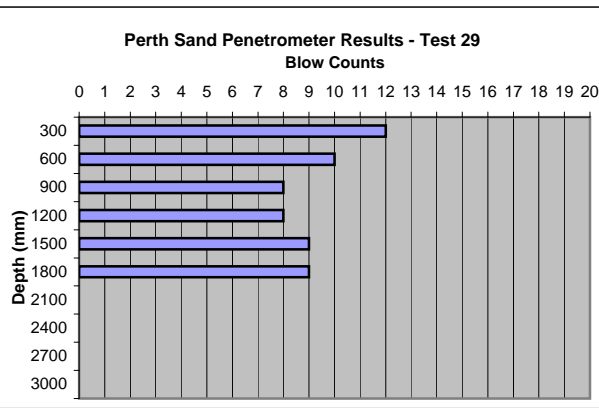
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP27

Depth (mm)	Blow Counts
300	20
600	
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



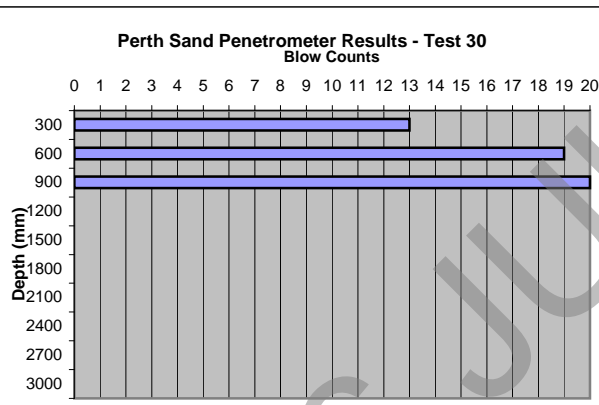
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP28

Depth (mm)	Blow Counts
300	12
600	10
900	8
1200	8
1500	9
1800	9
2100	
2400	
2700	
3000	



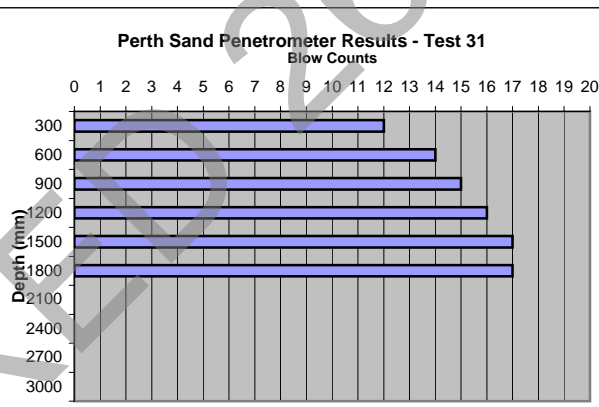
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP29

Depth (mm)	Blow Counts
300	13
600	19
900	20
1200	
1500	
1800	
2100	
2400	
2700	
3000	



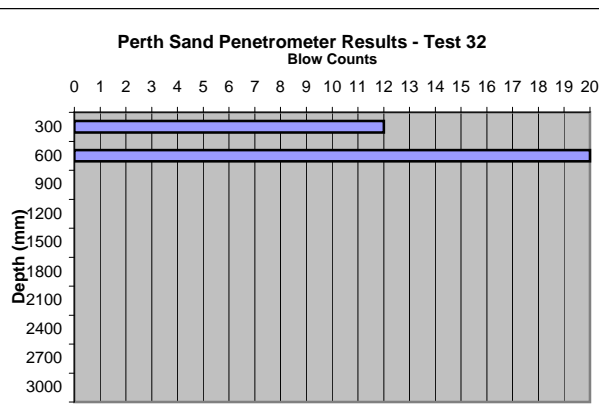
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP30

Depth (mm)	Blow Counts
300	12
600	14
900	15
1200	16
1500	17
1800	17
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP31

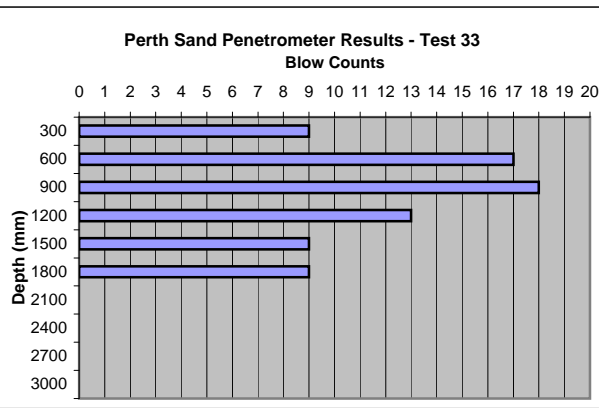
Depth (mm)	Blow Counts
300	12
600	20
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP32

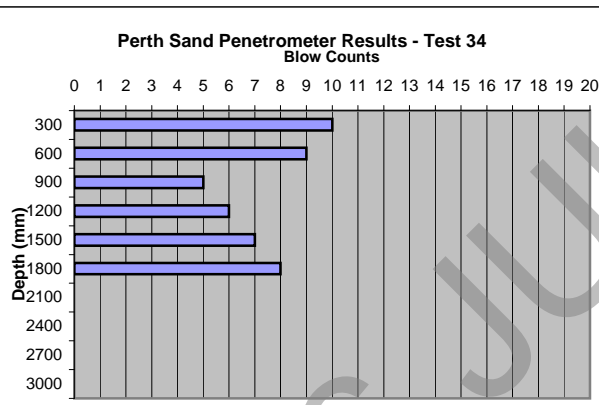


Depth (mm)	Blow Counts
300	9
600	17
900	18
1200	13
1500	9
1800	9
2100	
2400	
2700	
3000	



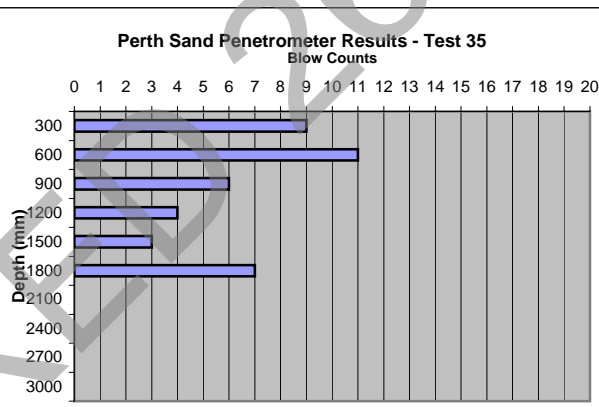
**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP33

Depth (mm)	Blow Counts
300	10
600	9
900	5
1200	6
1500	7
1800	8
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP34

Depth (mm)	Blow Counts
300	9
600	11
900	6
1200	4
1500	3
1800	7
2100	
2400	
2700	
3000	



**Job Name:** Lot 500 & 501  
Camberwarra Dr  
Craigie  
**Job No:** J09060  
**Date:** 28/10/2009  
**Location:** TP35

## APPENDIX C



# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

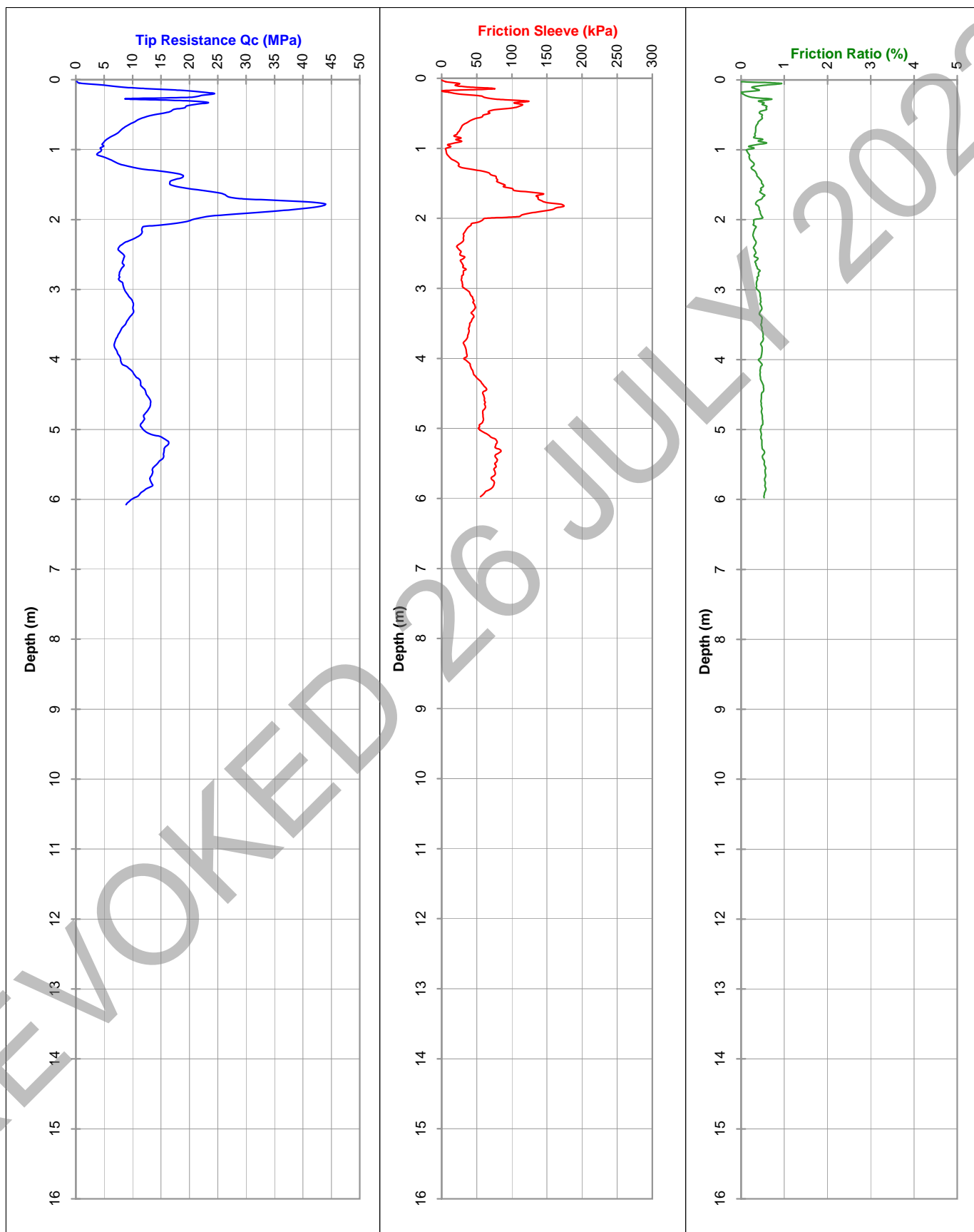
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 01

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

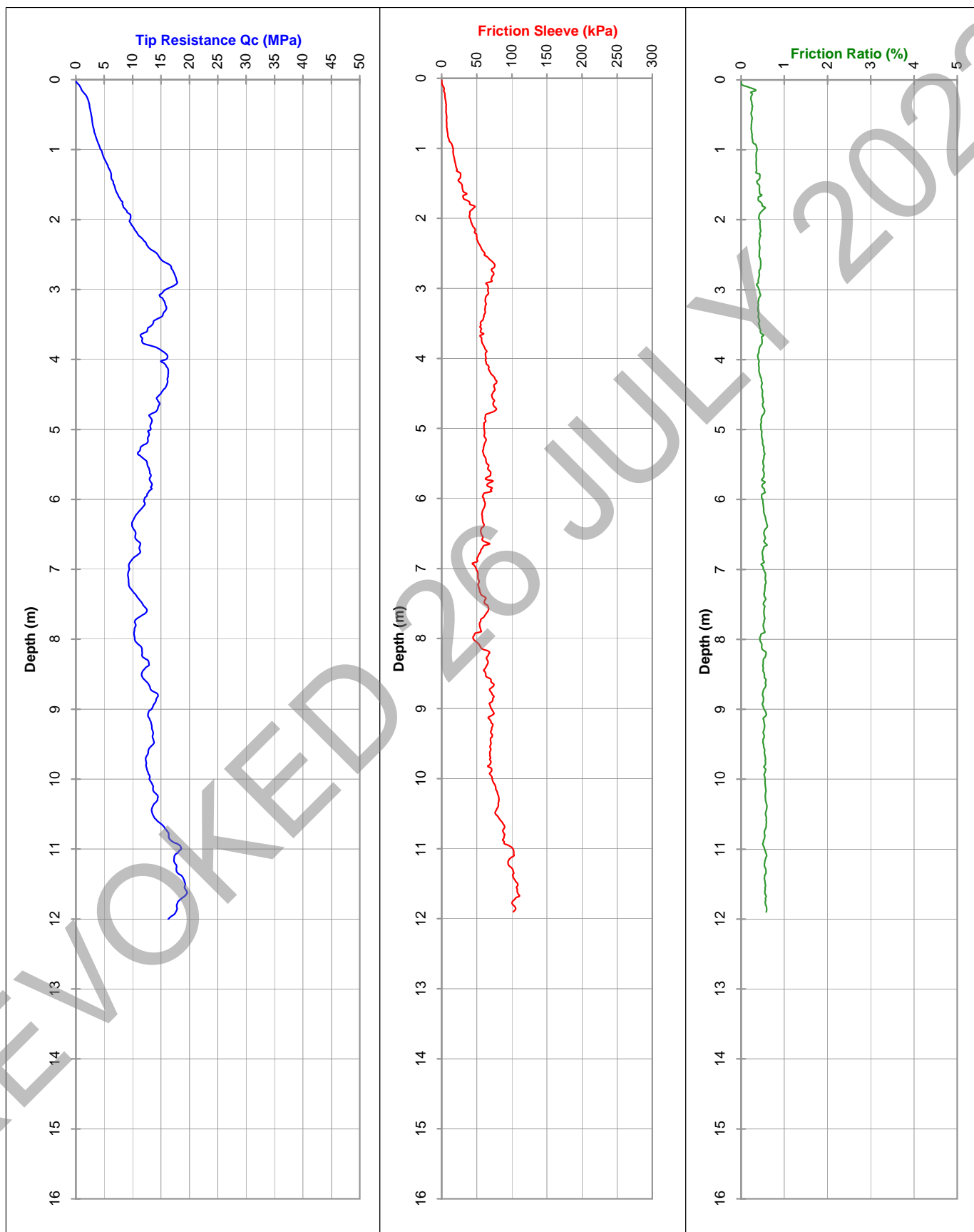
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 02

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

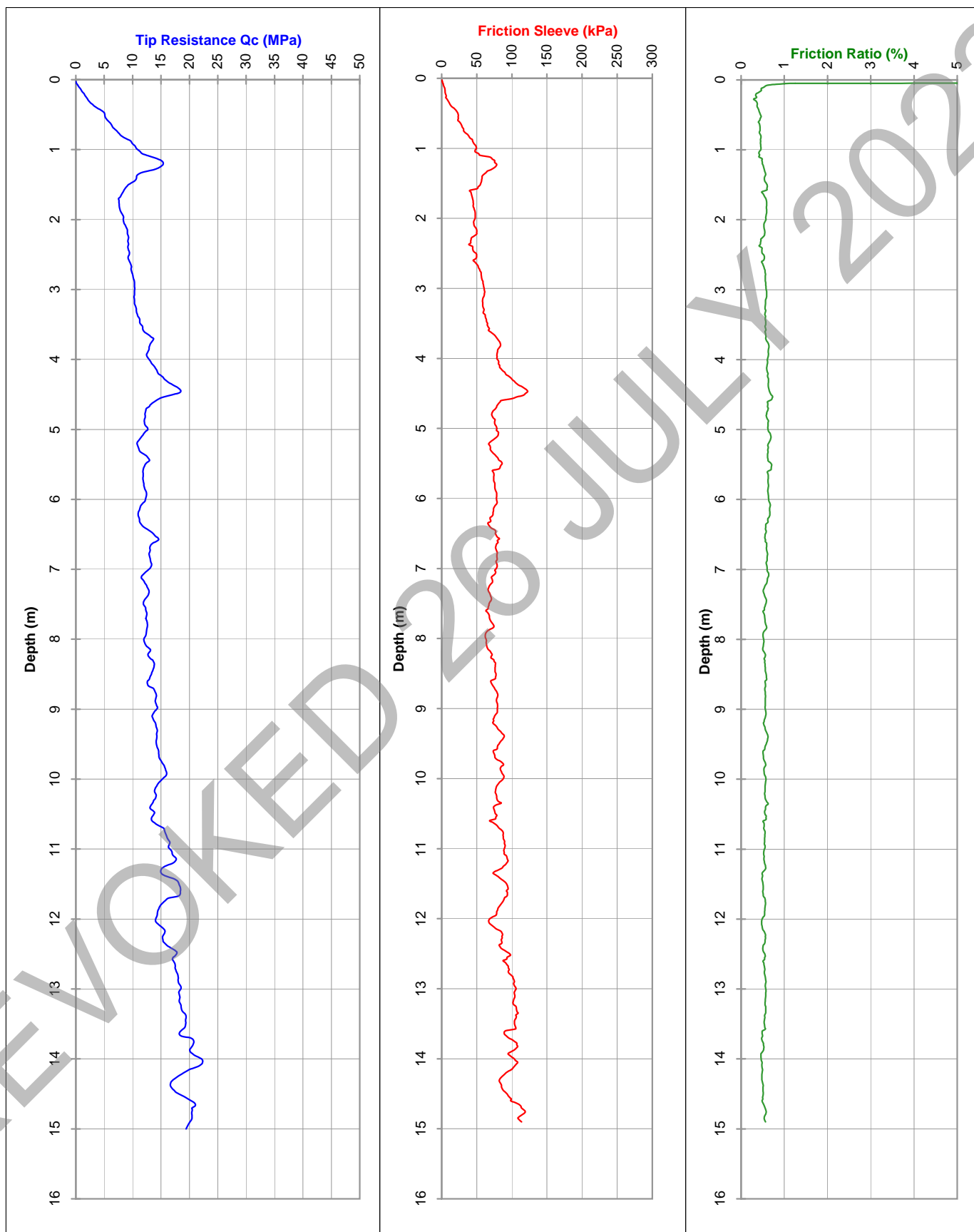
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 03

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer



# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

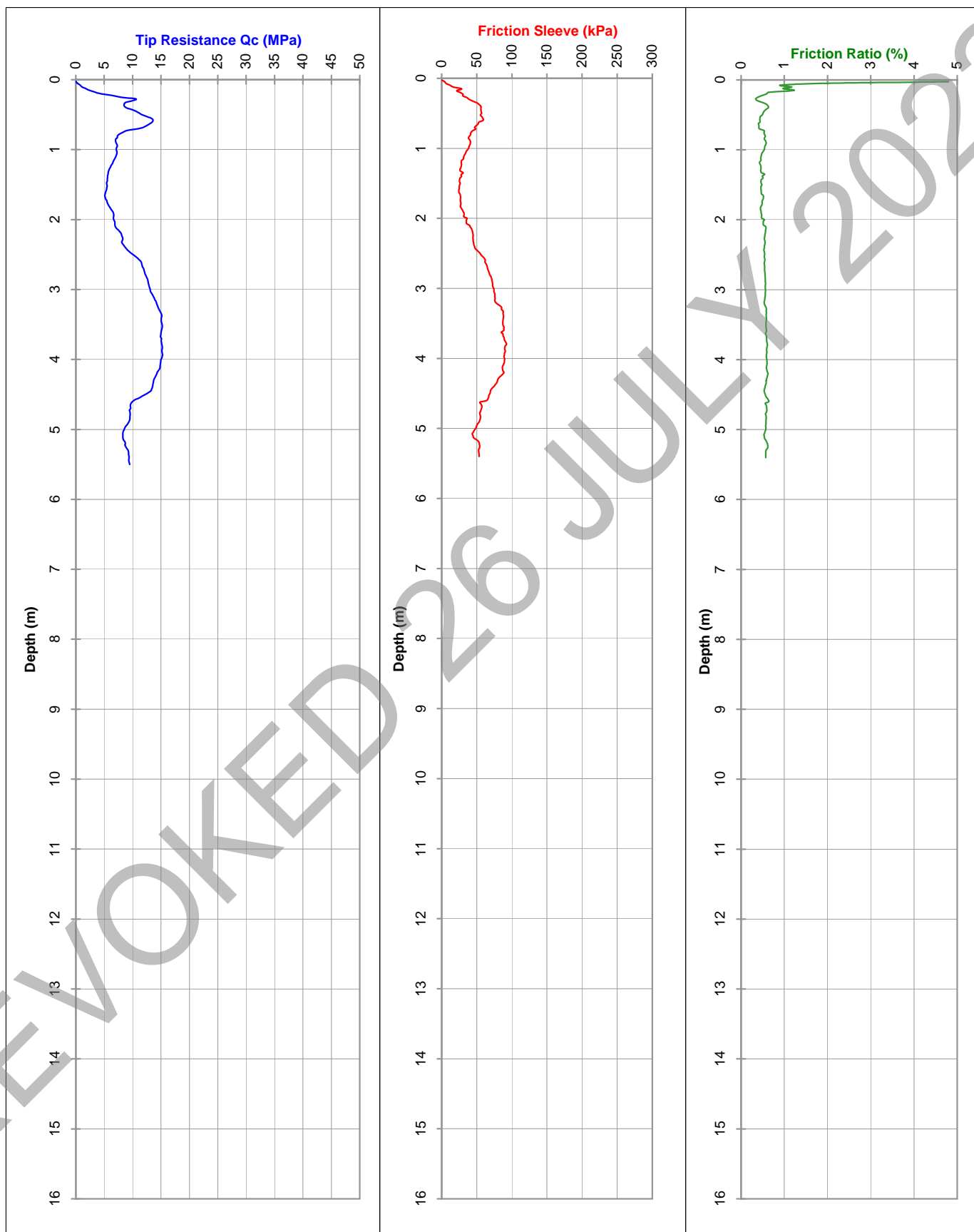
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 04

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

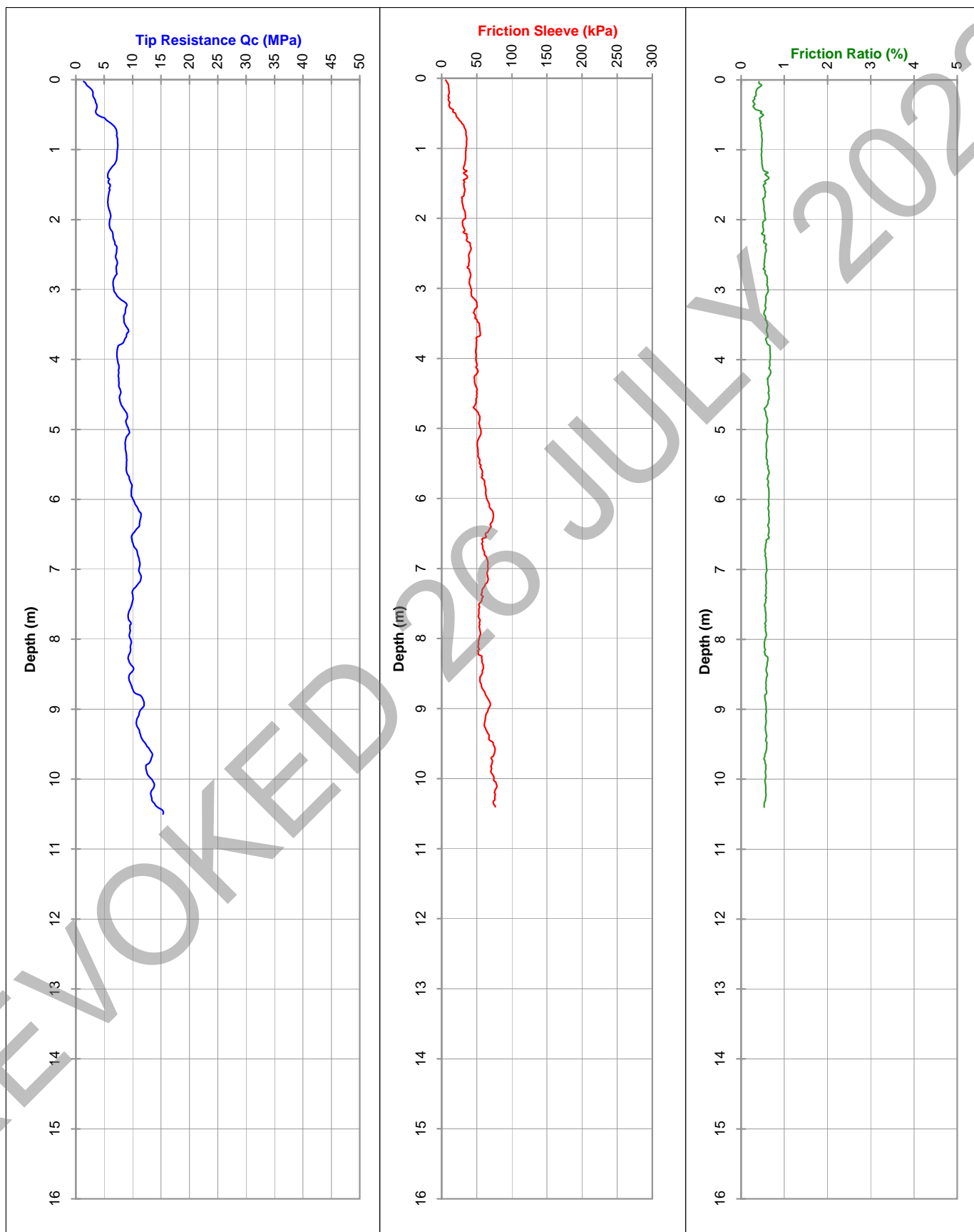
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 05

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

Date: 29/10/09

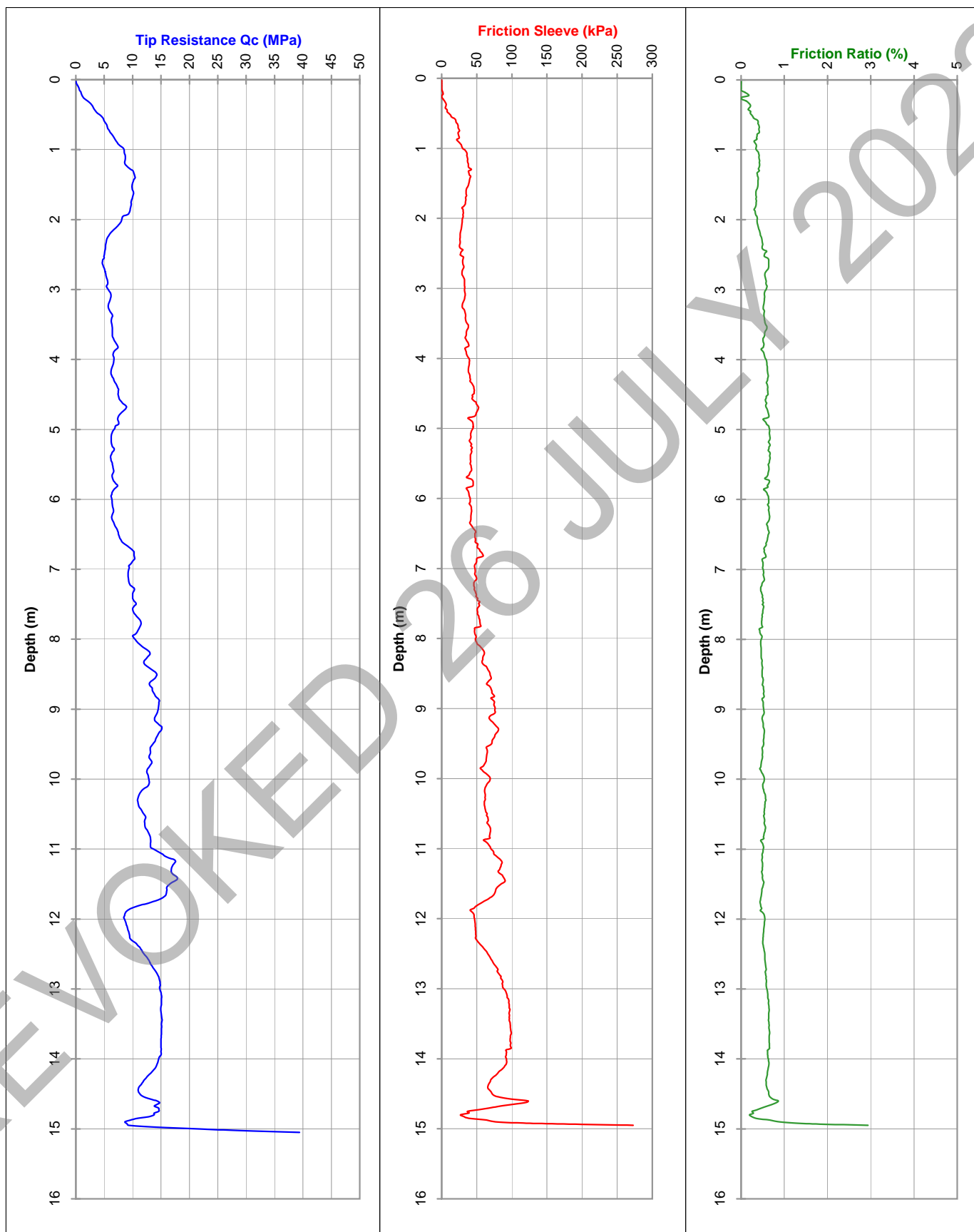
PROJECT: Craigie High School

Probe No.: CPT 06

LOCATION: Camberwarra Drive, Craigie

Job Number: 09327

Co-ordinates:



Water (m): Dry

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

Refusal:



# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

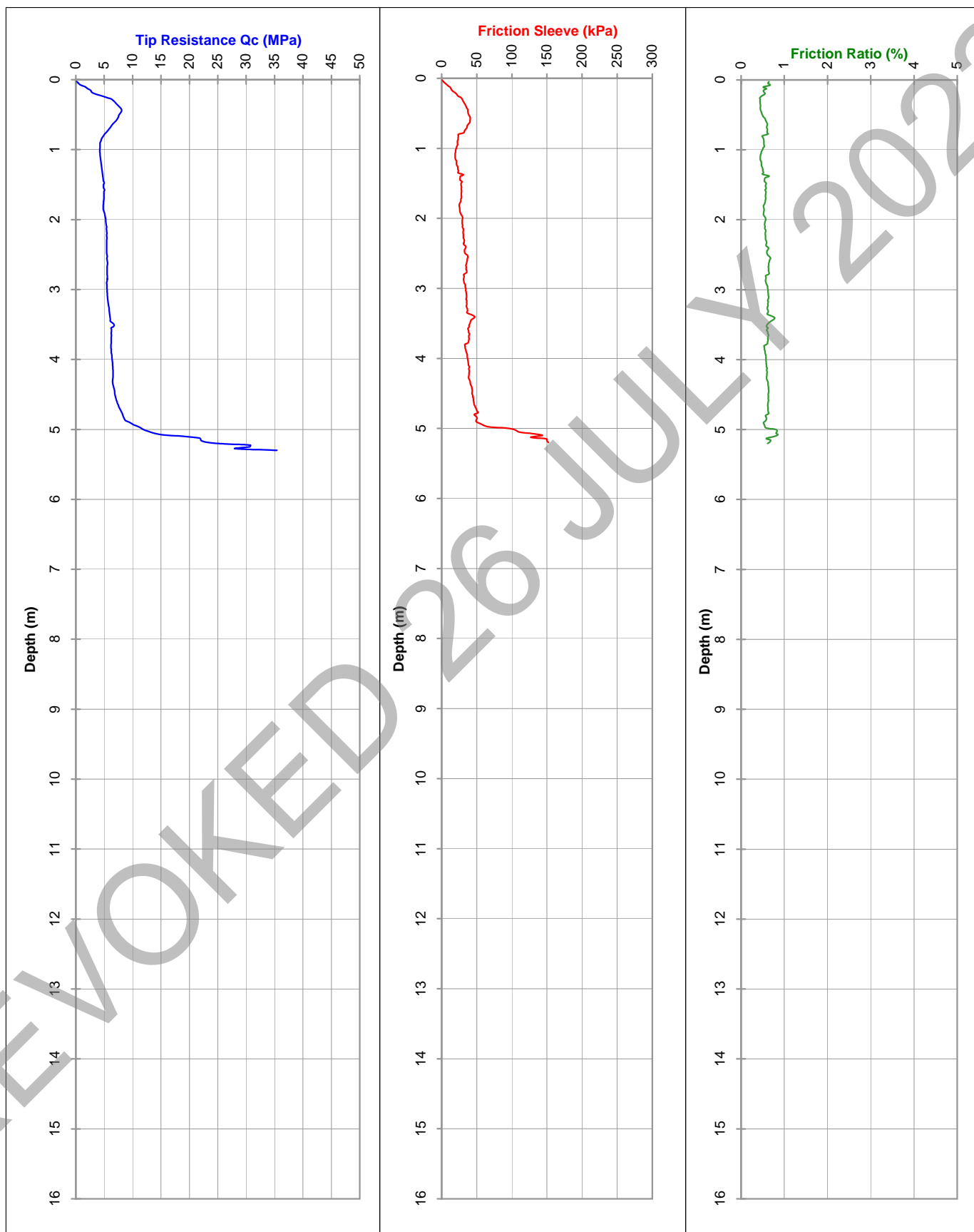
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 07

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

# ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: TME & Brown

PROJECT: Craigie High School

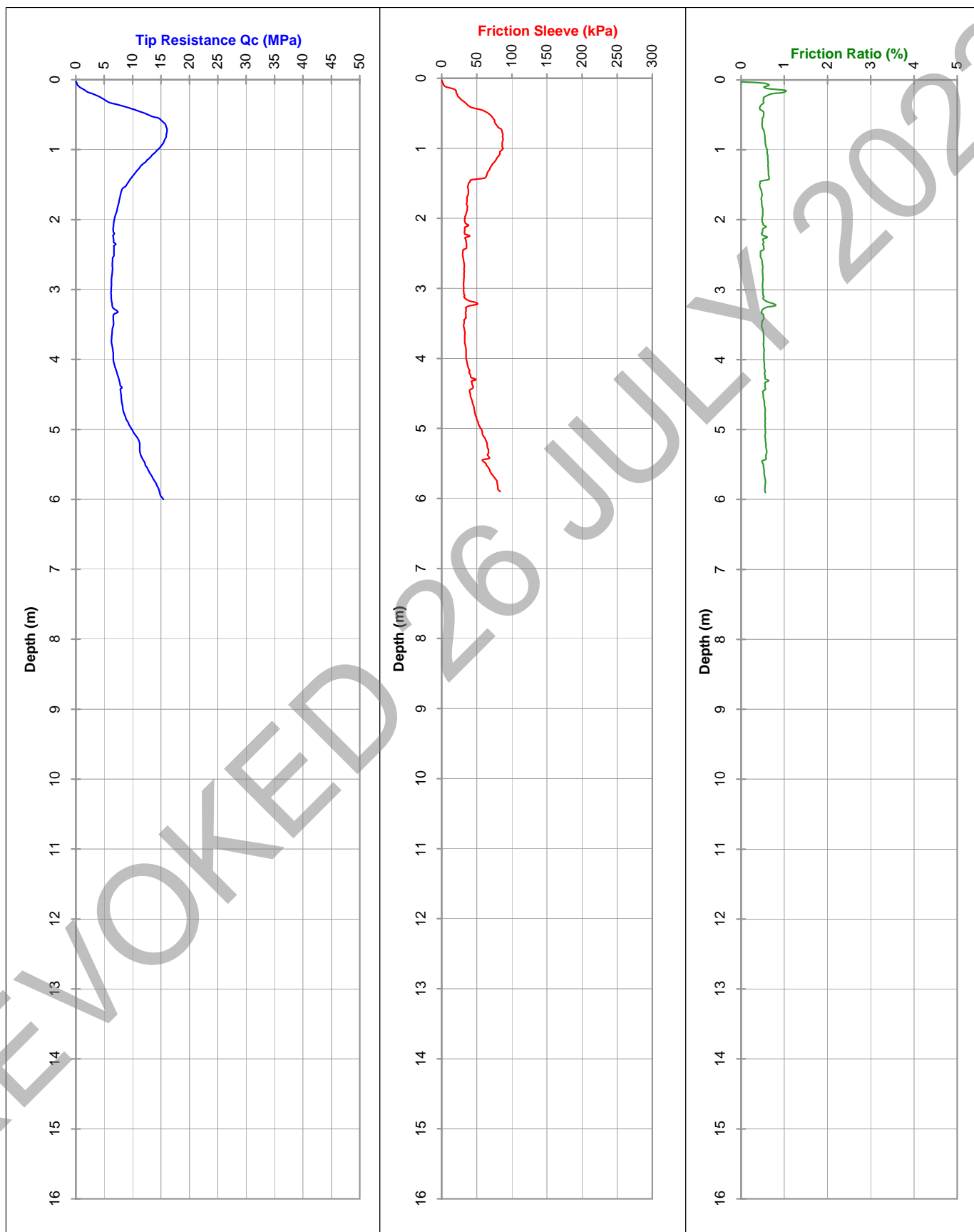
LOCATION: Camberwarra Drive, Craigie

Date: 29/10/09

Probe No.: CPT 08

Job Number: 09327

Co-ordinates:



Water (m): Dry

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999  
and IRTF 2001 for friction reducer

## APPENDIX D

REVOKED 26 JULY 2022



# TEST CERTIFICATE

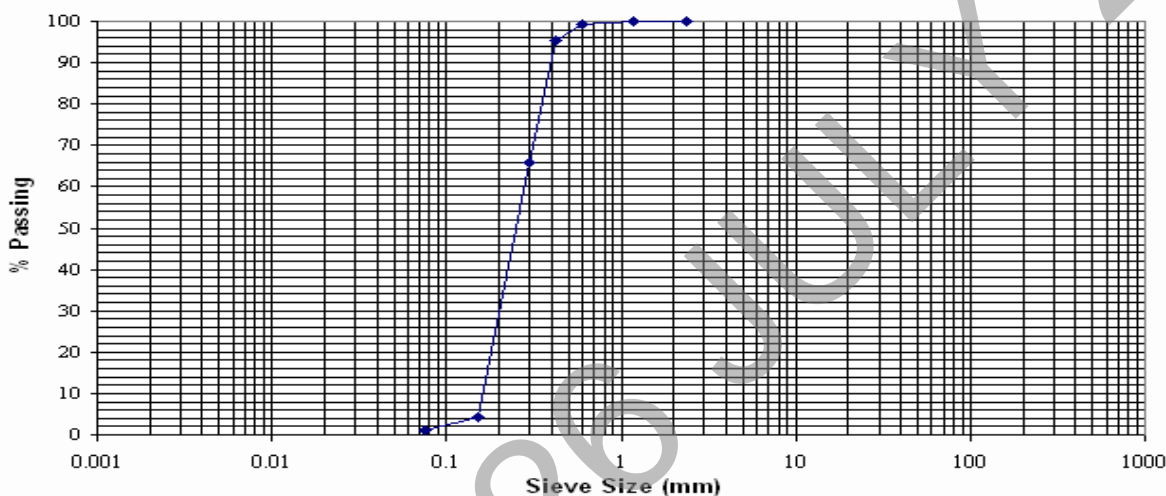
SGS Australia Pty Ltd  
 PO Box 219 Bentley WA 6982  
 36 Railway Parade  
 Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
 Client Address: Suite 4  
 47 Monash Ave  
 Como WA 6152  
 Project: Lots 500 & 501 Camberwarra Drive  
 Location: Craigie  
 Sample No: 09-MT-14115  
 Sample ID: TP01 (0.5 - 0.8m)

Client Job No: 09327J  
 Order No:  
 Tested Date: 20/10/2009  
 SGS Job Number: 09-01-2967  
 Lab: Welshpool

## PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size  
(mm)

% Passing

Sieve Size  
(mm)

% Passing

2.36	100
1.18	100
0.600	99
0.425	95
0.300	66
0.150	4
0.075	1

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

## TEST CERTIFICATE

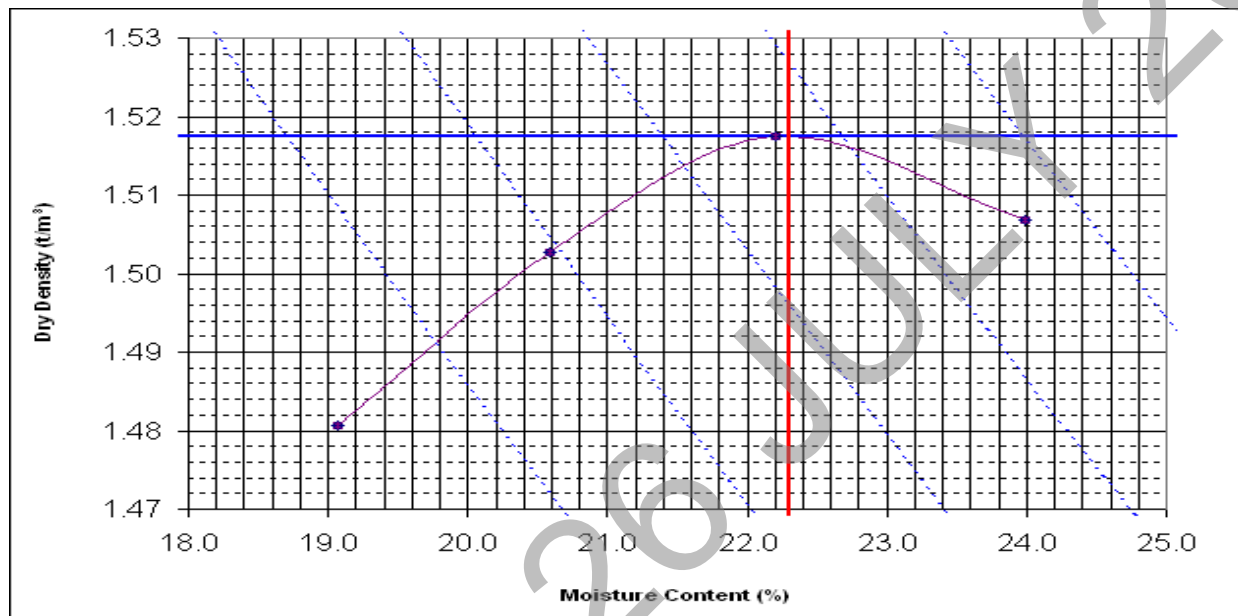
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14116  
Sample ID: TP05 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 21/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density **1.52**  
(t/m³):

Optimum Moisture Content **22.5**  
(%)

% Retained 37.5 mm 0

% Retained 19.0mm 0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at  
SPD: 2.39

Note: Sample supplied by client.

Approved Signatory: (Russell.Calvert)

Date: 28/10/2009



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# TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14116  
Sample ID: TP05 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

## PERMEABILITY: CONSTANT HEAD

AS1289.6.7.1 Remoulded sample

Max. Dry Density (t/m3)	1.52
Optimum Moisture Content (%)	22.3
Dry Density (t/m3)	1.44
Dry Density Ratio (%)	94.7
Moisture Content (%)	22.2
Moisture Ratio (%)	99.5
Surcharge (kPa)	0.0
Hydraulic Gradient (mm)	1,274
Percentage Retained	0
Sieve Size (mm)	4.75
Compactive Effort :	Standard Effort

### COEFFICIENT OF PERMEABILITY

m/s at 20 ° C 7.0E-05

Note: Sample supplied by client.

Approved Signatory:  (Russell Calvert)

Date: 28/10/2009



## TEST CERTIFICATE

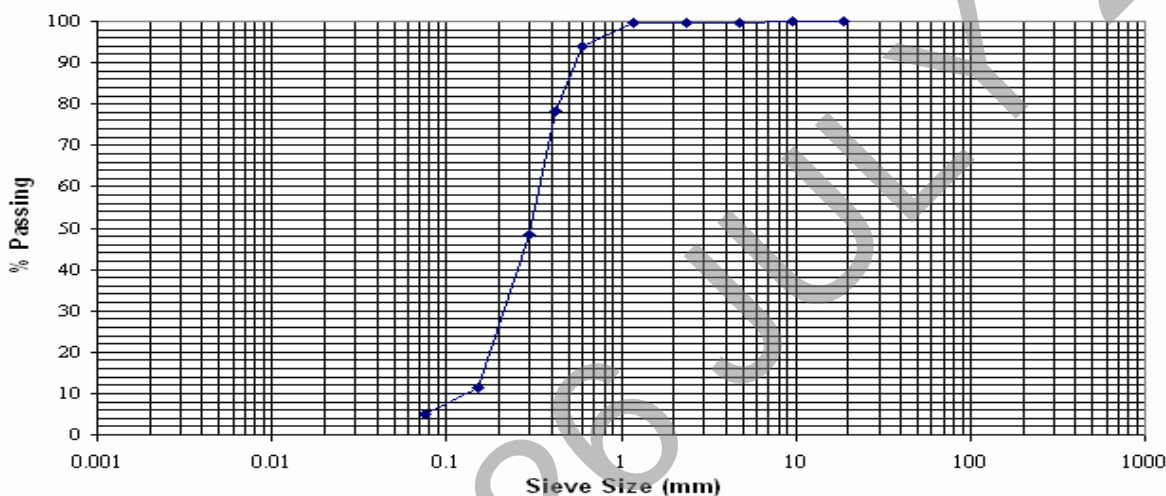
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14117  
Sample ID: TP10 (0.8 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



## TEST CERTIFICATE

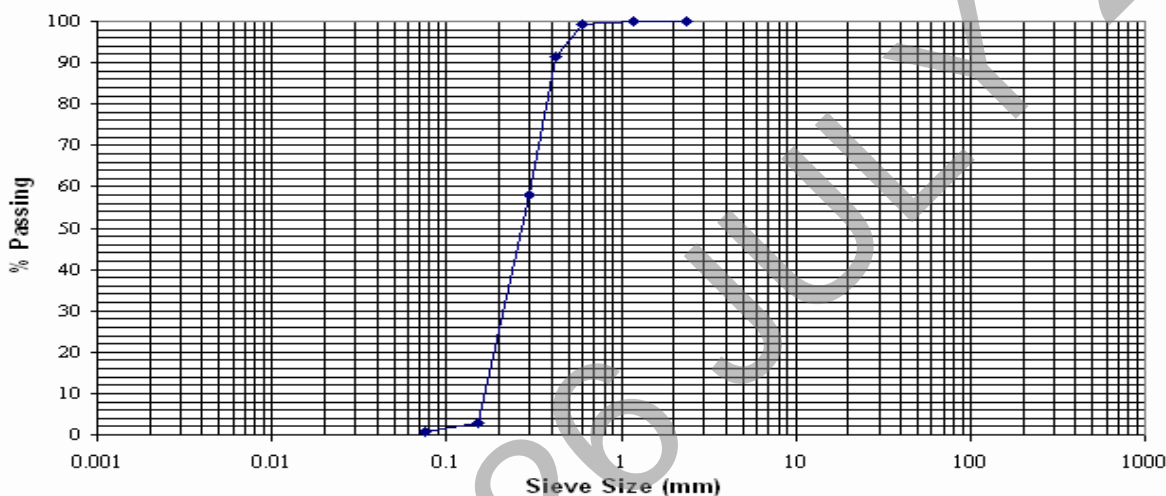
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14118  
Sample ID: TP13 (0.5 - 0.8m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size  
(mm)

% Passing

Sieve Size  
(mm)

% Passing

2.36	100
1.18	100
0.600	99
0.425	92
0.300	58
0.150	3
0.075	1

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

## TEST CERTIFICATE

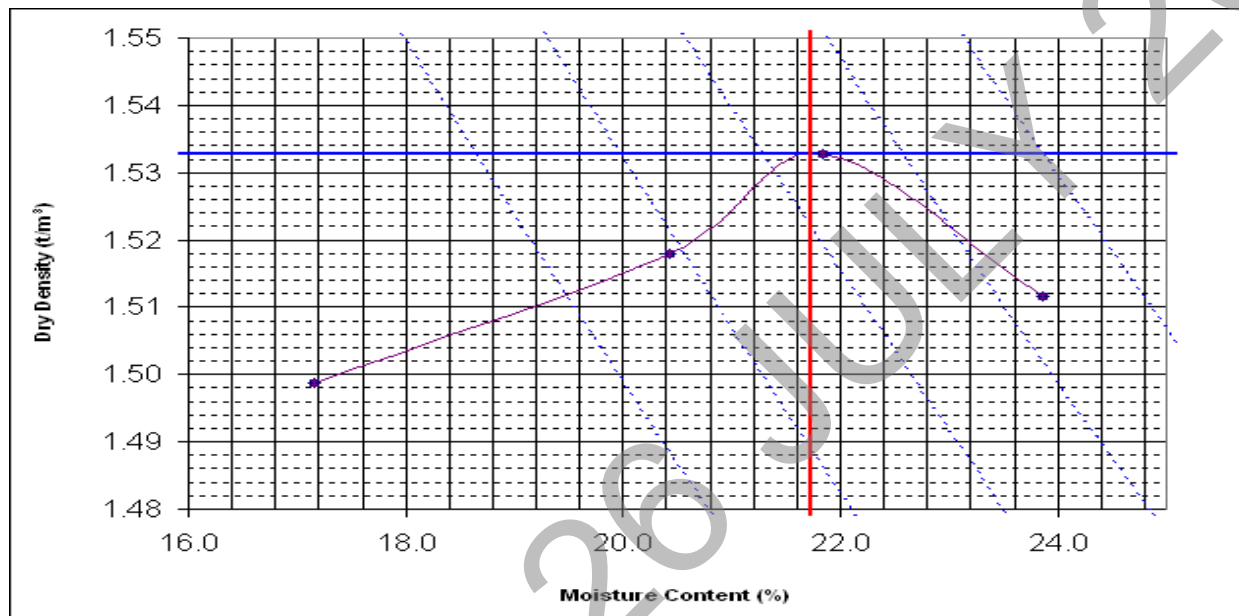
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14119  
Sample ID: TP14 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 21/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density **1.53**  
(t/m³):

Optimum Moisture Content **21.5**  
(%)

% Retained 37.5 mm 0

% Retained 19.0mm 0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at  
SPD: 2.42

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



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# TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14119  
Sample ID: TP14 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

## PERMEABILITY: CONSTANT HEAD

AS1289.6.7.1 Remoulded sample

Max. Dry Density (t/m3)	1.54
Optimum Moisture Content (%)	21.7
Dry Density (t/m3)	1.47
Dry Density Ratio (%)	95.7
Moisture Content (%)	21.5
Moisture Ratio (%)	99.0
Surcharge (kPa)	0.0
Hydraulic Gradient (mm)	1,296
Percentage Retained	0
Sieve Size (mm)	4.75
Compactive Effort :	Standard Effort

### COEFFICIENT OF PERMEABILITY

m/s at 20 ° C 7.5E-05

Note: Sample supplied by client.

Approved Signatory:  (Russell.Calvert)

Date: 28/10/2009

## TEST CERTIFICATE

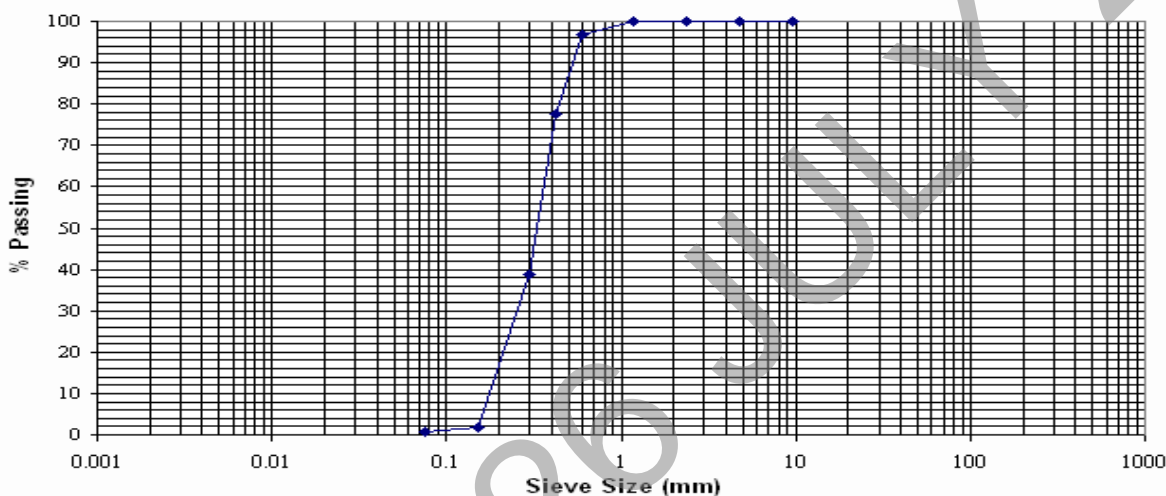
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14120  
Sample ID: TP19 (1.0 - 1.2m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size (mm)	% Passing
9.5	100
4.75	100

Sieve Size (mm)	% Passing
2.36	100
1.18	100
0.600	97
0.425	78
0.300	39
0.150	2
0.075	1

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

## TEST CERTIFICATE

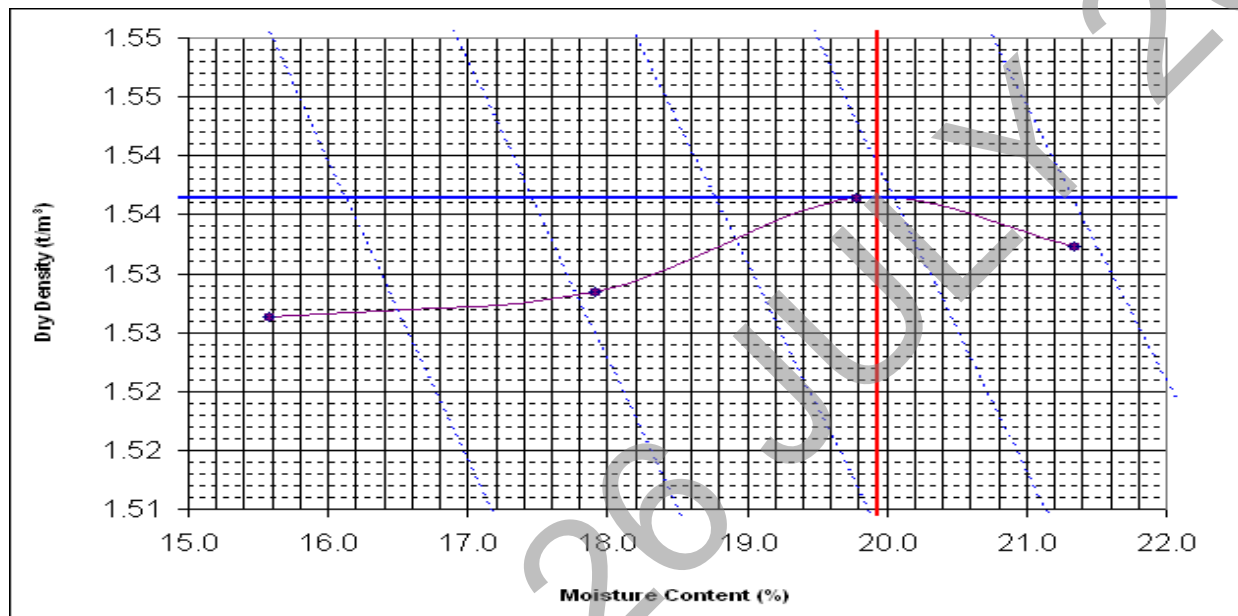
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14121  
Sample ID: TP21 (0.7 - 1.2m)

Client Job No: 09327J  
Order No:  
Tested Date: 21/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density  
(t/m³): **1.54**

Optimum Moisture Content  
(%): **20.0**

% Retained 37.5 mm: 0

% Retained 19.0mm: 0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at  
SPD: 2.29

Note: Sample supplied by client.

Approved Signatory: (Russell.Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements



# TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14121  
Sample ID: TP21 (0.7 - 1.2m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

## PERMEABILITY: CONSTANT HEAD

AS1289.6.7.1 Remoulded sample

Max. Dry Density (t/m3)	1.54
Optimum Moisture Content (%)	19.9
Dry Density (t/m3)	1.47
Dry Density Ratio (%)	95.4
Moisture Content (%)	19.8
Moisture Ratio (%)	99.5
Surcharge (kPa)	0.0
Hydraulic Gradient (mm)	1,253
Percentage Retained	0
Sieve Size (mm)	4.75
Compactive Effort :	Standard Effort

### COEFFICIENT OF PERMEABILITY

m/s at 20 ° C 7.0E-05

Note: Sample supplied by client.

Approved Signatory:  (Russell.Calvert)

Date: 28/10/2009

## TEST CERTIFICATE

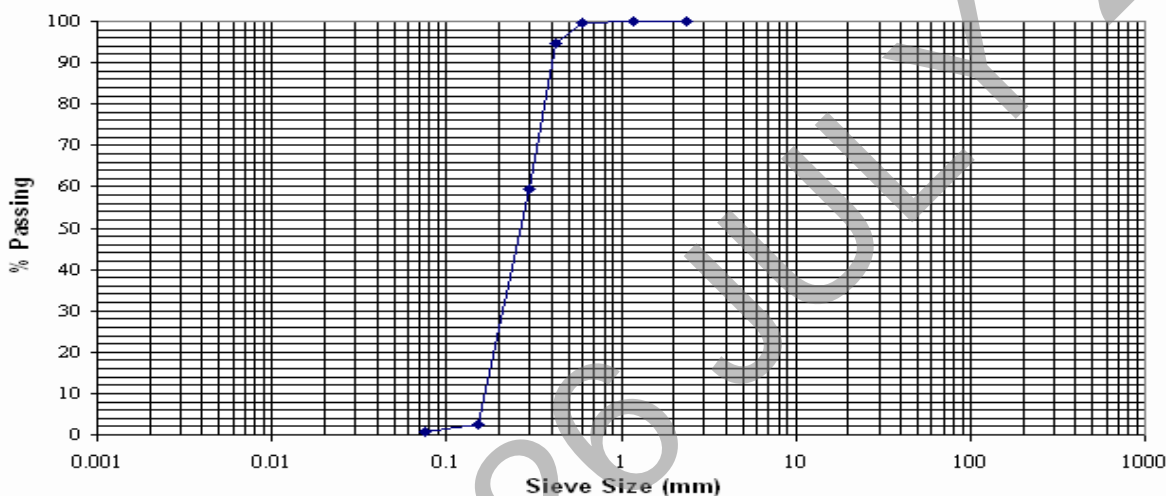
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14122  
Sample ID: TP23 (0.8 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size  
(mm)

% Passing

Sieve Size  
(mm)

% Passing

2.36	100
1.18	100
0.600	100
0.425	95
0.300	59
0.150	3
0.075	1

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

## TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152

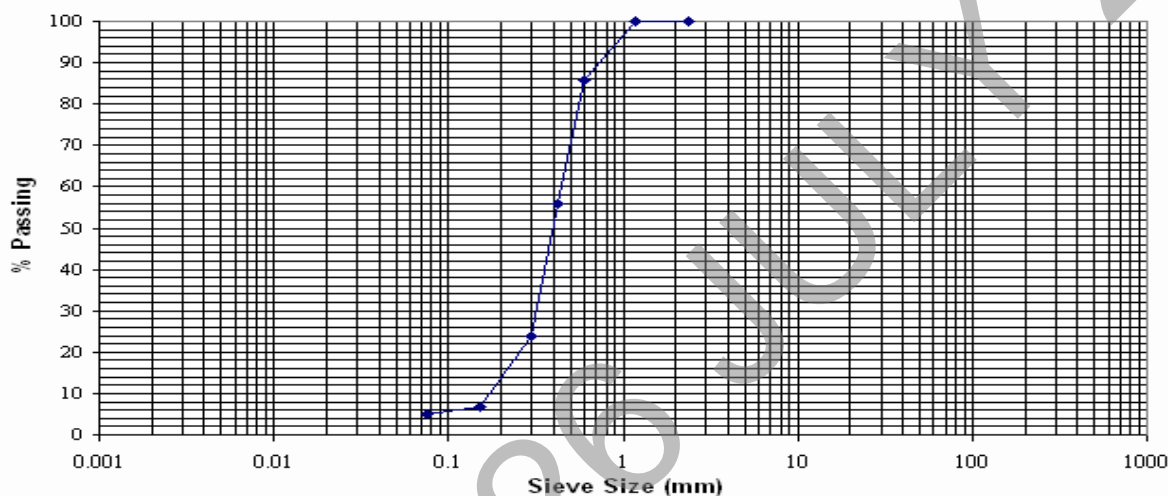
Client Job No: 09327J  
Order No:

Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14123  
Sample ID: TP29 (0.5 - 1.0m)

Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size  
(mm)

% Passing

Sieve Size  
(mm)

% Passing

2.36	100
1.18	100
0.600	86
0.425	56
0.300	24
0.150	7
0.075	5

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements



## TEST CERTIFICATE

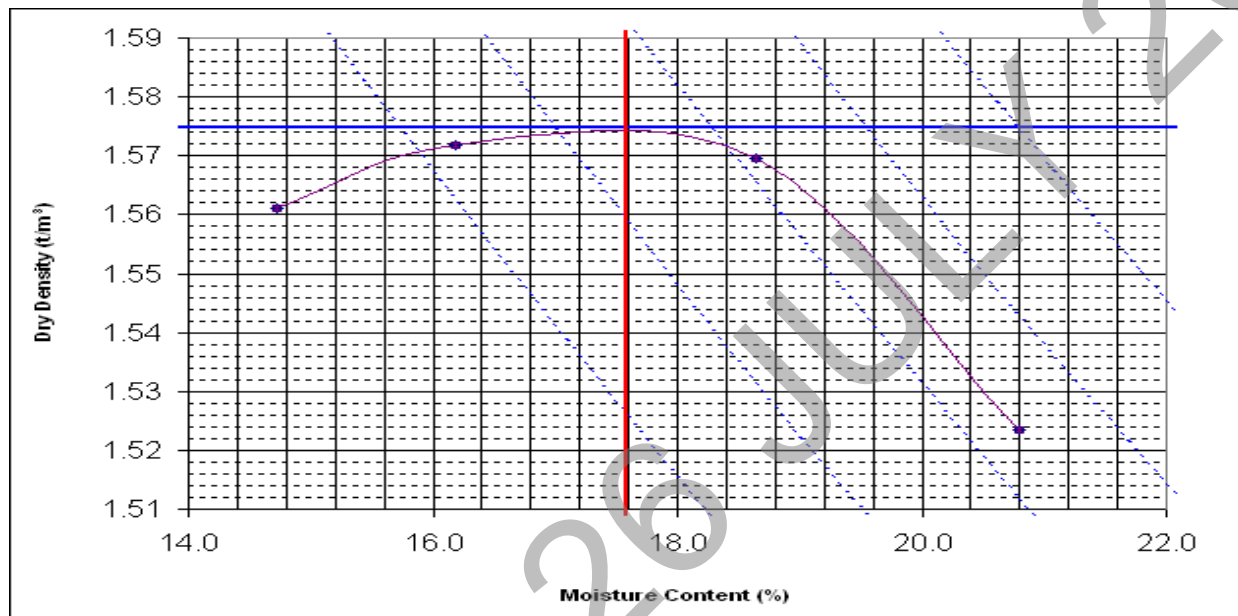
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14124  
Sample ID: TP31 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 21/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density **1.57**  
(t/m³):

Optimum Moisture Content **17.5**  
(%)

% Retained 37.5 mm 0

% Retained 19.0mm 0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at  
SPD: 2.34

Note: Sample supplied by client.

Approved Signatory: (Russell.Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

# TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14124  
Sample ID: TP31 (0.5 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 22/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

## PERMEABILITY: CONSTANT HEAD

AS1289.6.7.1 Remoulded sample

Max. Dry Density (t/m3)	1.58
Optimum Moisture Content (%)	17.6
Dry Density (t/m3)	1.50
Dry Density Ratio (%)	95.2
Moisture Content (%)	17.5
Moisture Ratio (%)	99.5
Surcharge (kPa)	0.0
Hydraulic Gradient (mm)	1,285
Percentage Retained	0
Sieve Size (mm)	4.75
Compactive Effort :	Standard Effort

### COEFFICIENT OF PERMEABILITY

m/s at 20 ° C 3.7E-05

Note: Sample supplied by client.

Approved Signatory:  (Russell Calvert)

Date: 28/10/2009

## TEST CERTIFICATE

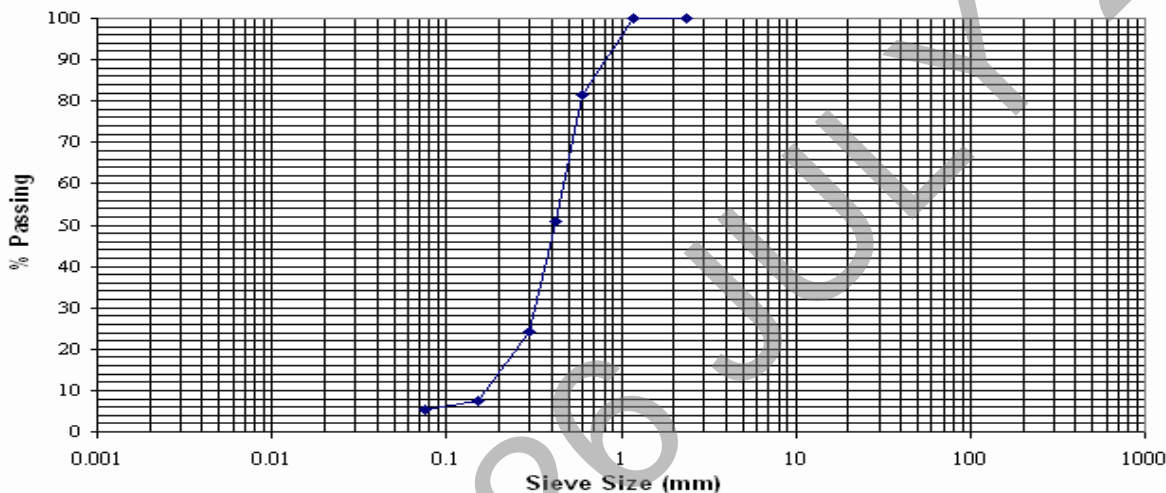
SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14125  
Sample ID: TP35 (0.6 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### PARTICLE SIZE DISTRIBUTION

AS1289.3.6.1



Sieve Size  
(mm)

% Passing

Sieve Size  
(mm)

% Passing

2.36	100
1.18	100
0.600	81
0.425	51
0.300	24
0.150	8
0.075	5

Note: Sample supplied by client.

Approved Signatory:

(Russell Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements



## TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14125  
Sample ID: TP35 (0.6 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

### DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m³): **1.74**

Optimum Moisture Content (%): **14.0**

% Retained 37.5 mm: 0

% Retained 19.0mm: 0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at  
SPD: 2.44

Note: Sample supplied by client.

Approved Signatory: (Russell.Calvert)

Date: 28/10/2009



This document is issued in accordance with NATA's accreditation requirements

# TEST CERTIFICATE

SGS Australia Pty Ltd  
PO Box 219 Bentley WA 6982  
36 Railway Parade  
Welshpool WA 6106

Client: Brown Geotechnical & Environmental Pty Ltd  
Client Address: Suite 4  
47 Monash Ave  
Como WA 6152  
Project: Lots 500 & 501 Camberwarra Drive  
Location: Craigie  
Sample No: 09-MT-14125  
Sample ID: TP35 (0.6 - 1.0m)

Client Job No: 09327J  
Order No:  
Tested Date: 20/10/2009  
SGS Job Number: 09-01-2967  
Lab: Welshpool

## PERMEABILITY: CONSTANT HEAD

AS1289.6.7.1 Remoulded sample

Max. Dry Density (t/m3)	1.74
Optimum Moisture Content (%)	14.0
Dry Density (t/m3)	1.65
Dry Density Ratio (%)	95.3
Moisture Content (%)	13.7
Moisture Ratio (%)	98.0
Surcharge (kPa)	0.0
Hydraulic Gradient (mm)	1,227
Percentage Retained	0
Sieve Size (mm)	4.75
Compactive Effort :	Standard Effort

### COEFFICIENT OF PERMEABILITY

m/s at 20 ° C 6.6E-05

Note: Sample supplied by client.

Approved Signatory:  (Russell Calvert)

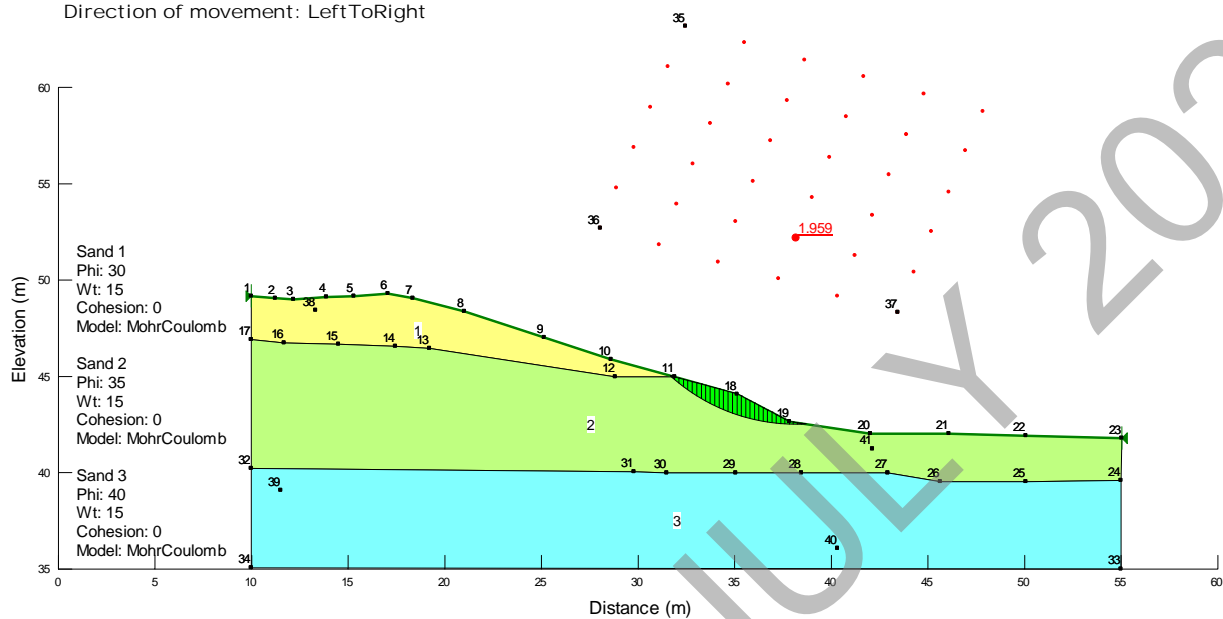
Date: 28/10/2009

## APPENDIX E



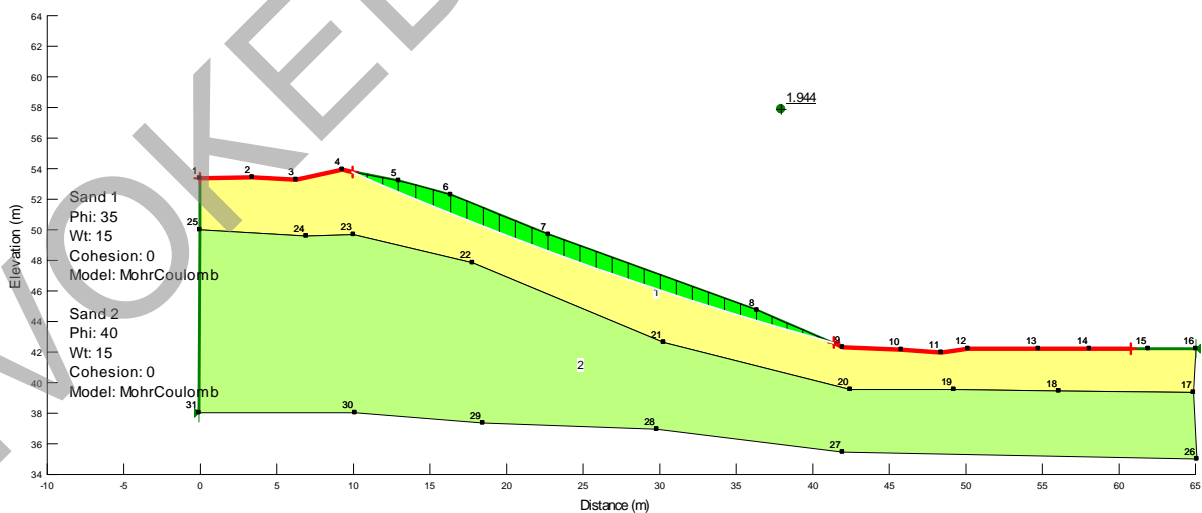
Slope Stability Section A – A’  
Data : CPT01, CPT 02

Title: Craigie Slope Stability  
Comments: Camberwarra Drive, Section A-A’  
Method: Morgenstern-Price  
Direction of movement: LeftToRight



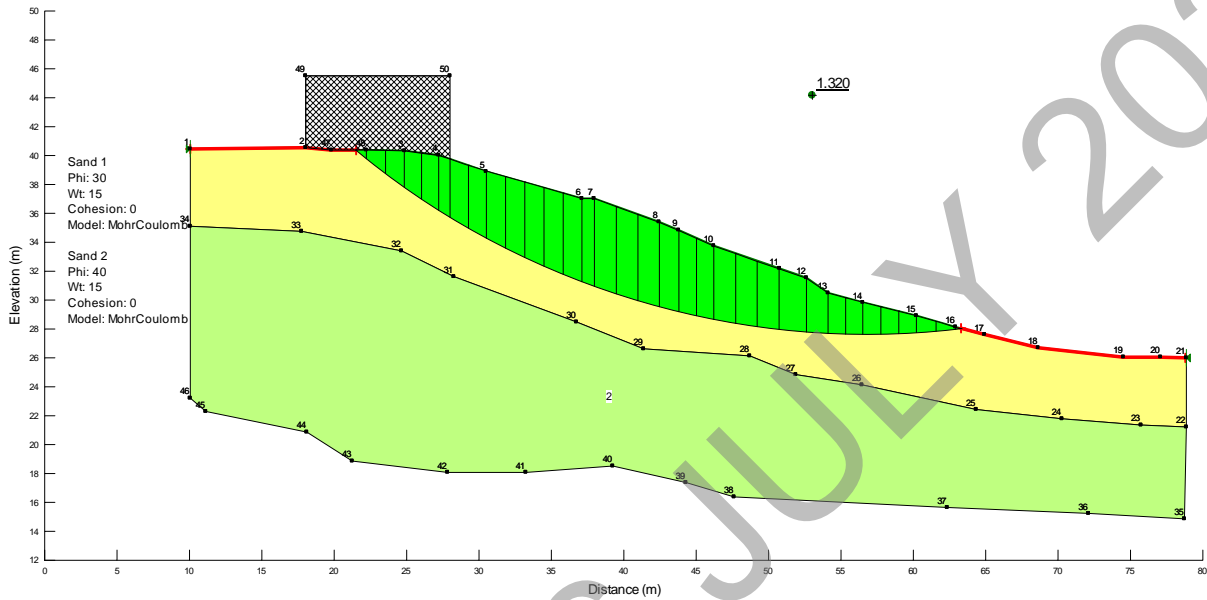
Slope Stability Section B – B’  
Data : CPT03, CPT 04

Title: Craigie Slope Stability  
Comments: Camberwarra Drive, Section B-B’  
Method: Morgenstern-Price  
Direction of movement: LeftToRight  
Slip Surface Option: EntryAndExit



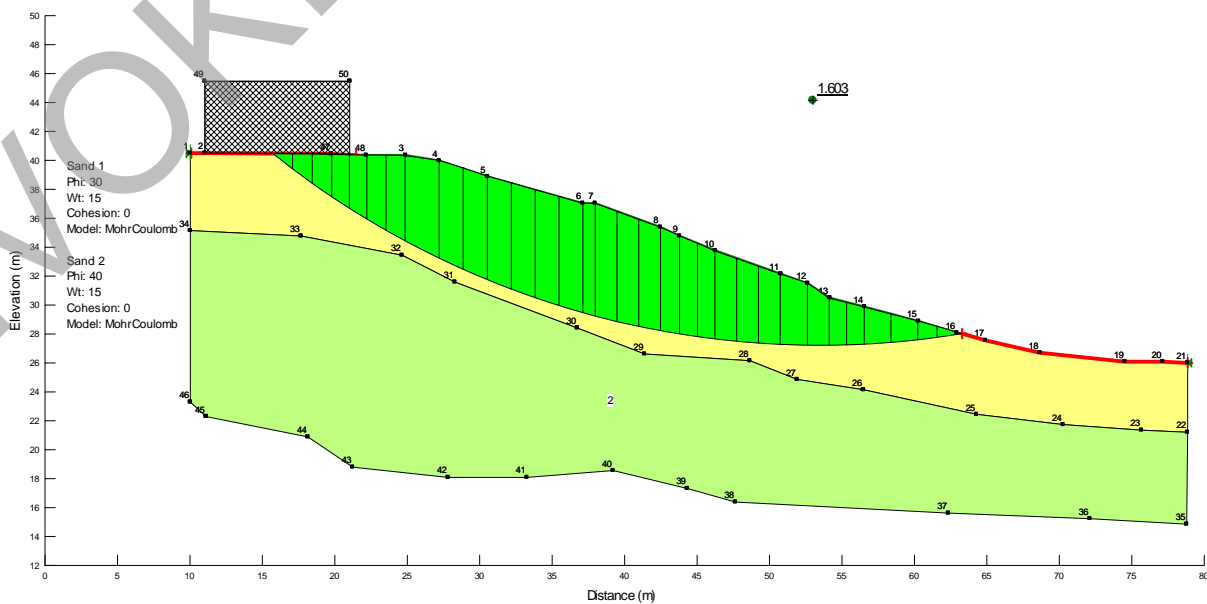
**Slope Stability Section C – C’**  
**Data : CPT05, CPT 08**  
**Load 250kPa at crest**

Title: Craigie Slope Stability  
Comments: Camberwarra Drive, Section C-C', Load at crest of slope  
Method: Morgenstern-Price  
Direction of movement: LeftToRight  
Slip Surface Option: EntryAndExit



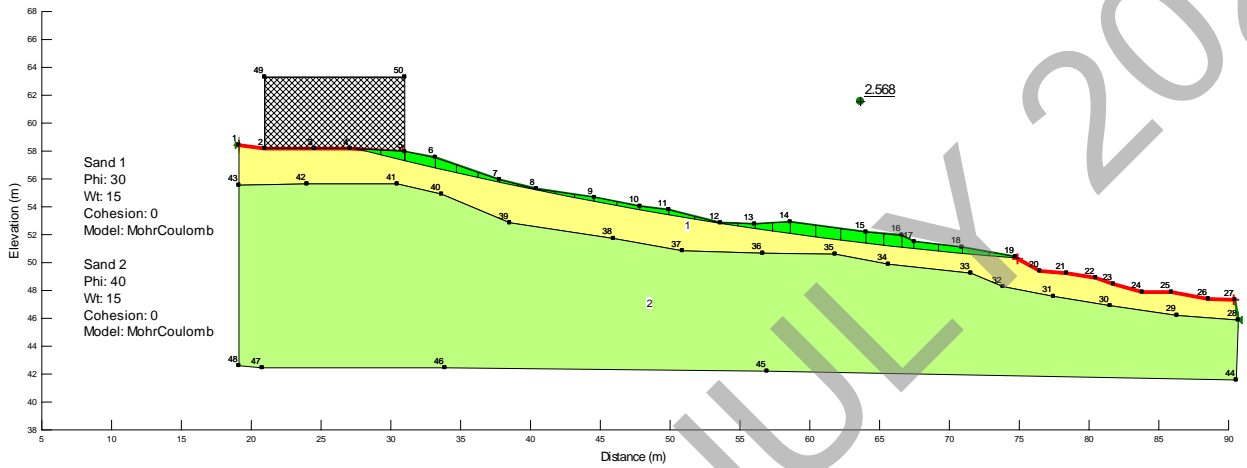
**Slope Stability Section C – C’**  
**Data : CPT06, CPT 07**  
**Load 250kPa 10m from crest**

Title: Craigie Slope Stability  
Comments: Camberwarra Drive, Section C-C', 10 m from crest  
Method: Morgenstern-Price  
Direction of movement: LeftToRight  
Slip Surface Option: EntryAndExit



**Slope Stability Section D – D'**  
**Data : CPT06, CPT 07**

Title: Craigie Slope Stability  
Comments: Camberwarra Drive, Section D-D'  
Method: Morgenstern-Price  
Direction of movement: LeftToRight  
Slip Surface Option: EntryAndExit







environments

SPECIALISTS IN LIVING AND WORKING PLACES

**SPRING FLORA & VEGETATION SURVEY  
FORMER CRAIGIE HIGH SCHOOL SITE,  
CRAIGIE**

Prepared for:

LandCorp  
3rd Floor Wesfarmers House  
40 The Esplanade  
Perth WA 6231

Report Date: 15 January 2008  
Project Ref: 2007/289, V1

Written/Submitted by:

Janelle Atkinson  
Environmental Scientist -  
Botanist

Reviewed/Approved by:

Shaun Grein  
Manager - Field Ecology

15 January 2008

LandCorp  
3rd Floor Wesfarmers House  
40 The Esplanade  
Perth WA 6231

**Attention: Derwent Southern**

Dear Derwent

**RE: Spring Flora and Vegetation Survey, Former Craigie High School Site**

Please find attached a copy of the report outlining findings and recommendations from the spring flora and vegetation survey conducted at the Craigie High School site (Coffey Environments Report 2007/289, V1).

Should you have any further questions or comments regarding the information presented, please contact either myself or Shaun Grein.

For and on behalf of Coffey Environments Pty Ltd



Janelle Atkinson  
Environmental Scientist - Botanist

## RECORD OF DISTRIBUTION

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1	LAN-2007-044_VEGE_001_ja_V1	V1	16 January 2008	Coffey Environments	JA



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Appendix B:	Flora Species Recorded at Craigie High School Site



## ABBREVIATIONS

<b>AHD</b>	Australian Height Datum
<b>DEC</b>	Department of Environment and Conservation
<b>DRF</b>	Declared Rare Flora
<b>EPA</b>	Environment Protection Authority
<b>FCT</b>	Floristic Community Type
<b>POS</b>	Public Open Space
<b>SCP</b>	Swan Coastal Plain
<b>TEC</b>	Threatened Ecological Community

## EXECUTIVE SUMMARY

Coffey Environments Pty Ltd was commissioned by LandCorp to conduct a spring flora and vegetation survey on the former Craigie High School site in Craigie. The survey was conducted on 9 October 2007 by Ms Janelle Atkinson, an experienced botanist from Coffey Environments to determine whether any conservation significant flora and vegetation occur on the site and to determine any potential impacts on the conservation values of local vegetation resulting from the proposed residential development.

The majority of the survey area occurs in association with the Cottesloe – Central and South Vegetation Complex, although the southeast corner is associated with the Quindalup Complex. The majority of the survey area has been previously cleared and very little remnant vegetation remains. The remnant vegetation in the northwest corner of the survey area was classed as Excellent condition. Other areas of remnant vegetation were classed as Very Good condition as weeds have colonised from surrounding areas. All cleared areas are Degraded or Completely Degraded depending on whether any native species occur.

Remnant vegetation in the survey area is most closely associated with Swan Coastal Plain Floristic Community Type (FCT) 24: Northern Spearwood Shrublands and Woodlands. FCT 24 is well reserved on the Swan Coastal Plain but its conservation status is considered to be 'susceptible'. No Threatened Ecological Communities (TEC's) were recorded in the survey area. The dunes in the north west of the survey area may be considered locally significant as they represent a good quality vegetation type which normally occurs in closer proximity to the coast.

A total of 53 flora species were recorded during the spring survey. Of these, 16 species are weeds, many of which are considered to be aggressive. No flora of conservation significance were recorded in the survey area.

It is recommended that disturbance to the dunes in the northwest of the survey area is minimised and the better quality remnant vegetation is retained where possible. It is also recommended that mature native tree species that may provide potential habitat for native fauna are retained within any proposed future development where possible.

## **1 INTRODUCTION**

### **1.1 Background**

Coffey Environments was commissioned by LandCorp to conduct a flora survey on the site of the former Craigie High School, which was closed in 2003. LandCorp acquired the site and proposes to develop the site for residential purposes. LandCorp is currently accepting expressions of interest from private tenders to redevelop the site.

A spring flora and vegetation survey was conducted by Ms Janelle Atkinson, an experienced botanist from Coffey Environments, to determine the presence/absence of conservation significant flora in the survey area. An assessment of the conservation values of the site and potential impacts on vegetation was also incorporated in the survey.

### **1.2 Location**

The survey area occurs in Craigie, a suburb approximately 22km north west of the Perth Central Business District. It is bound by Camberwarra Drive to the west, north and east and Arawa Place to the south. The site is 10.147 ha in size. The regional location of the survey area is shown in Figure 1.

The northern edge of the survey area is surrounded by a ridge of coastal dunes. All buildings associated with the former high school have been removed. Approximately 80% of the survey area has been previously cleared.



variations include the low closed forest of *Melaleuca lanceolata* – *Callitris preissii* and the closed scrub of *Acacia rostellifera* (Hedde *et al.*, 1980)..

### 2.2.3 Bush Forever

The Bush Forever Strategy is a ten year strategic plan which formally commenced in 2000 to protect approximately 51,200ha of regionally significant bushland within approximately 290 Bush Forever Sites, representing where achievable, a target of at least 10 percent of each of the original 26 vegetation complexes of the Swan Coastal Plain portion of the Perth Metropolitan Region (Government of Western Australia, 2000b).

No Bush Forever sites occur within or in the immediate vicinity of the study area. However, three Bush Forever Sites occur within approximately 2km of the survey area:

**Bush Forever Site 303 (Whitfords Avenue Bushland Padbury/Craigie):** Limestone ridge, tall dune and vegetated uplands supporting four Floristic Community Types (FCT's): FCT 24: 'Northern Spearwood shrublands and woodlands'; FCT 26b: 'Woodlands and mallees on limestone'; FCT 28: 'Spearwood *Banksia attenuata* or *B. attenuata* – *Eucalyptus* woodlands'; and FCT 29a: 'Coastal Shrublands on shallow sands'. Total area is 215.1ha.

**Bush Forever Site 325: (Coastal Strip from Burns Beach to Hillarys):** Limestone cliff and coastal dune landscape supporting two confirmed FCT's: FCT 27: 'Species-poor mallees and shrublands on limestone'; FCT 29a: 'Coastal shrublands on shallow sands'; and five inferred floristic community types: FCT 16: 'Highly saline seasonal wetlands (*Frankenia pauciflora* Low Shrubland on Tamala Limestone Cliffs)'; FCT 29b: 'Acacia shrublands on taller dunes'; FCT S11: 'Northern *Acacia rostellifera* - *Melaleuca acerosa* shrublands'; FCT S13: 'Northern *Olearia axillaris* – *Scaevola crassifolia* shrublands'; and FCT S14: '*Spinifex longifolius* grasslands and low shrublands'. Total area is 195.3ha.

**Bush Forever Site 407: (Woodvale Nature Reserve, Woodvale):** Vegetated uplands supporting one FCT: FCT 28: 'Spearwood *Banksia attenuata* or *B. attenuata* – *Eucalyptus* woodlands'. Total area is 35.6ha.

### 3 FLORA AND VEGETATION SURVEY METHODOLOGY

The survey area was visited by Janelle Atkinson, an experienced botanist from Coffey Environments on 9 October, 2007. The survey was conducted in accordance with Coffey Environments interpretation of the Environmental Protection Agency's (EPA's) Guidance Statement 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. The flora and vegetation assessment consisted of two components:

1. Desktop study including a literature review and search of Department of Environment and Conservation (DEC) Declared Rare and Priority species databases and Threatened Ecological Communities database; and
2. Survey of the survey area to search for conservation significant species, categorise vegetation units and compose a species list of vegetation types.

Species and site characteristics were recorded from seven permanent 10m x 10m quadrats. Four quadrats were placed within the site boundary and three quadrats were placed in remnant vegetation adjacent to the site boundary to determine whether any conservation significant flora or vegetation occurred and may be impacted by the proposed development. A handheld GPS was used to record the location and photographs were taken from the northwest corner of each quadrat. The survey area was also thoroughly traversed to search for conservation significant flora. Samples of species which could not be identified in the field were collected for verification at the West Australian Herbarium.

#### 3.1 Data Collected

The following information was collected from each quadrat:

<b>Location</b>	AMG coordinates recorded in WGS84 datum using a hand-held GPS. Recording taken from the northeast corner of each quadrat. Accuracy to approximately 5m.
<b>Soil</b>	Description of soil texture and colour, presence of stony material and leaf litter.
<b>Vegetation Description</b>	Description of vegetation composition based on all species recorded within each quadrat and their relative dominance.
<b>Condition</b>	Condition was assessed according to the Vegetation Condition Rating Scale used in Bush Forever (Government of WA, 2000). Factors such as weed invasion, fire and grazing were considered.
<b>Percentage Foliar Cover</b>	The percentage of cover was estimated for each species. Dominant species were estimated to the nearest percentage, herbs and infrequent species were estimated in a range, e.g. 2%-5% or >2%.

#### 3.2 Vegetation

##### 3.2.1 Vegetation Types

Vegetation types in the survey area were described according to the Vegetation Structural Classes described in Table 1:

**Table 1**  
**Vegetation Structural Classes**  
(Adapted from Muir, 1977 and Aplin, 1979)

Stratum	Canopy Cover				
	70%-100%	30%-70%	10%-30%	2%-10%	<2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland	Scattered Tall Trees
Trees 10m-30m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees under 10m	Low Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Low Trees
Shrubs over 2m	Tall Closed Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland	Scattered Tall Trees
Shrubs 1m-2m	Closed Heath	Open Heath	Shrubland	Low Open Shrubland	Scattered Low Shrubs
Shrubs under 1m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Scattered Low Shrubs
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland	Scattered Grasses
Herbs and Sedges	Closed Sedgeland/Herbland	Sedgeland/Herbland	Open Sedgeland/Herbland	Very Open Sedgeland/Herbland	Scattered Sedges/ Herbs

Vegetation types were described according to dominant species recorded from both quadrat data and opportunistic sampling.

### 3.2.2 Floristic Community Types

The species composition from each quadrat surveyed was compared against the results of Gibson *et al.*, (1994) to determine floristic community types in the study area.

### 3.2.3 Threatened Ecological Communities

According to DEC database searches no Threatened Ecological Communities (TEC's) have been previously recorded in the vicinity of the survey area.



### 3.3 Flora

Results of the DEC's Declared Rare Flora (DRF) and Priority Species database searches indicated that ten conservation significant species has been previously recorded in the vicinity of the survey area (Table 2). No Declared Rare Flora (DRF) have been previously recorded within the vicinity of the survey area.

**Table 2**  
**Declared Rare and Priority Flora found within the Vicinity of the Survey Area**

Species	Conservation Status	Preferred habitat
<i>Acacia benthamii</i>	P2	Sand, limestone breakaways. Flowers August – September.
<i>Calectasia</i> sp. Pinjar	P1	Deep grey quartzite soils. Gentle slopes, above damplands. Flowers November.
<i>Conostylis bracteata</i>	P3	Sand, limestone. Consolidated sand dunes. Flowers August – September.
<i>Drosera sidjamesii</i> x	P1	Peaty sand. Lake margins. Flowers November – March.
<i>Gastrolobium axillare</i>	P3	Sand over laterite. Hills. Flowers September.
<i>Grevillea thelemanniana</i>	P4	Sand, sandy clay. Winter wet low lying flats. Flowers May – November.
<i>Jacksonia sericea</i>	P3	Calcareous and sandy soils. Flowers December – February.
<i>Leucopogon</i> sp. Perth Coastal	P1	
<i>Sarcozona bicarinata</i>	P3	White sand. Flowers August.
<i>Stachystemon axillaris</i>	P4	White or grey sand, gravel, laterite. Sandplains. Flowers February – October.

### 3.4 Survey Limitations

The spring flora survey was conducted during what was considered an optimal time of the year for identification of flowering plants on the Swan Coastal Plain. The Perth weather station had received close to average rainfall in the year up to the date of the survey, including approximately 620mm of rain in the six months prior to the survey, slightly less than the 632mm average for the same period (Bureau of Meteorology, 2007). As a result of the favourable weather the majority of annual and ephemeral species which could be expected in the survey area were recorded. Other potentially limiting factors taken into consideration are presented in Table 3.

**Table 3**  
**Statement of Botanical Limitations**

Potential Limitations	Constraints (Yes/No); Significant/ moderate/ negligible	Comment
Competency/experience of the consultant conducting the survey	No constraints	Botanist with extensive survey experience and taxonomic skills.
Proportion of the flora identified	No constraints	Three hours spent on site, no limitations.
Sources of information (historic/recent or new data)	No constraints	The Perth Metropolitan Region and Swan Coastal Plain are well documented.
Proportion of the task achieved and further work that may need to be undertaken	No constraints	Spring survey completed. No further survey work required
Timing/weather/season/cycle	No constraints	Spring survey conducted in October following good annual rainfall.
Intensity of survey (e.g. In retrospect was the intensity adequate)	No constraints	The proposed disturbance area was mapped and searched comprehensively, with the entire site traversed by foot.
Completeness (e.g. was relevant area fully surveyed)	No constraints	
Resources (e.g. degree of expertise available for plant identification)	No constraints	Experienced botanist undertook plant identifications in field and at the Western Australian Herbarium.
Remoteness and/or access problems	No constraints	The site was relatively small and accessible by foot.
Availability of contextual (e.g. bioregional) information for the survey area.	No constraints	Vegetation, floristic communities and species of the Swan Coastal Plain have been well documented.

## 4 FLORA AND VEGETATION RESULTS

### 4.1 Vegetation

#### 4.1.1 Vegetation Types

Five distinct vegetation types were recorded in the survey area during the October 2007 survey and are described as:

- MsArOh** *Melaleuca systema*, *Acacia rostellifera*, *Santalum acuminatum*, *Olearia axillaris*, *Acanthocarpus preissii* and *Gastrolobium nervosum* Open Heath to 1.3m over Low Open Heath of *Phyllanthus calycinus*, *Hibbertia subvaginata*, *Lomandra maritima*, *Lechenaultia linaroides*, *Conostylis candicans* ssp. *calicola* and *Lepidosperma pubisquameum* to 0.6m. Vegetation is generally in Excellent Condition.
- EgW** *Eucalyptus gomphocephala* (Tuart) Woodland to 9m over *Melaleuca lanceolata* to 4m over Open Heath of *Melaleuca systema*, *Acanthocarpus preissii*, *Phyllanthus calycinus* to 1.3m over Open Grassland of *\*Avena fatua* and *\*Ehrharta calycina* to 1m over Low Shrubland of *Lomandra maritima*, *Conostylis aculeata*, *Desmocladius flexuosa*, *\*Euphorbia terracina* and *\*Pelargonium capitatum* to 0.5m. Vegetation condition is Good to Very Good.
- PC** Parkland Cleared with Mixed Grassland and Herbland of of *\*Cynodon dactylon*, *Gazania linearis*, *\*Avena fatua*, *Lotus subbiflorus* and *Trifolium campestre* to 0.5m. Vegetation is in Completely Degraded condition.
- PCEc** Parkland Cleared with *Eucalyptus camaldulensis* (River Gum), *Eucalyptus platypus* (Moort) and *\*Ficus* sp. to 14m over scattered *Acacia saligna* and *Acacia rostellifera* to 2.5m over Open Woodland over Grassland of *\*Cynodon dactylon* (Couch), *\*Avena fatua* (Wild Oats) and *\*Bromus hordaceus* to 0.5m. Vegetation is in Degraded condition.
- PTs** Planted tree species including *\*Eucalyptus camaldulensis* (River Gum), *\*Eucalyptus platypus* (Moort), *Callitris preissii* (Rottnest Island Pine), *\*Agonis flexuosa* (Native Peppermint) and *\*Eucalyptus conrnuta* (Yate) to 16m over Herbland of *\*Gazania linearis*, *\*Fumaria capreolata* and *\*Cynodon dactylis* (Couch) to 0.3m. Vegetation is in Degraded Condition.

\* = non-native species

The location and extent of these vegetation types are presented in Figure 2. The exposed dunes to the north west of the survey area are formed of deep calcareous sands and support a low heath with no distinct upper storey. The swales to the north are more protected and have a higher organic content in the soils. This allows for tree species such as *Eucalyptus gomphocephala* (Tuart) to grow and assists in supporting a tiered vegetation community with upper, middle and lower stratum.

A number of species were common throughout remnant vegetation in the survey area, irrespective of soils, including *Acacia rostellifera*, *Melaleuca systema*, *Phyllanthus calycinus*, *Olearia axillaris* and *Lechenaultia linaroides*.



#### 4.1.2 Vegetation Condition

Vegetation condition was assessed according to the condition rating scale adopted from Bush Forever (Government of Western Australia, 2000). The Bush Forever condition scale rates vegetation from Completely Degraded to Pristine, as shown in Table 4.

**Table 4**

**Vegetation Condition Rating Scale**

Vegetation Condition Rating Scale (Government of WA, 2000)	
P	Pristine Pristine or nearly so, no obvious signs of disturbance
Ex	Excellent Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species
VG	Very Good Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
G	Good Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Deg	Degraded Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
CD	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 composing weed or crop species with isolated native trees or shrubs.

The condition of remnant vegetation in the survey area ranges from Very Good to Excellent. The vegetation in the dunes to the north-west of the survey area was classified as being in Excellent condition. Other than a narrow track which winds through the dune, little disturbance has occurred in this area and few weeds occur. The vegetation dominated by remnant *Eucalyptus gomphocephala* (Tuart) is generally in Good condition. A number of aggressive weed species have colonised this vegetation type and have out-competed some native species.

The remainder of the survey area has been cleared and therefore the condition is considered to be Degraded or Completely Degraded. Aggressive weed species dominate in these areas and there is little opportunity for rehabilitating the site. The condition of vegetation types is presented in Appendix B.

#### **4.1.3 Conservation Significance of Vegetation**

The survey area occurs in association with the Cottesloe – Central and South and Quindalup Vegetation Complexes. Approximately 36% of the original 8,670ha of the Cottesloe – Central and South Complex remained in 2000, with 18% proposed to be protected in reserves. Bush Forever indicated that approximately 48% of the original 24,381ha of the Quindalup complex remained in 2000, with 20% proposed to be protected. Both of these vegetation complexes therefore meet the minimum 10% reservation proposed by Bush Forever and are not considered to be of local or regional significance (Government of Western Australia, 2000a).

The dune to the northwest of the survey area may be considered to be of local significance as it supports a high quality representation of a vegetation type more typically located closer to the coast. Both the landform and vegetation are unusual in being located almost 5km from the coastline, surrounded by residential development and having few weed species other than on the edges.

##### **4.1.3.1 Floristic Community Types**

Vegetation in the survey area is most closely associated with Swan Coastal Plain (SCP) Floristic Community Type (FCT) 24: Northern Spearwood Shrublands and Woodlands. Most of the FCT 24 sites occur on the Cottesloe unit of the Spearwood Dune System. The community is well-reserved but is considered to be susceptible to modification from threatening processes which would threaten its conservation status. Average species per plot is 41.8 and weed frequency is high, with a mean of 14.2 per plot. FCT 24 is not categorised as a TEC by the DEC.

##### **4.1.3.2 Threatened Ecological Communities**

No Threatened Ecological Communities (TEC's) were identified from the survey area.

## **4.2 Flora**

A total of 53 species from 29 plant families were recorded from the spring flora survey. The dominant families were Poaceae (Grasses) and Myrtaceae (*Eucalypts*) with six taxa represented from each. Papilionaceae (Pea family) was also dominant with five taxa represented. A full species list is presented in Appendix B.

Sixteen of the species recorded are classified as weeds. The dominant weed family was Poaceae (Grasses) with five taxa. A number of species which are native to Western Australia, but not the survey area were recorded (from quadrats and opportunistically), including *Eucalyptus camaldulensis* (River Gum), *Eucalyptus cornuta* (Yate), *Eucalyptus platypus* (Moort) and *Callitris preissii* (Rottnest Island Pine).

Quadrat 3 had the highest species richness with 22 species recorded. Quadrat 6 had the lowest species richness with six species (all weeds) recorded. Quadrat data is presented in Appendix A.

#### 4.2.1 Conservation Significance of Flora

No flora of conservation significance were recorded in the survey area. As much of the survey area has been cleared, the northern extent of the survey area represents the only area where conservation significant species were potentially considered to occur. The majority of the conservation significant species listed by the DEC are associated with winter wet area and/or limestone which did not occur in the survey area.

Soils in the survey area range from deep white-grey sand to brown-grey sand which are similar to the soils associated with some of the DEC listed conservation significant species. None of these species were recorded, however, despite it being considered an optimal time of the year to search for them.



## 5 POTENTIAL IMPACTS OF PROPOSED DEVELOPMENT

The majority of the survey area is considered appropriate for the proposed residential development of the site. As the majority of the remnant vegetation has been cleared from the site, little native vegetation of high quality remains. The vegetation to the northwest of the survey area is in Excellent condition and it is recommended that where possible, clearing in this area should be avoided and consideration given to the retention of the area as Public Open Space (POS) within any future proposed residential development of the site. Consideration should be put towards maintaining the quality of this and other remnant vegetation surrounding the proposed development.

No TEC's were recorded within or surrounding the survey area and similarly, no flora of conservation significance were recorded within or adjacent to the proposed project area.

Mature trees should be retained where possible and preference given to retaining native flora species rather than planted exotic species.

## 6 SUMMARY AND CONCLUSIONS

The following is a summary of the works conducted, results and recommendations of the spring flora and vegetation survey conducted on 9 October, 2007:

- The survey area was surveyed by an experienced botanist from Coffey Environments on 9 October 2007. The survey was conducted in accordance with EPA Guidance Statement 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*;
- The survey area occurs on the site of the former Craigie High School, in Craigie. The majority of the survey area has been previously cleared. One area of remnant vegetation remains. Seven permanent quadrats were sampled in representative vegetation types as part of this survey;
- The majority of the survey area has been mapped by Heddle *et al.* (1980) as occurring in association with, the Cottesloe – Central and South vegetation Complex, although the southeast corner is mapped as associated with the Quindalup Vegetation Complex. Both Vegetation Complexes are well reserved on the Swan Coastal Plain;
- Five vegetation types were recorded in the survey area. The condition of vegetation in the survey area ranges from Completely Degraded to Excellent depending on the extent of disturbance and weed species present;
- Remnant vegetation in the survey area is most closely associated with Swan Coastal Plain Floristic Community 24: Northern Spearwood Shrublands and Woodlands. FCT 24 is well reserved on the Swan Coastal Plain, although it is considered 'susceptible' to threatening processes. FCT 24 is not classified as a TEC by the DEC;
- No TEC's or conservation significant vegetation were recorded in the survey area, although the dune and associated vegetation present in the northwest of the survey area are considered to be locally significant due to the distance from the coast and high quality;
- A total of 53 species were recorded from the seven sampled quadrats and from opportunistic observations over the site. The dominant family was Poaceae (Grasses). Sixteen weed species were recorded, many of which are considered aggressive;
- No flora of conservation significance were recorded in the survey area;
- It is recommended that where possible, disturbance is minimised to the vegetation in the northwest corner of the survey area and mature native trees are retained.

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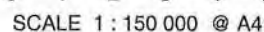
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# Figures

**Flora & Vegetation Survey  
Former Craigie High School Site, Craigie**





# Appendix A Quadrat Data

Flora & Vegetation Survey  
Former Craigie High School Site, Craigie

# Craigie High School Site

Site: Quadrat 1

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382511mE; 6482686mN

Habitat: North side of dune.

Soil: White-grey sand. No leaf litter.

Vegetation: *Melaleuca systema*, *Acacia rostellifera*, *Santalum acuminatum*, *Olearia axillaris*, *Acanthocarpus preissii* and *Gastrolobium nervosum* Open Heath over Low Open Heath of *Phyllanthus calycinus*, *Hibbertia subvaginata*, *Lomandra maritima*, *Lechenaultia linaroides*, *Conostylis candicans* ssp. *calicola* and *Lepidosperma pubisquameum*.

Veg Condition: Excellent



## Species List:

### Name

### Cover (%)

### Height (m)

*Acacia lasiocarpa*

5-10

0.8

*Acacia rostellifera*

25

1.4

*Acanthocarpus preissii*

2-5

0.6

*Anagalis arvensis* var. *arvensis*

2

0.15

*Conostylis aculeata*

5-10

0.2

*Desmocladius flexuosus*

5-10

0.15

*Conostylis candicans* ssp. *candicans*

2

0.2

*Euphorbia terracina*

2

0.2

*Gastrolobium nervosum*

5

0.8

*Gompholobium tomentosum*

2-5

0.3

*Hemiandra pungens*

5

0.15

*Hibbertia subvaginata*

5

0.4

*Kennedia prostrata*

5

0.15

*Lepidosperma squamatum*

15-20

0.2

*Lomandra maritima*

20

0.2

*Melaleuca systema*

15-20

1.2

*Nitraria billardiarei*

5

0.6

*Olearia axillaris*  
*Pelargonium capitatum*

10  
2-5

1.4  
0.2

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# Craigie High School Site

Site: Quadrat 2

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382533mE; 6482735mN

Habitat: North side of dune.

Soil: Grey sand. No leaf litter.

Vegetation: *Melaleuca systema*, *Acacia rostellifera*, *Santalum acuminatum*, *Olearia axillaris*, *Acanthocarpus preissii* and *Gastrolobium nervosum* Open Heath over Low Open Heath of *Phyllanthus calycinus*, *Hibbertia subvaginata*, *Lomandra maritima*, *Lechenaultia linarioides*, *Conostylis candicans* ssp. *calicola* and *Lepidosperma pubisquameum*.

Veg Condition: Excellent



## Species List:

Name	Cover (%)	Height (m)
<i>Acacia lasiocarpa</i>	5-10	0.8
<i>Acanthocarpus preissii</i>	2-5	0.5
<i>Calandrinia liniflora</i>	2-5	0.05
<i>Conostylis aculeata</i>	10	0.2
<i>Conostylis aurea</i>	2-5	0.25
<i>Desmocladius flexuosus</i>	5-10	0.15
<i>Conostylis candicans</i> ssp. <i>candicans</i>	2-5	0.2
<i>Diplotaxis muralis</i>	2	0.4
<i>Euphorbia terracina</i>	2	0.2
<i>Gompholobium tomentosum</i>	5	0.3
<i>Grevillea crithmifolia</i>	5-10	0.5
<i>Lechenaultia linarioides</i>	5	0.3
<i>Lepidosperma squamatum</i>	10	0.2
<i>Lomandra maritima</i>	10	0.2
<i>Melaleuca systema</i>	20	1.2
<i>Olearia axillaris</i>	5-10	1
<i>Opercularia vaginata</i>	5	0.15

*Pelargonium capitatum*  
*Phyllanthus calycinus*  
*Santalum acuminatum*

2-5  
5  
35

0.25  
0.35  
2

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**Craigie High School Site**  
**Site: Quadrat 3**

**Described:** JA                      **Date:** 9/10/2007                      **Type:** Quadrat (10m x 10m)                      **Season:** Excellent

**MGA Zone:** 50                      382626mE; 6482715mN

**Soil:**                      White - grey sand. No leaf litter.

**Vegetation:**                      *Melaleuca systema*, *Acacia rostellifera*, *Olearia axillaris*, *Acanthocarpus preissii* and *Gastrolobium nervosum* Open Heath over Low Open Heath of *Phyllanthus calycinus*, *Hibbertia subvaginata*, *Lomandra maritima*, *Lechenaultia linarioides*, *Conostylis candicans* ssp. *calicola* and *Lepidosperma pubisquameum*.

**Veg Condition:**                      Very Good – Excellent



**Species List:**

Name	Cover (%)	Height (m)
<i>Acacia lasiocarpa</i> var. <i>lasiocarpa</i>	5-10	0.75
<i>Acacia rostellifera</i>	5	1.1
<i>Acanthocarpus preissii</i>	2-5	0.5
<i>Anagallis arvensis</i> var. <i>arvensis</i>	2-5	0.15
<i>Conostylis aculeata</i>	5	0.2
<i>Euphorbia terracina</i>	5	0.3
<i>Hardenbergia comptoniana</i>	5	climber
<i>Hibbertia subvaginata</i>	5	0.5
<i>Lagurus ovatus</i>	5-10	0.2
<i>Lechenaultia linarioides</i>	2-5	0.3
<i>Lepidosperma squamatum</i>	5	0.2
<i>Leucopogon parviflorus</i>	5	0.6
<i>Lomandra maritima</i>	5-10	0.2
<i>Melaleuca systema</i>	25	1.2
<i>Olearia axillaris</i>	5	0.5
<i>Opercularia vaginata</i>	5	0.2
<i>Oxalis pes-caprae</i>	2-5	0.2
<i>Phyllanthus calycinus</i>	5-10	0.6



<i>Pimelea rosea</i>	5	0.5
<i>Santalum acuminatum</i>	5	1
<i>Sonchus oleraceus</i>	2	0.2
<i>Trifolium campestre</i>	5	0.1

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# Craigie High School Site

Site: Quadrat 4

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382732mE; 6482802mN

Soil: Brown - grey sand. Moderate - High leaf litter.

Vegetation: *Eucalyptus gomphocephala* Woodland over *Melaleuca lanceolata* and *Acacia cyclops* over Open Heath of *Melaleuca systema*, *Acanthocarpus preissii*, *Phyllanthus calycinus* over Low Shrubland of *Lomandra maritima*, *Conostylis aculeata*, *Desmocladius flexuosa*, \**Euphorbia terracina* and \**Pelargonium capitatum*.

Veg Condition: Very Good



## Species List:

### Name

### Cover (%)

### Height (m)

*Acacia rostellifera*

5

0.9

*Acanthocarpus preissii*

5

0.6

*Avena fatua*

20

1

*Conostylis aculeata*

2-5

0.2

*Desmocladius flexuosus*

5

0.15

*Diplotaxis muralis*

2

0.4

*Eucalyptus gomphocephala*

20

9

*Euphorbia terracina*

10

0.2

*Fumaria capreolata*

5

0.1

*Gazania linearis*

2

0.15

*Lechenaultia linarioides*

2

0.3

*Lomandra maritima*

5

0.2

*Melaleuca lanceolata*

5

1.4

*Melaleuca systema*

40

1.6

*Olearia axillaris*

5

1

*Pelargonium capitatum*

5-10

0.2

*Phyllanthus calycinus*

5

0.4

*Sonchus oleraceus*

2-5

0.5

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# Craigie High School Site

Site: Quadrat 5

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382678mE; 6482764mN

Soil: Grey sand. Little leaf litter.

Vegetation: *Eucalyptus gomphocephala* Woodland over *Melaleuca lanceolata* and *Acacia cyclops* over Open Heath of *Melaleuca systema*, *Acanthocarpus preissii*, *Phyllanthus calycinus* over Low Shrubland of *Lomandra maritima*, *Conostylis aculeata*, *Desmocladius flexuosa*, \**Euphorbia terracina* and \**Pelargonium capitatum*.

Veg Condition: Very Good – Excellent



## Species List:

### Name

### Cover (%)

### Height (m)

*Acacia lasiocarpa* var. *lasiocarpa*

5

0.7

*Acacia rostellifera*

5

1

*Acanthocarpus preissii*

2-5

1

*Anagallis arvensis* var. *arvensis*

5

0.15

*Avena fatua*

5-10

1

*Conostylis aculeata*

5

0.2

*Desmocladius flexuosus*

5

0.15

*Diploaxis muralis*

2

0.5

*Eucalyptus gomphocephala*

30

8

*Euphorbia terracina*

2-5

0.2

*Lechenaultia linarioides*

2

0.3

*Lepidosperma squamatum*

5

0.2

→ *Lomandra maritima*

5

0.2

*Melaleuca systema*

25

1.3

*Opercularia vaginata*

5

0.15

*Pelargonium capitatum*

2-5

0.2

*Schoenus grandiflorus*

2-5

0.8

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# Craigie High School Site

Site: Quadrat 6

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382840mE; 6482652mN

Soil: Grey sand. No leaf litter.

Vegetation: Parkland Cleared of \**Cynodon dactylon*, *Gazania linearis*, \**Avena fatua*, *Lotus subbiflorus*.and *Trifolium campestre*.

Veg Condition: Degraded



## Species List:

### Name

*Avena fatua*  
*Cynodon dactylon*  
*Gazania linearis*  
*Lotus subbiflorus*  
*Sonchus oleraceus*  
*Trifolium campestre*

### Cover (%)

2  
60  
2-5  
2  
2  
2-5

### Height (m)

0.5  
0.1  
0.1  
0.05  
0.2  
0.05



# Craigie High School Site

Site: Quadrat 7

Described: JA

Date: 9/10/2007

Type: Quadrat (10m x 10m)

Season: Excellent

MGA Zone: 50 382649mE; 6482629mN

Soil: Grey sand. No leaf litter.

Vegetation: Parkland Cleared with *Eucalyptus camaldulensis*, *Eucalyptus platypus* and \**Ficus* sp. with scattered *Acacia saligna* and *Acacia rostellifera* over Open Woodland over Grassland of \**Cynodon dactylon*, \**Avena fatua* and \**Bromus hordaceus*.

Veg Condition: Completely Degraded



## Species List:

### Name

*Avena fatua*

*Bromus diandrus*

*Bromus hordaceus*

*Cynodon dactylon*

*Eucalyptus camaldulensis*

*Euphorbia terracina*

*Lagurus ovatus*

*Sonchus oleraceus*

### Cover (%)

10

5

15

60

40

2

5

2

### Height (m)

0.5

0.15

0.2

0.05

12

0.2

0.2

0.4

**Appendix B**  
**Flora Species Recorded at**  
**Craigie High School Site**

**Flora & Vegetation Survey**  
**Former Craigie High School Site, Craigie**

# FLORA SPECIES RECORDED AT CRAIGIE HIGH SCHOOL SITE

Number of quadrats recorded from

<b>018 CUPRESSACEAE</b>	
<i>Callitris preissii</i>	1
<b>031 POACEAE</b>	
* <i>Avena fatua</i>	2
* <i>Bromus diandrus</i>	1
* <i>Bromus hordaceus</i>	1
* <i>Cynodon dactylon</i>	2
* <i>Lagurus ovatus</i>	1
* <i>Ehrharta calycina</i>	1
<b>032 CYPERACEAE</b>	
<i>Lepidosperma squamatum</i>	4
<i>Schoenus grandiflorus</i>	1
<b>039 RESTIONACEAE</b>	
<i>Desmocladius flexuosus</i>	4
<b>054C DASYPOGONACEAE</b>	
<i>Acanthocarpus preissii</i>	5
* <i>Lomandra maritima</i>	5
<b>055 HAEMODORACEAE</b>	
<i>Conostylis aculeata</i>	5
<i>Conostylis aurea</i>	1
<i>Conostylis candicans</i> ssp. <i>candicans</i>	2
<b>087 MORACEAE</b>	
<i>Ficus</i> sp.	1
<b>089 ARAUCARIACEAE</b>	
<i>Araucaria heterophylla</i>	1
<b>090 PROTEACEAE</b>	
<i>Grevillea crithmifolia</i>	1
<b>092 SANTALACEAE</b>	
<i>Santalum acuminatum</i>	2
<b>111 PORTULACACEAE</b>	
<i>Calandrinia liniflora</i>	1
<b>136 FUMARIACEAE</b>	
* <i>Fumaria capreolata</i>	1
<b>138 BRASSICACEAE</b>	
* <i>Diplotaxis muralis</i>	3
<b>163 MIMOSACEAE</b>	
<i>Acacia cyclops</i>	1
<i>Acacia lasiocarpa</i> var. <i>lasiocarpa</i>	4
<i>Acacia rostellifera</i>	4



*Acacia saligna* 1

**165 PAPILIONACEAE**

*Gastrolobium nervosum* 1

*Gompholobium tomentosum* 2

*Hardenbergia comptoniana* 1

*Kennedia prostrata* 1

\* *Trifolium campestre* 1

**167 GERANIACEAE**

\* *Pelargonium capitatum* 4

**168 OXALIDACEAE**

\* *Oxalis pes-caprae* 1

**173 ZYGOPHYLLACEAE**

*Nitraria billardiarei* 1

**185 EUPHORBIACEAE**

\* *Euphorbia terracina* 5

*Phyllanthus calycinus* 3

**226 DILLENIACEAE**

*Hibbertia subvaginata* 2

**263 THYMELAEACEAE**

*Pimelea rosea* 1

**273 MYRTACEAE**

*Agonis flexuosa* 1

*Eucalyptus camaldulensis* 1

*Eucalyptus gomphocephala* 2

*Melaleuca lanceolata* 1

*Eucalyptus platypus* 1

*Melaleuca systema* 5

**281 APIACEAE**

*Trachymene coerulea* 1

**288 EPACRIDACEAE**

*Leucopogon parviflorus* 1

**293 PRIMULACEAE**

\* *Anagalis arvensis* var. *arvensis* 3

**313 LAMIACEAE**

*Hemiandra pungens* 1

**331 RUBIACEAE**

*Opercularia vaginata* 3

**341 GOODENIACEAE**

*Lechenaultia linarioides* 4

**345      ASTERACEAE**

* <i>Cotula turbinata</i>	1
* <i>Gazania linearis</i>	1
<i>Olearia axillaris</i>	4
* <i>Sonchus oleraceus</i>	3

Total species recorded	53
Total native species	37
Total non-native species	16





# LEGEND

- Site Boundary
- Cadastral Boundary
- Vegetation Complex Boundary
- Vegetation Type Boundary
- Quadrat Location

## VEGETATION COMPLEXES

- 52 Cottesloe Complex - Central And South
- 55 Qindalup Complex

## VEGETATION TYPE DESCRIPTIONS

### MsArOh

*Melaleuca systema*, *Acacia rostellifera*, *Santalum acuminatum*, *Olearia axillaris*, *Acanthocarpus preissii* and *Gastrolobium nervosum* Open Heath over Low Open Heath of *Phyllanthus calycinus*, *Hibbertia subvaginata*, *Lomandra maritima*, *Lechenaultia linaroides*, *Conostylis candicans* ssp. *calicola* and *Lepidosperma pubisquameum*.

### EgW

*Euclayptus gomphocephala* (Tuart) Woodland to 9m over *Melaleuca lanceolata* to 4m over Open Heath of *M. systema*, *A. preissii*, *P. calycinus* to 1.3m over Open Grassland of *Avena fatua* and *Ehrharta calycina* to 1m over Low Shrubland of *L. maritima*, *Conostylis aculeata*, *Desmodcladus flexuosa*, *Euphorbia terracina* and *Pelargonium capitatum* to 0.5m.

### PC

Parkland Cleared of *Cynodon dactylon* (Couch), *Avena fatua* (Wild Oat), *Ehrharta calycina* (Veldt Grass), *Lotus subbiflorus* and *Cotula turbinata* to 0.7m.

### PcEc

Parkland Cleared with *Eucalyptus camaldulensis* (River Gum), *Araucaria heterophylla* (Norfolk Island Pine), *Eucalyptus platypus* and *Ficus* sp. Open Woodland to 15m over Grassland of *Cynodon dactylon* (Couch), *Avena fatua* (Wild Oat) and *Bromus hordaceus* to 1m.

### PTs

Planted tree species including *Eucalyptus camaldulensis*, *Eucalyptus platypus*, *Callitris preissii*, *Agonis flexuosa* and *Eucalyptus cornuta* over Herbland of *Gazania linearis*, *Fumaria capreolata* and *Cynodon dactylis* (Couch) to 0.3m.

\* = non-native species

## VEGETATION CONDITION

(Legend Source: BUSH FOREVER Govt. of W.A.)

- P Pristine. (Not Applicable)
- Ex Excellent.
- VG Very Good.
- G Good.
- D Degraded.
- CD Completely Degraded.

NOTE: For full description see text.

SOURCE: CAD - DPI, 2000; IMAGERY - Google Earth, 2007

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## VEGETATION TYPES AND CONDITION

FIGURE 2





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19 April 2010

Our ref: 7200-2107-09R

## **CRAIGIE HIGH SCHOOL VEGETATION CONDITION AND LOMANDRA SURVEY**

### **1. Introduction**

Landcorp and Stockland are currently redeveloping the Craigie High School. Part of the development works will affect the northern adjacent dune vegetation. Landcorp and Stockland have committed to restoring the dunal vegetation and installing some paths and infrastructure to increase social amenity value.

Also, the vegetation has been confirmed by DEC to contain habitat for the conservation significant Graceful Sun Moth (GSM) (*Synemon gratiosai*). The plant species *Lomandra maritima* is recorded throughout the study area. The herb is known to be a host plant for the endangered moth species. Part of the development constraints is that it cannot result in an impact on the *Lomandra* populations, as this would reduce potential GSM habitat.

Ecoscape was commissioned to conduct biological surveys of the dunal vegetation north of the Craigie High School Development project. Two surveys – vegetation condition and woody weeds – were conducted to aid in directing future restoration and landscaping works. A flora survey was also conducted to determine the distributions and densities of *Lomandra maritima* populations.

## Methods

### 2.1 Vegetation Condition

A senior environmental scientist traversed the site on foot and map the bushland condition using the Keighery (1994) *Bushland Condition Scale* (**Table 1**). The footprint of any tracks were mapped and attributed as 'Completely Degraded' where they exceeded 2 metres in width. Any observations of what may be affecting the bushland condition other than weeds were also recorded (eg "goat tracks", fire, rubbish dumping, damage by vehicles).

**Table 1: Keighery (1994) Bushland condition scales for natural area assessment**

Scale	Condition
Pristine	No obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance only affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered, obvious signs of disturbance (eg repeated fires, aggressive weeds, dieback, logging and grazing)
Good	Vegetation structure altered, obvious signs of disturbance. Retains basic vegetation structure or ability to regenerate it. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Requires intensive management. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Completely Degraded	Vegetation structure is no longer intact and the area is completely or almost completely without native flora. 'Parkland Cleared'.

### 2.2 Weed Mapping

The timing of the survey was not optimal for a detailed weed survey. Many herbaceous, geophytic (bulb) and grass weeds cannot be identified or mapped at the end of summer. Weed mapping was then restricted to "woody" perennial weed species, as these plants can be surveyed at any time of year.

A senior environmental scientist identified and recorded the location of individual plants or boundaries of populations of woody weeds using a hand held Global Positioning System (GPS) unit. In addition, any identified herbaceous and grass species were recorded.

### 2.3 *Lomandra* Survey

A *Lomandra* survey was performed in the part of the dunal vegetation that was encroached by the development. The survey involved searching for two *Lomandra* species known to provide habitat value for GSM:

- *Lomandra hermaphrodita*
- *Lomandra maritima*.

A botanist traversed this area on foot randomly placing fourteen 2 m x 2 m quadrats. The following items were recorded for each quadrat:

- *Lomandra* species
- number of plants
- percentage cover
- GSP position

Plant specimens were retained to confirm identification of the *Lomandra* species.

The area surveyed was then mapped according to three density ratings of *Lomandra* plants, according to the quadrat data and site observations:

- 0-10%
- 10-30%
- 30-70%.

## 2. Results

### 2.1 *Vegetation Condition*

Vegetation condition varied from *Completely Degraded* to *Excellent* (Table 2, Map 1). Overall, over two third of the site was in *Good* or better condition. Most of the western and central areas were in *Good* to *Very Good* condition, having some site disturbance and weed cover. A section of vegetation adjacent to the western end of Cawarra Crescent was in *Excellent* condition, having most of its vegetation structure and very little disturbance. The eastern portion of the study area varied from *Completely Degraded* to *Good*.

Much of the vegetation immediately north of the oval had recently been burnt, so could not be assessed. However, judging from adjacent vegetation, it was likely to have been originally in *Good* condition.

Main factors attributing to site disturbance and degradation were:

- invading weeds
- walk trails
- fire
- vehicles.



**Table 2: Vegetation Condition of Craigie Bushland**

Condition	Area	
	ha	%
Pristine	0	0
Excellent	0.25	5.4
Very Good	1.22	26.0
Good	1.68	35.7
Degraded	0.75	15.9
Completely Degraded	0.25	5.2
Burnt	0.56	11.8
<b>TOTAL</b>	<b>4.70</b>	<b>100</b>

### **3.2 Weed Mapping**

A total of four woody weed species were recorded in the study area and mapped:

- *Agave americana* (Century Plant)
- *Arundo donax* (Giant Reed)
- *Leptospermum laevigatum* (Victorian Tea Tree)
- *Schinus terebinthifolia* (Japanese Pepper)

Locations of the woody weeds are presented in **Map 2**.

*Agave americana* (Century Plant) was the most proliferate weed species and is continuing to spread into the study area. The species appears to be a “garden escape” from the adjacent northern residential gardens

A single plant of *Arundo donax* (Giant Reed) was observed in the north-east area. The plant was observed to recently set seed, so it is likely to further spread and further degrade the vegetation condition.

Several large shrubs of *Leptospermum laevigatum* (Victorian Tea Tree) were observed near the eastern end of Cawarra Crescent. This species is known to be highly invasive of Perth bushlands and poses a high risk to the vegetation condition.

A total of 12 *Schinus terebinthifolia* (Japanese Pepper) trees were recorded scattered across the study area. The species prefers moister environments, such as near lakes and rivers, so is unlikely to spread further into the dunal vegetation. However, if not removed, the plants will grow into large trees (>10m height) and become much more expensive to remove.

Herbaceous and grass weed species observed were:

- *Avena* sp. (Wild Oat).
- *Bromus diandrus* (Brome Grass)
- *Conyza bonariensis* (Fleabane)
- *Cynodon dactylon* (Couch)
- *Ehrharta calycina* (Perennial Veldt Grass)
- *Euphorbia terracina* (Geraldton Carnation Weed)
- *Lagurus ovatus* (Hares Tail Grass)
- *Pelargonium capitatum* (Rose Pelargonium)

No geophyte species were observed. Species such as *Gladiolus caryophyllaceus* (Wild Gladiolus) may be on site, however these plant die back to undergrounds bulbs and remain dormant in summer, waiting for winter rains to resprout and reproduce.

An additional survey in winter or autumn will be required if any of the observed species and any present geophyte species are required to be mapped.

### 3.2 *Lomandra* Survey

*Lomandra maritima* was identified within the study area (**Table 3**). A total of 58 individuals were recorded within fourteen 2m x 2m quadrats. No *Lomandra hermaphrodita* was found during the survey or the targeted searches carried out.

Dunal areas with the development boundary vary from 0 to 70% cover of *Lomandra maritima*. Distributions of the *L. maritima* densities are illustrated in **Map 3**.

**Table 3: Abundance of *Lomandra* species per quadrat in Craigie dunal vegetation**

Quadrat	Species	Count	Cover	Easting	Northing
1	<i>L. maritima</i>	12	60%	382523.032	6482641.789
2	<i>L. maritima</i>	13	50%	382549.215	6482670.913
3	<i>L. maritima</i>	21	38	382559.517	6482681.008
4	<i>L. maritima</i>	2	6%	382591.571	6482693.569
5	<i>L. maritima</i>	5	1%	382616.946	6482710.488
6	<i>L. maritima</i>	6	50%	382645.288	6482716.354
7	<i>L. maritima</i>	1	3%	382662.104	6482736.501
8	<i>L. maritima</i>	5	24%	382675.082	6482761.040
9	<i>L. maritima</i>	4	7%	382647.636	6482759.618
10	<i>L. maritima</i>	0	0%	382635.655	6482730.657
11	<i>L. maritima</i>	2	2%	382621.491	6482727.169
12	<i>L. maritima</i>	3	8%	382601.619	6482725.834
13	<i>L. maritima</i>	2	40%	382555.097	6482736.390
14	<i>L. maritima</i>	3	10%	382526.768	6482729.415
<b>TOTAL</b>		<b>58</b>			

## **Conclusion**

### ***Retoration***

Over two thirds of the site was observed to be in *Good* or better condition. These areas are resilient and should fully eventually recover once disturbance pressures (such as walk trails and weeds) are removed. Recovery time may be significantly reduced by some infill planting.

A fifth of the study areas was observed to be degraded. These poorer areas will need more work to properly recover. Restoration works should include:

- controlling weeds
- restricting access to the public
- infill planting with local native species.

The burnt area will need to be monitored and assisted in recovery where required. It is important that any weeds observed in the burnt area are quickly removed before they can spread and dominate the site. Some infill planting may also be required.

All known populations of four woody weed species should be removed to improve the site condition. Work should be done within the next year, as the plants will continue to grow and spread, resulting in higher control costs.

It is recommended that another weed survey be conducted in winter to map herbaceous, grass and geophyte weeds in order to assist in the restoration works.

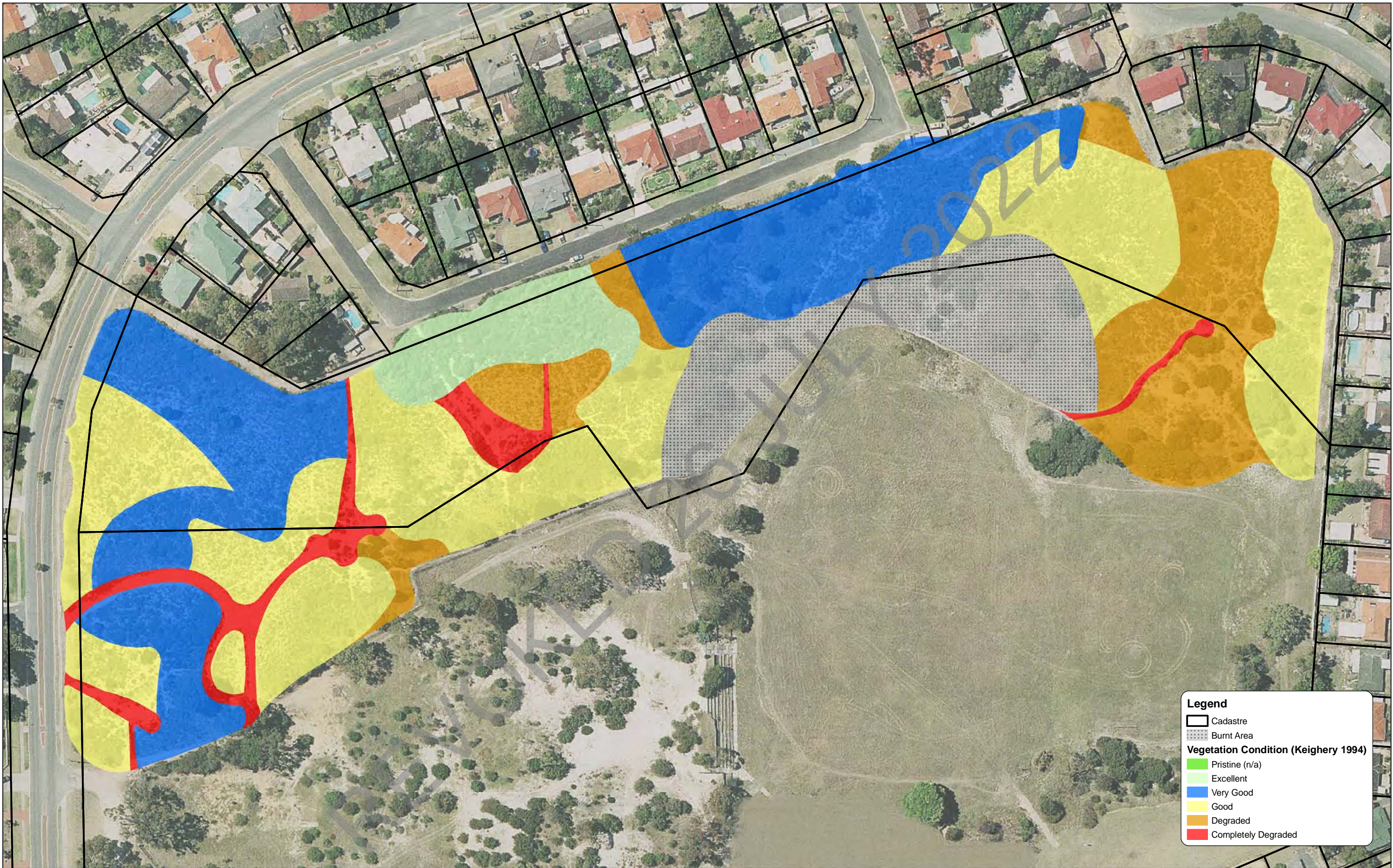
It is understood that there is an active Friends group for the Craigie bushland. It is recommended that this group should be involved in restoration works of the study area.

### ***Graceful Sun Moth Habitat***

The presence of large numbers of *L. maritima* within *Good* to *Excellent* condition bushland creates ideal habitat for the GSM. It is recommended that any developments/clearing of vegetation avoids this area.

Furthermore, GSM have been previously identified within the study area in a survey by the DEC. Larvae are therefore mostly likely to be currently present in the *Lomandra* plants. As GSM larvae may take almost two years to develop and emerge (Carly Bishop, DEC pers comm.), the *Lomandra* host plants must be retained for adults that may emerge next March.





**Legend**

▬ Cadastre

▨ Burnt Area

**Vegetation Condition (Keighery 1994)**

■ Pristine (n/a)

■ Excellent

■ Very Good

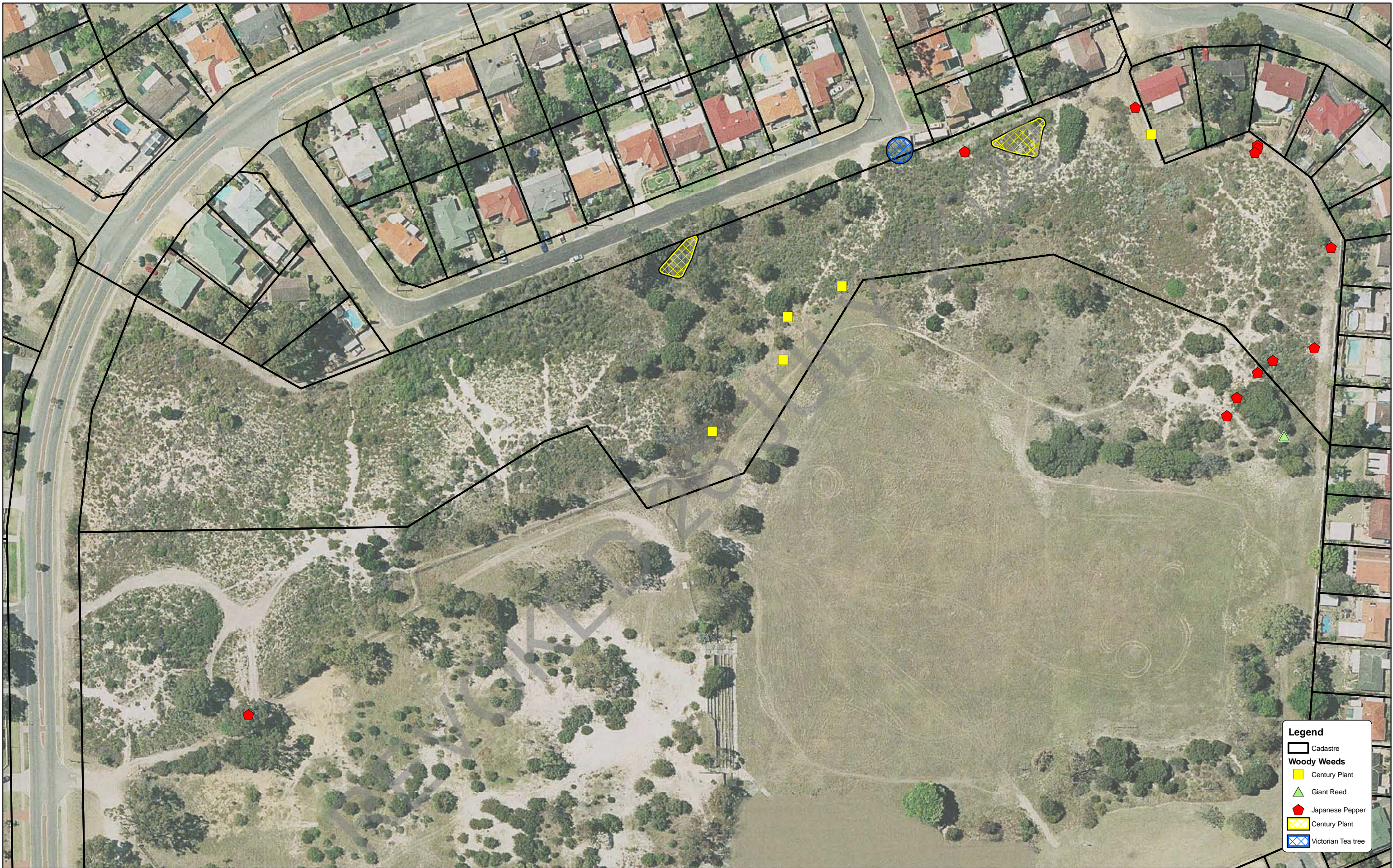
■ Good

■ Degraded

■ Completely Degraded







**Legend**

- Cadastral
- Woody Weeds**
  - Century Plant
  - Giant Reed
  - Japanese Pepper
  - Century Plant
  - Victorian Tea tree











**LOT 500 & 501**  
**LOCAL STRUCTURE PLAN**  
**TRAFFIC & MOVEMENT NETWORK**

CRAIGIE, CITY OF JOONDALUP

**Final Report**

for Emerson Stewart Engineers

July 2010

*Bruce Aulabaugh*

*Traffic Engineering & Transport Planning*

*Integrated Transport Solutions for Sustainable Communities*

LOT 500 & 501  
CAMBERWARRA DRIVE,  
CRAIGIE

LOCAL STRUCTURE PLAN:

TRAFFIC AND MOVEMENT  
NETWORK

*Final Report*

For:  
Emerson Stewart Consulting Engineers

July 2010  
Craigie Lot 500 & 501

This report has been prepared in accordance with the scope of services described in the contract or agreement between Bruce Aulabaugh and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client and Bruce Aulabaugh accepts no responsibility for its use by other parties.

Approved by: Bruce Aulabaugh (Traffic/ Transport Engineer)

Signed:



Date:

30 July 2010



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## APPENDICES

- A. EXISTING ROAD PHOTOS
- B. TRAFFIC COUNTS & SPEED DATA
- C. SCHOOL TRAFFIC PHOTOS (PM PEAK)
- D. TRAFFIC MODELLING INFORMATION
- E. ALBION STREET WIDENING AT MARMION AVE
- F. TRANSPERTH ROUTE 463 TIMETABLE

# INTRODUCTION

Bruce Aulabaugh was appointed by Emerson Stewart Consulting Engineers to provide traffic and transport planning advice for the Lot 500 & 501, Craigie Local Structure Plan.

The scope of works includes traffic forecasting, traffic management advice, internal street design, and advice on public transport and pedestrian/cyclist facilities.



Figure 1: Locality Plan for Lot 500 & 501 Local Structure Plan (red line shows site boundary)

# EXISTING ROADS & TRAFFIC

## 2.1 EXISTING ROADS

### District Distributor Type A – Marmion A

Marmion Avenue is an Other Regional Road (Blue Road) in the Metropolitan Region Scheme and is classified as a District Distributor Type A. It is constructed to a 4-lane divided arterial standard with a median.

### Albion Street and Camberwarra Crescent

Albion Street and Camberwarra Crescent are Local Distributor Roads, designed to provide property access, distribute local traffic and provide connection to District Distributor Roads. These are 2-lane roads with 4m carriageways and a 2m painted median. Kerbed median islands are located at key intersections and driveways.

Camberwarra Crescent provides a local traffic loop with other roads (such as Albion Street) providing the final connection to the district/ regional road network.

### Arawa Place

Arawa Place is a 2-lane undivided local Access Street which provides property access and connects to Camberwarra Crescent.

### Other Local Roads

There are other local roads in the vicinity of the site but those mentioned above are the most important to Lot 500 & 501 access planning and traffic management and are the focus of this report.

Refer to *Appendix A* for photographs of these roads.



## 2.2 EXISTING TRAFFIC COUNT AND SPEED DATA

Existing traffic count data (August 2008) was provided by the City of Joondalup for Albion Street and Camberwarra Crescent. In addition, AM peak hour turn movement traffic counts were collected on Wednesday the 3<sup>rd</sup> and Thursday the 4<sup>th</sup> of February, 2010.

The counts covered the 7:30-9:00am period at the intersections shown in Figure 2 and listed below:

- Marmion Ave/ Albion Street
- Albion Street/ Camberwarra Crescent
- Camberwarra Crescent/ Arawa Place
- Camberwarra Crescent/ Catholic Church & Primary School.



Figure 2. February 2010 AM Peak Traffic Count Locations (photo by NearMap)

Two way daily traffic volumes and speed data (August 2008 counts) are summarised below:

- Albion Street: 1435 veh/day; 99% of vehicles < 60km/hr, 79.4% of vehicles < 50km/hr
- Camberwarra Crescent: 2098 veh/day; 86% of vehicles < 60km/hr, 46.6% of vehicles < 50km/hr

No count data was available from the City of Joondalup for Arawa Place. However, the intersection turning counts from the 3 February 2010 revealed that very little traffic uses this street in the AM peak hour (i.e. 7 vehicles exited and 2 vehicles entered from Camberwarra Crescent).

Refer to *Appendix B* for traffic count data.

## 2.3 PEAK HOUR TRAFFIC OBSERVATIONS

The AM peak hour traffic observations are summarised in *Table 1*.

<b>Intersection</b>	<b>Observations</b>
Albion/ Marmion Ave	2-4 vehicle queue for left turn to Marmion 1-3 vehicle queue for right turn to Marmion 2-4 vehicle queue for right turn from Marmion.
Albion/ Camberwarra	No vehicle queuing observed
Arawa/ Camberwarra	No vehicle queuing observed
Catholic Church Car Park/ Camberwarra Crescent	Car park fills and occasionally vehicles entering need to turn around using verge or reverse out onto Camberwarra Crescent
Catholic Primary School/ Camberwarra Crescent	Very busy with traffic dropping off students. Some vehicles use verge both sides of Camberwarra Crescent for parking. Occasionally 2-4 vehicles queue to turn right into school car park from Camberwarra. Queues of short duration.

During AM traffic observations, a local resident advised that the PM peak hour had heavy traffic at the Catholic Primary School on Camberwarra Crescent. The school closing time on Friday afternoon was reported to be particularly busy.

A site visit was subsequently undertaken on 5<sup>th</sup> February from 3pm to 4pm. Observations from this visit are summarised in *Table 2*.

<b>Table 2: Traffic Observations PM Peak Hour (3pm-4pm) 3<sup>rd</sup> and 4<sup>th</sup> Feb 2010</b>	
<b>Intersection</b>	<b>Observations</b>
Catholic Church Car Park/ Camberwarra Crescent	Car park fills and vehicles park on adjacent verge.
Catholic Primary School/ Camberwarra Crescent	Very busy with vehicles arriving to pick up children. Traffic attempting to enter the car park sometimes cannot due to internal vehicle queues. Queuing spills onto Camberwarra Crescent for up to an estimated 70-80m.  Vehicles park on verges each side of Camberwarra Crescent. Vehicle speeds are low due to traffic congestion.

The vehicle congestion at the entry to the school car park in the PM peak is greater than the AM peak. In the AM, vehicles can arrive and discharge passengers over a longer time period, without exceeding the storage capacity of the car park.

In the PM, vehicles arrive and store in the car park while waiting for the end of the school day. The vehicles form a dual lane queue and progress to the entrance 'staging' area where students enter vehicles. This arrangement processing appears to be a conscious/ planned operation which the parents are familiar with.

Refer to *Appendix C* for PM Peak photographs of the Primary School/ Camberwarra Crescent intersections.



# TRAFFIC FORECAST AND MICRO SIMULATION

## 3.1 INTRODUCTION

This chapter provides information on the proposed development on Lot 500 & 501, Craigie and the post-development traffic forecast for the AM peak hour. It also discusses the simulation of AM peak hour post development traffic using Paramics-S Micro Simulation software.

## 3.2 LOT 500 & 501 PROPOSED DEVELOPMENT

Information provided by Taylor Burrell Barnett indicates approximately 150 residential dwelling units for the Lot 500 & 501 Local Structure Plan.

## 3.3 SITE TRAFFIC GENERATION

A trip generation rate of 0.8 vehicle trip ends per dwelling per hour is used in this AM Peak Hour traffic forecast and micro simulation. This is the rate recommended in Transport Development Guidelines for Developments Volume 5 – Technical Appendix. An extract from this guide is included in *Appendix D*.

Refer to *Appendix D* for AM Peak Hour Trip Generation information.

Using 0.8 vehicle trips/ AM peak hour per dwelling and an 80% OUT/ 20% IN directional split, yields 130 veh/hour, with 96 vehicle trips exiting the site and 24 vehicle trips entering the site.

## 3.4 VEHICLE ACCESS TO LOT 500 & 501

Two road intersections are proposed to serve Lot 500 & 501:

- Camberwarra Crescent intersection opposite the Catholic Church car park; and
- Arawa Place intersection (west end).

Traffic generated by Lot 500 & 501 will therefore be distributed across two access points. Measured on a daily traffic basis, the amount of traffic is expected to average 650 vehicle trips per access point (using a daily/ peak hour multiplier of 10).

Refer to *Chapter 4* and *Chapter 5* for the Lot 500 & 501 road access and internal network details.

### **3.5 PARAMICS MICRO SIMULATION METHODOLOGY**

Existing traffic conditions were simulated in Paramics using traffic count and queuing information gathered on February 3 and 4, 2010 in the AM peak hour (8am-9am). A post development Paramics model was then developed. The post development traffic was created by adding the Lot 500 & 501 site traffic estimate to the existing traffic.

The road network included in the post development Paramics model included the following changes:

- Lot 500 & 501 site access roads added;
- New roundabout at the access on Camberwarra Crescent opposite the Catholic Church car park; and
- Informal parking area on east side of Camberwarra Crescent is closed. This parking area is located on Lot 500 & 501 landholding and will be replaced with residential dwellings.

### **3.6 PARAMICS MICRO SIMULATION RESULTS**

The post development traffic outputs provided by the Paramics Data Analysis Module include:

- Directional traffic by road link;
- Intersection turning movements;
- Vehicle queuing distances (average and maximum queues);
- Road link travel times (in seconds).

Refer to *Appendix D* for Paramics Micro Simulation Results.

Summary results are provided in *Tables 3, 4 and 5*.

Traffic in AM Peak Hour (8am-9am)

<b>Table 3: Comparison of Pre and Post Development Traffic (AM Peak Hour)</b>		
<b>Location</b>	<b>Post Development</b>	<b>Existing</b>
Albion Street	365veh/hr	293 veh/hr
Camberwarra Crescent (north of Albion Street)	526 veh/hr	435 veh/hr
Arawa Place (east of Camberwarra)	52 veh/hr	16 veh/hr

Maximum '5 minute interval' Average Vehicle Queue (metres) –AM Peak Hour

<b>Table 4: Comparison of Pre and Post Development Queues (AM Peak)</b>		
<b>Location</b>	<b>Post Development</b>	<b>Existing</b>
Marmion Ave - Right turn to Albion	42m	21m
Albion at Marmion at Camberwarra	48m L, 43m R 25m	40m L, 35m R 23m
Camberwarra at Albion (north approach) at Arawa (south approach)	23m 22m	20m 22m
at Church Car Park - North approach - East approach - South approach - West approach	17m 19m 23m 0m	17m 0m 0m 18m
at School Entry - North Approach	35m	20m
Arawa at Camberwarra	23m	0m

*Average queue lengths recorded in 5min intervals over AM peak hour from 6 simulations.  
The maximum of these '5min interval' average queues is shown above.*



Link Travel Time seconds) at intersections

<b>Table 5: Comparison of Pre and Post Development Average Link Travel Time (AM Peak)</b>		
<b>Location</b>	<b>Post Development</b>	<b>Existing</b>
Marmion Ave - Right turn to Albion	40 sec	37 sec
Albion at Marmion at Camberwarra	78 sec 12 sec	49 sec 10 sec
Camberwarra at Albion (north approach) at Arawa (south approach)	6 sec 6 sec	6 sec 6 sec
at Church Car Park - North approach - East approach - South approach - West approach	5 sec 10 sec 5 sec 8 sec	3 sec 9 sec 4 sec 8 sec
at School Entry - North approach	5 sec	4 sec
Arawa at Camberwarra	15 sec	10sec

*These link travel times include 'free flow travel time' which is the time spent by a vehicle in uncongested conditions.*

# INTERSECTION CONTROL AND TRAFFIC MANAGEMENT

## 4.1 PROPOSED ROUNDABOUT ON CAMBERWARRA CRESCENT

On-site consultation with City of Joondalup Technical Service officers on 19 November 2009 resulted in a decision to investigate and confirm Lot 500 & 501 road access to Camberwarra Crescent at a point directly opposite the Catholic Church car park crossover.

After considering a number of factors (forecast traffic loading, sight distance, 4-way configuration, traffic speeds, etc), it was decided that this intersection would be best served with roundabout control. Emerson Stewart Consulting Engineers, in consultation with the City of Joondalup, subsequently prepared a roundabout design drawing (refer to *Figure 3*) which incorporates pre-deflection geometry and median breaks to accommodate existing property access needs.

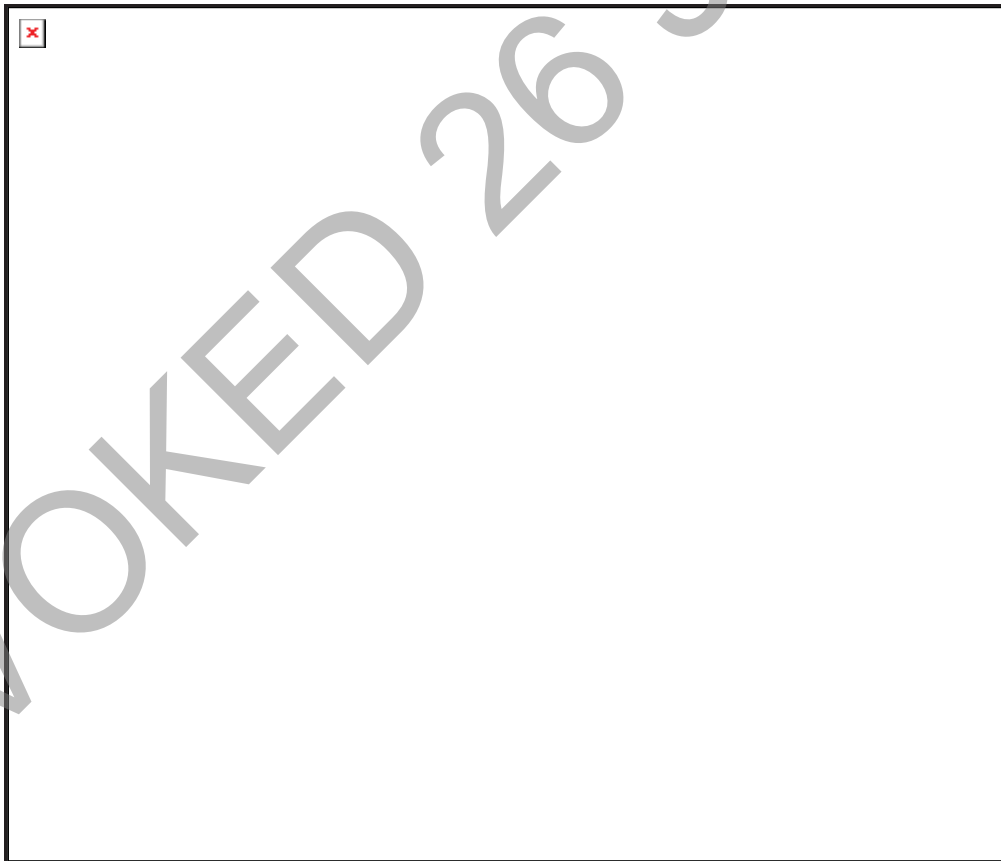


Figure 3: Lot 500 & 501 Site Access: Camberwarra Crescent Roundabout

The Paramics micro simulation (*Chapter 3* and *Appendix D*), shows that the roundabout is expected to perform well, with low delays and moderate queues.

Notwithstanding this finding, observations on site (February 3, 4 and 5, 2010) suggest that vehicles entering the Catholic Church car park (which has 22 car bays) will need some type of 'turnaround' facility.

There are a number of potential design solutions and/ or operational management solutions. The options and best solution will be worked up in consultation with the Catholic Church and the City of Joondalup to optimise traffic efficiency and safety outcomes.

#### **4.2 PROPOSED T-JUNCTION ON ARAWA PLACE**

At the site consultation meeting on 19 November 2009, a second and supporting local road access option was identified for Arawa Place (to the west of existing north side residential properties).

This access will help spread site traffic and importantly will offer an alternative to the Camberwarra roundabout access point during busy school opening/ closing times (when that 'northern' portion of Camberwarra Crescent becomes very busy).

The Paramics Simulation (*Chapter 3* and *Appendix D*) confirms that the intersection of this access road with Arawa Place and the nearby Arawa Place intersection with Camberwarra Crescent perform well in the 'post development' traffic simulation.

#### **4.3 PROPOSED SUPPLEMENTAL EMERGENCY VEHICLE ACCESS ON ARAWA PLACE**

The primary site access (at Camberwarra Crescent roundabout) and the supplemental site access (at west end of Arawa Place) have a common origin point within Lot 500 & 501. At this junction, they combine to form a single 'gateway' to the site.

In order to build robustness into the site design, it is important to provide alternative emergency vehicle access. This is accomplished by using the existing reserve linking Lot 500 & 501 to Arawa Place. It is proposed that this reserve be used only for pedestrian/ cyclist and emergency vehicle access. This access is shown in *Figure 4, Street Types Plan* (see Chapter 5).



#### 4.4 CARRIAGEWAY WIDENING ON ALBION STREET

The Paramics Micro Simulation (Chapter 3 and Appendix D) reveals that vehicle queuing increases on Albion Street at the Marmion Avenue intersection. In order to provide separate traffic lanes for right and left turning vehicle, it is recommended that the westbound carriageway is widened slightly (approximately 1 metres) over a distance of 50 metres. The Emerson Stewart preliminary design drawing for this work is provided in *Appendix E*.

#### 4.5 PRIMARY SCHOOL - PEAK PERIOD TRAFFIC OPERATIONS.

Existing traffic observations provided in *Chapter 2* and *Appendix C* cover the issue of peak hour activity at the Catholic Primary School and Catholic Church Car Park. Car parking is at a premium at these times.

*Section 3.5* notes that the existing informal car parking on the east side of Camberwarra Crescent (on Lot 500 & 501) will be closed as a result of residential development on the site. It will be necessary for the Catholic Primary School car park to 'make up' for the reduced 'off-site' parking. This could be done through travel demand management, through provision of additional parking on school property or through increasing the efficiency with which students are 'discharged to waiting vehicles' in the PM peak (3pm -3:30pm).

## LOT 500 & 501 STREETS

### 5.1 INTERNAL STREET CROSS SECTIONS (EMERSON STEWART)

Emerson Stewart Consulting Engineers have prepared typical street cross sections for the Lot 500 & 501 LSP application (refer *Figure 4, overleaf*).

These streets are derived from Liveable Neighbourhoods Policy (WAPC, 2009 update). The streets are all categorized as Access Streets due to the very localised residential area served. The target operating speed for Access Streets is in the 30-40 km/hr range.

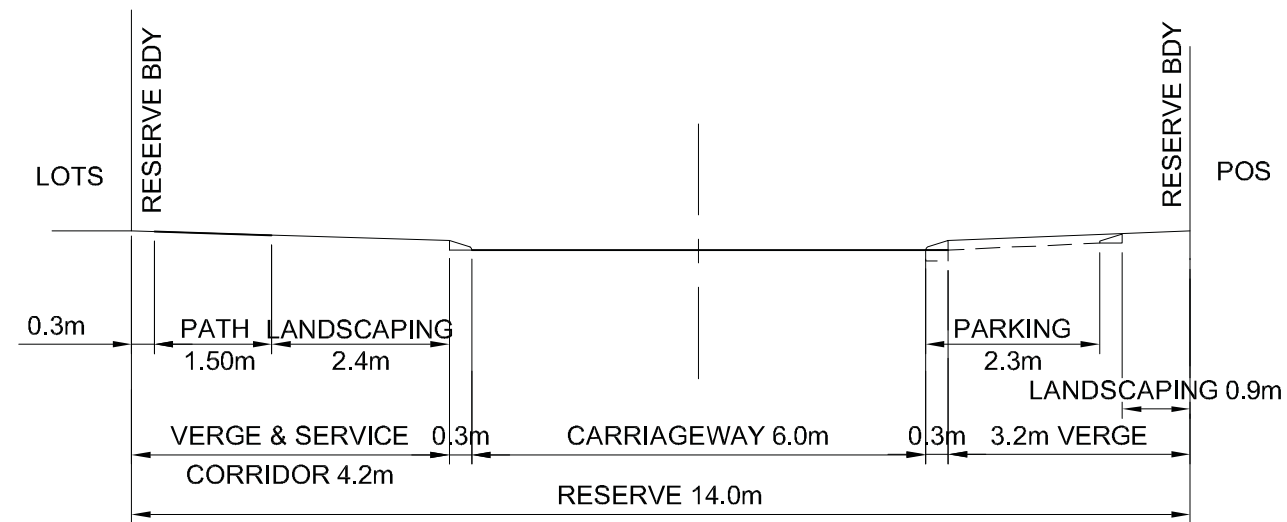
The streets have been designed with 6m paved travel way within road reserve widths which vary according to the specific parking, path, services and landscaping requirements throughout the application area.

Section 3.3 & 3.4 of this report discusses traffic loading for Lot 500 & 501. Maximum traffic loading is expected to be approximately 1300 veh/day (just east of the junction of the two external access links).

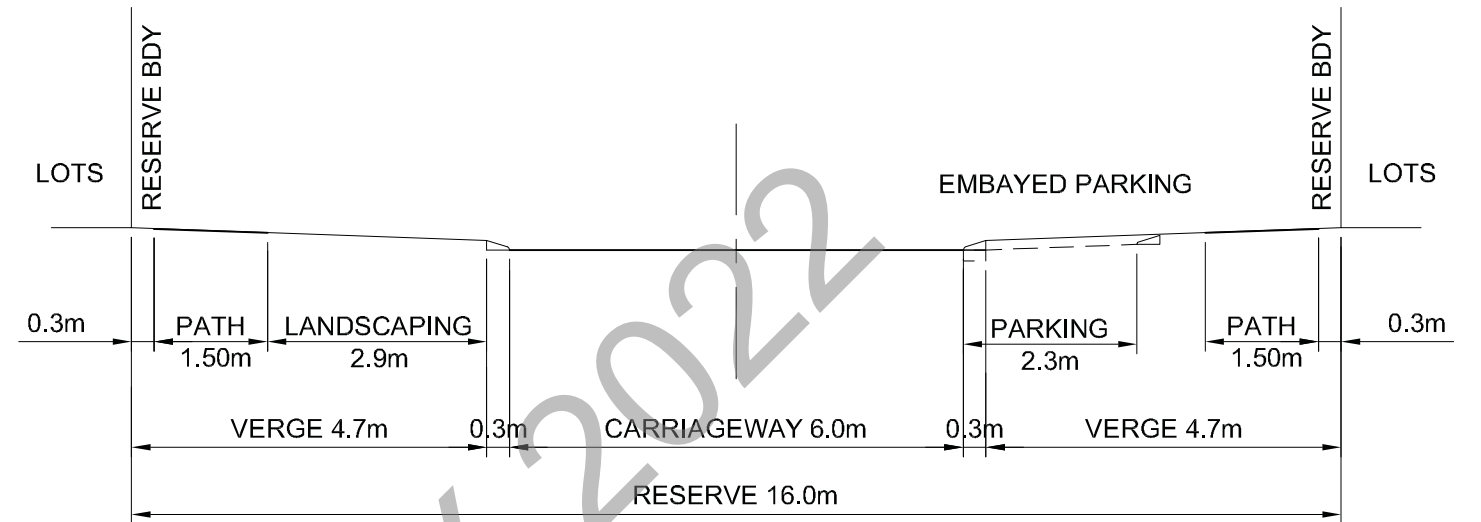
### 5.2 STREET TYPE PLAN

*Figure 5* (prepared by Emerson Stewart Consulting Engineers) shows the allocation of street cross-sections throughout the internal street network of Lot 500 & 501.

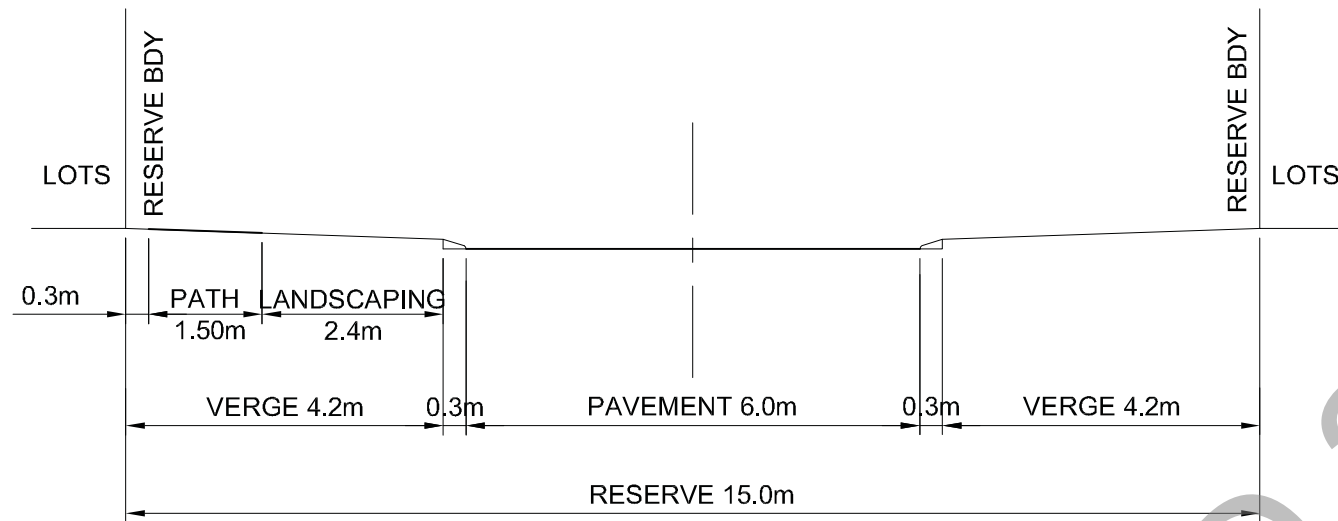
The primary east-west access road connecting to Camberwarra Crescent has the largest reserve (16-18m). The 18m dimension is required to deal with the curvilinear street alignment on the approach to the nearby roundabout and to allow embayed parking adjacent to the P.O.S. Other streets have reserve widths of 15-16m generally. Where streets front public open space, however, the reserve is 14m (as allowed by the reduced verge requirement adjacent to the P.O.S).



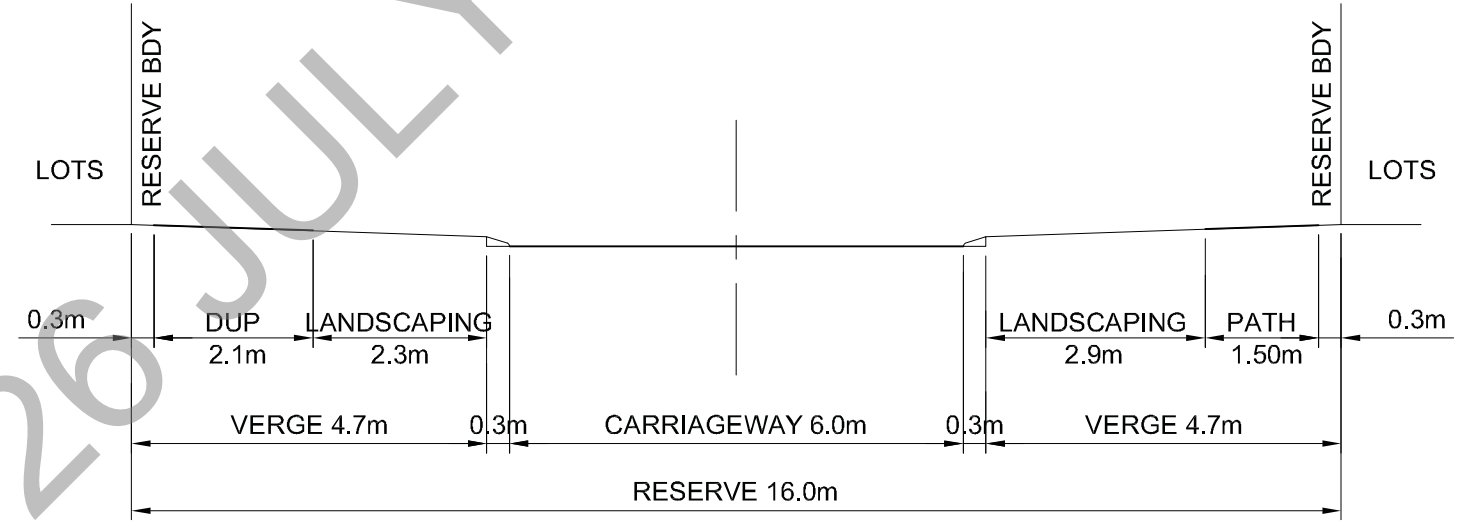
14m ROAD RESERVE



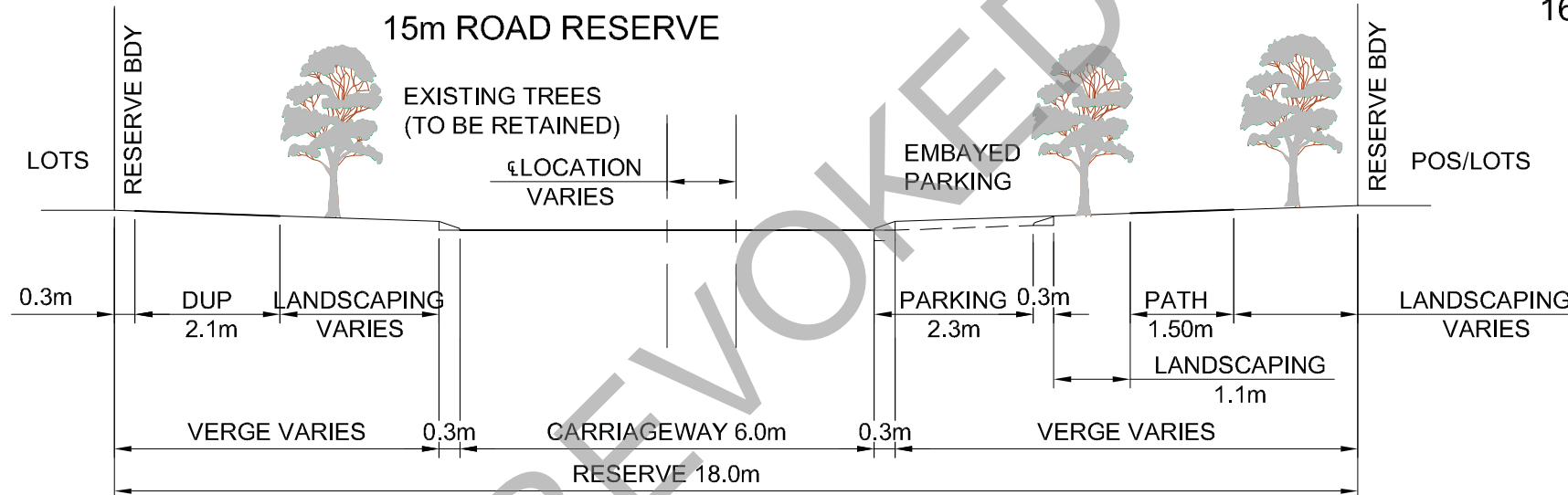
16m ROAD RESERVE



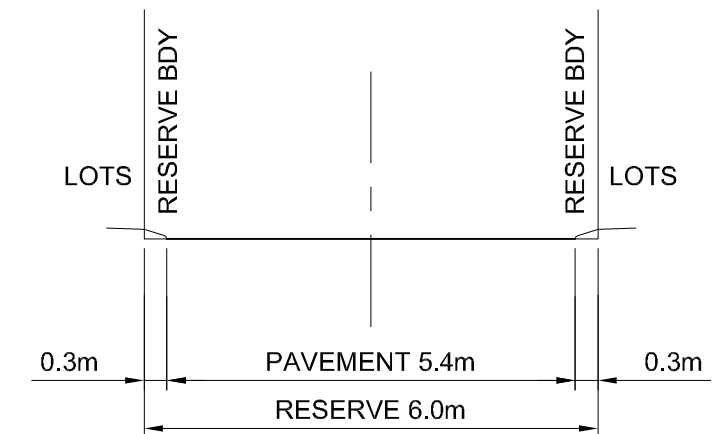
15m ROAD RESERVE



16m ROAD RESERVE (ENTRY ROAD)



18m ROAD RESERVE (MEANDERING)



6m ROAD RESERVE (LANEWAY)

CLIENT LANDCORP-STOCKLAND  
REVISION B  
DATE 17/07/2010  
DRAWN M. VAN NIEL  
CHECKED J. OLSEN



0 25 50 75  
Full Size 12500 A3;  
SCALE (m)

LOT 500 & 501 CAMBERWARRA DRIVE, CRAIGIE  
11.4.1.4 B

PROJECT EMERSON  
FIGURE  
TITLE STEWART

TYPICAL ROAD CROSS SECTIONS





CLIENT LANDCORP-STOCKLAND  
REVISION A  
DATE 17/07/2010  
DRAWN M. VAN NIEL  
CHECKED J. OLSEN



0 25 50 75  
Full Size 12500 A3;  
SCALE (m)

LOT 500 & 501 CAMBERWARRA DRIVE, CRAIGIE  
11.4.1.4

ROAD CLASSIFICATION PLAN

PROJECT EMERSON  
FIGURE 11.4.1.4  
TITLE STEWART

OLD SWAN BREWERY 110/171 Mounts Bay Road Perth Western Australia 6000

+61 8 9424 9555

+61 8 9485 1339

www.emersonstewart.com

Cad File: W:\B+P\1033-Craigie High School (ex 108030)\06-CADD\00\1033-00-FIG-11.4.1.4.dwg  
Plotted By: marcus.vanniel Plot Date: 21/07/10 - 09:17



# BUS ROUTES & PEDESTRIAN / CYCLE FACILITIES

## 6.1 BUS ROUTES

Figure 6 shows that Transperth Route 463 runs along Camberwarra Crescent. Route 463 operates between Joondalup Station and Whitfords Station.

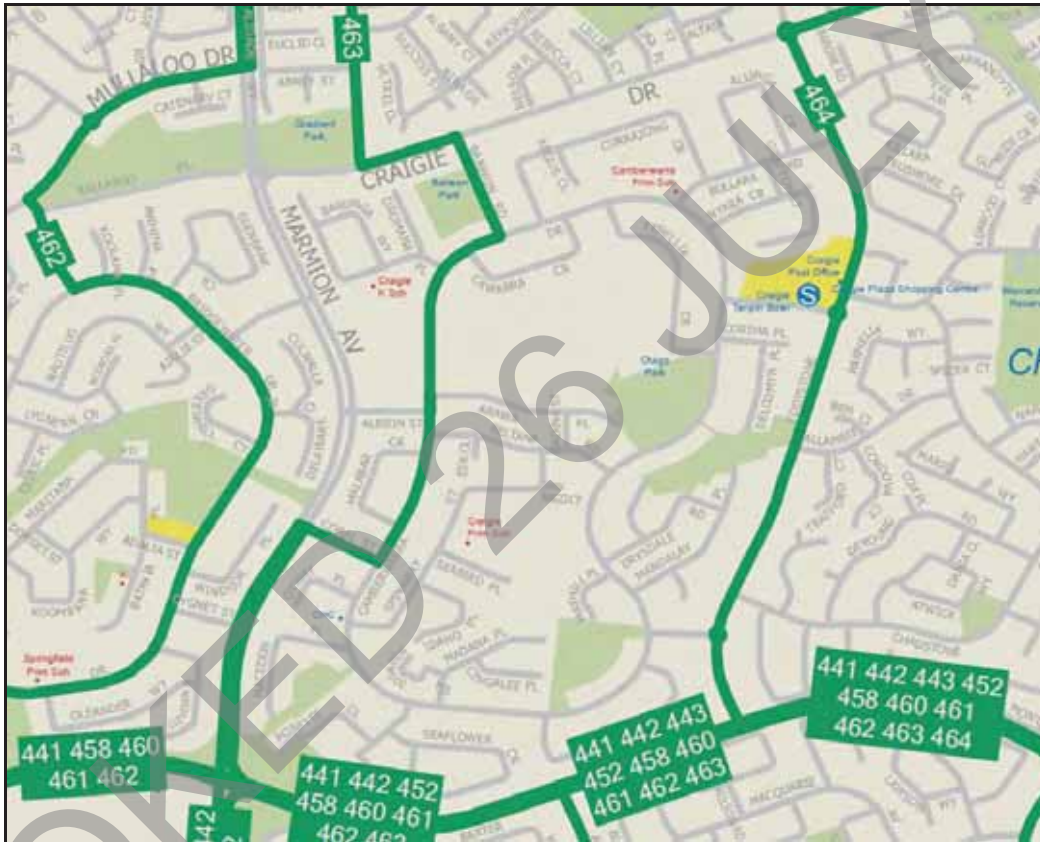


Figure 6. Bus Routes (Source: Transperth Website).

Refer to *Appendix F* for the Route 463 timetable.

The Route 463 bus stop and shelter on Camberwarra Crescent just north of Arawa Place intersection are shown in *Figure 7*.



Figure 7 Route 463 bus stop & shelter on Camberwarra Crescent.

## 6.2 EXISTING PATH NETWORK

The existing path network is shown in *Figure 8* and *Figure 9*.



Figure 9. Path Network West Side (photo by NearMap).



The existing path network is well established at the perimeter of the Lot 500 & 501 development site.



Figure 9. Path Network East Side (photo by NearMap).

The paths are generally in good condition, but the path on the north side of Arawa Place, near Camberwarra Crescent (west loop) is in a state of poor repair and should be replaced as part of the Lot 500 & 501 development works.

### 6.3 LOT 500 & 501 INTERNAL PATHS

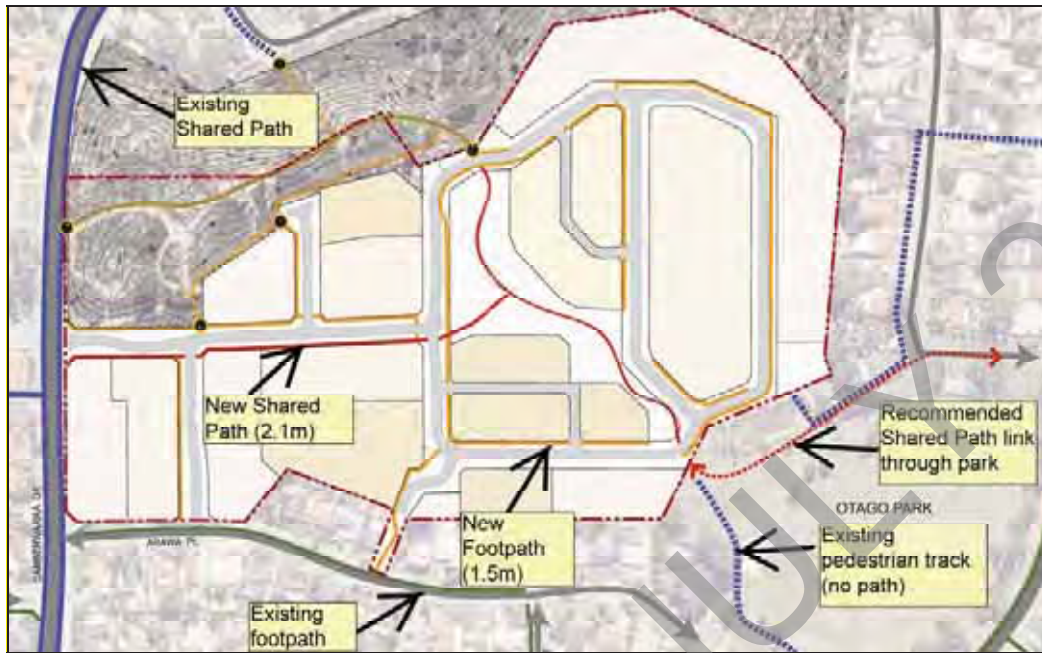


Figure 10. Lot 500 & 501 Internal Path Network (Plan by Ecoscape).

Figure 10 shows the proposed shared paths and footpaths for the Lot 500 & 501 LSP application area. Each street has a footpath and/ or shared path. In combination, the footpaths and shared paths provide links to each of the existing paths surrounding the site.

## SUMMARY/ CONCLUSION

This report has provided transport planning information for the Lot 500 & 501 Local Structure Plan (for Emerson Stewart Consulting Engineers.). Summary points are as follows:

### **Existing Roads and Traffic (Chapter 2)**

Two way daily traffic volumes and speed data (August 2008 counts) show:

- Albion Street: 1435 veh/day; 99% of vehicles < 60km/hr, 79.4% of vehicles < 50km/hr
- Camberwarra Crescent: 2098 veh/day; 86% of vehicles < 60km/hr, 46.6% of vehicles < 50km/hr

No count data was available from the City of Joondalup for Arawa Place. However, the intersection turning counts from the 3 February 2010 revealed that very little traffic uses Arawa Place in the AM peak.

Site investigations revealed that the AM peak (8-9am) and PM peak (3-4pm) are busy around the Catholic Primary School. Parking occurs on road verge on both sides of Camberwarra Crescent. Despite this level of activity, traffic flows well in the AM period but in the PM there are occasional blockages of Camberwarra Crescent traffic due to capacity limitations at the Primary School entry.

### **Traffic Forecasting and Paramics Micro Simulation (Chapter 3)**

The Lot 500 & 501 Local Structure Plan is expected to yield approximately 150 residential dwelling units, resulting in an additional 130 veh/hr of traffic in the AM peak period.

Using a daily/ peak hour multiplier of 10 indicates total daily traffic generation of 1300 veh/day of traffic. This traffic will be spread across two road access points, one on Camberwarra Crescent and one on Arawa Place.

Paramics Micro Simulation software was used to model the existing and the post development cases. The simulation indicates that all intersections will operate well, with moderate increases in queuing and delay.

### **Intersection Control & Traffic Management (Chapter 4)**

As a result of on-site consultation with City of Joondalup Technical Service personnel and subsequent traffic modelling, it is proposed to use roundabout control at the Camberwarra Crescent access to Lot 500 & 501.

The roundabout will feature pre-deflection geometry and median gaps to accommodate existing property access requirements. The Paramics micro



simulation shows that the roundabout should operate well, with moderate queues and low delays.

Notwithstanding this finding, observations on site (February 3, 4 and 5, 2010) suggest that vehicles entering the Catholic Church car park (which has 22 car bays) will need some type of 'turnaround' facility.

There are a number of potential design solutions and/ or operational management solutions. The options and best solution will be worked up in consultation with the Catholic Church and the City of Joondalup to optimise traffic efficiency and safety outcomes.

The Paramics Micro Simulation (Chapter 3 and Appendix D) reveals that vehicle queuing increases on Albion Street at the Marmion Avenue intersection. In order to provide separate traffic lanes for right and left turning vehicle, it is recommended that the westbound carriageway is widened slightly (approximately 1 metres) over a distance of 50 metres. The Emerson Stewart preliminary design drawing for this work is provided in *Appendix E*.

Section 3.5 notes that the existing informal car parking on the east side of Camberwarra Crescent (on Lot 500 & 501) will be closed as a result of residential development on the site. It will be necessary for the Catholic Primary School car park to 'make up' for the reduced off-site parking. This could be done through travel demand management, through provision of additional parking on school property or through increasing the efficiency with which students are discharged to waiting vehicles in the PM peak (3pm -3:30pm).

#### **Lot 500 & 501 Streets (Chapter 5)**

Internal street types are covered in Chapter 5. These streets are appropriate to traffic volumes and parking demand expected within Lot 500 & 501.

#### **Bus Route (Chapter 6)**

Bus route and service information is provided in Chapter 6. Route 463 operates between Joondalup and Whitfords Station and uses Camberwarra Crescent on the west boundary of Lot 500 & 501. There is an existing bus stop located just north of Arawa Place intersection with Camberwarra Crescent. This is very convenient for Lot 500 & 501 future residents.

#### **Pedestrian & Cyclist Facilities (Chapter 6)**

Good path connections will be provided within Lot 500 & 501 and to the existing external path network.

## APPENDICES

Appendix A

## EXISTING ROAD PHOTOS

REVOKED 26 JULY 2022

























Appendix B

# TRAFFIC COUNTS & SPEED DATA

REVOKED 26 JULY 2022

## Weekly Vehicle Counts (Virtual Week)

VirtWeeklyVehicle-154

Site: COJ720.0WE

Description: ALBION ST E OF MARMION AVE

Filter time: 15:00 Wednesday, 6 August 2008 => 12:00 Wednesday, 13 August 2008

Scheme: Vehicle classification (AustRoads94)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 ) Dir(EW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages	
								1 - 5	1 - 7
Hour									
0000-0100	1.0	2.0	0.0	4.0	3.0	17.0	12.0	2.0	5.6
0100-0200	1.0	0.0	0.0	3.0	0.0	5.0	5.0	0.8	2.0
0200-0300	0.0	1.0	1.0	1.0	0.0	4.0	4.0	0.6	1.6
0300-0400	1.0	2.0	0.0	2.0	0.0	4.0	5.0	1.0	2.0
0400-0500	7.0	5.0	7.0	4.0	4.0	1.0	0.0	5.4	4.0
0500-0600	13.0	14.0	14.0	11.0	11.0	4.0	8.0	12.6	10.7
0600-0700	51.0	47.0	47.0	47.0	49.0	10.0	10.0	48.2	37.3
0700-0800	72.0	88.0	79.0	64.0	71.0	31.0	70.0	74.8	67.9
0800-0900	239.0<	253.0<	256.0<	253.0<	279.0<	52.0	54.0	256.0<	198.0<
0900-1000	79.0	76.0	97.0	71.0	96.0	98.0<	198.0<	83.8	102.1
1000-1100	42.0	48.0	65.0	49.0	49.0	64.0	188.0	50.6	72.1
1100-1200	40.0	47.0	56.0	60.0	66.0	81.0	197.0	53.8	78.1
1200-1300	48.0	42.0	*	54.0	58.0	87.0	113.0	50.5	67.0
1300-1400	55.0	51.0	*	55.0	52.0	91.0	89.0	53.3	65.5
1400-1500	115.0	118.0	*	136.0	137.0	86.0	50.0	126.5	107.0
1500-1600	205.0<	190.0<	191.0	221.0<	208.0<	69.0	57.0	203.0<	163.0<
1600-1700	101.0	101.0	109.0	111.0	77.0	76.0	63.0	99.8	91.1
1700-1800	69.0	79.0	111.0	105.0	108.0	75.0	132.0<	94.4	97.0
1800-1900	70.0	73.0	71.0	75.0	72.0	118.0<	105.0	72.2	83.4
1900-2000	63.0	45.0	53.0	71.0	57.0	109.0	50.0	57.8	64.0
2000-2100	28.0	41.0	33.0	43.0	38.0	36.0	29.0	36.6	35.4
2100-2200	22.0	18.0	29.0	40.0	38.0	31.0	12.0	29.4	27.1
2200-2300	14.0	12.0	9.0	11.0	15.0	20.0	11.0	12.2	13.1
2300-2400	4.0	4.0	10.0	7.0	22.0	11.0	0.0	9.4	8.3
Totals									
0700-1900	1135.0	1166.0	*	1254.0	1273.0	928.0	1316.0	1218.7	1192.4
0600-2200	1299.0	1317.0	*	1455.0	1455.0	1114.0	1417.0	1390.7	1356.2
0600-0000	1317.0	1333.0	*	1473.0	1492.0	1145.0	1428.0	1412.3	1377.6
0000-0000	1340.0	1357.0	*	1498.0	1510.0	1180.0	1462.0	1434.7	1403.5
AM Peak	0800	0800	0800	0800	0800	0900	0900		
	239.0	253.0	256.0	253.0	279.0	98.0	198.0		
PM Peak	1500	1500	*	1500	1500	1800	1700		
	205.0	190.0	*	221.0	208.0	118.0	132.0		

\* - No data



## Class Speed Matrix

**ClassMatrix-165**

**Site:**

COJ720.0WE

**Description:**

ALBION ST E OF MARMION AVE

**Filter time:**

15:00 Wednesday, 6 August 2008 => 12:00 Wednesday, 13 August 2008

**Scheme:**

Vehicle classification (AustRoads94)

**Filter:**

Cls(1 2 3 4 5 6 7 8 9 10 11 12 ) Dir(EW) Sp(10,160) Headway(>0)

Speed (km/h)

Speed Totals

		Class													
		1	2	3	4	5	6	7	8	9	10	11	12		
10 - 20		41	.	4	1	.	.	.	.	.	.	.	.	46	0.5%
20 - 30		141	2	6	4	4	.	.	.	.	.	.	.	157	1.6%
30 - 40		1403	33	40	14	4	3	4	.	.	.	.	.	1501	15.7%
40 - 50		5672	53	70	5	3	3	3	.	.	.	.	.	5809	60.6%
50 - 60		1946	7	21	.	.	.	.	.	.	.	.	.	1974	20.6%
60 - 70		85	.	.	.	.	.	.	.	.	.	.	.	85	0.9%
70 - 80		9	.	.	.	.	.	.	.	.	.	.	.	9	0.1%
80 - 90		4	.	.	.	.	.	.	.	.	.	.	.	4	0.0%
90 - 100		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
100 - 110		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
110 - 120		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
120 - 130		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
130 - 140		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
140 - 150		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
150 - 160		.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%
		9301	95	141	24	11	6	7	0	0	0	0	0	9585	
		97.0%	1.0%	1.5%	0.3%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%		
		Class Totals													

## Weekly Vehicle Counts (Virtual Week)

VirtWeeklyVehicle-152

Site: COJ718.0SN

Description: CAMBERWARRA DVE - N OF ARAWA PI ..< 50 >

Filter time: 15:00 Wednesday, 6 August 2008 => 12:00 Wednesday, 13 August 2008

Scheme: Vehicle classification (AustRoads94)

Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 ) Dir(NS) Sp(10,160) Headway(>0)

	o	T e	ed	Th		Sat	S	e a es	
								1 - 5	1 - 7
0000-0100	2.0	4.0	5.0	6.0	3.0	26.0	12.0	4.0	8.3
0100-0200	2.0	1.0	1.0	1.0	2.0	10.0	8.0	1.4	3.6
0200-0300	3.0	6.0	0.0	2.0	1.0	4.0	7.0	2.4	3.3
0300-0400	1.0	1.0	2.0	4.0	2.0	3.0	5.0	2.0	2.6
0400-0500	7.0	5.0	7.0	6.0	6.0	3.0	2.0	6.2	5.1
0500-0600	14.0	16.0	17.0	13.0	17.0	3.0	9.0	15.4	12.7
0600-0700	46.0	61.0	59.0	48.0	57.0	15.0	14.0	54.2	42.9
0700-0800	90.0	97.0	94.0	84.0	95.0	27.0	101.0	92.0	84.0
0800-0900	355.0	388.0	390.0	378.0	397.0	72.0	60.0	381.6	291.4
0900-1000	107.0	129.0	100.0	103.0	142.0	120.0	247.0	116.2	135.4
1000-1100	70.0	88.0	93.0	76.0	88.0	101.0	248.0	83.0	109.1
1100-1200	60.0	87.0	69.0	86.0	90.0	109.0	255.0	78.4	108.0
1200-1300	75.0	82.0		90.0	92.0	125.0	169.0	84.8	105.5
1300-1400	71.0	80.0		105.0	84.0	139.0	133.0	85.0	102.0
1400-1500	188.0	208.0		233.0	206.0	106.0	87.0	208.8	171.3
1500-1600	293.0	245.0	280.0	325.0	291.0	112.0	85.0	286.8	233.0
1600-1700	120.0	144.0	172.0	154.0	129.0	109.0	94.0	143.8	131.7
1700-1800	109.0	113.0	126.0	155.0	156.0	115.0	179.0	131.8	136.1
1800-1900	115.0	91.0	132.0	123.0	105.0	180.0	146.0	113.2	127.4
1900-2000	78.0	68.0	84.0	92.0	71.0	152.0	69.0	78.6	87.7
2000-2100	39.0	55.0	56.0	64.0	35.0	60.0	27.0	49.8	48.0
2100-2200	25.0	34.0	51.0	53.0	44.0	33.0	22.0	41.4	37.4
2200-2300	26.0	21.0	26.0	24.0	25.0	26.0	24.0	24.4	24.6
2300-2400	12.0	4.0	12.0	7.0	29.0	20.0	1.0	12.8	12.1
<b>Totals</b>									
0700-1900	1653.0	1752.0		1912.0	1875.0	1315.0	1804.0	1805.3	1735.1
0600-2200	1841.0	1970.0		2169.0	2082.0	1575.0	1936.0	2029.3	1951.1
0600-0000	1879.0	1995.0		2200.0	2136.0	1621.0	1961.0	2066.5	1987.8
0000-0000	1908.0	2028.0		2232.0	2167.0	1670.0	2004.0	2097.9	2023.4
<b>Peak</b>	0800	0800	0800	0800	0800	0900	1100		
	355.0	388.0	390.0	378.0	397.0	120.0	255.0		
<b>Peak</b>	1500	1500		1500	1500	1800	1700		
	293.0	245.0		325.0	291.0	180.0	179.0		

\* - No data

[illegible]**Site:**

COJ718.0SN

**Description:**

**CAMBERWARRA DVE - N OF ARAWA PI ..< 50 >**

**Filter time:**

**15:00 Wednesday, 6 August 2008 => 12:00 Wednesday, 13 August 2008**

**Scheme:**

Vehicle classification (AustRoads94)

**Filter:**

Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NS) Sp(10,160) Headway(>0)

Speed (km/h)													Speed Totals		
Class															
	1	2	3	4	5	6	7	8	9	10	11	12			
10 - 20	20	.	.	.	.	.	.	.	.	.	.	.	20	0.1%	
20 - 30	130	1	8	4	1	1	1	.	2	.	.	.	148	1.1%	
30 - 40	1173	16	48	4	4	.	6	.	.	.	.	.	1251	9.1%	
40 - 50	4829	51	110	6	5	4	4	.	1	.	.	.	5010	36.3%	
50 - 60	5205	55	151	3	4	8	.	.	1	.	.	.	5427	39.4%	
60 - 70	1566	18	42	.	1	2	.	.	.	.	.	.	1629	11.8%	
70 - 80	247	2	3	.	.	.	.	.	.	.	.	.	252	1.8%	
80 - 90	35	1	.	.	.	.	.	.	.	.	.	.	36	0.3%	
90 - 100	7	.	1	.	.	.	.	.	.	.	.	.	8	0.1%	
100 - 110	4	.	.	.	.	.	.	.	.	.	.	.	4	0.0%	
110 - 120	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%	
120 - 130	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%	
130 - 140	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%	
140 - 150	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%	
150 - 160	.	.	.	.	.	.	.	.	.	.	.	.	0	0.0%	
	13216	144	363	17	15	15	11	0	4	0	0	0	13785		
	95.9%	1.0%	2.6%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%			
	Class Totals														



# Weekly Volumes By Hour



Count: **COMBINED**  
 Site No: **2313**  
 Date Range: **17/09/2007 to 20/09/2007**

Road Name: **MARMION AV**  
 Location Description: **N OF WHITFORDS AV**

Hour	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average M-F	Average M-S
00 - 01		70	102	110				93	
01 - 02		52	46	84				59	
02 - 03		30	28	59				37	
03 - 04		34	50	63				48	
04 - 05		100	103	110				103	
05 - 06		455	456	475				461	
06 - 07		2128	2121	2153				2132	
07 - 08		2845	2983	2901				2909	
08 - 09		3033	2875	3040				2981	
09 - 10		1767	1816	1847				1808	
10 - 11		1577	1698	1750				1674	
11 - 12		1598	1706	1762				1687	
12 - 13		1732	1715	1849				1735	
13 - 14		1676	1687	1781				1712	
14 - 15		1936	2078					1975	
15 - 16		2669	2482					2583	
16 - 17		2565	2645					2630	
17 - 18		2679	2785					2688	
18 - 19		1920	1868					1848	
19 - 20		1030	1230					1061	
20 - 21		687	788					705	
21 - 22		610	689					610	
22 - 23		340	414					368	
23 - 24		188	236					184	
AM Peak 1/4 Vol		867	779	849				803	
AM 1/4 Hour		0815	0815	0830				0815	
AM 1/2 Vol		1670	1518	1613				1588	
AM 1/2 Hour		0815	0700	0815				0815	
AM 1hr Vol		3040	2983	3054				2981	
AM 1hr Hour		0745	0700	0745				0800	
AM 1hr Fact		0.88	0.97	0.90				0.93	
AM 2hr Vol		5878	5858	5941				5890	
AM 2hr Hour		0700	0700	0700				0700	
PM Peak 1/4 Vol		717	732					703	
PM 1/4 Hour		1715	1715					1715	
PM 1/2 Vol		1385	1459					1398	
PM 1/2 Hour		1700	1700					1700	
PM 1hr Vol		2713	2831					2725	
PM 1hr Hour		1645	1645					1630	
PM 1hr Fact		0.95	0.97					0.97	
PM 2hr Vol		5244	5430					5318	
PM 2hr Hour		1600	1600					1600	
Peak 12hr Vol		25997	26338					26230	
Peak 12hr		0700	0700					0700	
24hr Total		31721	32601					32161	

# Weekly Volumes By Hour



Count: **DIRECTIONAL**  
 Site No: **2313**  
 Date Range: **17/09/2007 to 20/09/2007**

Road Name: **MARMION AV**  
 Location Description: **N OF WHITFORDS AV**

Hour	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg M-F		Avg M-S	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
00 - 01			40	30	61	41	71	39							57	36		
01 - 02			24	28	22	24	55	29							32	26		
02 - 03			12	18	17	11	33	26							20	16		
03 - 04			14	20	23	27	26	37							21	27		
04 - 05			21	79	24	79	30	80							23	78		
05 - 06			74	381	78	378	84	391							78	381		
06 - 07			315	1813	310	1811	322	1831							315	1817		
07 - 08			601	2244	572	2411	580	2321							583	2324		
08 - 09			832	2201	832	2043	842	2198							835	2146		
09 - 10			621	1146	647	1169	688	1159							651	1156		
10 - 11			657	920	766	932	773	977							731	941		
11 - 12			782	816	844	862	838	924							820	866		
12 - 13			882	850	893	822	966	883							903	831		
13 - 14			928	748	944	743	1037	744							979	733		
14 - 15			1141	795	1157	921									1130	843		
15 - 16			1514	1155	1459	1023									1480	1102		
16 - 17			1720	845	1750	895									1755	873		
17 - 18			1840	839	1945	840									1877	811		
18 - 19			1232	688	1145	723									1166	681		
19 - 20			569	461	689	541									581	479		
20 - 21			408	279	415	373									398	307		
21 - 22			379	231	390	299									369	240		
22 - 23			215	125	231	183									214	151		
23 - 24			114	74	154	82									118	66		
AM Peak 1/4 Vol			229	647	240	684	249	669							234	636		
AM 1/4 Hour			0830	0815	0815	0700	0830	0700							0830	0700		
AM 1/2 Vol			449	1221	464	1310	465	1265							459	1233		
AM 1/2 Hour			0815	0815	0815	0700	0815	0645							0815	0700		
AM 1hr Vol			835	2332	848	2430	846	2390							835	2383		
AM 1hr Hour			0815	0645	0745	0645	0815	0645							0800	0645		
AM 1hr Fact			0.91	0.96	0.88	0.89	0.85	0.89							0.89	0.94		
AM 2hr Vol			1433	4445	1404	4454	1422	4519							1418	4470		
AM 2hr Hour			0700	0700	0700	0700	0700	0700							0700	0700		
PM Peak 1/4 Vol			492	327	506	283									488	307		
PM 1/4 Hour			1715	1500	1730	1500									1715	1500		
PM 1/2 Vol			967	604	1006	542									962	588		
PM 1/2 Hour			1715	1500	1715	1500									1715	1500		
PM 1hr Vol			1859	1155	1962	1056									1887	1108		
PM 1hr Hour			1715	1500	1645	1445									1645	1445		
PM 1hr Fact			0.95	0.88	0.97	0.93									0.97	0.90		
PM 2hr Vol			3560	1684	3695	1735									3632	1684		
PM 2hr Hour			1600	1600	1600	1600									1600	1600		
Peak 12hr Vol			12750	13247	12954	13384									12910	13307		
Peak 12hr			0700	0700	0700	0700									0700	0700		
24hr Total			14935	16786	15368	17233									15152	17010		

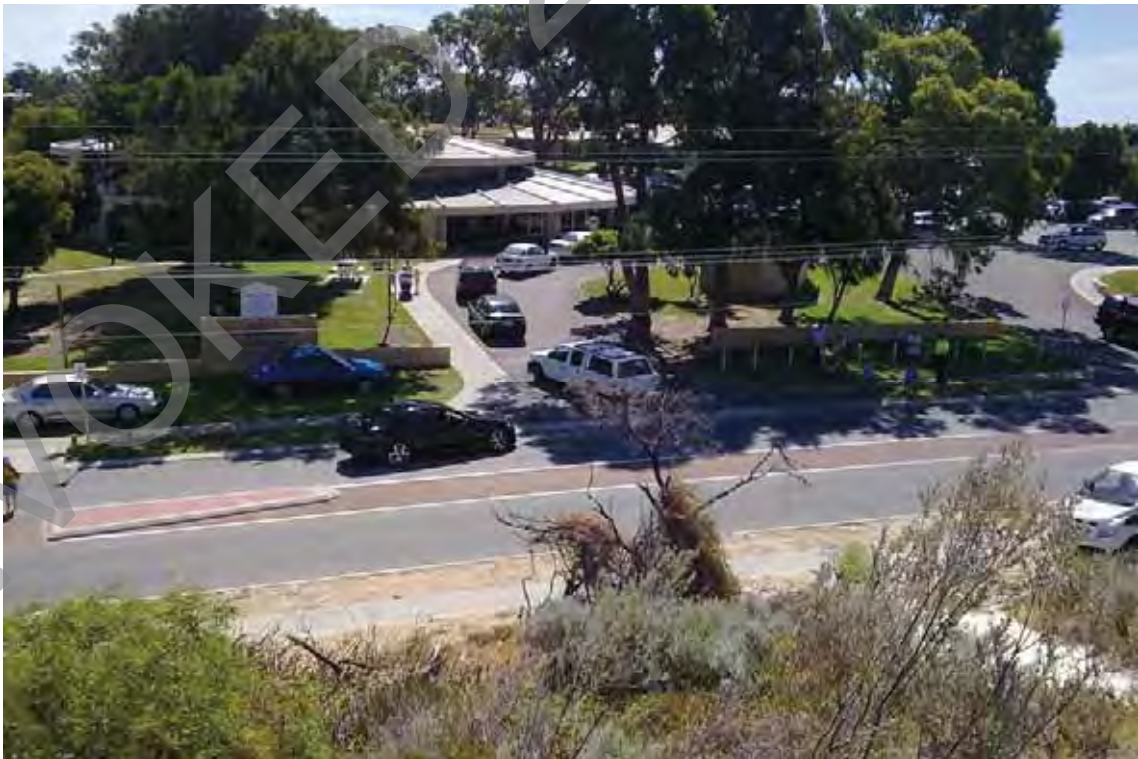
Appendix C

# PRIMARY SCHOOL PHOTOS

(3-3:45 PM 5<sup>TH</sup> FEB 2010)

REVOKED 26 JULY 2022





Appendix D

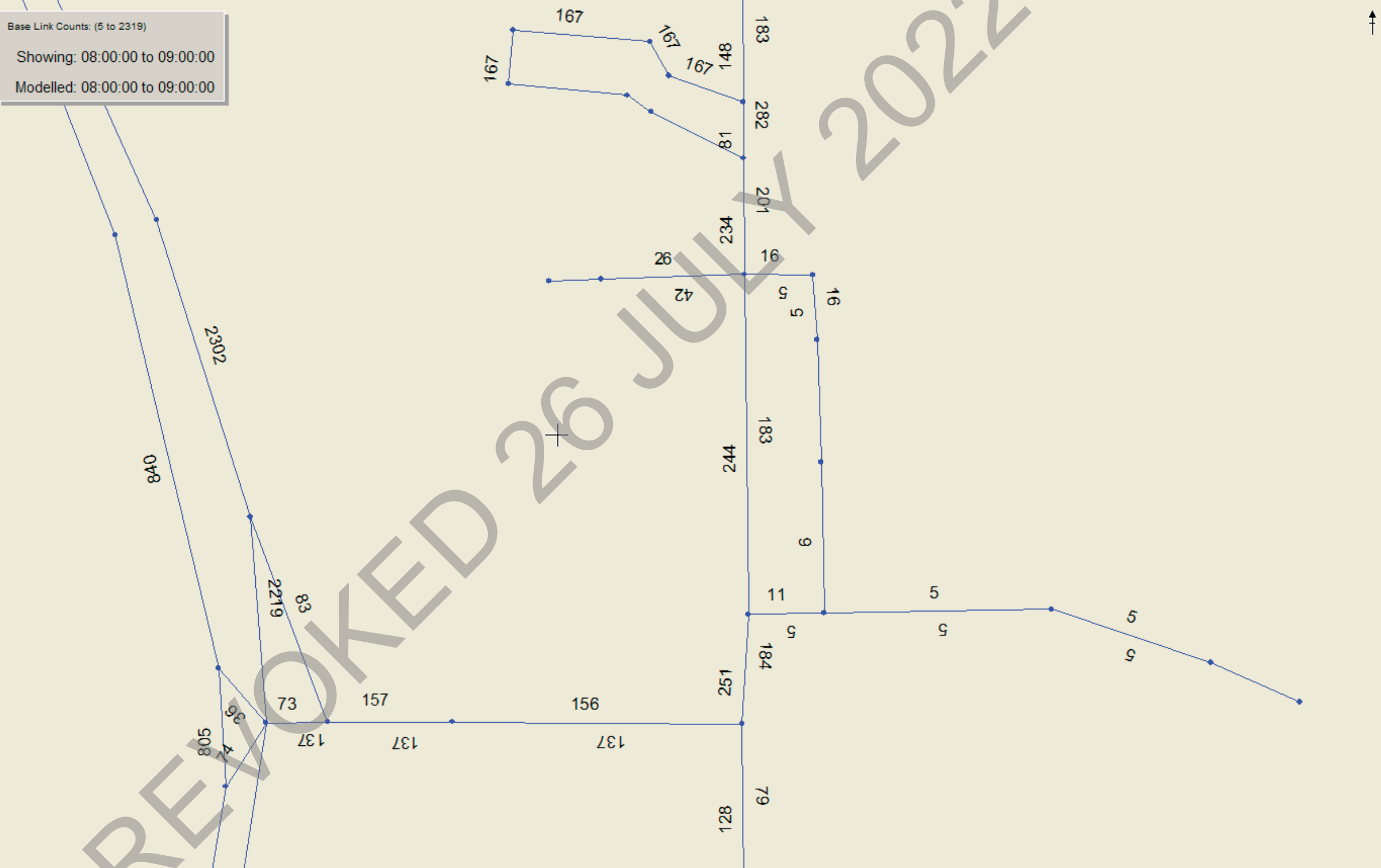
# TRAFFIC MODELLING

REVOKED 26 JULY 2022

Base Link Counts: (5 to 2319)

Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00

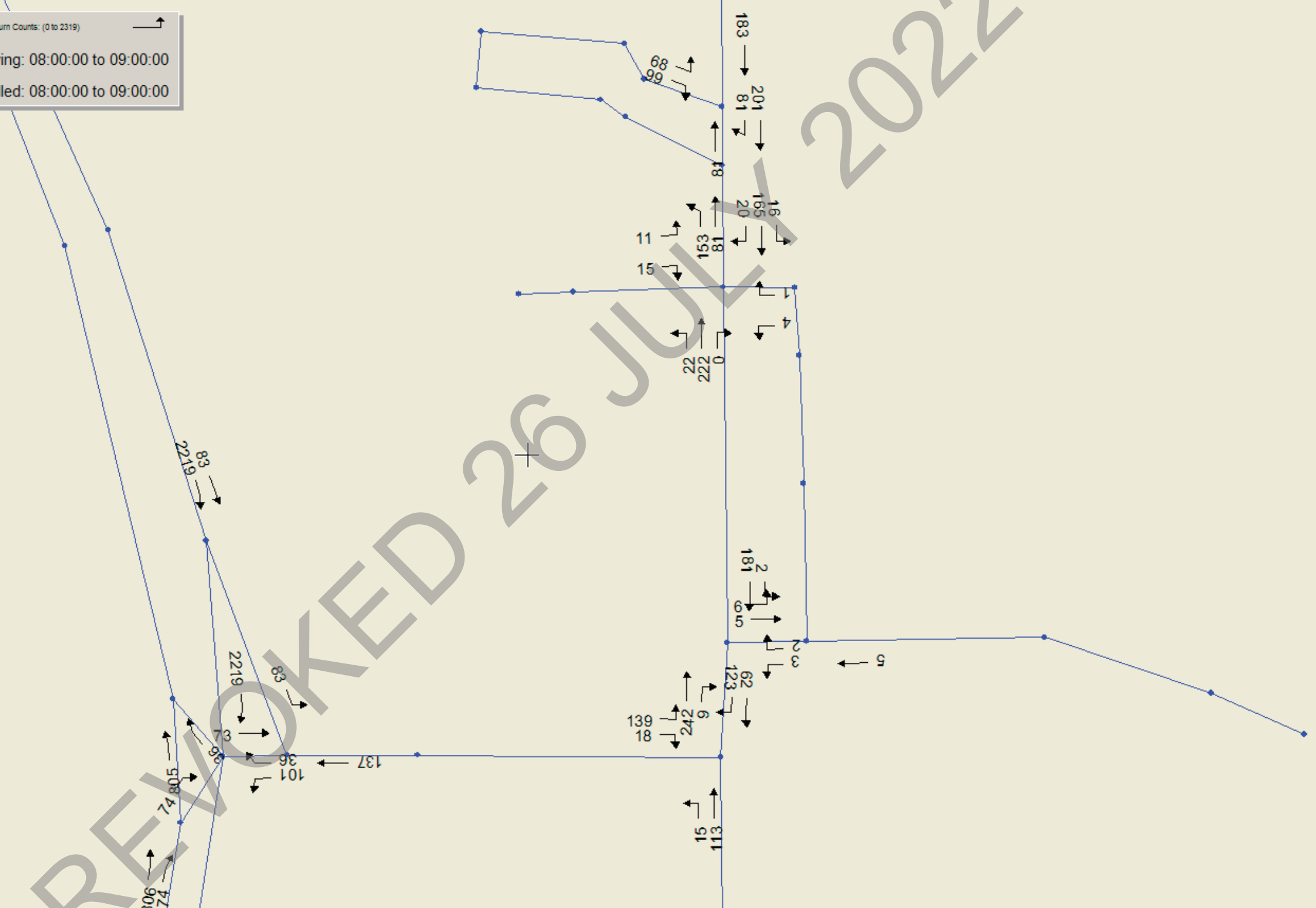




Base Case Turn Counts: (0 to 2319)

Showing: 08:00:00 to 09:00:00

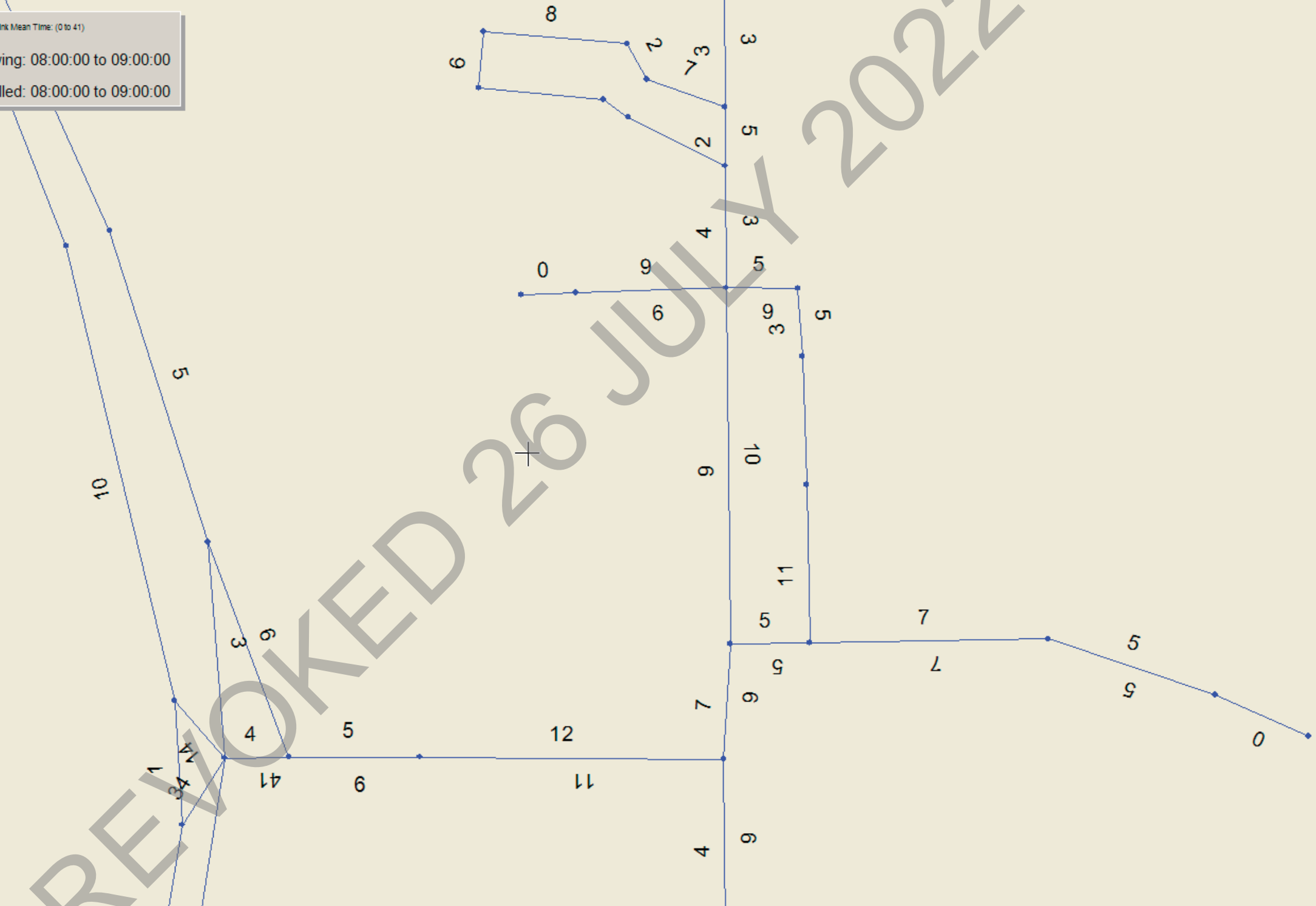
Modelled: 08:00:00 to 09:00:00



Base Case Link Mean Time: (0 to 41)

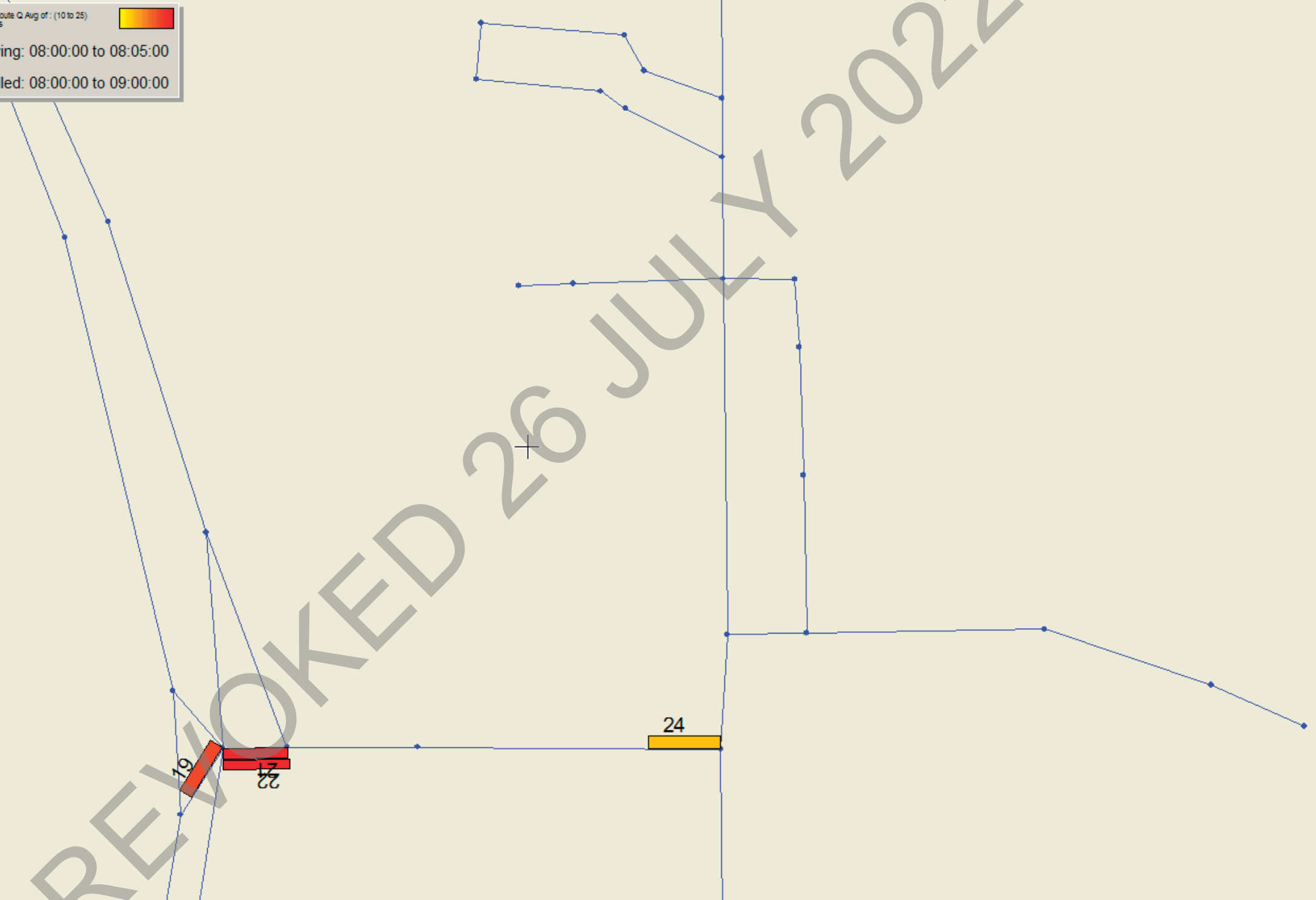
Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:00:00 to 08:05:00  
Modelled: 08:00:00 to 09:00:00



19  
22  
21

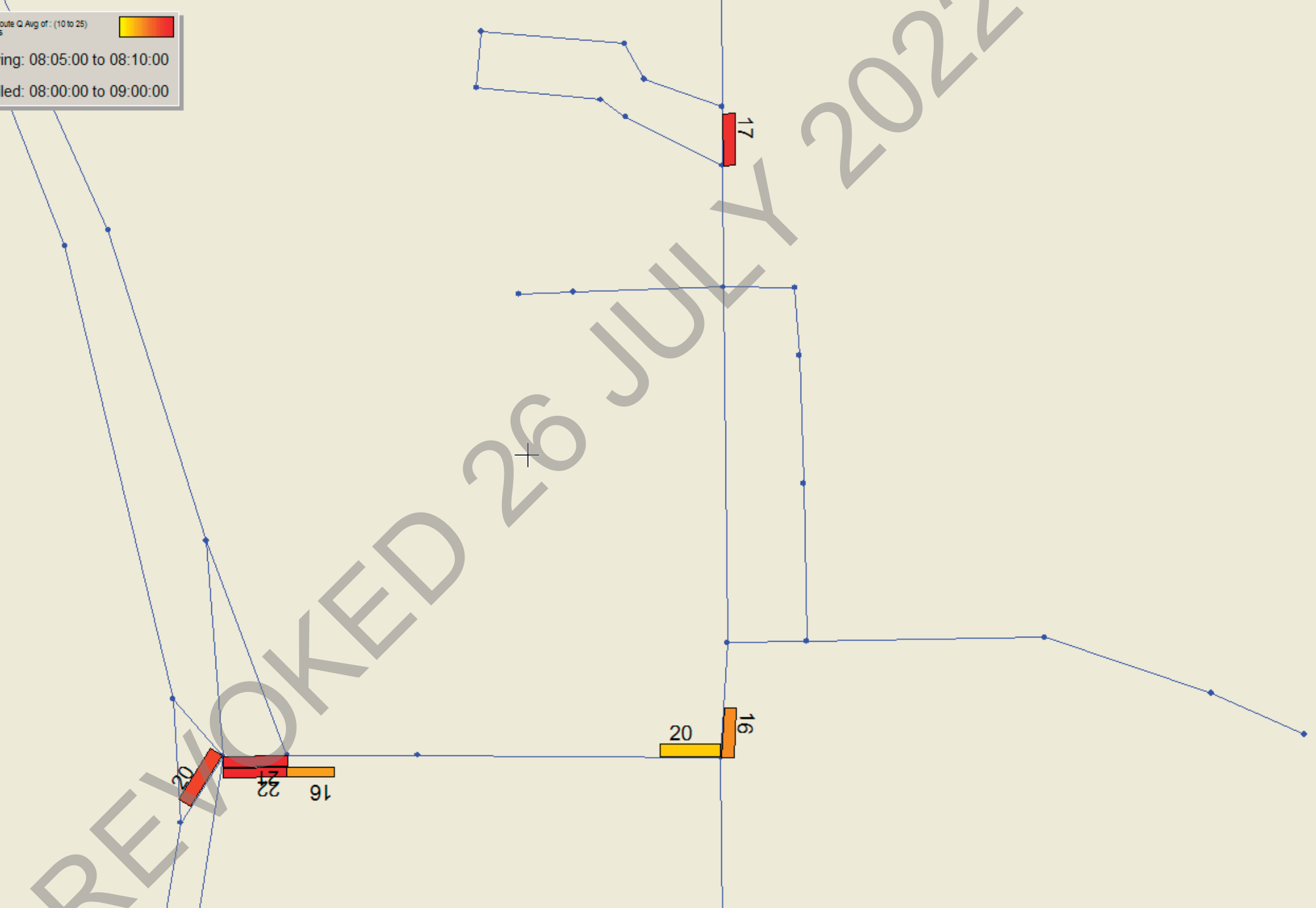
24



Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:05:00 to 08:10:00

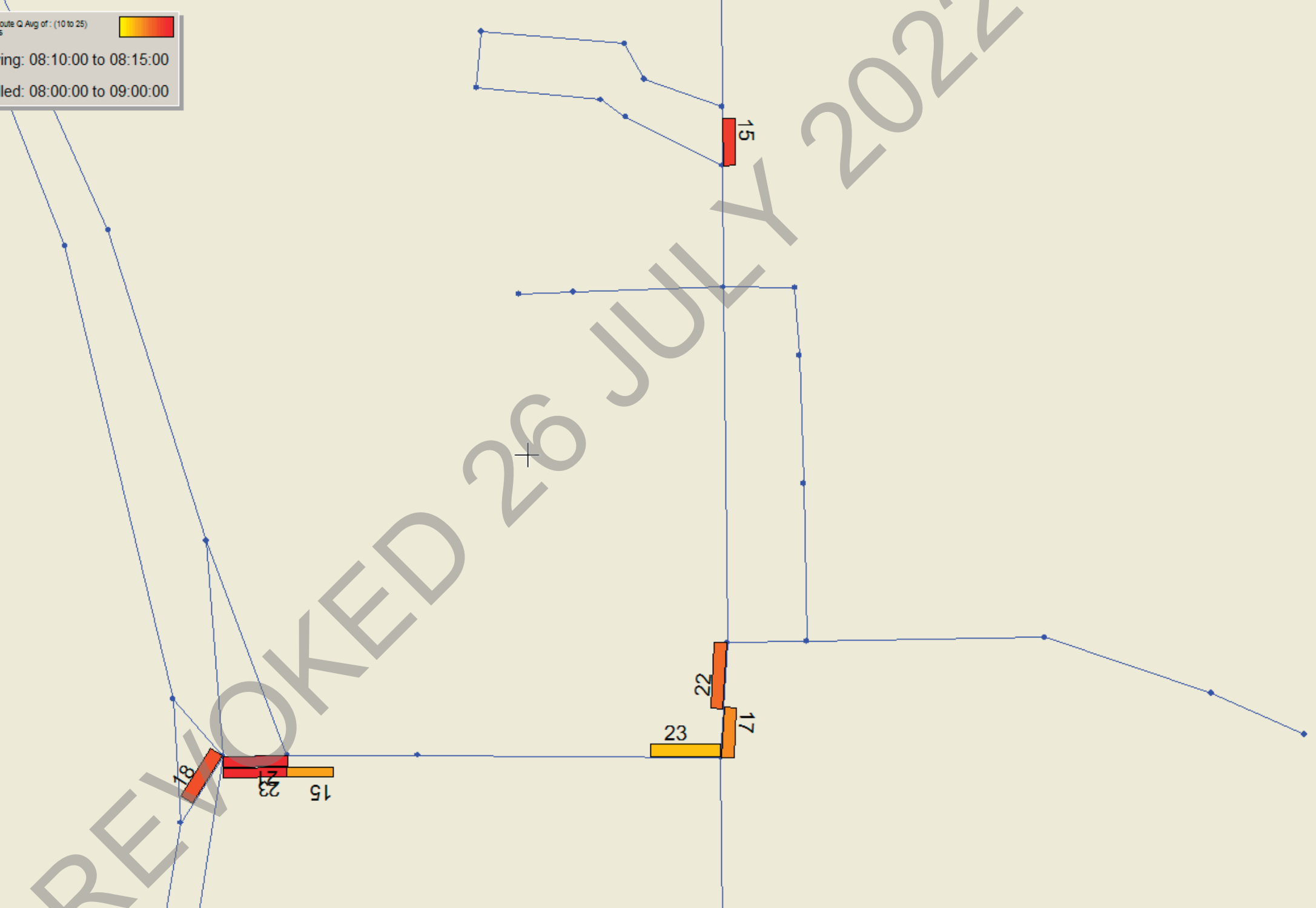
Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

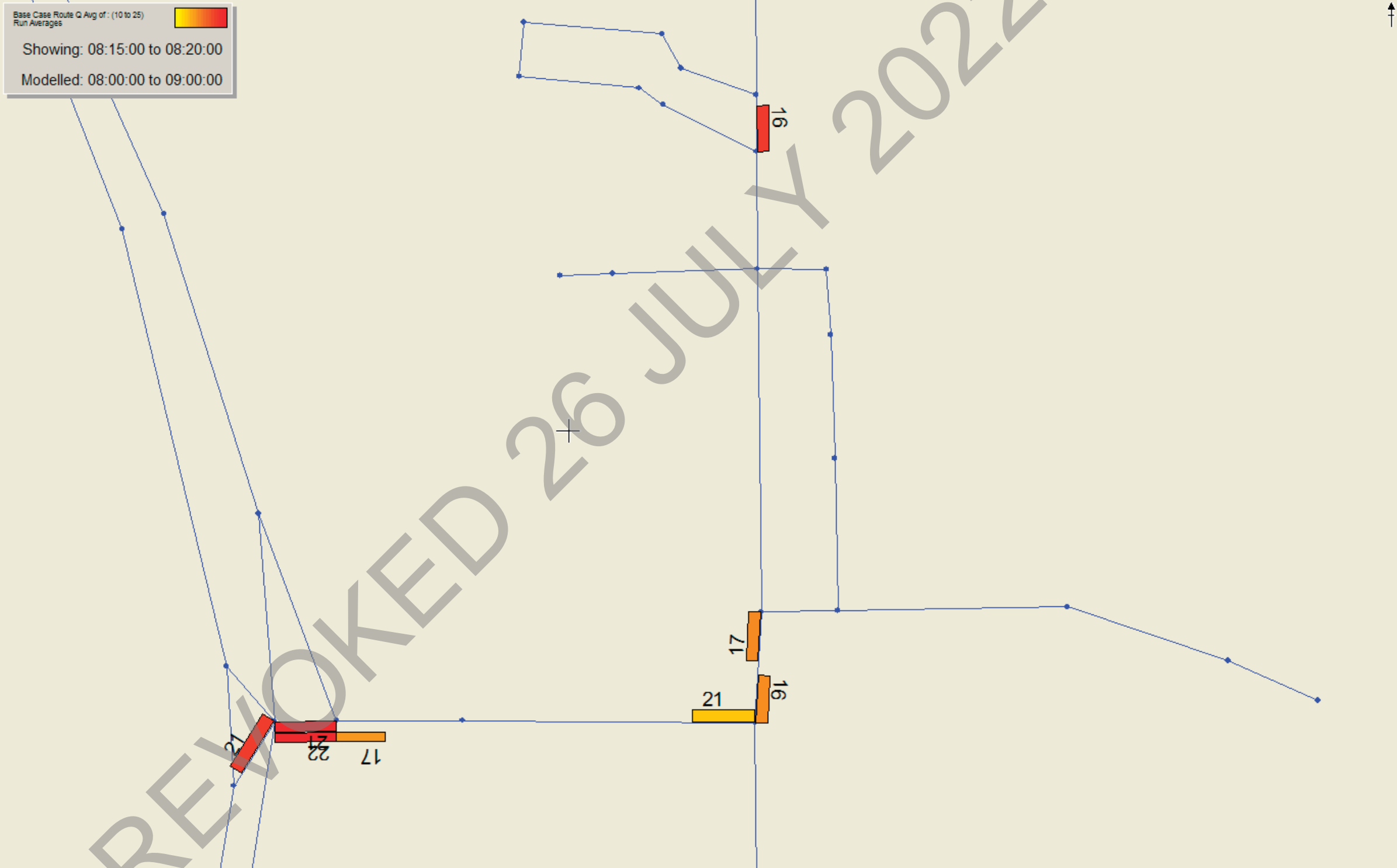
Showing: 08:10:00 to 08:15:00

Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

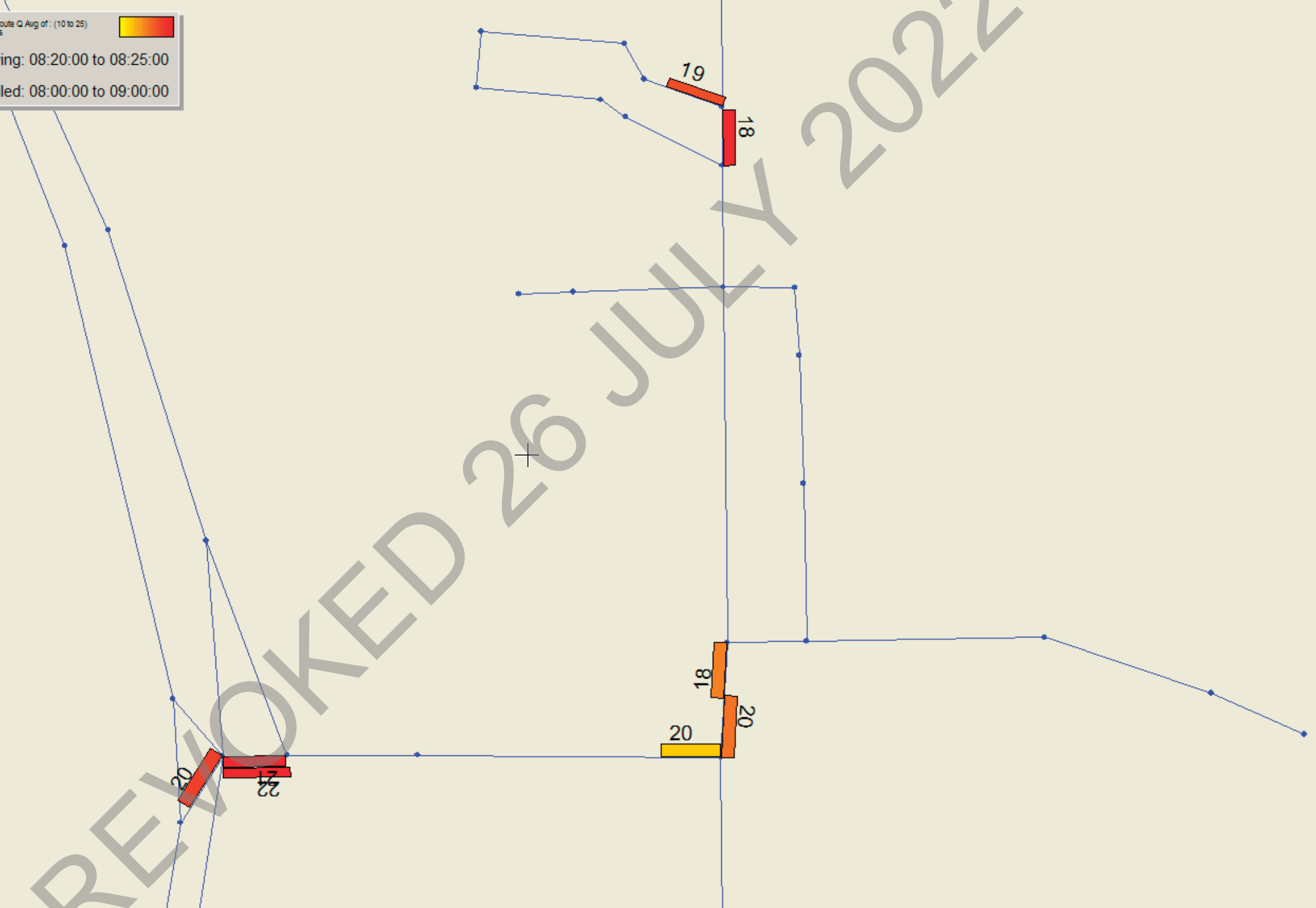
Showing: 08:15:00 to 08:20:00  
Modelled: 08:00:00 to 09:00:00





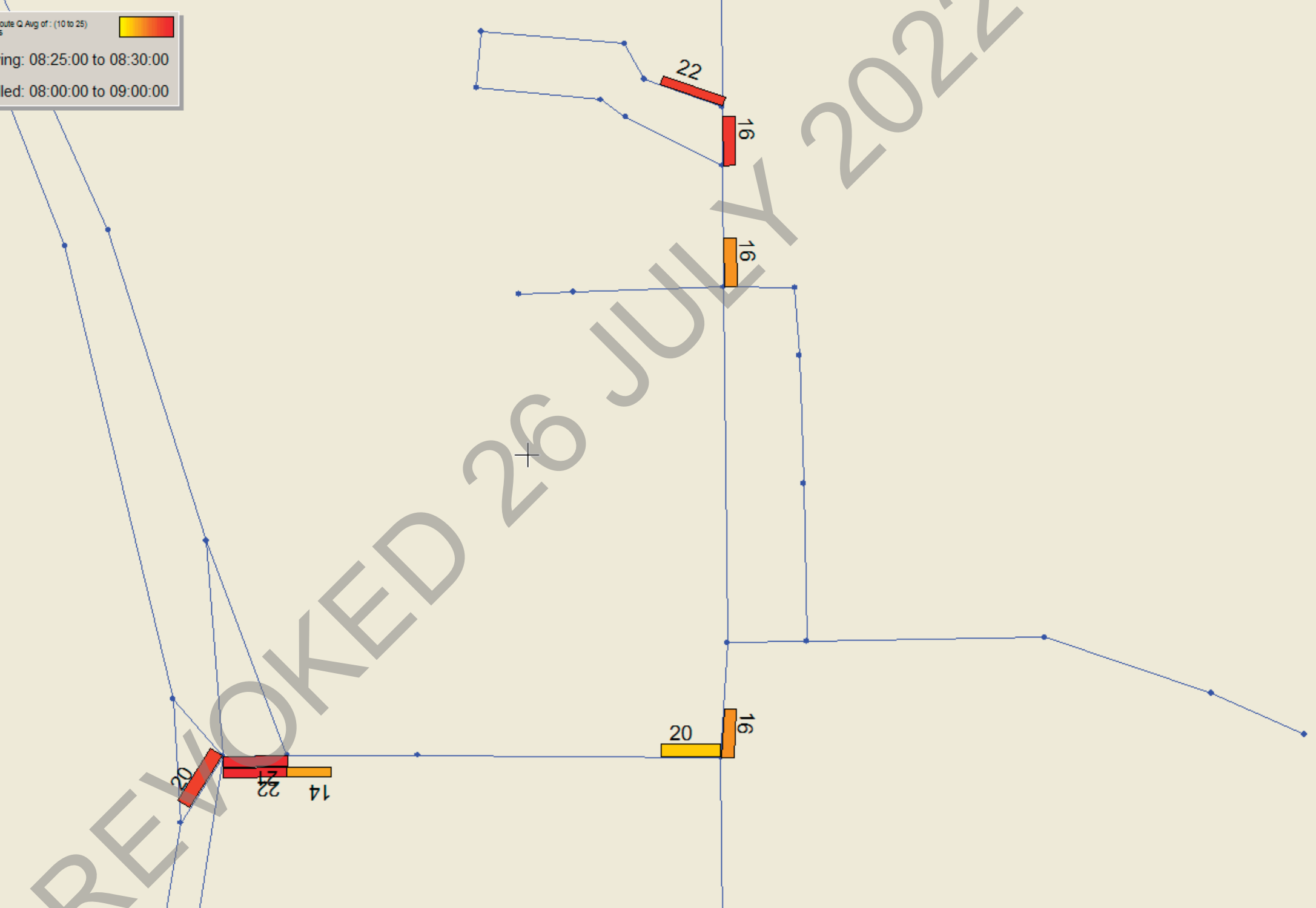
Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:20:00 to 08:25:00  
Modelled: 08:00:00 to 09:00:00



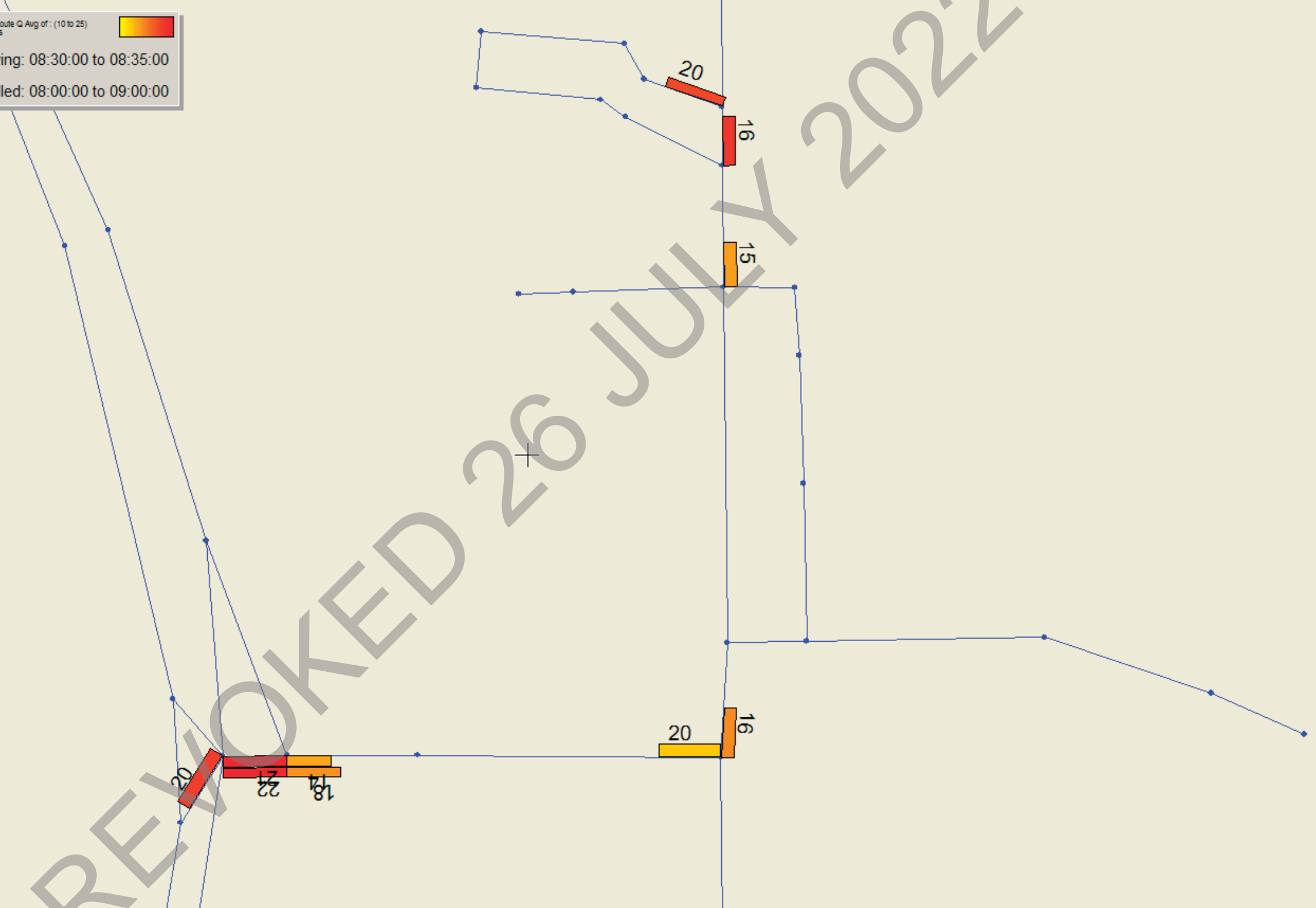
Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:25:00 to 08:30:00  
Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

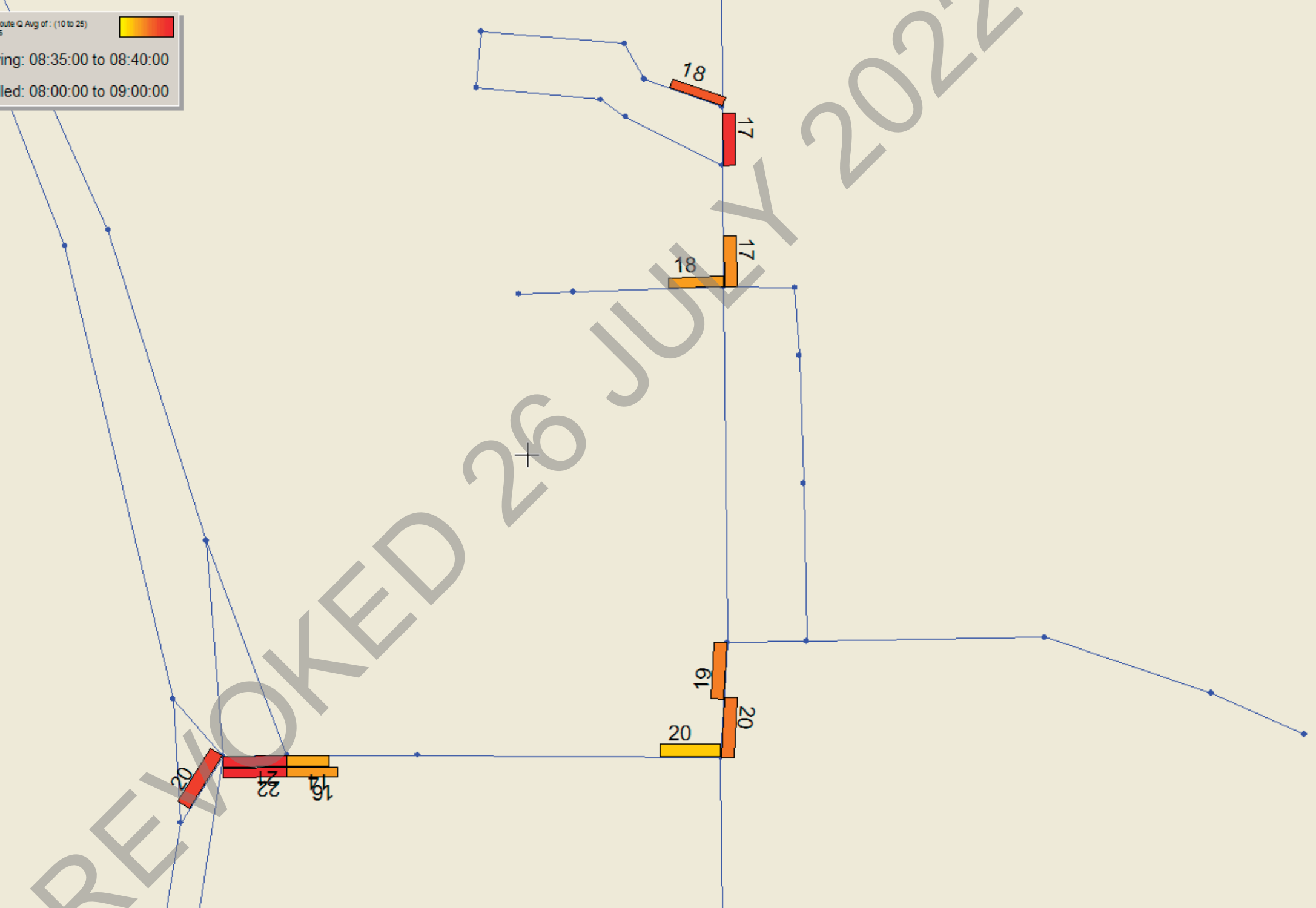
Showing: 08:30:00 to 08:35:00  
Modelled: 08:00:00 to 09:00:00





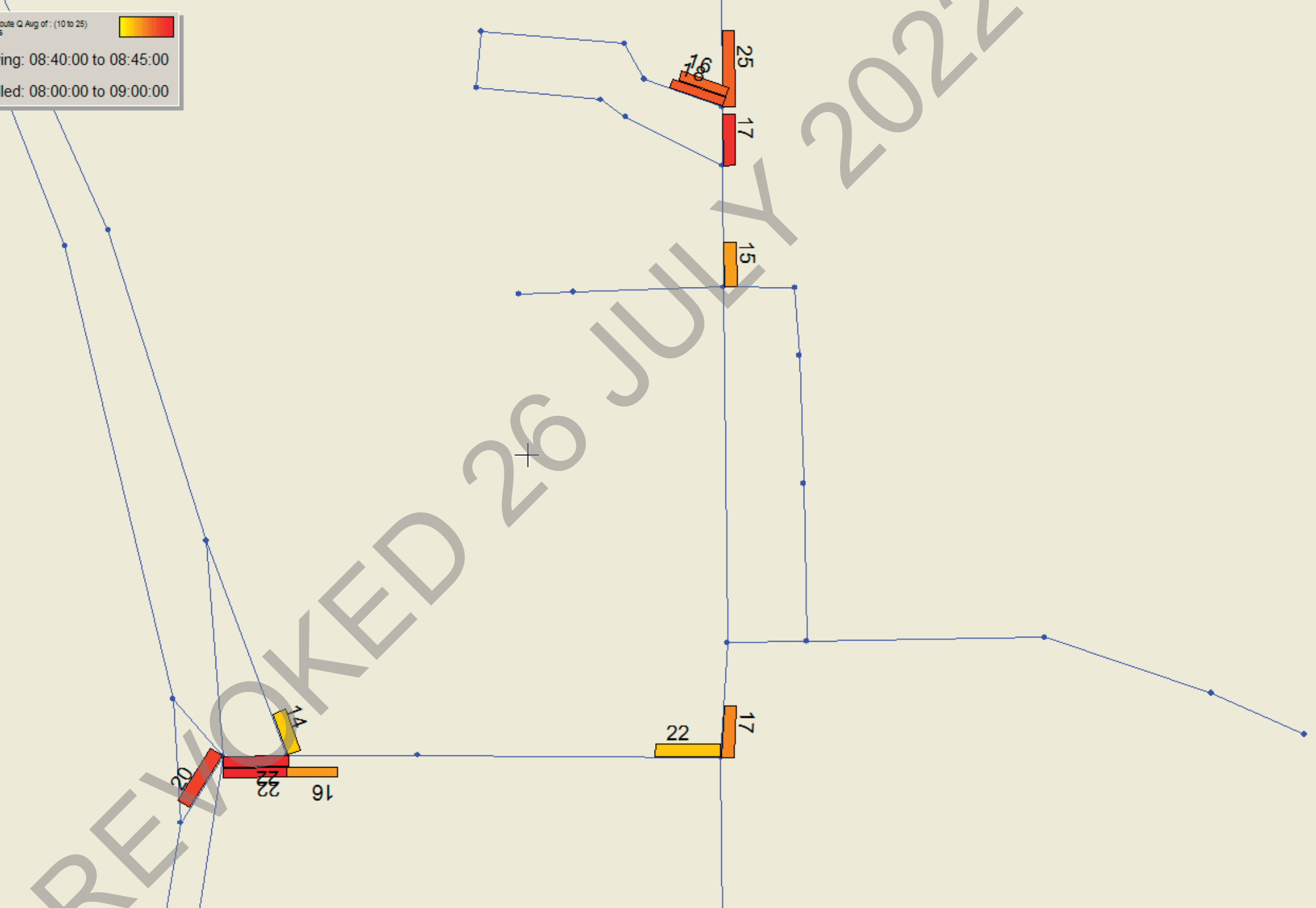
Base Case Route Q Avg of: (10 to 25)  
Run Averages

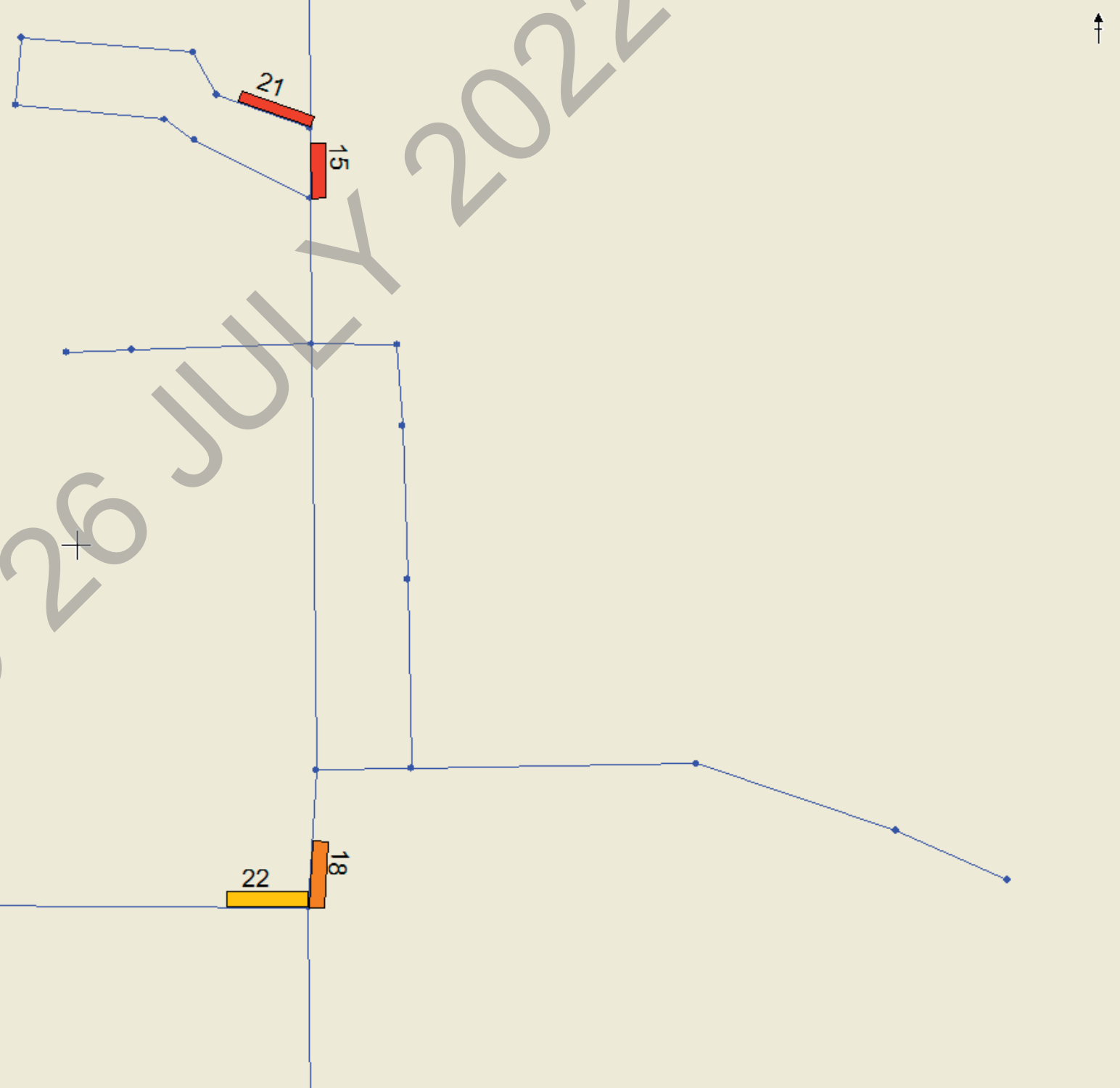
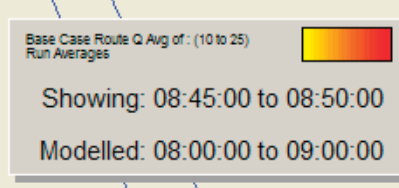
Showing: 08:35:00 to 08:40:00  
Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:40:00 to 08:45:00  
Modelled: 08:00:00 to 09:00:00

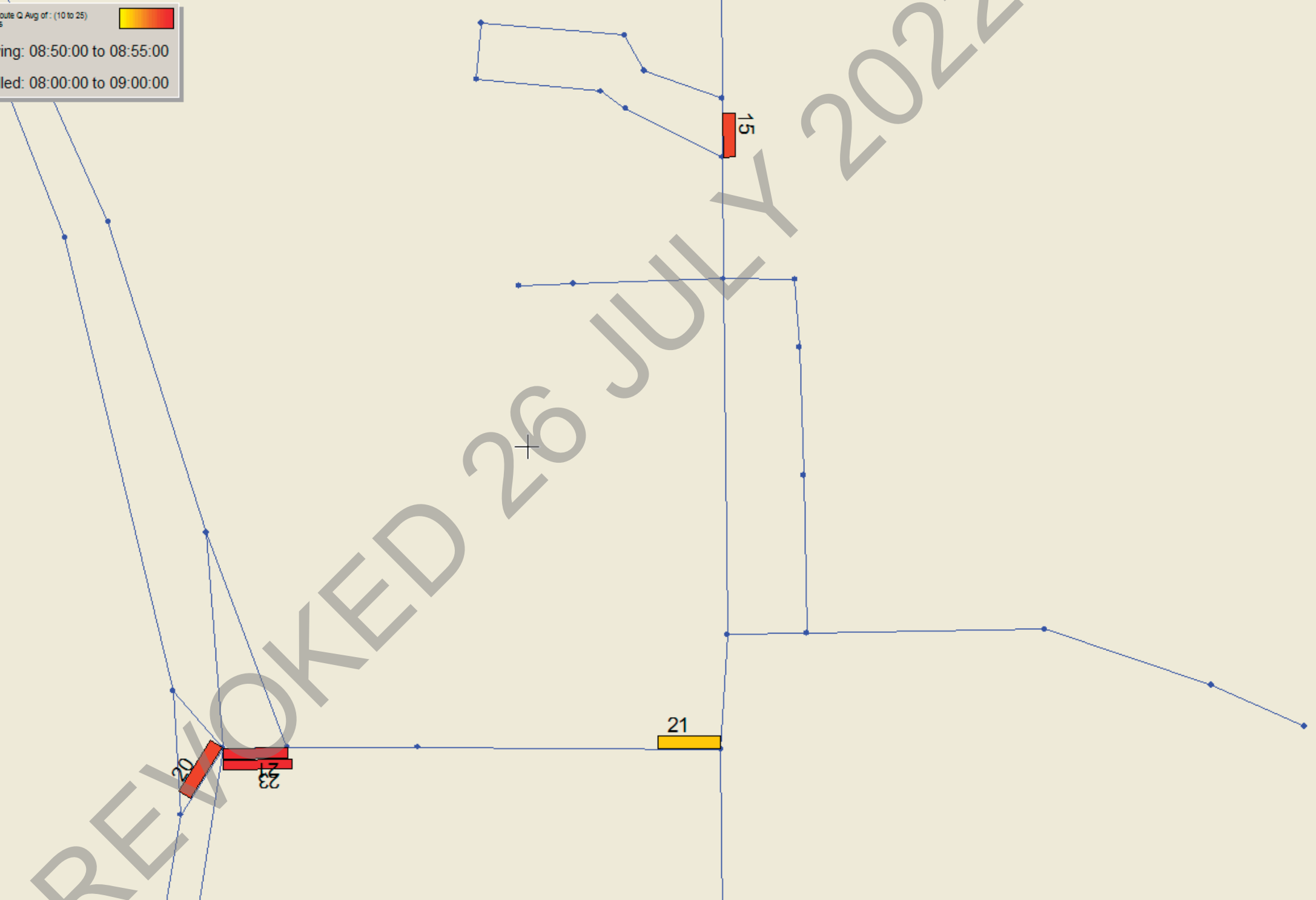






Base Case Route Q Avg of: (10 to 25)  
Run Averages

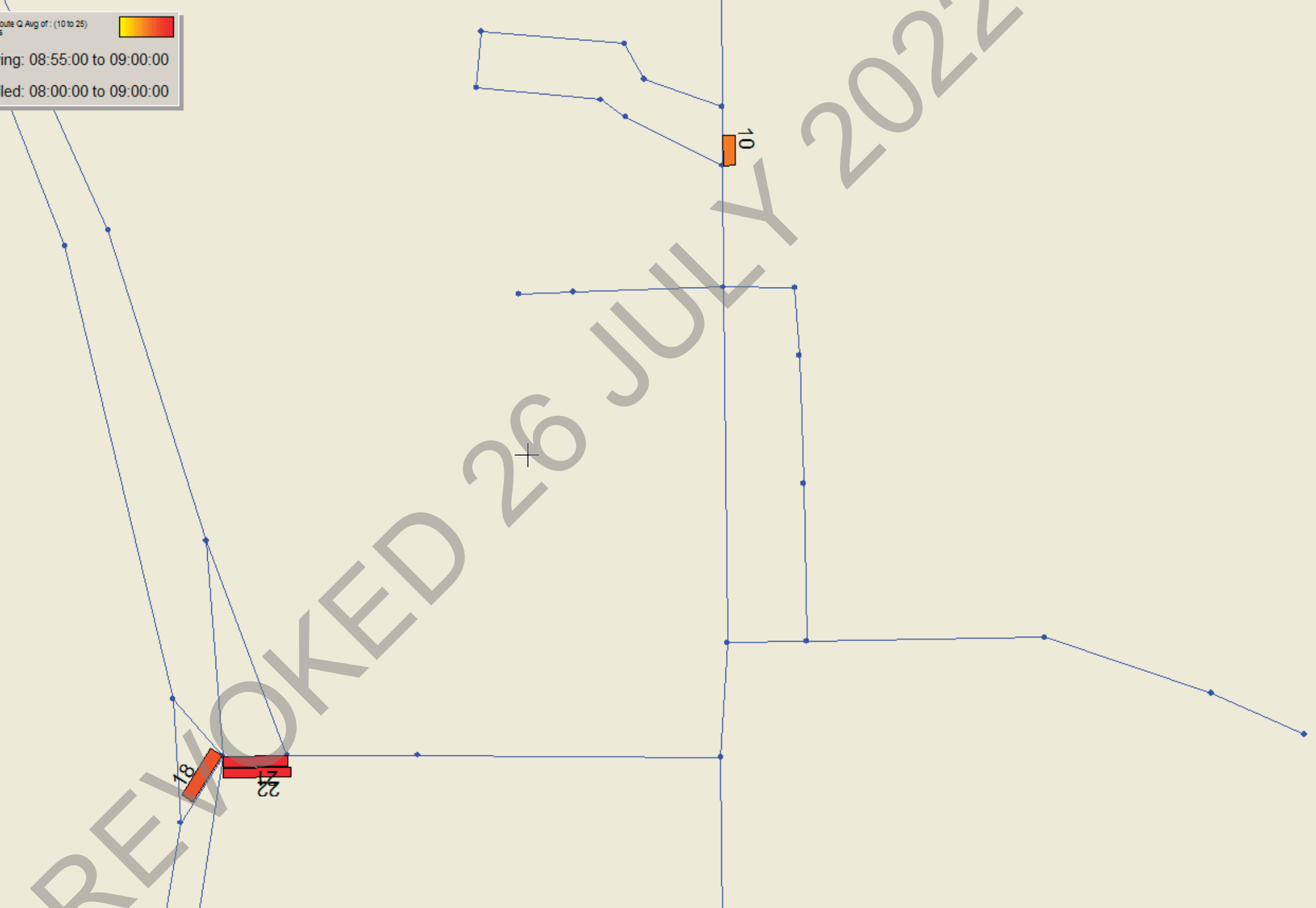
Showing: 08:50:00 to 08:55:00  
Modelled: 08:00:00 to 09:00:00



Base Case Route Q Avg of: (10 to 25)  
Run Averages

Showing: 08:55:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00



Link Count: (1 to 2362)

Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00

Link Count: (1 to 2362)

Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00


Link Count: (1 to 2362)

Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00

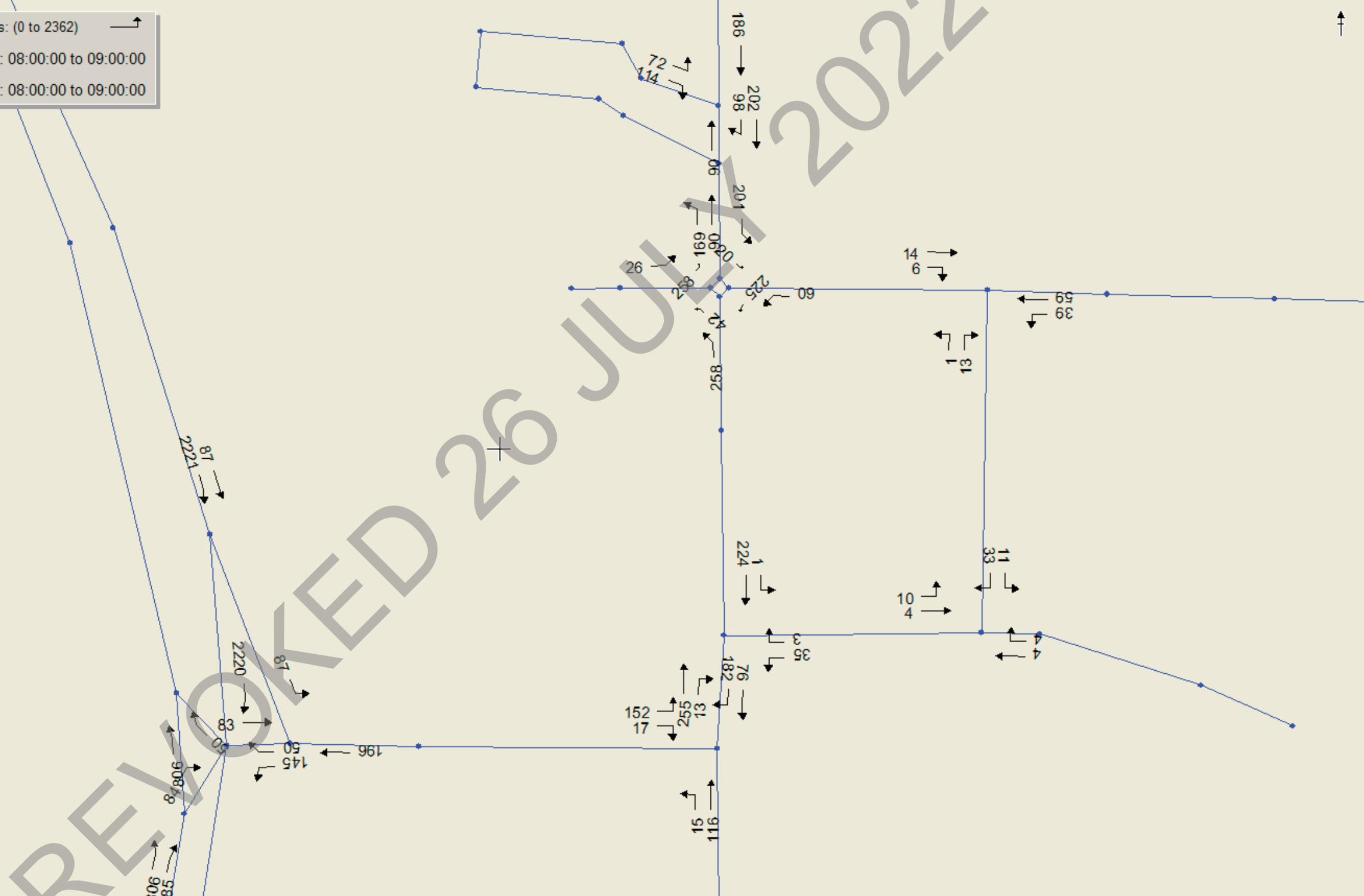




Turn Counts: (0 to 2362) 

Showing: 08:00:00 to 09:00:00

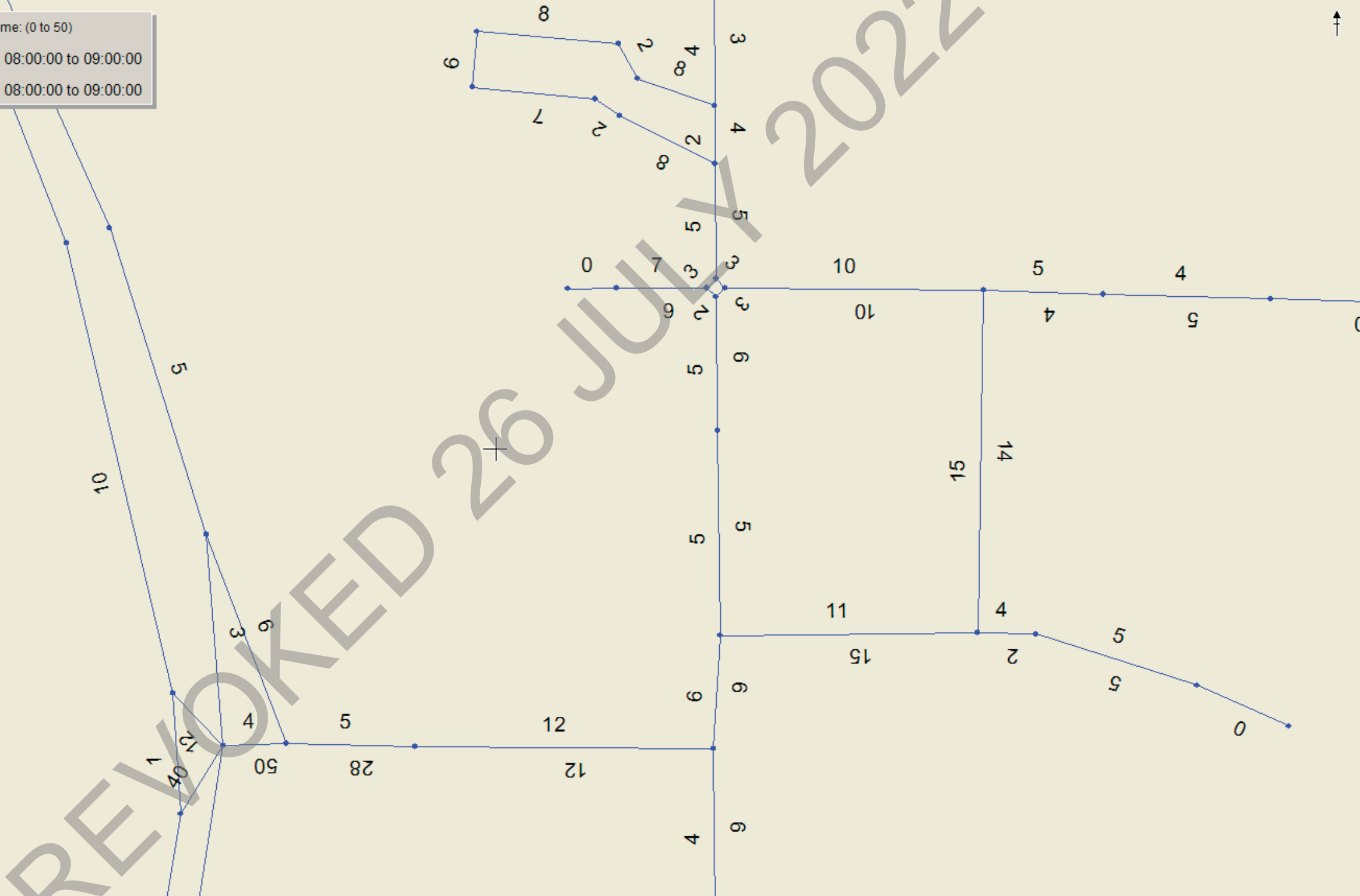
Modelled: 08:00:00 to 09:00:00



Link Mean Time: (0 to 50)

Showing: 08:00:00 to 09:00:00

Modelled: 08:00:00 to 09:00:00



Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:00:00 to 08:05:00  
Modelled: 08:00:00 to 09:00:00

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19  
22  
21

18



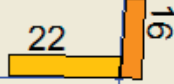
Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:05:00 to 08:10:00  
Modelled: 08:00:00 to 09:00:00

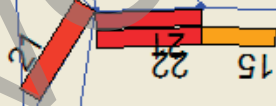
RELOADED 26 JULY 2022



15



16

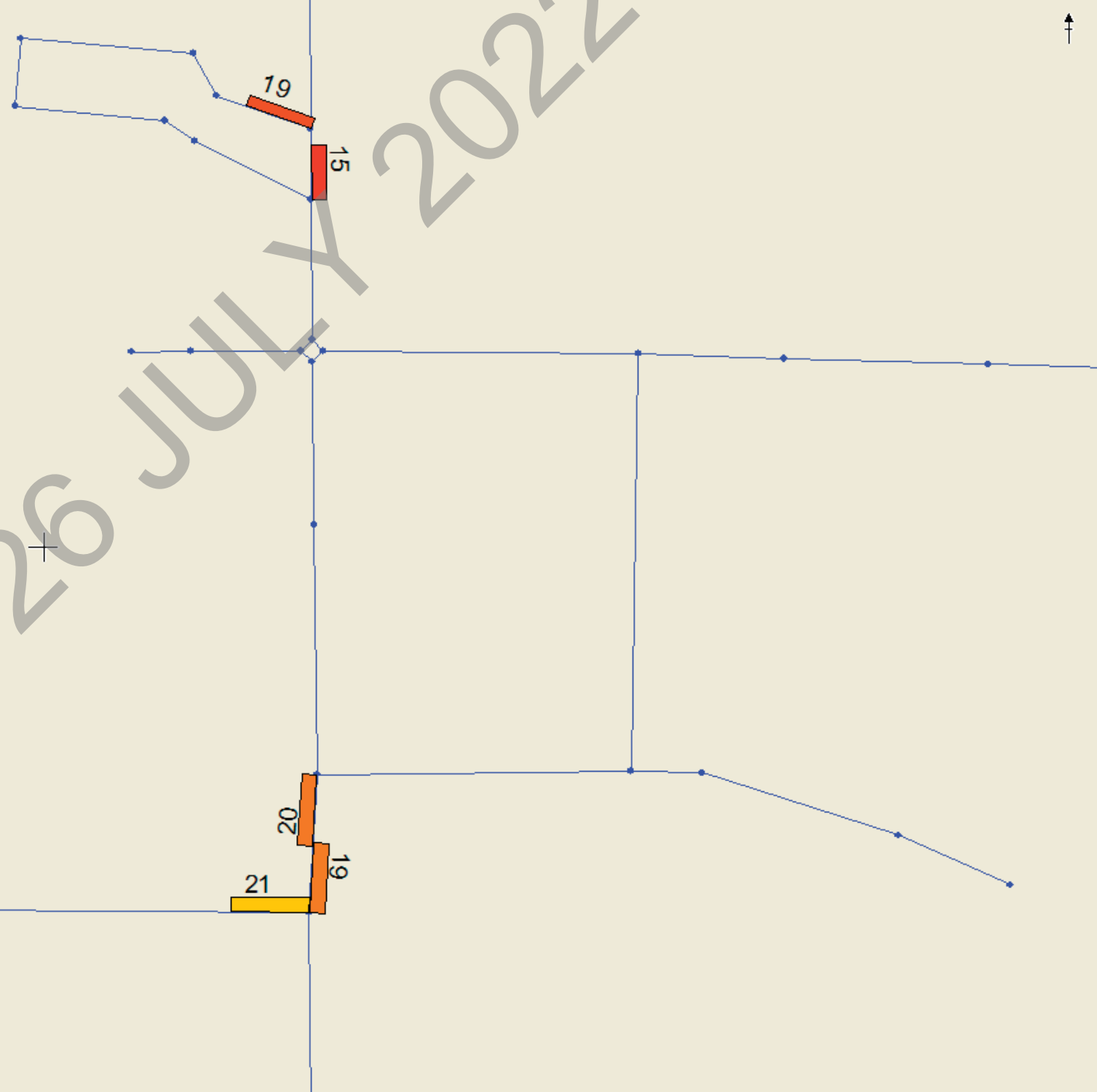


15

Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:10:00 to 08:15:00  
Modelled: 08:00:00 to 09:00:00

RELOADED 26 JULY 2022



Route Q Avg of Run Averag: (10 to 26)  
66

Showing: 08:55:00 to 09:00:00  
Modelled: 08:00:00 to 09:00:00

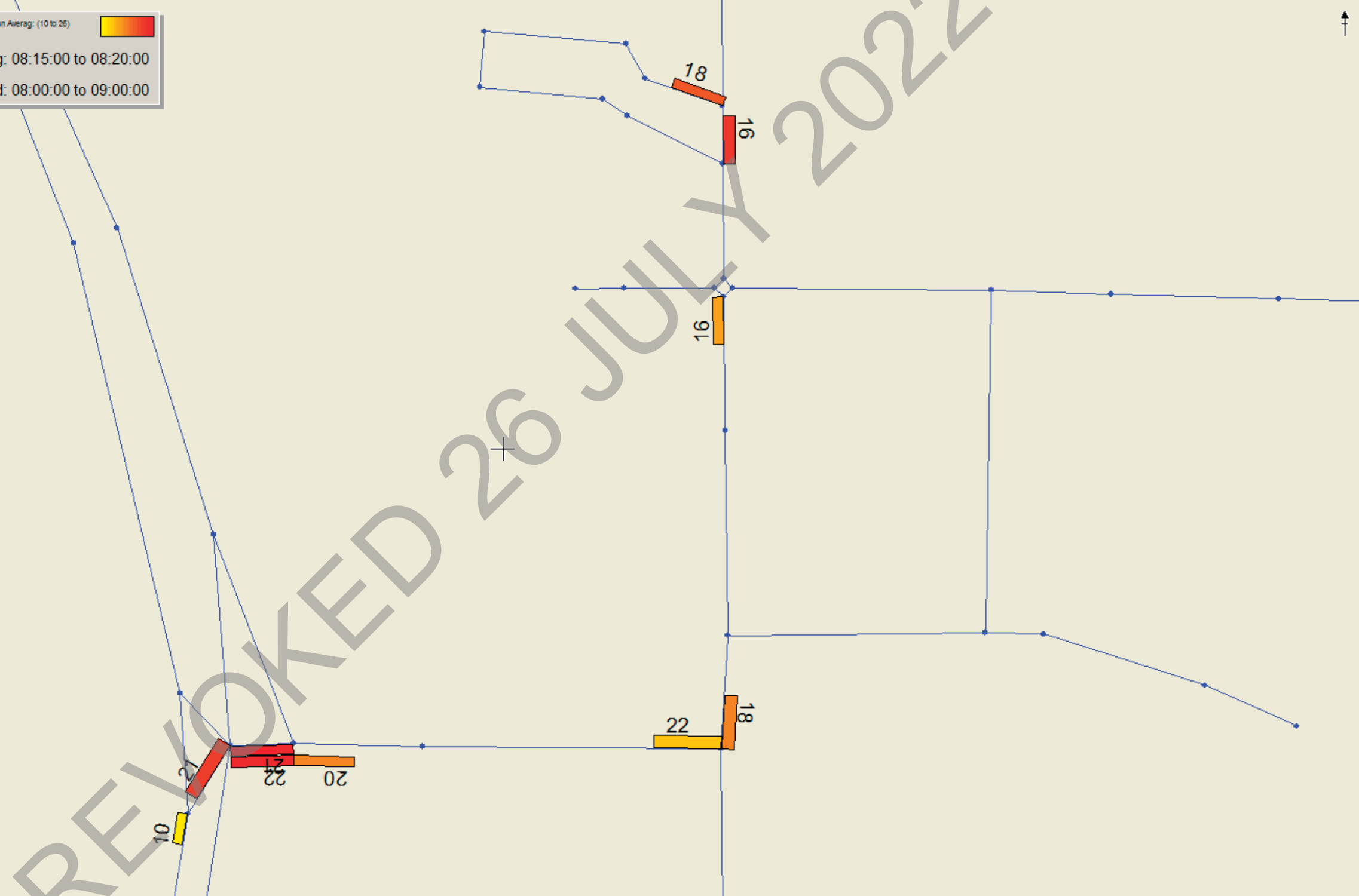
RELOADED 26 JULY 2022





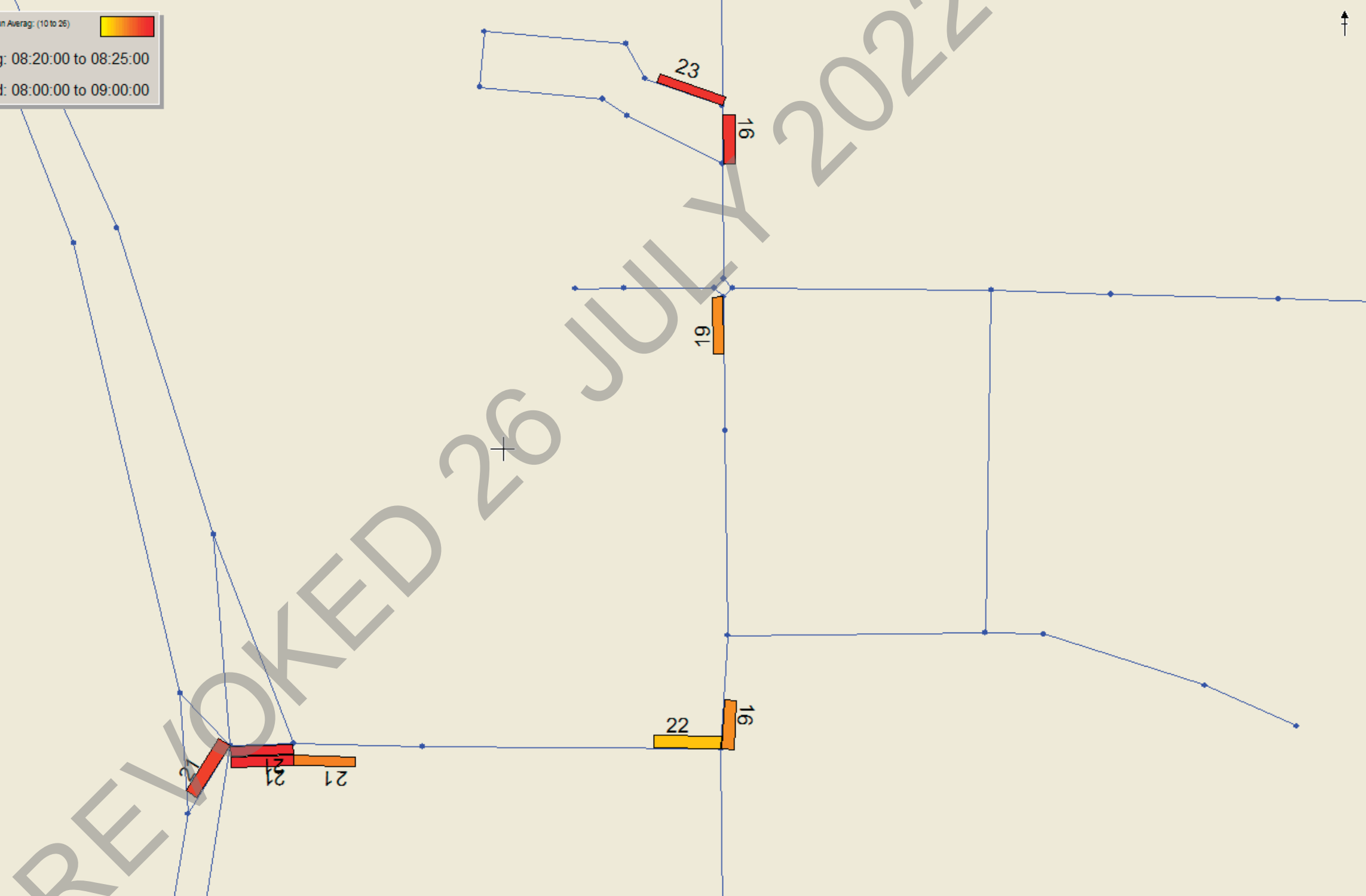
Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:15:00 to 08:20:00  
Modelled: 08:00:00 to 09:00:00



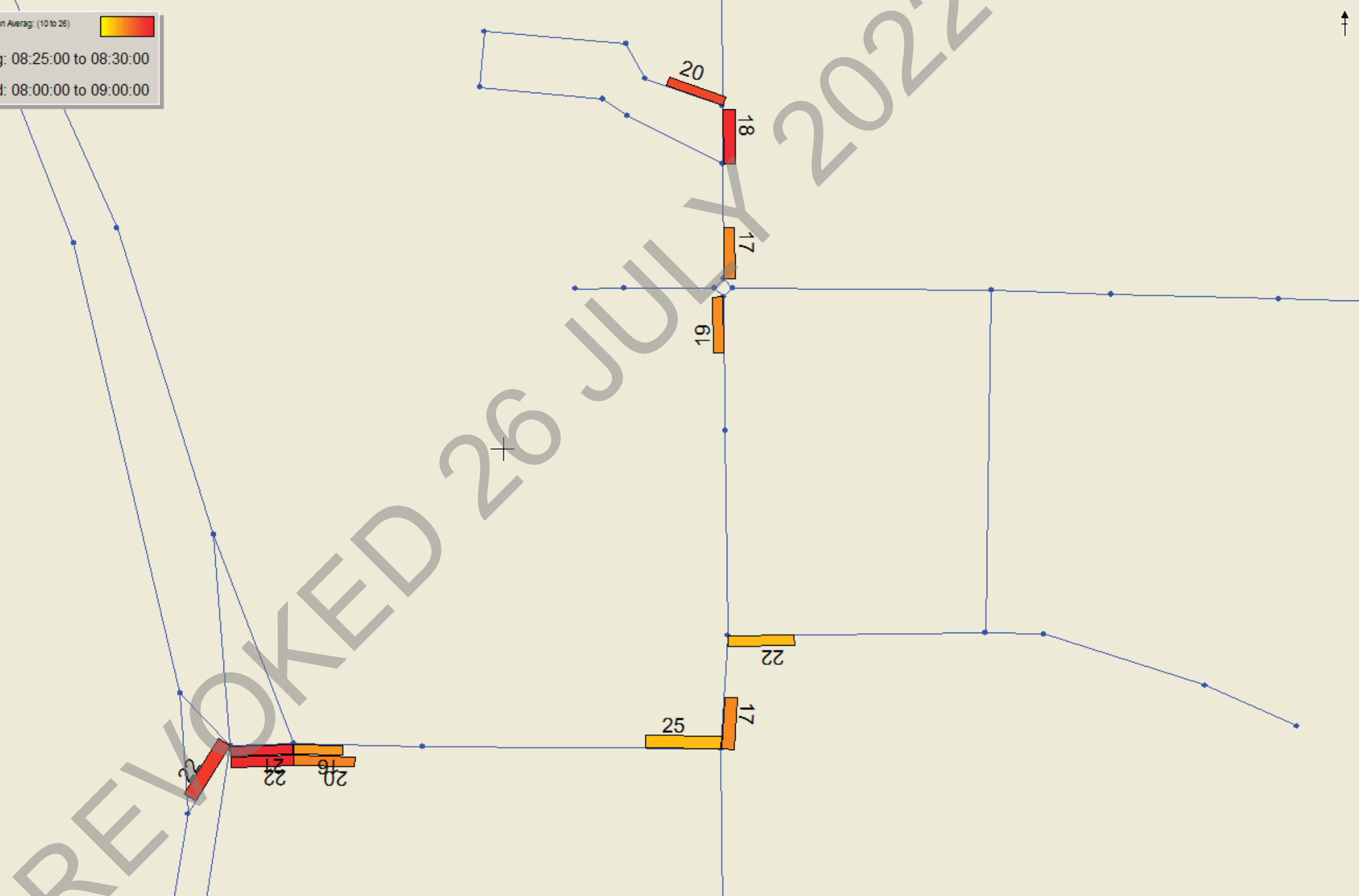
Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:20:00 to 08:25:00  
Modelled: 08:00:00 to 09:00:00



Route Q Avg of Run Average: (10 to 26)  
66

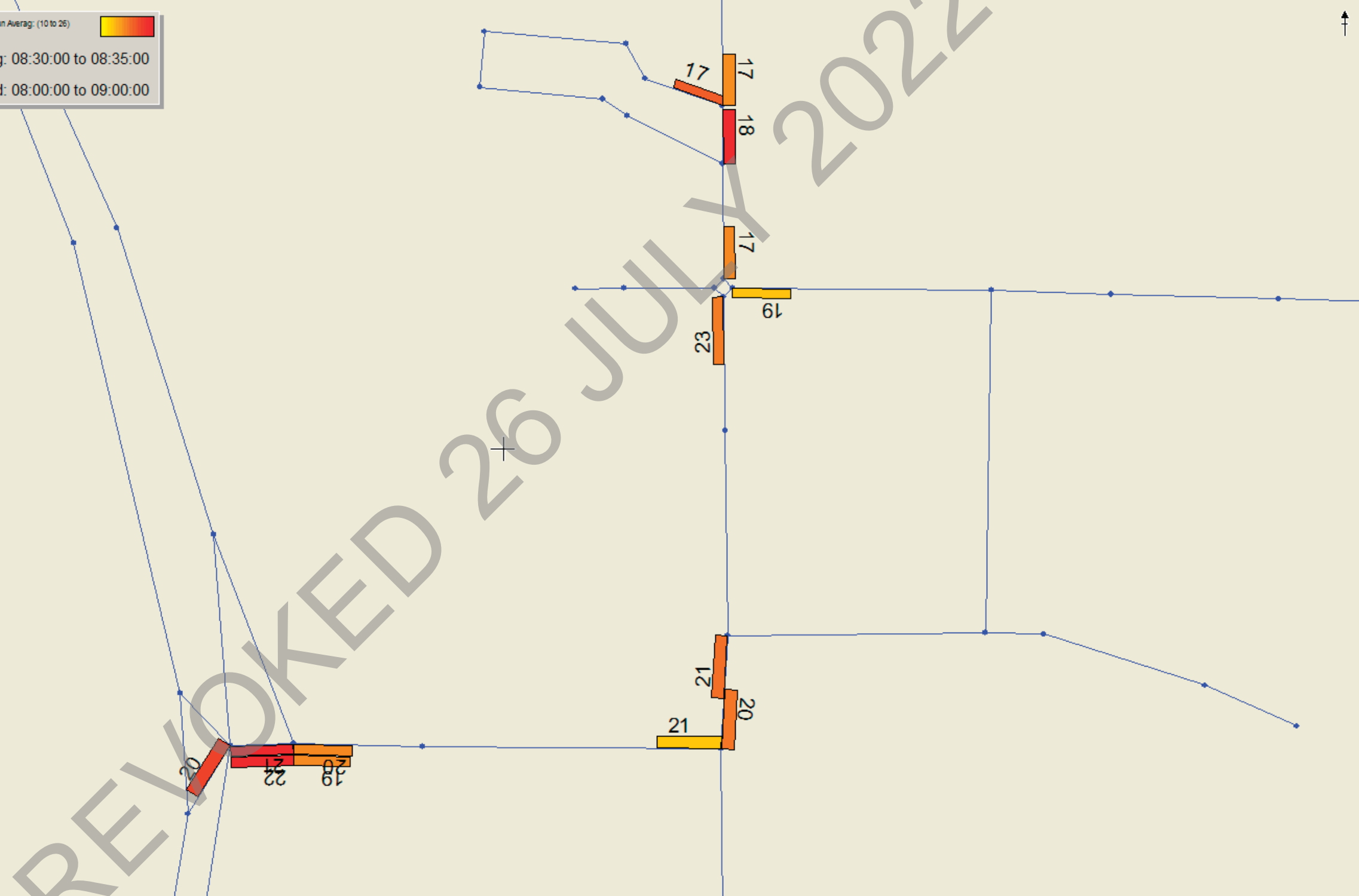
Showing: 08:25:00 to 08:30:00  
Modelled: 08:00:00 to 09:00:00





Route Q Avg of Run Average: (10 to 26)  
66

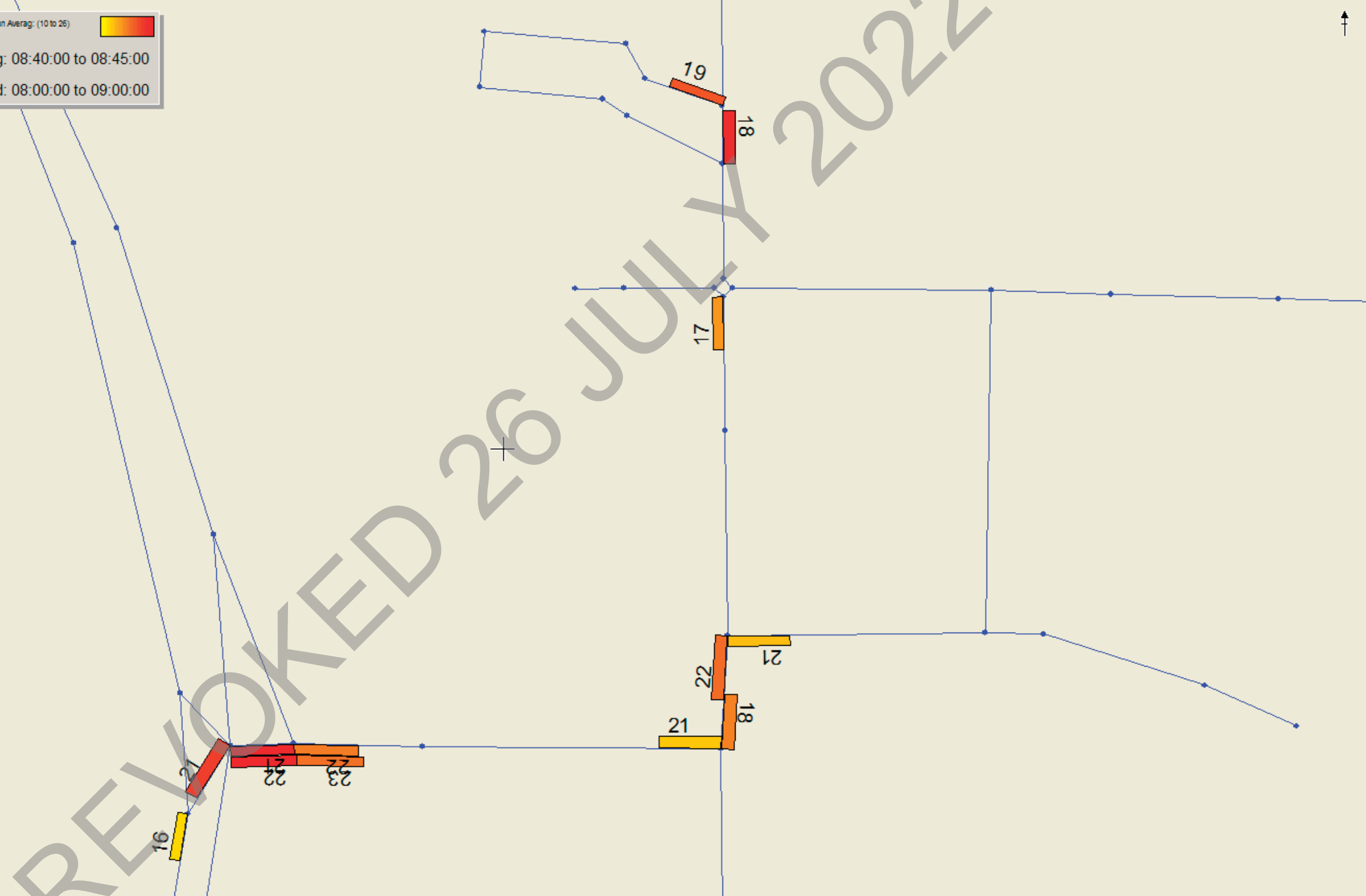
Showing: 08:30:00 to 08:35:00  
Modelled: 08:00:00 to 09:00:00





Route Q Avg of Run Average: (10 to 26)  
66

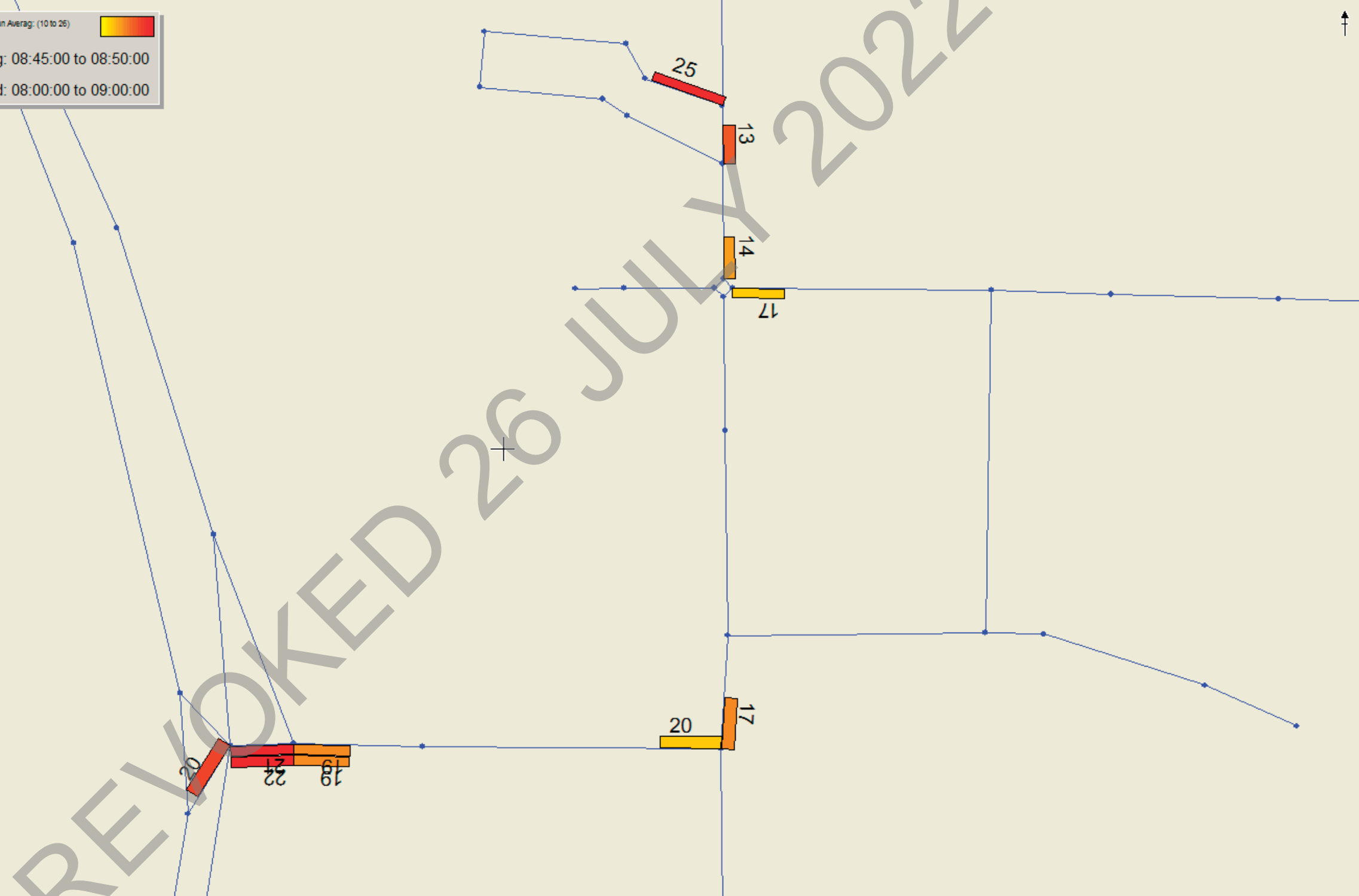
Showing: 08:40:00 to 08:45:00  
Modelled: 08:00:00 to 09:00:00





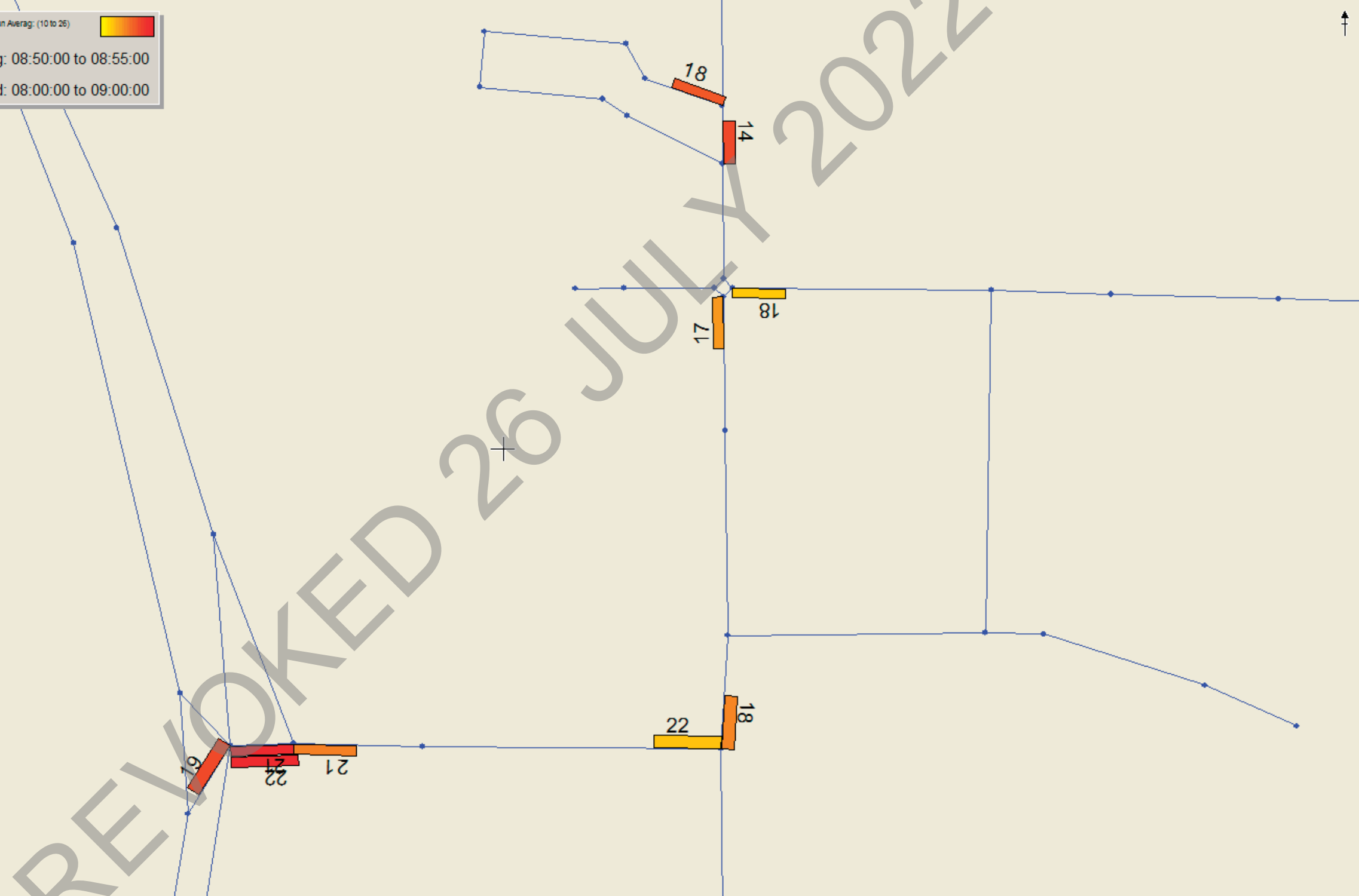
Route Q Avg of Run Average: (10 to 25)  
66

Showing: 08:45:00 to 08:50:00  
Modelled: 08:00:00 to 09:00:00



Route Q Avg of Run Average: (10 to 26)  
66

Showing: 08:50:00 to 08:55:00  
Modelled: 08:00:00 to 09:00:00



Route Q Avg of Run Averag: (10 to 26)  
66

Showing: 08:55:00 to 09:00:00  
Modelled: 08:00:00 to 09:00:00

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## Part B – Derivation of Technical Data

### 1.0 Trip Generation Rates

Trip generation rates are used in Table 1 of Volume 1 to determine the land use thresholds for the various levels of assessment for subdivisions and individual developments and are provided in Table 1 of Volume 2 to estimate the trip generating potential of structure plan land uses.

Data on the trip generating potential of the various land uses is fairly limited in Western Australia with the exception of the home end, (from the Perth and Regions Travel Surveys (PARTS) and TravelSmart).

As surveys are undertaken, over time, more data will become available and the above tables can be reviewed and revised.

Where more information is known on the likely trip generation of the development in question, site specific trip rates should be used in lieu of the rates in these guidelines.

The trip rates suggested in these guidelines have been derived mainly from the PARTS and TravelSmart surveys and the *RTA Guide to Traffic Generating Developments*, as outlined below.

#### Residential

The rates are based on the Perth and Regions Travel Surveys (PARTS) data averaged over the range of dwelling types. The rates for structure planning (Table 1 Volume 2) are:

0.8 vehicle trips per dwelling for the AM and PM peak hours

split as follows:

AM peak      25% IN / 75% OUT

PM peak      67% IN / 33% OUT

For the threshold calculations (Table 1 Volume 1) the rate has been rounded up to 1 vehicle trip per dwelling.

#### Schools

The rates are based on data from the PARTS surveys that indicate that around 65% - 70% of children are driven to primary school, with an average occupancy of around 1.4 - 1.5 children per car. This equates to:

0.5 trips per child to school and 0.5 trips per child from school in each of the AM and PM peak hours.

Appendix E

# ALBION WIDENING AT MARMION AVENUE

REVOKED 26 JULY 2022

1033-00-SK01

100mm AT FULL SIZE AT A1 SHEET SIZE

WAPC

EXISTING CARRIAGEWAY

APPROX. 17.6m

APPROX. 7m

APPROX. 7m

RIGHT TURN ENVELOPE  
INCREASED TO CATER FOR  
INCREASE IN TRAFFIC

MARMION AVENUE

MARMION AVENUE

ALBION STREET

EXISTING  
4.5m

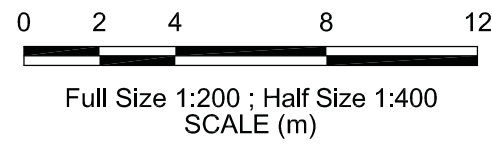
3.2m

3.2m

REVOKED 26 JULY 2022

PRELIMINARY

REV	DATE	DESCRIPTION	DRAWN	CHECKED	APPROVED
A					
NOTE: * INDICATES SIGNATURES ON ORIGINAL ISSUE OF DRAWING, OR LAST REVISION OF DRAWING					



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CLIENT			
PROJECT			
CRAIGIE HIGH SCHOOL			
SIZE	SCALE	DRAWING NUMBER	REV.
A1			A



Appendix E

## ROUTE 463 TIMETABLE

REVOKED 26 JULY 2022

To Joondalup timetable 463, 464									
Monday to Friday									
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		⌚	⌚	⌚	⌚	Train connection Joondalup to Perth Underground Departs Arrives	
		Route No.	* Whitfords Stn	18108 Ocean Reef Rd / Eddystone Av	18314 Belridge Senior High School	* Joondalup Stn			
-	-	464 am	-	6:08	-	6:22		6:27	6:53
6:43	7:02	464	7:07	7:14	-	7:29		7:39 C	8:03
7:03	7:22	463	7:27	-	7:39	7:53		7:59 C	8:23
7:19 W	7:37	464	7:42	7:49	-	8:04		8:09 C	8:33
7:35	7:54	463	7:59	-	8:11	8:25		8:29	8:55
7:51 W	8:09	464	8:14	8:21	-	8:38		8:54	9:20
8:05	8:24	463	8:28	-	8:40	8:54		9:07	9:33
8:15	8:34	464	8:38	8:45	-	9:00		9:07	9:33
8:39	8:58	463	9:03	-	9:15	9:28		9:39	10:05
9:05	9:24	464	9:29	9:36	-	9:52		10:09	10:35
9:39	9:58	463	10:03	-	10:15	10:28		10:39	11:05
10:09	10:28	464	10:33	10:40	-	10:56		11:09	11:35
10:39	10:58	463	11:03	-	11:15	11:28		11:39	12:05
11:09	11:28	464	11:33	11:40	-	11:56		12:09	12:35
11:39	11:58	463 pm	12:03	-	12:15	12:28		12:39	1:05
12:09	12:28	464	12:33	12:40	-	12:56		1:09	1:35
12:39	12:58	463	1:03	-	1:15	1:28		1:39	2:05
1:09	1:28	464	1:33	1:40	-	1:56		2:07	2:33
1:39	1:58	463	2:03	-	2:15	2:28		2:32	2:58
2:08	2:27	464	2:32	2:39	-	2:55		3:07	3:33
2:08	2:27	463	2:32	-	2:44	2:57		3:07	3:33
2:43	3:02	463	3:07	-	3:19	3:37		3:47	4:13
2:57 W	3:15	464	3:20	3:29	-	3:44		3:57	4:23
3:03	3:22	463	3:27	-	3:39	3:53		3:57	4:23
3:23	3:42	464	3:47	3:56	-	4:11		4:17	4:43
3:28 W	3:46	463	3:50	-	4:02	4:16		4:27	4:53
3:38 W	3:56	464	4:01	4:09	-	4:25		4:37	5:03
3:48 W	4:06	463	4:11	-	4:23	4:37		4:47	5:13
3:58 W	4:16	464	4:21	4:29	-	4:45		4:57	5:23
4:08 W	4:26	463	4:31	-	4:43	4:57		5:07	5:33
4:18 W	4:36	464	4:41	4:49	-	5:05		5:17	5:43
4:28 W	4:46	463	4:51	-	5:03	5:17		5:27	5:53
4:38 W	4:56	464	5:01	5:09	-	5:25		5:37	6:03
4:43 C	5:00	463	5:04	-	5:16	5:30		5:37	6:03
4:53 C	5:10	464	5:15	5:23	-	5:39		5:47	6:13
4:58 W	5:16	463	5:21	-	5:33	5:47		5:57	6:23
5:08 W	5:26	464	5:31	5:39	-	5:55		6:07	6:33
5:13 C	5:30	463	5:35	-	5:47	6:01		6:07	6:33
5:23 C	5:40	464	5:45	5:53	-	6:09		6:17	6:43
5:28	5:47	463	5:52	-	6:04	6:17		6:27	6:53
5:38	5:57	464	6:02	6:10	-	6:24		6:37	7:03
5:48	6:07	463	6:12	-	6:24	6:36		6:47	7:13
5:53 C	6:10	464	6:15	6:23	-	6:37		6:47	7:13
6:13 C	6:30	464	6:35	6:43	-	6:55		7:01	7:27
6:13 C	6:30	463	6:35	-	6:47	6:59		7:14	7:40
6:33 C	6:50	464	6:55	7:02	-	7:15		7:29	7:55
6:33 C	6:50	463	6:55	-	7:07	7:19		7:29	7:55
6:48	7:07	464	7:12	7:19	-	7:32		7:44	8:10
6:53	7:12	463	7:17	-	7:29	7:41		8:14	8:40
7:15	7:34	464	7:38	7:45	-	7:58		8:14	8:40
7:45	8:04	464	8:09	8:16	-	8:29		8:44	9:10
8:45	9:04	464	9:09	9:16	-	9:29		9:44	10:10
9:45	10:04	464	10:09	10:16	-	10:29		10:44	11:10
10:45	11:04	464	11:09	11:16	-	11:29		11:44	12:10
11:45	12:04	464 am	12:09	12:16	-	12:29		12:44 F	1:10
Saturday									
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		⌚	⌚	⌚	⌚	Train connection Joondalup to Perth Underground Departs Arrives	
		Route No.	* Whitfords Stn	18108 Ocean Reef Rd / Eddystone Av	18314 Belridge Senior High School	* Joondalup Stn			
7:29	7:48	464 am	7:52	7:59	-	8:14		8:18	8:44
7:44	8:03	463	8:07	-	8:19	8:31		8:48	9:14
8:14	8:33	464	8:37	8:44	-	8:59		9:03	9:29
8:29	8:48	463	8:52	-	9:04	9:16		9:33	9:59
8:44	9:03	464	9:07	9:14	-	9:29		9:33	9:59
9:14	9:33	463	9:37	-	9:49	10:01		10:18	10:44
9:44	10:03	464	10:07	10:14	-	10:29		10:33	10:59
10:14	10:33	463	10:37	-	10:49	11:01		11:18	11:44
10:44	11:03	464	11:07	11:14	-	11:29		11:33	11:59
11:14	11:33	463	11:37	-	11:49	12:01		12:18	12:44
11:44	12:03	464 pm	12:07	12:14	-	12:29		12:33	12:59
12:14	12:33	463	12:37	-	12:49	1:01		1:18	1:44
12:44	1:03	464	1:07	13:14	-	1:29		1:33	1:59
1:14	1:33	463	1:37	-	1:49	2:01		2:18	2:44
1:44	2:03	464	2:07	14:14	-	2:29		2:33	2:59
2:14	2:33	463	2:37	-	2:49	3:01		3:18	3:44
2:44	3:03	464	3:07	15:14	-	3:29		3:33	3:59
3:14	3:33	463	3:37	-	3:49	4:01		4:18	4:44
3:44	4:03	464	4:07	4:14	-	4:29		4:33	4:59
4:14	4:33	463	4:37	-	4:49	5:01		5:18	5:44
4:44	5:03	464	5:07	5:14	-	5:29		5:33	5:59
5:14	5:33	463	5:37	-	5:49	6:01		6:18	6:44
5:44	6:03	464	6:07	6:14	-	6:29		6:33	6:59
6:14	6:33	463	6:37	-	6:49	7:01		7:21	7:47
6:59	7:18	464	7:23	7:30	-	7:43		7:51	8:17
7:45	8:04	464	8:08	8:15	-	8:28		8:46	9:12
8:45	9:04	464	9:08	9:15	-	9:28		9:44	10:10
9:45	10:04	464	10:08	10:15	-	10:28		10:44	11:10
10:45	11:04	464	11:08	11:15	-	11:28		11:44	12:10
11:45	12:08	464 am	12:08	12:15	-	12:28		12:44	1:10
Sundays and Public Holidays									
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		⌚	⌚	⌚	Train connection Joondalup to Perth Underground Departs Arrives		
		Route No.	* Whitfords Stn	18108 Ocean Reef Rd / Eddystone Av	* Joondalup Stn				
8:59	9:18	464 am	9:23	9:30	9:43		9:48	10:14	
9:59	10:18	464	10:23	10:30	10:43		10:48	11:14	
10:59	11:18	464	11:23	11:30	11:43		11:48	12:14	
11:59	12:18	464 pm	12:23	12:30	12:43		12:48	1:14	
12:59	1:18	464	1:23	1:30	1:43		1:48	2:14	
1:59	2:18	464	2:23	2:30	2:43		2:48	3:14	
2:59	3:18	464	3:23	3:30	3:43		3:48	4:14	
3:59	4:18	464	4:23	4:30	4:43		4:48	5:14	
4:59	5:18	464	5:23	5:30	5:43		5:48	6:14	
6:29	6:48	464	6:53	7:00	7:13		7:21	7:47	
7:29	7:48	464	7:53	8:00	8:13		8:46	9:12	







LEGEND  
\* Stop number - refer to back panel for Station stand information.

Train from Perth  
C Express to Stirling, then all stops to Clarkson  
W Whitfords Shuttle. Does not stop at Greenwood.

Train to Perth  
C All stops to Stirling, then express to Perth  
F Operates on Friday only.

To Joondalup timetable 465, 466								
Monday to Friday								
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		18476 Whitfords Stn	18283 Edgewater Dr / Ocean Reef Rd	17849 Joondalup Stn	Train connection Joondalup to Perth Underground Departs Arrives	
		Route No.						
6:43	7:02	466 am		7:07	7:16	7:32	7:39 C	8:03
7:03	7:22	465		7:27	7:36	7:51	7:59 C	8:23
7:41 W	7:59	465		8:03	8:12	8:28	8:39	9:05
7:45	8:04	466		8:08	8:17	8:36	8:54	9:20
8:09 W	8:27	465 H		8:32	8:41	8:54	9:07	9:33
8:09 W	8:27	465 S		8:32	8:43	8:58	9:07	9:33
8:15	8:34	466		8:38	8:47	9:05	9:25	9:51
8:29	8:48	465 H		8:52	9:01	9:13	9:25	9:51
8:29	8:48	465 S		8:52	9:03	9:19	9:25	9:51
9:05	9:24	466		9:29	9:38	9:53	10:09	10:35
9:39	9:58	465		10:03	10:12	10:24	10:39	11:05
10:09	10:28	466		10:33	10:42	10:57	11:09	11:35
10:39	10:58	465		11:03	11:12	11:24	11:39	12:05
11:05	11:28	466		11:33	11:42	11:57	12:09	12:35
11:39	11:58	465 pm		12:03	12:12	12:24	12:39	1:05
12:09	12:28	466		12:33	12:42	12:57	1:09	1:35
12:39	12:58	465		1:03	1:12	1:24	1:39	2:05
1:09	1:28	466		1:33	1:42	1:57	2:07	2:33
1:39	1:58	465		2:03	2:12	2:24	2:32	2:58
2:08	2:27	466 E		2:37	2:49	3:06	3:10	3:36
2:34	2:53	465		2:58	3:07	3:23	3:27	3:53
2:53	3:12	466 H		3:16	3:25	3:41	3:47	4:13
2:53	3:12	466 B		3:16	3:31	3:51	3:57	4:23
2:53	3:12	466 C		3:16	3:37	3:57	4:07	4:33
3:03	3:22	465 H		3:26	3:35	3:50	3:57	4:23
3:03	3:22	465 S		3:26	3:35	3:59	4:07	4:33
3:33	3:52	466		3:56	4:05	4:21	4:27	4:53
3:43 C	4:00	465		4:05	4:14	4:31	4:37	4:03
3:53 C	4:10	466		4:15	4:24	4:41	4:47	5:13
4:03 C	4:20	465		4:25	4:34	4:50	4:57	5:23
4:13 C	4:30	466		4:35	4:44	5:00	5:07	5:33
4:23 C	4:40	465		4:45	4:54	5:10	5:17	5:43
4:33 C	4:50	466		4:55	5:04	5:20	5:27	5:53
4:43 C	5:00	465		5:05	5:14	5:30	5:37	6:03
4:53 C	5:10	466		5:15	5:24	5:40	5:47	6:13
5:03 C	5:20	465		5:25	5:34	5:49	5:57	6:23
5:13 C	5:30	466		5:35	5:44	6:00	6:07	6:33
5:23 C	5:40	465		5:45	5:54	6:09	6:17	6:43
5:33 C	5:50	466		5:55	6:04	6:19	6:27	6:53
5:43 C	6:00	465		6:05	6:13	6:26	6:37	7:03
5:53 C	6:10	466		6:15	6:24	6:37	6:47	7:13
6:03	6:22	465		6:27	6:35	6:47	7:01	7:27
6:13 C	6:30	466		6:35	6:44	6:57	7:01	7:27
6:23 C	6:40	465		6:45	6:53	7:05	7:14	7:40
6:33 C	6:50	466		6:55	7:04	7:17	7:29	7:55
6:43	7:02	465		7:07	7:15	7:27	7:44	8:10
6:48	7:07	466		7:12	7:21	7:34	7:44	8:10
7:03	7:22	465		7:26	7:34	7:46	8:14	8:40
7:45	8:04	465		8:09	8:17	8:29	8:44	9:10
8:45	9:04	465		9:09	9:17	9:29	9:44	10:10
9:45	10:04	465		10:09	10:17	10:29	10:44	11:10
10:45	11:04	465		11:09	11:17	11:29	11:44	12:10
11:45	12:04	465 am		12:09	12:17	12:29	12:44 F	1:10
Saturday								
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		18476 Whitfords Stn	18283 Edgewater Dr / Ocean Reef Rd	17849 Joondalup Stn	Train connection Joondalup to Perth Underground Departs Arrives	
		Route No.						
7:29	7:48	465 am		7:53	8:02	8:14	8:18	8:44
7:59	8:18	466		8:23	8:32	8:46	9:03	9:29
8:29	8:48	465		8:53	9:02	9:14	9:18	9:44
8:59	9:18	466		9:23	9:32	9:46	10:03	10:29
9:29	9:48	465		9:53	10:02	10:14	10:18	10:44
9:59	10:18	466		10:23	10:32	10:46	11:03	11:29
10:29	10:48	465		10:53	11:02	11:14	11:18	11:44
10:59	11:18	466		11:23	11:32	11:46	12:03	12:29
11:29	11:48	465		11:53	12:02	12:14	12:18	12:44
11:59	12:18	466 pm		12:23	12:32	12:46	1:03	1:29
12:29	12:48	465		12:53	1:02	1:14	1:18	1:44
12:59	1:18	466		1:23	1:32	1:46	2:03	2:29
1:29	1:48	465		1:53	2:02	2:14	2:18	2:44
1:59	2:18	466		2:23	2:32	2:46	3:03	3:26
2:29	2:48	465		2:53	3:02	3:14	3:18	3:44
2:59	3:18	466		3:23	3:32	3:46	4:03	4:29
3:29	3:48	465		3:53	4:02	4:14	4:18	4:44
3:59	4:18	466		4:23	4:32	4:46	5:03	5:29
4:29	4:48	465		4:53	5:02	5:14	5:18	5:44
4:59	5:18	466		5:23	5:32	5:46	6:03	6:29
5:29	5:48	465		5:53	6:02	6:14	6:18	6:44
5:59	6:18	466		6:23	6:32	6:46	7:03	7:29
6:29	6:48	465		6:53	7:01	7:13	7:21	7:47
6:59	7:19	465		7:23	7:31	7:43	7:51	8:17
7:45	8:04	465		8:09	8:17	8:29	8:46	9:12
8:45	9:04	465		9:09	9:17	9:29	9:44	10:10
9:45	10:04	465		10:09	10:17	10:29	10:44	11:10
10:45	11:04	465		11:09	11:17	11:29	11:44	12:10
11:45	12:04	465 am		12:09	12:17	12:29	12:44	1:10
Sundays and Public Holidays								
Train connection Perth Underground to Whitfords Departs Arrives		Timed Stops		18476 Whitfords Stn	18283 Edgewater Dr / Ocean Reef Rd	17849 Joondalup Stn	Train connection Joondalup to Perth Underground Departs Arrives	
		Route No.						
8:59	9:18	465 am		9:23	9:31	9:43	9:48	10:14
9:59	10:18	465		10:23	10:31	10:43	10:48	11:14
10:59	11:18	465		11:23	11:31	11:43	11:48	12:14
11:59	12:18	465 pm		12:23	12:31	12:43	12:48	1:14
12:59	1:18	465		1:23	1:31	1:43	1:48	2:14
1:59	2:18	465		2:23	2:31	2:43	2:48	3:14
2:59	3:18	465		3:23	3:31	3:43	3:48	4:14
3:59	4:18	465		4:23	4:31	4:43	4:48	5:14
4:59	5:18	465		5:23	5:31	5:43	5:48	6:14
6:29	6:48	465		6:53	7:01	7:13	7:21	7:47
7:29	7:48	465		7:53	8:01	8:13	8:46	9:12












To Whitfords timetable    463, 464									
Monday to Friday									
Train connection Perth Underground to Joondalup Departs   Arrives		Timed Stops	 * Joondalup Stn	 18311 Belridge Senior High School	 18101 Ocean Reef Rd / Eddystone Av	 * Whitfords Stn	Train connection Whitfords to Perth Underground Departs   Arrives		
		Route No.							
-	-	464 am	5:47	-	5:55	6:06	6:11	6:31	
5:30	5:55	463	6:19	6:28	-	6:43	6:47	7:07	
5:30	5:55	464	6:21	-	6:29	6:43	6:47	7:07	
6:00	6:25	463	6:32	6:41	-	6:58	7:03	7:23	
6:00	6:25	464	6:33	-	6:41	6:58	7:03	7:23	
-	-	464	6:48	-	6:56	7:13	7:17	7:37	
-	-	463	6:50	6:59	-	7:18	7:23 C	7:41	
6:23	6:48	464	7:03	-	7:11	7:29	7:33	7:53	
6:43	7:08	463	7:13	7:22	-	7:41	7:45 C	8:03	
6:53	7:18	464	7:24	-	7:32	7:50	7:55 C	8:13	
6:53	7:18	463	7:26	7:35	-	7:54	7:59 W	8:17	
7:03	7:28	464	7:39	-	7:47	8:05	8:09 W	8:27	
7:13	7:38	463	7:46	7:55	-	8:14	8:19 W	8:37	
7:23	7:48	464	8:00	-	8:08	8:26	8:31 W	8:49	
7:23	7:48	463	8:02	8:11	-	8:30	8:35	8:55	
7:55	8:20	464	8:31	-	8:39	8:56	9:00	9:20	
8:05	8:30	463	8:42	8:51	-	9:08	9:13	9:33	
8:29	8:54	464	9:02	-	9:10	9:26	9:31	9:51	
8:55	9:20	463	9:29	9:38	-	9:55	10:00	10:20	
9:24	9:49	464	10:01	-	10:09	10:25	10:30	10:50	
9:54	10:19	463	10:29	10:38	-	10:55	11:00	11:20	
10:24	10:49	464	11:01	-	11:09	11:25	11:30	11:50	
10:54	11:19	463	11:29	11:38	-	11:55	12:00	12:20	
11:24	11:49	464 pm	12:01	-	12:09	12:25	12:30	12:50	
11:54	12:19	463	12:29	12:38	-	12:55	1:00	1:20	
12:24	12:49	464	1:01	-	1:09	1:25	1:30	1:50	
12:54	1:19	463	1:29	1:38	-	1:55	2:00	2:20	
1:24	1:49	464	2:04	-	2:12	2:28	2:33	2:53	
1:53	2:18	463 H	2:32	2:41	-	2:58	3:03	3:23	
1:53	2:18	463 S	2:35	2:44	-	3:09	3:13	3:33	
2:34	2:59	464	3:08	-	3:16	3:33	3:38 W	3:56	
3:03	3:28	463	3:32	3:41	-	3:58	4:03	4:23	
3:13	3:38	464	3:44	-	3:52	4:09	4:13	4:33	
3:23	3:48	463	3:58	4:07	-	4:24	4:28 W	4:46	
3:23	3:48	464	4:00	-	4:08	4:24	4:28 W	4:46	
3:53 C	4:16	463	4:28	4:37	-	4:54	4:58 W	5:16	
4:03 C	4:26	464	4:39	-	4:47	5:03	5:08 W	5:26	
4:33 C	4:56	463	5:02	5:11	-	5:28	5:33	5:53	
4:43 C	5:06	464	5:10	-	5:18	5:33	5:38 W	5:56	
5:03 C	5:26	463	5:33	5:42	-	5:59	6:03	6:23	
5:23 C	5:46	464	5:55	-	6:03	6:18	6:23	6:43	
6:43	7:08	464	7:12	-	7:20	7:31	7:35	7:55	
7:03	7:28	464	7:43	-	7:51	8:02	8:20	8:40	
8:15	8:40	464	8:45	-	8:53	9:04	9:20	9:40	
9:15	9:40	464	9:45	-	9:53	10:04	10:20	10:40	
10:15	10:40	464	10:45	-	10:53	11:04	11:20	11:40	
11:15	11:40	464	11:45	-	11:53	12:04	12:50 F	1:10	
Saturday									
Train connection Perth Underground to Joondalup Departs   Arrives		Timed Stops	 * Joondalup Stn	 18311 Belridge Senior High School	 18101 Ocean Reef Rd / Eddystone Av	 * Whitfords Stn	Train connection Whitfords to Perth Underground Departs   Arrives		
		Route No.							
5:59	6:24	463 am	6:42	6:50	-	7:04	7:09	7:29	
5:59	6:24	464	6:44	-	6:52	7:04	7:09	7:29	
6:29	6:54	464	7:11	-	7:19	7:34	7:39	7:59	
6:29	6:54	463	7:24	7:32	-	7:49	7:54	8:14	
7:29	7:54	464	7:57	-	8:05	8:20	8:24	8:44	
7:44	8:09	463	8:25	8:33	-	8:50	8:54	9:14	
7:59	8:24	464	8:42	-	8:50	9:05	9:09	9:29	
8:29	8:54	463	9:10	9:18	-	9:35	9:39	9:59	
8:59	9:24	464	9:42	-	9:50	10:05	10:09	10:29	
9:29	9:54	463	10:10	10:18	-	10:35	10:39	10:59	
9:59	10:24	464	10:42	-	10:50	11:05	11:09	11:29	
10:29	10:54	463	11:10	11:18	-	11:35	11:39	11:59	
10:59	11:24	464	11:42	-	11:50	12:05	12:09	12:29	
11:29	11:54	463 pm	12:10	12:18	-	12:35	12:39	12:59	
11:59	12:24	464	12:42	-	12:50	1:05	1:09	1:29	
12:29	12:54	463	1:10	1:18	-	1:35	1:39	1:59	
12:59	1:24	464	1:42	-	1:50	2:05	2:09	2:29	
1:29	1:54	463	2:10	2:18	-	2:35	2:39	2:59	
1:59	2:24	464	2:42	-	2:50	3:05	3:09	3:29	
2:29	2:54	463	3:10	3:18	-	3:35	3:39	3:59	
2:59	3:24	464	3:42	-	3:50	4:05	4:09	4:29	
3:29	3:54	463	4:10	4:18	-	4:35	4:39	4:59	
3:59	4:24	464	4:42	-	4:50	5:05	5:09	5:29	
4:29	4:54	463	5:10	5:18	-	5:35	5:39	5:59	
4:59	5:24	464	5:42	-	5:50	6:05	6:09	6:29	
5:44	6:09	463	6:15	6:23	-	6:35	6:39	6:59	
6:14	6:39	464	6:45	-	6:53	7:05	7:09	7:29	
7:14	7:39	464	7:44	-	7:52	8:03	8:27	8:47	
8:15	8:40	464	8:45	-	8:53	9:04	9:20	9:40	
9:15	9:40	464	9:45	-	9:53	10:04	10:20	10:40	
10:15	10:40	464	10:45	-	10:53	11:04	11:20	11:40	
11:15	11:40	464	11:45	-	11:53	12:04	12:50	1:10	
Sundays and Public Holidays									
Train connection Perth Underground to Joondalup Departs   Arrives		Timed Stops	 * Joondalup Stn	 18101 Ocean Reef Rd / Eddystone Av	 * Whitfords Stn	Train connection Whitfords to Perth Underground Departs   Arrives			
		Route No.							
8:29	8:54	464 am	8:59	9:07	9:19	9:24	9:44		
9:29	9:54	464	9:59	10:07	10:19	10:24	10:44		
10:29	10:54	464	10:59	11:07	11:19	11:24	11:44		
11:29	11:54	464	11:59	12:07	12:19	12:24	12:44		
12:29	12:54	464 pm	12:59	1:07	1:19	1:24	1:44		
1:29	1:54	464	1:59	2:07	2:19	2:24	2:44		
2:29	2:54	464	2:59	3:07	3:19	3:24	3:44		
3:29	3:54	464	3:59	4:07	4:19	4:24	4:44		
4:29	4:54	464	4:59	5:07	5:19	5:24	5:44		
5:59	6:24	464	6:28	6:36	6:48	6:54	7:14		
6:59	7:24	464	7:28	7:36	7:48	7:52	8:12		

LEGEND  
\* Stop number - refer to back panel for Station stand information.  
463 H Operates on school holidays only.  
463 S Operates on school days only.

Train from Perth  
C Express to Stirling, then all stops to Clarkson

Train to Perth  
C All stops to Stirling, then express to Perth  
F Operates on Friday only.  
W Whitfords Shuttle. Does not stop at Greenwood.

To Whitfords timetable    465, 466									
Monday to Friday									
Train connection Perth Underground to Joondalup Departs   Arrives		Timed Stops <div>Route No.</div>					Train connection Whitfords to Perth Underground Departs   Arrives		
				17849 Joondalup Stn	18282 Edgewater Dr / Ocean Reef Rd	18476 Whitfords Stn			
-	-	465 am		5:29	5:36	5:49		5:53	6:13
5:30	5:55	466		6:06	6:13	6:28		6:33	6:53
5:30	5:55	465		6:21	6:28	6:43		6:47	7:07
5:30	5:55	466		6:25	6:33	6:49		6:53	7:13
6:00	6:25	465		6:40	6:47	7:02		7:07	7:27
6:00	6:25	466		6:45	6:53	7:09		7:13 C	7:31
6:23	6:48	465		6:55	7:02	7:19		7:23 C	7:41
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6:43	7:08	465		7:20	7:27	7:45		7:49 W	8:07
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6:44	7:09	465		7:14	7:21	7:34		7:52	8:12



# PROPOSED CRAIGIE HIGH SCHOOL REDEVELOPMENT

Infrastructure Report

Stockland WA Pty Ltd

January 2010 / Revision 1 (Draft)

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## EXECUTIVE SUMMARY

This report is prepared in support of the proposed Local Structure Plan for the redevelopment of the former Craigie high school site and sets out the major external infrastructure requirements for the project. The findings are based on preliminary advice provided by utility providers and the Local Authority and assumptions made by Emerson Stewart.

The following services are included in this infrastructure report:

- Sewer
- Potable water supply
- Road upgrades
- Surface water management
- Power, gas & communications

The site is located on a former high school property within the existing residential area of Craigie, approximately 20km north of the Perth CBD. In general the area is well serviced with existing infrastructure, which has sufficient capacity to service the proposed additional lots with only minor alterations or network expansions.

No infrastructure constraints have been identified that could significantly affect the redevelopment of the project site in accordance with the proposed local structure plan.

# 1 INTRODUCTION

## 1.1 BACKGROUND

The project site is located in the existing residential suburb of Craigie approximately 20km north of the Perth CBD and falls within the City of Joondalup municipal area.

The property is legally described as Lots 500 and 501 Swan Location 9801 Reserve 35310. The former high school buildings located on Lot 501 were demolished during 2004 and the site has remained vacant ever since. Lot 501 is currently zoned for urban use in the Metropolitan Region Scheme. Under the City of Joondalup's District Planning Scheme No. 2 the Site is reserved as 'Urban Development' and Lot 500 is currently undergoing a District Planning Scheme amendment to rezone it from 'Cultural and Civil' to 'Urban Development'. The surrounding land use is residential houses and is zoned Residential – R20 in the City of Joondalup's DPS No. 2.

The project intends to rezone the site for residential purposes under the DPS No 2 and thereafter to proceed with subdivision to ultimately deliver approximately 135 single and high density residential lots.

## 1.2 TOPOGRAPHY AND FEATURES

The site covers an area of approximately 10.5 hectares. It is bounded by Camberwarra Drive to the west and south east, Arawa Place to the south, Cawarra Crescent to the north and Fenellia Crescent to the east. Previous school buildings, pavilions and hard courts have been demolished and the site is currently vacant.

The site has previously been earth worked into two distinct terraces that will be maintained in the redevelopment of the site. The first terrace has a general elevation of 42mAHD and is located in the eastern portion of the site where the former school buildings were located. The second terrace, also to be developed, is local centrally in the site and has a general elevation of 37mAHD.

A significant dune system with elevations ranging between 46 – 49mAHD is located on the northern boundary of the site and is covered in high amenity bushland. Walking trails and timber steps have been established on the dune system and are frequently accessed by the public. Otago Park public open space is located to the south-east of the site and is generally comprises of grass sports playing fields with some large trees on the fringes of the playing fields



## 1.3 GEOTECHNICAL CONDITIONS

A geotechnical investigation was undertaken on the site during October 2009 and comprised a series of excavated test pits and Cone Penetration Tests (CPT) to obtain a understanding of the geotechnical conditions on the site and the stability parameters of the dune system.

The Environmental Geology sheet for the area shows the site to be underlain by Safety Bay Sand system. The Perth Groundwater Atlas shows the maximum historical groundwater level to be approximately 2m AHD.

Fine to medium grained, brown sandy topsoil with rootlets was encountered over the majority of the site from 0.1m to 0.2m depth. Fine to medium grained light brown and light grey sand was encountered below the surface layer and extended to the base of all excavations.

Occasional of cobbles and boulders were observed in eight test pits from approximately 0.5m to 1.5m depth. The relative density of the sand was generally medium dense and dense to very dense. No groundwater was observed during the investigation

The site classification in accordance with AS 2870 – 1996 will be Class 'A'.

Four critical sections in northern part of the site were assessed for slope stability

Analysis were carried out both with and without loading at the crest of the dune profile. It has been assumed that one or two storey residential structures with Class 'A' footing may be placed close to the crest in these locations. 250kPa was taken as the maximum load for one to two storey Class 'A' structures.

Results have shown all sections have a safety factor greater than 1.5 where no loading is present at the crest of the dune. The natural slopes in these areas are therefore in a stable condition.

A load of 250kPa was then placed at the immediate crest of the dunes. Safety factors in the post development condition with imposed building loads varied between 1.3 and 2.6. It is therefore recommended that building envelope should be at least 10 meters from the crest.

## 1.4 PROPOSED LAND-USE

Preliminary concept plans indicate that the site may be developed into approximately 130 - 135 residential lots. Layout concepts will be developed further during the local structure planning process.

## 2 SEWER

### 2.1 EXISTING INFRASTRUCTURE

The Craigie area is well serviced by existing Water Corporation sewer assets with existing sewers located on the boundary of the development site. The site is located within two sewer catchments, as described below:

- » The western portion of the site (approximately 40 lots) is located within the catchment serviced by Whitfords Pumpstation No. 7 located in Camerwarra Drive, south of the existing school.
- » The eastern portion (approximately 95 lots) is serviced by Whitfords Pumpstation No. 8 located off Fenellia Crescent on the south eastern boundary of the development site. In accordance with Water Corporation Design Standard 51 a buffer zone of 20m to 30m will apply from the centre of the wetwell to the closest building and should be taken into account during the preparation of the local structure plan.

### 2.2 PROPOSED INFRASTRUCTURE

Preliminary calculations indicate that sufficient capacity exists in the two existing pumpstations to accommodate the additional 1.7l/s sewer design flow that will be generated by the re-development of the site. The Water Corporation has advised that further design of the local structure plan and proposed earthworks levels will be required to ascertain the split between the two catchments and whether any upgrading may be required. Internal sewer reticulation will connect into the two, or possibly single, existing pumpstations. A road crossing of Cambewarra Crescent will be required to connect into Whitfords Pumpstation 7.

Standard Water Corporation sewer headworks contributions will apply to the development.

The proposed sewer infrastructure requirements for the site are shown in Figure 2.

## 3 WATER

### 3.1 EXISTING INFRASTRUCTURE

Several existing water mains are located in close proximity to the site, including a DN200 diameter main located on Camberwarra Drive on the western boundary of the site, a DN100 diameter main on Camberwarra Drive to the east and a 100mm diameter on Arawa Place on the southern boundary.

The water corporation has advised that these existing mains have sufficient capacity to provide water supply to the proposed development.

### 3.2 PROPOSED INFRASTRUCTURE

No significant upgrading to the existing water supply infrastructure will be required. Minor upgrading of the DN100 main located in Arawa Place may be required if the internal water reticulation network is to be connected to it. Road crossings will be required under Cambewarra Drive and Arawa Place to connect into the existing water mains.

Standard Water Corporation water headworks contributions will apply to the development.

The proposed water infrastructure requirements for the site are shown in Figure 1.



## 4 ROADS AND TRAFFIC

### 4.1 EXISTING ROAD INFRASTRUCTURE

The site is bordered by the Camberwarra Road to the West, Arawa Place to the South, Cawarra Drive to the North and Fenelia Crescent to the East. The main district roads servicing the site are described in more detail below.

- » **Marmion Avenue** – This road is classified as a Primary Distributor and is a major north-south linkage to the Perth CBD and is located approximately 250m to the west of the site. It is a four lane dual carriageway road with an un-signalised T-intersection providing access to Albion Street, the connection road between Camberwarra Drive and Marmion Avenue.
- » **Craigie Drive** – This road is classified as an Integrator Arterial B and is located 400m to the North of the site. It is a two lane dual carriageway road that provides a linkage to Marmion Avenue and to the Mitchell Freeway, via Ocean Reef Road.
- » **Eddystone Avenue** – This road is classified as a Neighbourhood Connector A and is located 250m to the East of the site. It is a two lane dual carriageway road that provides a linkage to Whitfords Avenue to the South and Craigie Avenue to the North.

Further information on the level of service and the traffic volumes carried by the roads can be found in the traffic impact report by Bruce Aulabaugh Traffic Consultants.

### 4.2 PROPOSED ROAD UPGRADING

Road and intersection upgrading, if required, will be identified during the traffic modelling of the draft local structure plan.

Preliminary discussions and a site visit have been held with officials of the City of Joondalup to obtain preliminary traffic and intersection requirements. The following requirements were identified:

- » **Camberwarra Drive** – This road will serve as the main access to the site and a new roundabout may be required to provide access to the site and to safely integrate the existing access point into the school parking/drop-off area on the western side of the road.
- » **Albion Street** – Modification to the intersections with Marmion Avenue and Camberwarra Drive may be required if intersection service levels are below standard during the peak periods. This will be identified once a draft local structure plan has been prepared and the relevant access points to and from the site have been identified.

- » **Fenelia Crescent** – The City of Joondalup has advised that a connection from Fenelia Crescent is not preferred and will only be considered if traffic modelling indicates the requirement for a eastern access into the project site via Fenelia Crescent. Such a new road will also require the relocation of exiting sewer pressure mains and electrical equipment located to the west of Fenelia Crescent, within the development site.
- » **Arawa Place** - The City of Joondalup has advised that a connection to Arawa place via the existing right of way easement is not preferred and will require traffic modelling to support such a proposal.

Further detailed traffic assessment will be prepared once a draft local structure plan is available and traffic splits can be applied to the traffic generated by the proposed development.

## 5 SURFACE WATER MANAGEMENT

### 5.1 STORMWATER DRAINAGE

The project site is located on the Safety Bay Sands system with maximum groundwater levels located some 35m – 45m below ground level. The geotechnical investigation revealed that the in-situ sand generally has a fines content of less than 5% (typically 1-2%) with permeability at post development compacted densities expected to be in the 5-6m per day range. The site is therefore very well suited to the on-site disposal of stormwater runoff. An existing drainage sump is located in the south-eastern corner of the site and receives drainage from the adjacent road drainage system. This existing sump may be integrated into the estate drainage and public open space (POS) system. Estate drainage will be integrated into POS in accordance with the requirements of Liveable Neighbourhoods and the Local Authority through the application of Water Sensitive Urban Design principles.

### 5.2 LOCAL STORMWATER MANAGEMENT

#### 5.2.1 Lot Runoff

- » Roof runoff will be directed into internal soakwells to promote infiltration where soil conditions permit.

#### 5.2.2 Road Runoff

- » A conventional piped network with 'leaky' side entry/gully pits located to suit appropriate spread rates and pit spacings will be designed for the road drainage. The level of service for the side entry/gully pits and the pipe network will be dependent on the road hierarchy.

#### 5.2.3 Post Development Flows and Storage

The following strategy has been adopted in relation to post development flows and storage:

- » Post-development flow rates are to be similar to the pre-development flow rates. Provide off line storage on a sub-catchment level to attenuate post development flows to predevelopment levels.
- » Retain 100year ARI flows on site though use of the existing open space areas.



## 6 POWER

### 6.1 EXISTING SERVICES

A feasibility study was prepared by Western Power to assess the capacity of the existing HV infrastructure to supply the proposed development and any upgrading works that may be required.

The site well serviced by existing Western Power infrastructure with the adjacent Gibson Avenue 22kV feeder the main High Voltage infrastructure. The feeder is supplied from the Padbury zone substation located some 3km to the south-east of the site.

There are no aerial mains visible within the site that will require relocation to underground services.

### 6.2 PROPOSED SERVICES

The Western Power feasibility study concluded that the Gibson Avenue feeder will have sufficient capacity to supply the proposed development. Supply to the development will be via looping in and out of the HV distribution backbone located in Cambewarra Drive or Arawa Place to a new RMU located within the development site.

Some HV switching may be required to finalise network configuration to improve the reliability of supply to the development.

A copy of the Western power feasibility study is included as Appendix A of this report.

## 7 GAS AND COMMUNICATIONS

### 7.1 GAS INFRASTRUCTURE

The general area is well reticulated with Alinta Gas infrastructure and the existing network has the capacity to service the redevelopment of the site.

No headwork charges apply to this site. The developer will be required to provide a bore to connect to the existing gas network. This developer funded bore will be located under Camberwarra Drive just north of Arawa Place junction.

### 7.2 COMMUNICATIONS INFRASTRUCTURE

The general area is well serviced with Telstra infrastructure with a major exchange building located south-west of the development site. Communications infrastructure can be readily provided to the proposed development.

The Commonwealth has released draft legislation in 2009 that will require optical fibre cables to be installed as part of any new development after July 2010.

## 8 INFRASTRUCTURE FUNDING

The cost of providing the required external infrastructure to the site may be funded from a variety of sources, as described below.

### 8.1 WATER AND SEWER

Water Corporation policy states that any water main less than 350 mm diameter and any gravity sewer less than 375 mm diameter will need to be fully funded by the developer. Funding for services larger than these stated diameters are normally by the Water Corporation as part of their Capital works Programme or as a prefunding agreement with Developers. Capital Works expenditure by the Water Corporation is usually limited to the larger diameter distribution mains, gravity sewers and major pump stations and the programme for implementing these is normally driven by the projected rate of development in the area.

As part of the assessment of subdivision applications, the Water Corporation will advise which infrastructure needs to be prefunded by the Developers. Under this agreement, the Developers fully fund the construction, and are then being reimbursed by the Water Corporation over a period of time as lots are developed in the performance area of the asset.

### 8.2 GAS AND TELSTRA

Similar circumstances apply to WestNet Energy and Telstra infrastructure. Developers are normally required to provide trenches for their infrastructure, however, if the staging is non-frontal, these utility companies may require headworks contributions to extend their infrastructure to the development front. These costs are normally carried by the Developers.

### 8.3 WESTERN POWER

Western Power requires developers to install low voltage and high voltage infrastructure, including transformers and switchgears. Western Power levy a System Charge for developments, and a Developer installing HV infrastructure will receive a credit for certain works under the System Charge.

### 8.4 ROADS

Roads within the area are usually funded by developers as part of the conditions of subdivision. Major roads (District Distributors) have in the past partly been funded by Developers / Local Authority / Developer Contribution Schemes.



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## 8.5 DRAINAGE

Drainage will need to be funded by Developers in compliance with the district, local and urban water management strategies.

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## APPENDIX A

### WESTERN POWER FEASIBILITY STUDY

# FEASIBILITY STUDY

**Project Name:** Craigie High School,  
Residential Development

**Customer Name:** Stockland Corporation Limited

**Consultant Name:** Underground Power and Development Pty Ltd

**Proposed Load:** 130 Residential Lots



## Introduction

Western Power has been requested to conduct a feasibility study to connect 130 residential lots at Lot 501 Camberwarra Dr, Craigie High School Development. It is assumed that the start of construction for this project is December 2009.



*Figure 1: Photo Overview of Lot Location*

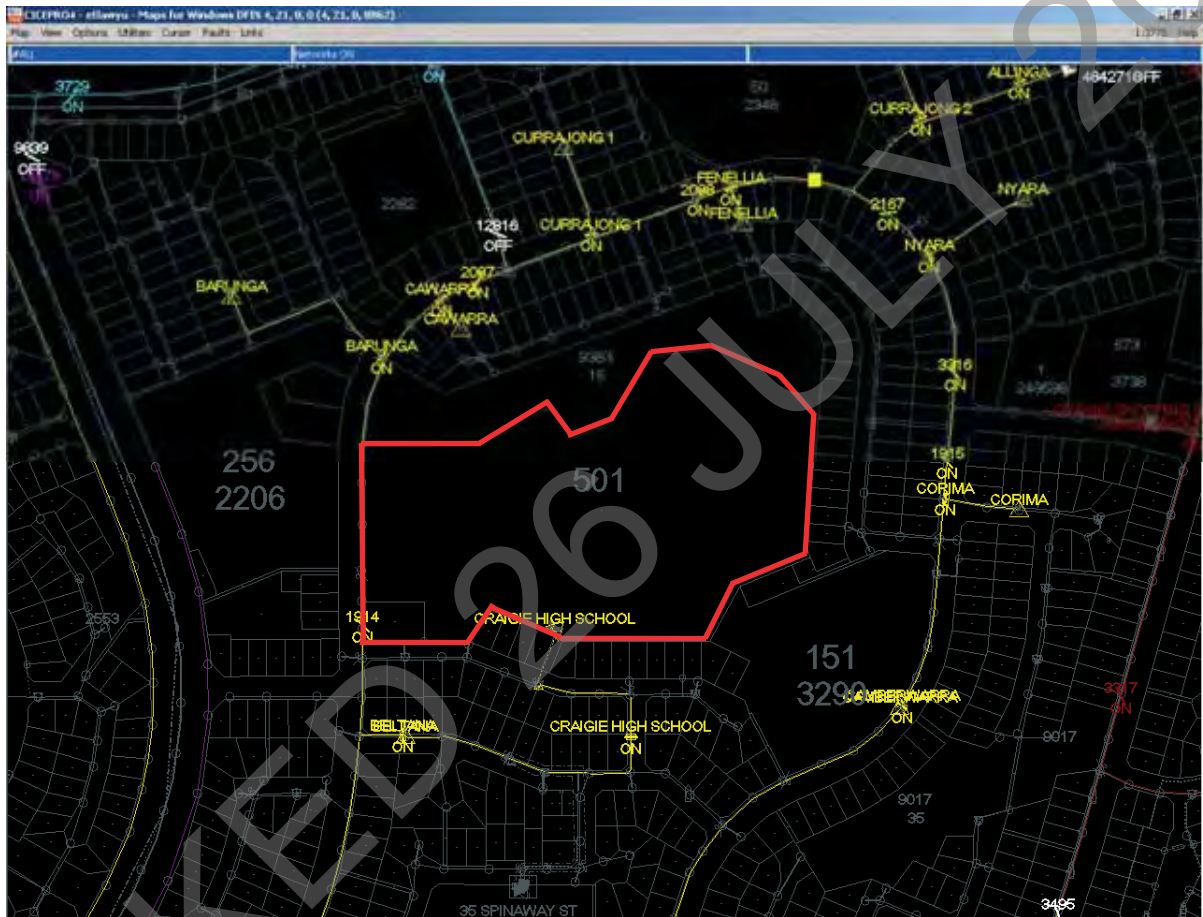


Figure 2: DFIS Overview of Lot Location



### Study Details

The 130 residential lots will most likely be supplied via the adjacent 22 kV PBY 540.0 243 Gibson Ave Feeder. The proposed site is approximately 3 km distance from the Padbury Zone Substation.

Estimate design load demand per residential lot is 4.7 kVA.

Therefore anticipated load demand:

$$130 \times 4.7 \text{ kVA} = 611 \text{ kVA.}$$

A 611 kVA load on the 22 kV Distribution network would represent approximately a 16 Amp increase on feeder loading. The adjacent PBY 540.0 243 Gibson Ave feeder should be able to accommodate this load increase by the time frame required.

### Possible Reinforcement Requirements

The backbone conductor between the proposed subdivision and PBY Zone Substation, on the PBY 540 feeder, are adequately rated to accommodate the proposed subdivision load.

The subdivision will most likely be supplied via looping in and out of the HV distribution backbone along Camberwarra Dr or Arawa Pl to a new RMU within the new subdivision.

No aerial mains look to be included within the subdivision boundary.

HV some switching may be required to finalise the network configuration to improve the reliability of supply to the subdivision.

### Conclusion

The above study indicated that there should be adequate capacity available to supply the proposed subdivision by the required time frame.

Due to the dynamic nature of the distribution network, further studies for network reinforcements would be required at the time the subdivision is to proceed to determine the final network requirements. This study is only an indicative appraisal at this stage.

Developers are required to follow normal processes and make an application to Western Power for firm connection proposals when the initial development is to commence. It would be appreciated that at the time of the application, a staging plan with expected takeoff dates be provided to Western Power.



## APPENDIX B

### FIGURES





CLIENT CRAIGIE HIGH SCHOOL  
REVISION A  
DATE 17/11/2009  
DRAWN P.RODRIGUEZ  
CHECKED S.WOLMARANS



0 25 50 75  
Full Size 1:2500 A3;  
SCALE (m)

CRAIGIE-HIGH SCHOOL  
1.0  
PROJECT  
FIGURE  
TITLE

EMERSON  
IMPLEMENTEURS  
STEWART

EXISTING AND PROPOSED WATER SERVICE

OLD SWAN BREWERY 110/171 Mounts Bay Road Perth Western Australia 6000

+61 8 9424 9555

+61 8 9485 1339

www.emersonstewart.com

Cad File: W:\Infrastructure\Infrastructure\_Projects\1033-Craigie High School (ex 108030)\08\_CaddGis\Drawings\1033-00-FIG-0100.dwg  
Plotted By: peter.rodriguez Plot Date: 06/01/10 - 12:05





CLIENT LANDCORP-STOCKLAND  
 REVISION B  
 DATE 18/07/2010  
 DRAWN P.RODRIGUEZ  
 CHECKED J.OLSEN



0 25 50 75  
 Full Size 1:2500 A3;  
 SCALE (m)

LOT 500 & 501 CAMBERWARRA DRIVE, CRAIGIE  
 2.0  
 EXISTING AND PROPOSED SEWER

PROJECT  
 FIGURE  
 TITLE

EMERSON  
 IMPLEMENTEURS  
 STEWART

OLD SWAN BREWERY 110/171 Mounts Bay Road Perth Western Australia 6000

+61 8 9424 9555

+61 8 9485 1339

www.emersonstewart.com

Cad File: W:\B+P\1033-Craigie High School (ex 108030)\06-CADD\00\1033-00-FIG-0200.dwg  
 Plotted By: marcus.vanniel Plot Date: 03/08/10 - 09:10





CLIENT CRAIGIE HIGH SCHOOL  
REVISION A  
DATE 17/11/2009  
DRAWN P.RODRIGUEZ  
CHECKED S.WOLMARANS



0 25 50 75  
Full Size 1:2500 A3:  
SCALE (m)

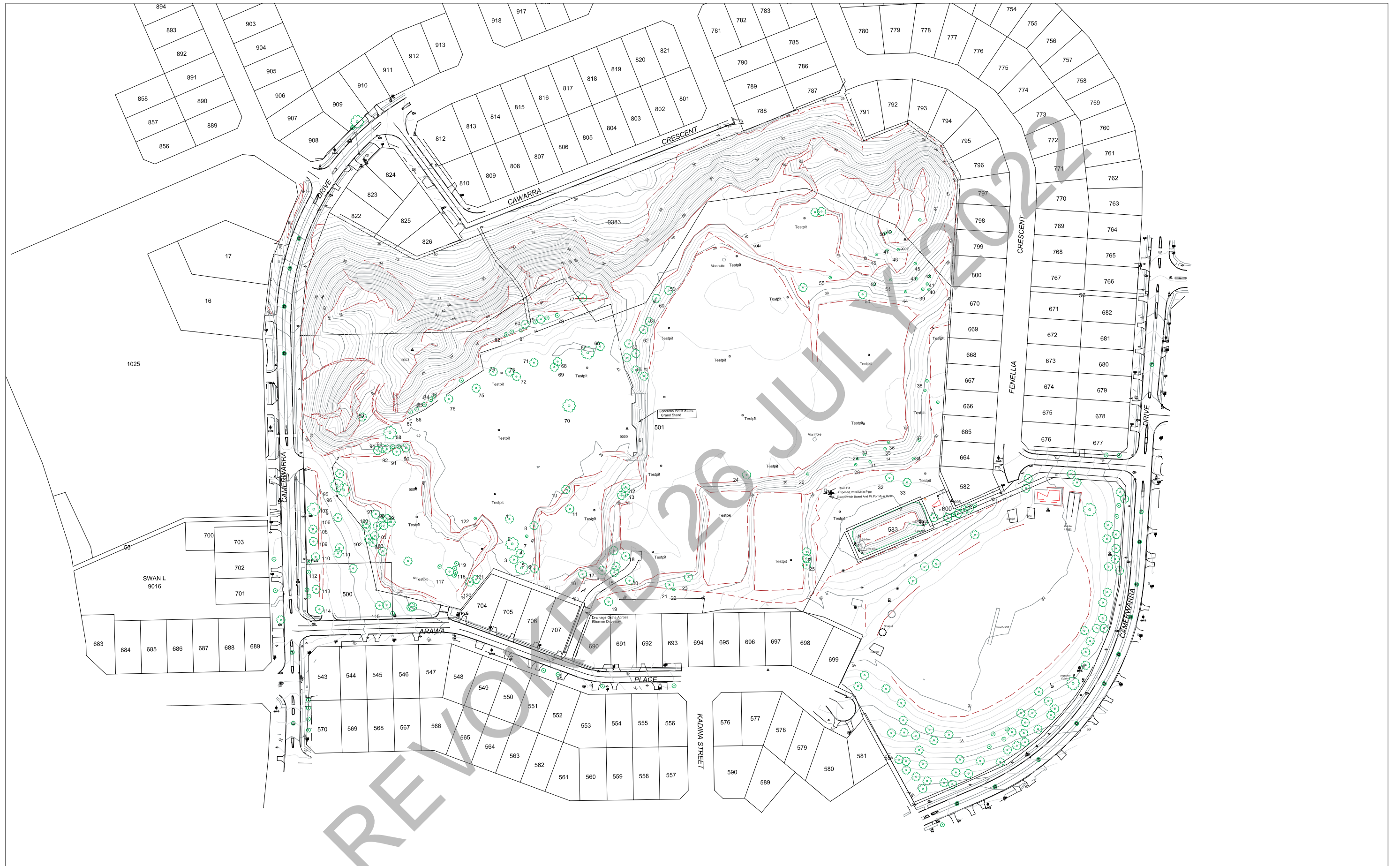
CRAIGIE-HIGH SCHOOL  
3.0

PROJECT  
FIGURE  
TITLE

EMERSON  
IMPLEMENTEURS  
STEWART

PROPOSED GAS CONNECTION





CLIENT CRAIGIE HIGH SCHOOL  
REVISION A  
DATE 06/01/2010  
DRAWN P.RODRIGUEZ  
CHECKED S.WOLMARANS



0 25 50 75  
Full Size 1:2500 A3:  
SCALE (m)

CRAIGIE-HIGH SCHOOL PROJECT EMERSON  
4.0 FIGURE IMPLEMENTEURS  
FEATURE SURVEY TITLE STEWART

OLD SWAN BREWERY 110/171 Mounts Bay Road Perth Western Australia 6000 +61 8 9424 9555 +61 8 9485 1339 www.emersonstewart.com

Cad File: W:\Infrastructure\Infrastructure\_Projects\1033-Craigie High School (ex 108030)\08\_CaddGis\Drawings\1033-00-FIG-0400.dwg  
Plotted By: peter.rodriguez Plot Date: 06/01/10 - 12:02

*Arboricultural Assessment*

*Craigie Senior High School Development Site*

*Prepared For*  
*Stockland*

**ARBOR** logic



**Contents**

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Table of Assessment Results; Opinion 1 Trees Only		
Table of Assessment Results; Opinion 2 Trees Only		
Table of Assessment Results; Opinion 3 Trees Only		

## **Purpose of the Report**

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At the request of Stockland, an inspection has been undertaken of the area known as Craigie Senior High School ("Site").

The purpose of the Site inspection was to:

1. Undertake an inspection of all of the trees present on the Site.
2. Identify any trees considered suitable for inclusion into an urban development.
3. Provide information for each of the identified trees in regards to its; species, approximate height, trunk calliper and canopy spread, current health condition, current structural condition, estimated 'safe useful life expectancy' ('SULE'), recommended zone of protection, and any comments deemed pertinent to the specific tree.
4. Provide any broad-brush purposeful and practical recommendations for any design and construction implications that may apply for any trees selected for retention within the development to ensure their successful protection and preservation.

The following is a brief of my findings from the Site inspection.

## **Trees and Development Sites**

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Tree preservation is an important part of responsible urban development.

Whilst not all trees are good candidates for retention, and while preserving every tree on a site may not be feasible, those that are identified for incorporation into a development become valuable assets and require a comprehensive strategy to help ensure their survival.

It is important to note that it is the tree's absorbing root zone that is primarily responsible for the health, vigour, and overall aesthetic appearance of the trees canopy.

It is also important to note that this absorbing root zone is generally found in the initial 300 – 500 mm of the soil profile, where soil oxygen, water, and nutrient levels are at their highest. It is therefore essential that the retention of a suitable volume/area of this section of the soil profile becomes the primary concern when designing and constructing an area of development adjacent to existing trees desired to be retained.

Each individual tree must be allocated a 'zone of protection' ("Zone") during all phases of the design and construction of the development.

These Zones must be protected throughout all phases of the development; from site clearance works through to soft landscaping so that damage and disturbance to the Zone is minimised.

It is common occurrence for tree preservation strategies to be implemented once root zone damage has already occurred. However remedial efforts are often of little to no value (depending on the extent of damage that has been caused), and have proven to become a difficult, potentially expensive, and time consuming exercise to implement once the damage has occurred.

It is also important to note that in many instances (especially with mature trees) it can take a number of years before the effects of any root zone damage and/or loss becomes evident in the canopy; through an increase of deadwood material, and/or canopy decline.

Successful preservation of trees on a development site must therefore begin at the design and planning stages of a development; even for the landscaping of an area of public open space ("POS")



## **Tree Assessment Criteria**

---

Whilst tree preservation and environmental concerns are important considerations, site safety must become the primary concern when the development of a given area leads to the introducing of (or increase of) the occurrence of people, property and/or structures ("Targets").

Tree assessment incorporates a wide variety of criteria to assess the viability of retaining and successfully managing any given tree in an area of current or foreseeable potential Targets. It is primarily undertaken in view of the relevant legal and risk management responsibilities that are generally associated with tree 'ownership'.

Whilst habitat for other flora and fauna is taken into consideration, unless the tree is of particular note for its species and/or has significance with the history/heritage of the local area site safety must become the primary criteria; especially in areas where a large number of potential Targets are likely to be introduced due to a development occurring.

Each individual tree requires a different approach to management with regards to its species, structural characteristics, and current health.

### **Health Condition**

Each tree on the Site is visually assessed to determine its current health from inspection of its leaf, overall canopy condition, and the presence (or absence) of any pests/disease that may have an adverse effect on its health.

### **Structural Condition**

The structural integrity of each tree has been determined from a visual inspection of its main stem, primary (and secondary) branch unions, and its root plate area. The presence of cavities, decay, and/or any pathogen that could have an effect on the structural integrity of the tree is also taken into consideration as part of the assessment process.

### **Known Species Traits**

Species suitability for inclusion into an area of urban environment is also considered as part of the assessment process.

Its ability to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased un-seasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure (roads, walls, buildings etc.) are all taken into consideration.

The known root zone morphology of the species is also of key importance when allocating recommended zones of protection for each of the identified trees.

## Site Assessment Results

### General Comments

The Site was noted to be a relatively well treed area, and fairly typical of an old school site.

There was a large number of noticeable changes in the ground levels throughout the Site, and this will have a major bearing on the feasibility of the retention of a number of the trees that were considered suitable for retention as part of the development.

A wide variety of tree, shrub and other plant species were noted on the Site most of which are all commonly found in this area of metropolitan Perth.



A few very good mature specimens were noted, including a number of *Ficus* specimens, Tuart, Norfolk Island Pine, and River Red Gum.



Conversely (as with any large tree population) there are a large number of trees on the Site that would not be considered suitable for retention within a proposed development; either due to their current health, structural form, or known natural species traits.



## Site Assessment Results

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### Health Condition

As with any large tree population the trees on Site showed varying degrees of health and vitality in their canopy mass; examples of which can be seen in the images below taken on Site.



*Tree showing to be in good health*



*Tree showing to be declining in health*



*Dead Tree*

The majority however showed to be in good health based on their current leaf mass and overall canopy conditions.

There was no evidence of any other major pest or disease factor that could affect the health of the trees on Site, and any canopy decline in evidence was adjudged to be (mainly) in response to environmental factors such as poor seasonal rainfalls, changes to the water table etc.

As with many large tree populations a number of dead and declining trees were noted on Site. Although such trees are acknowledged to provide valuable habitat for a myriad of flora and fauna, they are generally not suggested for inclusion into an urban development area due to the increased risks for potential site safety issues to arise with these trees once an increase in the frequency and volumes of potential Targets occurs within their respective fall zone areas as a result of the development.



## Site Assessment Results

### Structural Condition

Whilst the health of a tree is an important consideration, its structural condition is of more concern; mindful the area around these trees is proposed for development and an increased volume and frequency of potential targets is likely to arise once the development has been completed.

The majority of the trees on Site showed to have typical form for their given species, with all main stem and secondary branch unions showing typical form at the point of attachment.

A number however showed to have poor (or even hazardous) structural forms with a history of major stem failures, basal cavities and/or decay in their main stems, or presence of poor unions within their stem structures. A few also showed some evidence of termite activity within their main stem structure.



*Tree 120; Coastal Moort (Eucalyptus platypus var heterophylla)*

*Evidence of advanced decay within its main stem structure.*

*Note: This species is known to be poor at compartmentalisation; the trees natural defence mechanisms against the onset of decay within its woody structures. As a result they are known to be prone to decay issues once mature, which typically affects the integrity of their main stem structure to an extent.*

*As such the 'safe-useful-life-expectancy' of the majority (if not all) of the mature specimens of this species on the Site is considered to be limited to another 10 – 20 years at best.*

Whilst such trees can (sometimes) be included into an area of POS where design can minimise the occurrence and frequency of potential Targets within their likely fall zones, they would not be considered suitable for retention into a streetscape, roadside verge, roundabout, or Lot situation.

This is primarily in view of the increased risks such trees would represent to any Targets created by way of development.

As such trees displaying undesirable, poor or hazardous structural forms have generally been omitted from inclusion in this survey, although some were included and could be retained providing they can be retained into areas where limited.

## Site Assessment Results

### Species Suitability

The majority of the tree species found on Site are considered suitable for inclusion into an urban development as they will tolerate an extent of disturbance and loss to their root zone areas; providing it is undertaken sensitively and minimised at all times.

There are however a number of species found on this Site that would not be considered suitable for inclusion into an urban development; primarily due to the species having a propensity for unpredictable stem failure, or known to cause issues with high volumes of leaf, bark and nut litter.



Northern River Red Gum  
(*Eucalyptus camaldulensis* 'Obtusa')



Rose Gum  
(*Eucalyptus grandis*)

Species known to have a propensity for stem failures found on this Site includes the Bangalay (*Eucalyptus botryoides*), Lemon Scented Gum (*Corymbia citriodora*), Rose Gum (*Eucalyptus grandis*) and Northern River Red Gum (*Eucalyptus camaldulensis* 'Obtusa'). Note: To a lesser extent, species such as the Flooded Gum (*Eucalyptus rudis*), River Red Gum (*Eucalyptus camaldulensis* 'Camaldulensis') and Tuart (*Eucalyptus gomphocephala*) are also known to have some propensity for stem failures although in this consultant's opinion not to the same extent as the other species mentioned above and the risks can often be ameliorated through the use of canopy management practices.

Species known to cause issues with volumes of leaf, bark and nut litter include the Bangalay (*Eucalyptus botryoides*), and River Sheoak (*Casuarina cunninghamiana*).

Specimens of the above species found on Site have typically been omitted from inclusion in the survey assessment results, or recommended only to be retained if they are found to be located in an area where limited potential targets are likely to occur by way of the use of the area (i.e. areas of public open space).

*Ficus* are another species of tree that could cause future issues with surrounding urban infrastructure; primarily as they are known to have a large surface orientated root system as part of their natural species trait. It must however be noted that most of the disturbance arises due to the tree's roots simply taking advantage of the conditions created below ground as part of the construction process. By incorporating such species into areas of open space where disturbance issues can be limited by way of good design, or by implementing suitable root barrier/protection strategies for the areas of urban infrastructure many of the *Ficus* specimens could actually be readily retained as part of the development as they have proven to be a reliable and long lasting tree species for urban environments and tolerable of changes to their environment that often occurs during a development process.



## Site Assessment Results

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### Species Suitability

As such specimens of this species found on Site have (generally) been suggested/recommended to be retained, although their retention will be heavily reliant on the eventual use of the area around them.

*Acacia* and some of the smaller shrub *Melaleuca* species are also generally not considered to be retained as part of a development process given their smaller physical stature, typically short life span, and common nature of the genus/species. As such specimens of these species were generally not included as part of the assessment results.

### Potential Transplants

A number of the trees on the Site were noted to be of a size and species that would be suitable for transplanting if time frames and any budget constraints allow.

This included 21 semi-mature West Australian Peppermint (example seen in the image below left), and the two Palm specimens (seen in the images below right and centre).



The following pages provide a full table of results from the Site inspection.



### Explanation of Fields of Information

**Tree Tag No. ~**

Provides the schedule number of a specimen tagged on Site, and corresponds to a number in the table of data collected on each tree and a number on the survey plan showing the location of the given tree.

**Species ~**

Provides the most commonly used species name of the specimen.

**Estimated Height ~**

Provides an estimated height (in metres) of the specimen.

**Estimated Trunk Calliper ~**

Provides an estimated trunk calliper of the specimen (in mm, and generally measured at 1.3 metres above ground level as per the industry standard). Specimens with multiple stems typically have multiple entries in this field.

**Estimated Canopy Spread ~**

Provides an estimated spread of the trees canopy; provided in metres diameter.

**Health Condition ~**

Provides a view of the specimen's health/vigour condition at the time of inspection based on a number of predetermined criteria.

Health Rating	Explanation
Good	Shows to have typical foliage condition and amount of foliage mass for a specimen of the species. May have a minor amount of deadwood, but no signs of any pest or disease factor that may affect its health.
Acceptable - Good	Shows to have typical foliage condition. Canopy foliage may be slightly chlorotic, or it may have a slightly higher percentage of deadwood than usual, or exhibit signs of being affected by environmental conditions. May have a minor pest or disease present that could start to affect its health.
Acceptable; Indicating Decline	Shows to have a relatively high percentage of deadwood than considered typical for a specimen of the given species and/or a low volume of live canopy leaf mass for a specimen of the given species. Apical sections of the canopy (may also be) dead. Signs of a pest or disease factor evident.
Poor	Canopy mass and foliage condition shows to be in a poor state for a specimen of the species. Has a high percentage of deadwood material in its canopy and a low volume of live canopy mass (typically <20%).
Dead	Shows to have either no live tissue within its structure, or at best have <5% live foliage mass remaining in its canopy.

## Glossary of Terms

### Structural Form ~

Provides a view of the specimen's structural form at the time of inspection based on a number of predetermined criteria.

Structure Rating	Explanation
Good	Shows typical structural form for a specimen of the species. Branch unions show typical form at the point of attachment. May have a small number of minor structural defects; but are within the scope of tree surgery management to rectify. Shows to be root-stable.
Acceptable - Good	Shows an acceptable form, but may have a number of structural defects present i.e. bi-furcation with noticeable swelling, or large stem cavities, but structure remains within the scope of management at this stage; albeit with a higher risk/management requirement.
Acceptable (Undesirable)	Shows an undesirable structure for a specimen of the species. Structural condition likely to cause future issues in regards to the potential for stem or complete tree failure to occur. Generally includes previously lopped trees.
Poor	Major structural defects evident. May have large stem cavities, extensive termite damage, or noticeable movement in main stem, branch unions or root plate area.

### Recommended Protection Zone ~

Provides a recommended area in metres RADIUS of the trees main stem which is recommended to be retained and protected from any major disturbances during the development. This protection zone serves as protection for the tree's canopy mass as well as its root zone area.

### Comment ~

Provides any additional information (seen as relevant) to the individual specimen. Comments are (generally) self explanatory.

### Safe Useful Life Expectancy (SULE) ~

Provides an estimated 'safe' future life span for the tree. Ratings have been provided based on the tree receiving all best possible care and management for the foreseeable future; including during the development. As there are many variables that can affect trees (especially during a development process), the 'SULE' ratings must be considered a guideline only. Note: Although many of the tree species found on Site could readily continue to survive for many decades, a rating of 50 years (plus) has been provided as the maximum.

## Glossary of Terms

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**Opinion ~** Provides an overall opinion on the specimen:

**1 ~** Denotes a specimen of particular note as they are deemed to be good/very good specimens of their given species; showing both good health and good (typical) structural condition. Efforts are recommended to be spent during the design and construction process to retain such specimens; even at the detriment of specimens that have been given other category ratings.

A total of 23 trees have been placed in this category, and a separate table of these trees has been provided as an additional appendix to this report.

**2 ~** Denotes a good specimen and efforts should be made during the design/construction process to incorporate such specimens into the proposed development, as this will be seen as a positive approach to development in today's environmentally conscious community.

A total of 47 trees have been placed in this category.

**3 ~** Typically denotes a reasonably good specimen. Specimens in this category may have a number of structural defects, undesirable structural forms (i.e. leaning), show indications of a decline in their health, or be of a species that are known to have undesirable natural species traits for trees in urban areas with a high number of potential targets within their likely projected fall zone.

As such the Opinion '3' trees are (generally) only recommended to be retained in areas of lower potential targets, (i.e. public open space areas) and efforts are often better spent on retaining '1' and/or '2' Opinion specimens.

A total of 48 trees have been placed in this category, and a separate table of these trees has been provided in the appendix of this report.

**4 ~** Denotes a tree that is recommended to be omitted from any further part of the design process, and removed during Site clearing works. Typically these trees are either dead, have a poor/hazardous structural form, or are of a species that is highly likely to create future tree related site safety issues once the development has been completed.

Although the majority of such trees identified on the site were ignored, total of 4 trees have been placed in this category and included in the survey by way of explanation.



**Tree Location Guide**

Please note the above is a guide to the location of the trees only; they have not been surveyed or marked using GPS equipment.

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
1	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
2	Port Jackson Fig	<i>Ficus rubiginosa</i>	14	950	18-20	Good	Good	10	Very good specimen. Has a low spreading canopy.	50+	1
3	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
4	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
5	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	22	1000	18-20	Good	Good	8	Good large specimen tree.	50+	2
6	Coastal Moort	<i>Eucalyptus platypus</i> var <i>heterophylla</i>	9	400	10-12	Good	Acceptable - Good	4	Mature specimen tree.	10-20	3
7	Date Palm	<i>Phoenix dactylifera</i>	8	500	4-6	Good	Good	2.5	Good specimen. Can be transplanted if desired.	50+	1
8	Norfolk Island Pine	<i>Araucaria heterophylla</i>	14	500	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
9	Senegal Date Palm	<i>Phoenix reclinata</i>	4	250	6-8	Good	Good	4	Typical clumping habit. Can be transplanted if desired.	50+	2
10	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	9	450	8-10	Good	Good	4	Reasonably good specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2



Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
11	Tuart	<i>Eucalyptus gomphocephala</i>	10	500	4-6	Good	Acceptable - Good	4	Reasonably good specimen tree; basal bark wound on main stem, signs of Longicorn damage but otherwise ok.	20-30	3
12	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	9	350	8-10	Good	Acceptable - Good	4	Ok specimen tree, large bark wound on main stem from previous stem failures. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	3
13	Flooded Gum	<i>Eucalyptus rudis</i>	14	500	10-12	Good	Acceptable - Good	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
14	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	300	8-10	Good	Acceptable (undesirable)	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
15	Coastal Moort	<i>Eucalyptus platypus var Heterophylla</i>	12	500	10-12	Good	Acceptable - Good	5	Ok specimen tree. Low spreading canopy habit.	10-20	3
16	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	300	8-10	Good	Acceptable (undesirable)	3 (each)	Group of 5 specimen trees. Canopy development/forms have been affected by proximity to each other; retain as one tree.	10-20	3
17	Northern River Red Gum	<i>Eucalyptus camaldulensis var 'Obtusa'</i>	15	750	14-16	Good	Good	6	Not considered a desirable species for urban areas due to propensity for unpredictable stem failures. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	4
18	Flooded Gum	<i>Eucalyptus rudis</i>	9	400	6-8	Acceptable	Good	5	Ok semi mature specimen, although its canopy is relatively sparse.	50+	3
19	Bald Island Marlock	<i>Eucalyptus conferruminata</i>	8	400	8-10	Good	Acceptable - Good	4	Ok mature specimen tree.	10-20	3
20	Flooded Gum	<i>Eucalyptus rudis</i>	19	600	12-14	Good	Acceptable - Good	6	Good mature specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3



Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
21	West Australian Peppermint	<i>Agonis flexuosa</i>	9	400	8-10	Good	Good	5	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
22	West Australian Peppermint	<i>Agonis flexuosa</i>	7	400	8-10	Acceptable - Good	Acceptable - Good	5	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
23	River Sheoak	<i>Casuarina cunninghamiana</i>	12	350	8-10	Good	Good	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2
24	Port Jackson Fig	<i>Ficus rubiginosa</i>	17	1050	18-20	Good	Good	10	Very good specimen with a low spreading canopy habit.	50+	1
25	Lemon Scented Gum	<i>Corymbia citriodora</i>	17	400	10-12	Good	Good	4.5	Not necessarily considered a desirable species for urban areas; but a good specimen nonetheless. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
26	West Australian Peppermint	<i>Agonis flexuosa</i>	5	200	4-6	Good	Good	2	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
27	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	11	350	10-12	Good	Acceptable - Good	4.5	Group of mature specimens. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
28	West Australian Peppermint	<i>Agonis flexuosa</i>	4	150	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
29	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
30	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	6	300	8-10	Good	Acceptable - Good	4.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
31	Marri	<i>Corymbia calophylla</i>	5	150	2-4	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
32	Firewood Banksia	<i>Banksia menziesii</i>	8	350	6-8	Good	Good	5	Mature specimen. Canopy relatively sparse for a specimen of this species/size/age. Species do not readily tolerate disturbance to their root zones.	10-20	3
33	Firewood Banksia	<i>Banksia menziesii</i>	9	500	8-10	Good	Good	6	Good mature specimen. Species do not readily tolerate disturbance to their root zones.	20-30	3
34	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	400	8-10	Good	Acceptable - Good	4.5 (each)	Two specimens in close proximity effectively forming the one canopy. Treat as one tree for preservation. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
35	Marri	<i>Corymbia calophylla</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
36	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	200	4-6	Good	Acceptable - Good	2.5 (each)	Group of 4 specimens in close proximity effectively forming the one canopy. Treat as one tree for preservation. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
37	Ironbark	<i>Eucalyptus sideroxylon</i>	9	300	4-6	Good	Good	3	Very good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
38	Flooded Gum	<i>Eucalyptus rudis</i>	17	700	14-16	Good	Good	6	Looks to be a hybrid with the Northern River Red Gum, so not necessarily considered a desirable species for urban areas; but a good specimen nonetheless. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
39	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
40	West Australian Peppermint	<i>Agonis flexuosa</i>	3	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
41	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
42	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
43	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
44	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
45	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	350	12-14	Good	Acceptable - Good	7	Reasonably good multi stemmed specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
46	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	250	8-10	Good	Acceptable - Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
47	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	4-6	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
48	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	4-6	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
49	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	250	4-6	Good	Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
50	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	350	6-8	Good	Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3



Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
51	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
52	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Acceptable - Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
53	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
54	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature multi stemmed specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
55	Bald Island Marlock	<i>Eucalyptus conferuminata</i>	11	550	12-14	Acceptable - Good	Acceptable - Good	6	Reasonably good mature specimen. Canopy half burnt by fire, but it may recover ok over time.	10-20	3
56	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
57	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	150	4-6	Good	Good	2.5	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
58	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	10	400	8-10	Good	Good	5	Reasonably good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
59	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	500	6-8	Good	Acceptable - Good	5	Reasonably good mature specimen. Some signs of decay in its main stem structure. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
60	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	400	6-8	Good	Good	5	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
61	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	6	350	6-8	Good	Good	3.5	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
62	River Red Gum	<i>Eucalyptus camaldulensis var 'Camaldulensis'</i>	12	450	10-12	Good	Good	5	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
63	River Red Gum	<i>Eucalyptus camaldulensis var 'Camaldulensis'</i>	18	600	10-12	Good	Good	6	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
64	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	350	6-8	Good	Acceptable - Good	3.5 (each)	Group of mature specimens. Low spreading canopy habit and their development/form has been affected due to their proximity to each other; suggest to retain as one group . Situated on an embankment so retention of levels will play a	10-20	3
65	River Red Gum	<i>Eucalyptus camaldulensis var 'Camaldulensis'</i>	16	500	10-12	Good	Good	6	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
66	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	450	8-10	Good	Acceptable - Good	4.5	Good mature specimen. Some signs of decay in its main stem structure.	10-20	3
67	River Red Gum	<i>Eucalyptus camaldulensis var 'Camaldulensis'</i>	18	600	12-14	Good	Good	6	Good mature specimen,	50+	1
68	Flooded Gum	<i>Eucalyptus rudis</i>	18	750	16-18	Good	Good	6	Good mature specimen,	50+	1
69	Flooded Gum	<i>Eucalyptus rudis</i>	18	550	14-16	Acceptable	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way of good design.	50+	3
70	Flooded Gum	<i>Eucalyptus rudis</i>	19	950	16-18	Good	Good	8	Good mature specimen,	50+	1

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
71	Flooded Gum	<i>Eucalyptus rudis</i>	19	850	14-16	Good	Good	8	Good mature specimen.	50+	1
72	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	14	600	10-12	Good	Good	5	Good mature specimen.		1
73	Flooded Gum	<i>Eucalyptus rudis</i>	17	550	10-12	Good	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way	50+	3
74	Flooded Gum	<i>Eucalyptus rudis</i>	19	700	10-12	Good	Good	6	Good mature specimen.	50+	1
75	Flooded Gum	<i>Eucalyptus rudis</i>	17	600	14-16	Good	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species. Possible hybrid with Northern River Red Gum. Suggest remove.	50+	4
76	Flooded Gum	<i>Eucalyptus rudis</i>	17	600	14-16	Good	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species. Evidence of a history of stem failures. Possible hybrid with Northern River Red Gum. Suggest remove.	50+	4
77	Tuart	<i>Eucalyptus gomphocephala</i>	12	500	6-8	Good	Good	5	Good mature specimen.	50+	1
78	Flooded Gum	<i>Eucalyptus rudis</i>	9	300	4-6	Good	Good	2.5	Good semi mature specimen.	50+	1
79	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	17	400	6-8	Good	Good	3.5	Good specimen.	50+	1
80	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	13	350	6-8	Good	Good	3	Good specimen.	50+	1
81	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	9	200	2-4	Good	Good	1.5	Good semi mature specimen.	50+	1
82	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	8	200	2-4	Good	Good	1.5	Good semi mature specimen.	50+	1
83	Tuart	<i>Eucalyptus gomphocephala</i>	9	250	4-6	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2



Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
84	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature multi stemmed specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
85	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	4-6	Good	Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
86	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
87	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
88	Tuart	<i>Eucalyptus gomphocephala</i>	20	850	16-18	Good	Good	9	Good mature specimen.	50+	1
89	Tuart	<i>Eucalyptus gomphocephala</i>	16	850	14-16	Good	Good	9	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
90	Tuart	<i>Eucalyptus gomphocephala</i>	16	500	8-10	Good	Good	5	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
91	River Sheoak	<i>Casuarina cunninghamiana</i>	17	400	6-8	Good	Good	4	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2
92	Tuart	<i>Eucalyptus gomphocephala</i>	14	450	10-12	Good	Acceptable (undesirable)	4.5	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way	20-30	3
93	Tuart	<i>Eucalyptus gomphocephala</i>	17	350	8-10	Good	Acceptable - Good	4	Ok specimen. Tall, upright canopy habit with no lower canopy.	50+	2
94	Tuart	<i>Eucalyptus gomphocephala</i>	15	400	8-10	Good	Good	4	Reasonably good specimen.	50+	1
95	Tuart	<i>Eucalyptus gomphocephala</i>	17	850	12-14	Good	Acceptable (undesirable)	8	Mature specimen. Canopy one sided and leaning due to adjacent tree. Only retain in an area of POS where occurrence of potential targets can be limited by way of good	20-30	3

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
96	Tuart	<i>Eucalyptus gomphocephala</i>	24	1000	16-18	Acceptable - Good	Good	10	Reasonably good mature specimen. Some signs of canopy decline and stress.	20-30	2
97	River Sheoak	<i>Casuarina cunninghamiana</i>	15	350	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
98	River Sheoak	<i>Casuarina cunninghamiana</i>	15	300	6-8	Good	Acceptable - Good	3	Ok mature specimen. Canopy one sided due to adjacent tree. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	3
99	River Sheoak	<i>Casuarina cunninghamiana</i>	15	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
100	River Sheoak	<i>Casuarina cunninghamiana</i>	17	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
101	River Sheoak	<i>Casuarina cunninghamiana</i>	15	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
102	River Sheoak	<i>Casuarina cunninghamiana</i>	16	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
103	River Sheoak	<i>Casuarina cunninghamiana</i>	13	250	6-8	Good	Good	2.5	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
104	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	10	450	8-10	Good	Good	4	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	2
105	River Sheoak	<i>Casuarina cunninghamiana</i>	17	500	8-10	Good	Acceptable - Good	4.5	Reasonably good mature specimen. Main stem bi-furcates. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	3
106	Tuart	<i>Eucalyptus gomphocephala</i>	22	750	14-16	Acceptable - Good	Good	8	Reasonably good mature specimen. Some signs of canopy decline and stress.	20-30	2

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
107	Tuart	<i>Eucalyptus gomphocephala</i>	20	1000	18-20	Acceptable - Good	Acceptable - Good	10	Reasonably good mature specimen. Canopy one sided due to adjacent powerlines. Some signs of canopy decline and stress.	20-30	2
108	Tuart	<i>Eucalyptus gomphocephala</i>	20	450	6-8	Indicates decline	Acceptable - Good	4.5	Mature specimen. Canopy one sided due to adjacent powerlines. Canopy indicates decline in health. Suggest remove.	10-20	4
109	Tuart	<i>Eucalyptus gomphocephala</i>	20	900	14-16	Good	Acceptable - Good	8	Reasonably good mature specimen. Canopy one sided due to adjacent powerlines.	50+	2
110	Tuart	<i>Eucalyptus gomphocephala</i>	20	900	14-16	Good	Good	8	Good mature specimen. Canopy slightly one sided due to adjacent powerlines.	50+	1
111	Tuart	<i>Eucalyptus gomphocephala</i>	20	750	12-14	Acceptable - Good	Acceptable - Good	10	Reasonably good mature specimen. Some signs of canopy decline and stress.	50+	3
112	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	300	6-8	Good	Acceptable - Good	3.5	Two reasonably good mature specimens. Some signs of decay in their main stem structures. Situated near powerlines so on-going issues with clearance likely to be remain throughout their natural life span.	10-20	3
113	Tuart	<i>Eucalyptus gomphocephala</i>	18	600	14-16	Good	Acceptable - Good	6	Reasonably good mature specimen. Canopy relatively one sided due to adjacent powerlines.	50+	2
114	West Australian Peppermint	<i>Agonis flexuosa</i>	10	500	10-12	Good	Good	5	Reasonably good mature specimen.	50+	2
115	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	450	14-16	Good	Acceptable (undesirable)	6	Old specimen. Some signs of decay in its main stem structure.	10-20	3
116	Tuart	<i>Eucalyptus gomphocephala</i>	17	500	18-20	Acceptable - Good	Acceptable (undesirable)	8	Old multi stemmed specimen. Some signs of canopy decline.	50+	3
117	Tuart	<i>Eucalyptus gomphocephala</i>	13	400	8-10	Acceptable - Good	Good	4	Ok specimen. Some signs of canopy decline.	20-30	3
118	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	300	8-10	Good	Acceptable - Good	4	Ok specimen. Canopy one sided due to adjacent tree.	10-20	3



Tree No	Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
119	Bald Island Marlock <i>Eucalyptus conferruminata</i>	6	300	4-6	Good	Acceptable - Good	3	Ok specimen. Canopy one sided due to adjacent tree.	10-20	3
120	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	9	350	8-10	Good	Acceptable - Good	4	Ok specimen. Signs of advanced decay in its main stem structure.	5-10	3
121	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	10	500	10-12	Acceptable - Good	Acceptable - Good	4	Old specimen. Some signs of advanced decay in its main stem structure. Canopy relatively sparse.	10-20	3
122	West Australian Peppermint <i>Agonis flexuosa</i>	5	200	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size.	50+	2

## Opinion

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Throughout the inspection it was noted that there are a number of reasonably good trees on Site that are considered suitable for retention and inclusion into an urban development area.

However there are a larger number of trees that are not considered to be suitable for inclusion into an urban development due to their current health condition, (and/or) their current structural form, and/or their known species traits and characteristics. Most of these undesirable trees are recommended to be omitted from any further part of the development process, and then removed during any Site clearing works; unless they can be located into an area of proposed public open space where the occurrence of potential Targets can be minimised by way of good design.

Based on this, at this stage it is recommended that:

1. All opinion 4 trees are omitted from any further part of the design process and then simply removed as part of any site clearing works.
2. The location of all Opinion 1, 2 and 3 trees are to be accurately surveyed and their location marked on all relevant plans, and provided to all relevant parties involved in the detailed design process. Plans are also suggested to highlight each trees zone of protection area for ease of reference.
3. Opinion 3 trees are only included into the design where site design can incorporate them into areas where a low volume and frequency of potential targets will occur (i.e. areas of public open space). Otherwise these trees are also suggested to be omitted from any further part of the design and removed during the site clearing works.
4. All parties involved in the design process are to be aware of the location of the remaining trees, and all efforts are recommended to be undertaken to design around the trees to enable their successful retention during the construction phase of the development.

As with any development area successful preservation of any of the suitable identified trees within the development will be largely dependent on the design and construction activities being able to provide the recommended tree-root preservation zone area (as detailed in column 9 of the table of assessment results) for each of the trees.

This will require a degree of further Arboricultural input as the design process continues to allow for the appropriate tree preservation measures to be implemented.

During the design stage of the development, further Arboricultural input will be required to discuss:

- Proposed resulting levels in the vicinity of any trees identified to be retained; Retention of the current existing ground level within a trees designated tree root protection zone area is of paramount importance to the success of tree preservation. Note: This includes any stripping of the top soil in areas where only a landscape process is to be undertaken.

It will be of critical importance to be aware of this factor on this Site due to the number of ground level changes currently existing.

- Drainage delineation and installation in the vicinity of trees identified to be retained; especially in any low lying areas to be used for drainage purposes;

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- Sewerage delineation and installation in the vicinity of trees identified to be retained, and location of common trench for underground services (i.e. electricity, gas, water etc.) in the vicinity of trees identified to be retained;

Note: In this way the need for excavations that could lead to root loss will be limited. If underground pipe work is required to pass through a designated protection zone, then they must either be installed using underground directional drilling methods of installation, or be preceded by root pruning exercises under the guidance, supervision and approval of the consulting arborist.

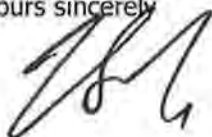
- Building considerations in the vicinity of trees identified to be retained (i.e. development of a Lot adjacent to a tree);
- Landscaping considerations (including irrigation design and installation) within designated preservation zones of trees identified to be retained.
- Erosion and siltation control in the vicinity of trees identified to be retained (if applicable);
- Effects of any de-watering operations during the development on the trees on site (if applicable);
- Supplementary watering requirements during construction for any trees identified to be retained;
- Specific root zone protection requirements prior to, and during, construction phases.
- Extent of canopy works on retained trees required to facilitate construction works, any building clearances, or to mitigate any perceived new potential Site safety issues (generally recommended to be undertaken as part of the site clearing works).

In the event that other site design parameters do not allow for the adoption of the recommended protection measures (for any given tree), then the future retention of the given tree within the development may be questionable due to the likely impact of the development on the tree, and its future health, vigour, and structural integrity.

Further Arboricultural advise will also be required as the design/planning process continues, to discuss specific tree preservation requirements for those trees chosen for retention within the development Site.

I look forward to aiding Stockland as the Site design process continues, and if you have any queries regarding the findings of this report, or if I can be of any further assistance, please do not hesitate to contact me.

Yours sincerely



Jason Royal



## **Appendices**

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**Opinion 1 Trees**

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Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
2	Port Jackson Fig	<i>Ficus rubiginosa</i>	14	950	18-20	Good	Good	10	Very good specimen. Has a low spreading canopy.	50+	1
7	Date Palm	<i>Phoenix dactylifera</i>	8	500	4-6	Good	Good	2.5	Good specimen. Can be transplanted if desired.	50+	1
24	Port Jackson Fig	<i>Ficus rubiginosa</i>	17	1050	18-20	Good	Good	10	Very good specimen with a low spreading canopy habit.	50+	1
37	Ironbark	<i>Eucalyptus sideroxylon</i>	9	300	4-6	Good	Good	3	Very good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
62	River Red Gum	<i>Eucalyptus camaldulensis</i> var ' <i>Camaldulensis</i> '	12	450	10-12	Good	Good	5	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
63	River Red Gum	<i>Eucalyptus camaldulensis</i> var ' <i>Camaldulensis</i> '	18	600	10-12	Good	Good	6	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
65	River Red Gum	<i>Eucalyptus camaldulensis</i> var ' <i>Camaldulensis</i> '	16	500	10-12	Good	Good	6	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
67	River Red Gum	<i>Eucalyptus camaldulensis</i> var ' <i>Camaldulensis</i> '	18	600	12-14	Good	Good	6	Good mature specimen.	50+	1
68	Flooded Gum	<i>Eucalyptus rudis</i>	18	750	16-18	Good	Good	6	Good mature specimen.	50+	1
70	Flooded Gum	<i>Eucalyptus rudis</i>	19	950	16-18	Good	Good	8	Good mature specimen.	50+	1



Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
71	Flooded Gum	<i>Eucalyptus rudis</i>	19	850	14-16	Good	Good	8	Good mature specimen.	50+	1
72	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	14	600	10-12	Good	Good	5	Good mature specimen.		1
74	Flooded Gum	<i>Eucalyptus rudis</i>	19	700	10-12	Good	Good	6	Good mature specimen.	50+	1
77	Tuart	<i>Eucalyptus gomphocephala</i>	12	500	6-8	Good	Good	5	Good mature specimen.	50+	1
78	Flooded Gum	<i>Eucalyptus rudis</i>	9	300	4-6	Good	Good	2.5	Good semi mature specimen.	50+	1
79	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	17	400	6-8	Good	Good	3.5	Good specimen.	50+	1
80	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	13	350	6-8	Good	Good	3	Good specimen.	50+	1
81	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	9	200	2-4	Good	Good	1.5	Good semi mature specimen.	50+	1
82	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	8	200	2-4	Good	Good	1.5	Good semi mature specimen.	50+	1
88	Tuart	<i>Eucalyptus gomphocephala</i>	20	850	16-18	Good	Good	9	Good mature specimen.	50+	1

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
89	Tuart	<i>Eucalyptus gomphocephala</i>	16	850	14-16	Good	Good	9	Good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	1
94	Tuart	<i>Eucalyptus gomphocephala</i>	15	400	8-10	Good	Good	4	Reasonably good specimen.	50+	1
110	Tuart	<i>Eucalyptus gomphocephala</i>	20	900	14-16	Good	Good	8	Good mature specimen. Canopy slightly one sided due to adjacent powerlines.	50+	1

**Opinion 2 Trees**

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Tree No	Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion	
1	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
3	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
4	Norfolk Island Pine	<i>Araucaria heterophylla</i>	17	450	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
5	River Red Gum	<i>Eucalyptus camaldulensis</i> var <i>camaldulensis</i>	22	1000	18-20	Good	Good	8	Good large specimen tree.	50+	2
8	Norfolk Island Pine	<i>Araucaria heterophylla</i>	14	500	8-10	Acceptable - Good	Good	4.5	Reasonably good specimen. Canopy relatively sparse though for a specimen of this species at this size/age.	20-30	2
9	Senegal Date Palm	<i>Phoenix reclinata</i>	4	250	6-8	Good	Good	4	Typical clumping habit. Can be transplanted if desired.	50+	2
10	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	9	450	8-10	Good	Good	4	Reasonably good specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2
21	West Australian Peppermint	<i>Agonis flexuosa</i>	9	400	8-10	Good	Good	5	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
23	River Sheoak	<i>Casuarina cunninghamiana</i>	12	350	8-10	Good	Good	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2
25	Lemon Scented Gum	<i>Corymbia citriodora</i>	17	400	10-12	Good	Good	4.5	Not necessarily considered a desirable species for urban areas; but a good specimen nonetheless. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
26	West Australian Peppermint	<i>Agonis flexuosa</i>	5	200	4-6	Good	Good	2	Good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
28	West Australian Peppermint	<i>Agonis flexuosa</i>	4	150	2-4	Good	Good	1.5	Good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
29	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	2-4	Good	Good	1.5	Good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
31	Marri	<i>Corymbia calophylla</i>	5	150	2-4	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
35	Marri	<i>Corymbia calophylla</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
39	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
40	West Australian Peppermint	<i>Agonis flexuosa</i>	3	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
41	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
42	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
43	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
44	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	2-4	Good	Good	1.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
47	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	4-6	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2

Tree No	Species		Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
48	West Australian Peppermint	<i>Agonis flexuosa</i>	4	100	4-6	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
51	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
53	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
56	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	2-4	Good	Good	2.5	Good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
83	Tuart	<i>Eucalyptus gomphocephala</i>	9	250	4-6	Good	Good	2	Reasonably good semi mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
84	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature multi stemmed specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
85	West Australian Peppermint	<i>Agonis flexuosa</i>	5	150	4-6	Good	Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
86	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
87	West Australian Peppermint	<i>Agonis flexuosa</i>	5	100	2-4	Good	Good	2	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	2
91	River Sheoak	<i>Casuarina cunninghamiana</i>	17	400	6-8	Good	Good	4	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	2
93	Tuart	<i>Eucalyptus gomphocephala</i>	17	350	8-10	Good	Acceptable - Good	4	Ok specimen. Tall, upright canopy habit with no lower canopy.	50+	2



Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
96	Tuart	<i>Eucalyptus gomphocephala</i>	24	1000	16-18	Acceptable - Good	Good	10	Reasonably good mature specimen. Some signs of canopy decline and stress.	20-30	2
97	River Sheoak	<i>Casuarina cunninghamiana</i>	15	350	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
99	River Sheoak	<i>Casuarina cunninghamiana</i>	15	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
100	River Sheoak	<i>Casuarina cunninghamiana</i>	17	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
101	River Sheoak	<i>Casuarina cunninghamiana</i>	15	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
102	River Sheoak	<i>Casuarina cunninghamiana</i>	16	450	8-10	Good	Good	4	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
103	River Sheoak	<i>Casuarina cunninghamiana</i>	13	250	6-8	Good	Good	2.5	Reasonably good mature specimen. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	2
104	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	10	450	8-10	Good	Good	4	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	2
106	Tuart	<i>Eucalyptus gomphocephala</i>	22	750	14-16	Acceptable - Good	Good	8	Reasonably good mature specimen. Some signs of canopy decline and stress.	20-30	2
107	Tuart	<i>Eucalyptus gomphocephala</i>	20	1000	18-20	Acceptable - Good	Acceptable - Good	10	Reasonably good mature specimen. Canopy one sided due to adjacent powerlines. Some signs of canopy decline and stress.	20-30	2
109	Tuart	<i>Eucalyptus gomphocephala</i>	20	900	14-16	Good	Acceptable - Good	8	Reasonably good mature specimen. Canopy one sided due to adjacent powerlines.	50+	2

Tree No	Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion	
113	Tuart	<i>Eucalyptus gomphocephala</i>	18	600	14-16	Good	Acceptable - Good	6	Reasonably good mature specimen. Canopy relatively one sided due to adjacent powerlines.	50+	2
114	West Australian Peppermint	<i>Agonis flexuosa</i>	10	500	10-12	Good	Good	5	Reasonably good mature specimen.	50+	2
122	West Australian Peppermint	<i>Agonis flexuosa</i>	5	200	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size.	50+	2

**Opinion 3 Trees**

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Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
6	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	400	10-12	Good	Acceptable - Good	4	Mature specimen tree.	10-20	3
11	Tuart	<i>Eucalyptus gomphocephala</i>	10	500	4-6	Good	Acceptable - Good	4	Reasonably good specimen tree; basal bark wound on main stem, signs of Longicorn damage but otherwise ok.	20-30	3
12	South Australian Blue Gum	<i>Eucalyptus leucoxylon</i>	9	350	8-10	Good	Acceptable - Good	4	Ok specimen tree, large bark wound on main stem from previous stem failures. Situated on an embankment so retention of levels will play a critical part in its retention.	20-30	3
13	Flooded Gum	<i>Eucalyptus rudis</i>	14	500	10-12	Good	Acceptable - Good	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
14	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	300	8-10	Good	Acceptable (undesirable)	4	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
15	Coastal Moort	<i>Eucalyptus platypus var Heterophylla</i>	12	500	10-12	Good	Acceptable - Good	5	Ok specimen tree. Low spreading canopy habit.	10-20	3
16	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	300	8-10	Good	Acceptable (undesirable)	3 (each)	Group of 5 specimen trees. Canopy development/forms have been affected by proximity to each other; retain as one tree.	10-20	3
18	Flooded Gum	<i>Eucalyptus rudis</i>	9	400	6-8	Acceptable	Good	5	Ok semi mature specimen, although its canopy is relatively sparse.	50+	3
19	Bald Island Marlock	<i>Eucalyptus conferruminata</i>	8	400	8-10	Good	Acceptable - Good	4	Ok mature specimen tree.	10-20	3
20	Flooded Gum	<i>Eucalyptus rudis</i>	19	600	12-14	Good	Acceptable - Good	6	Good mature specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
22	West Australian Peppermint	<i>Agonis flexuosa</i>	7	400	8-10	Acceptable - Good	Acceptable - Good	5	Ok specimen tree. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
27	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	11	350	10-12	Good	Acceptable - Good	4.5	Group of mature specimens. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
30	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	6	300	8-10	Good	Acceptable - Good	4.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
32	Firewood Banksia	<i>Banksia menziesii</i>	8	350	6-8	Good	Good	5	Mature specimen. Canopy relatively sparse for a specimen of this species/size/age. Species do not readily tolerate disturbance to their root zones.	10-20	3
33	Firewood Banksia	<i>Banksia menziesii</i>	9	500	8-10	Good	Good	6	Good mature specimen. Species do not readily tolerate disturbance to their root zones.	20-30	3
34	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	7	400	8-10	Good	Acceptable - Good	4.5 (each)	Two specimens in close proximity effectively forming the one canopy. Treat as one tree for preservation. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
36	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	200	4-6	Good	Acceptable - Good	2.5 (each)	Group of 4 specimens in close proximity effectively forming the one canopy. Treat as one tree for preservation. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
38	Flooded Gum	<i>Eucalyptus rudis</i>	17	700	14-16	Good	Good	6	Looks to be a hybrid with the Northern River Red Gum, so not necessarily considered a desirable species for urban areas; but a good specimen nonetheless. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
45	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	350	12-14	Good	Acceptable - Good	7	Reasonably good multi stemmed specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3

Tree No	Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
46	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	5	250	8-10	Good	Acceptable - Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
49	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	8	250	4-6	Good	Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
50	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	8	350	6-8	Good	Good	3.5	Ok specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
52	West Australian Peppermint <i>Agonis flexuosa</i>	5	100	2-4	Good	Acceptable - Good	2.5	Reasonably good semi mature specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
54	West Australian Peppermint <i>Agonis flexuosa</i>	5	100	4-6	Good	Acceptable - Good	2.5	Reasonably good semi mature multi stemmed specimen. Potential transplant at this size. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
55	Bald Island Marlock <i>Eucalyptus conferruminata</i>	11	550	12-14	Acceptable - Good	Acceptable - Good	6	Reasonably good mature specimen. Canopy half burnt by fire, but it may recover ok over time.	10-20	3
57	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	5	150	4-6	Good	Good	2.5	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
58	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	10	400	8-10	Good	Good	5	Reasonably good mature specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
59	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	8	500	6-8	Good	Acceptable - Good	5	Reasonably good mature specimen. Some signs of decay in its main stem structure. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
60	Coastal Moort <i>Eucalyptus platypus var heterophylla</i>	8	400	6-8	Good	Good	5	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3



Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
61	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	6	350	6-8	Good	Good	3.5	Reasonably good mature specimen. Low spreading canopy habit. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
64	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	350	6-8	Good	Acceptable - Good	3.5 (each)	Group of mature specimens. Low spreading canopy habit and their development/form has been affected due to their proximity to each other; suggest to retain as one group. Situated on an embankment so retention of levels will play a critical part in its retention.	10-20	3
66	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	450	8-10	Good	Acceptable - Good	4.5	Good mature specimen. Some signs of decay in its main stem structure.	10-20	3
69	Flooded Gum	<i>Eucalyptus rudis</i>	18	550	14-16	Acceptable	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way of good design.	50+	3
73	Flooded Gum	<i>Eucalyptus rudis</i>	17	550	10-12	Good	Acceptable (undesirable)	6	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way of good design.	50+	3
90	Tuart	<i>Eucalyptus gomphocephala</i>	16	500	8-10	Good	Good	5	Reasonably good specimen. Situated on an embankment so retention of levels will play a critical part in its retention.	50+	3
92	Tuart	<i>Eucalyptus gomphocephala</i>	14	450	10-12	Good	Acceptable (undesirable)	4.5	Undesirable structural form for specimen of this species; likely to cause future issues. Only retain in an area of POS where occurrence of potential targets can be limited by way of good design.	20-30	3
95	Tuart	<i>Eucalyptus gomphocephala</i>	17	850	12-14	Good	Acceptable (undesirable)	8	Mature specimen. Canopy one sided and leaning due to adjacent tree. Only retain in an area of POS where occurrence of potential targets can be limited by way of good design.	20-30	3
98	River Sheoak	<i>Casuarina cunninghamiana</i>	15	300	6-8	Good	Acceptable - Good	3	Ok mature specimen. Canopy one sided due to adjacent tree. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	3

Tree No		Species	Estimated Height (metres)	Estimated Stem Calliper (mm)	Canopy Spread (metres diameter)	Health Condition	Structural Form	Recommended Protection Zone (metres radius)	Comments	SULE	Opinion
105	River Sheoak	<i>Casuarina cunninghamiana</i>	17	500	8-10	Good	Acceptable - Good	4.5	Reasonably good mature specimen. Main stem bi-furcates. Species not usually favoured in urban areas though (mainly due to leaf (needle) litter issues).	20-30	3
111	Tuart	<i>Eucalyptus gomphocephala</i>	20	750	12-14	Acceptable - Good	Acceptable - Good	10	Reasonably good mature specimen. Some signs of canopy decline and stress.	50+	3
112	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	5	300	6-8	Good	Acceptable - Good	3.5	Two reasonably good mature specimens. Some signs of decay in their main stem structures. Situated near powerlines so on-going issues with clearance likely to be remain throughout their natural life span.	10-20	3
115	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	450	14-16	Good	Acceptable (undesirable)	6	Old specimen. Some signs of decay in its main stem structure.	10-20	3
116	Tuart	<i>Eucalyptus gomphocephala</i>	17	500	18-20	Acceptable - Good	Acceptable (undesirable)	8	Old multi stemmed specimen. Some signs of canopy decline.	50+	3
117	Tuart	<i>Eucalyptus gomphocephala</i>	13	400	8-10	Acceptable - Good	Good	4	Ok specimen. Some signs of canopy decline.	20-30	3
118	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	8	300	8-10	Good	Acceptable - Good	4	Ok specimen. Canopy one sided due to adjacent tree.	10-20	3
119	Bald Island Marlock	<i>Eucalyptus conferruminata</i>	6	300	4-6	Good	Acceptable - Good	3	Ok specimen. Canopy one sided due to adjacent tree.	10-20	3
120	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	9	350	8-10	Good	Acceptable - Good	4	Ok specimen. Some signs of decay in its main stem structure.	10-20	3
121	Coastal Moort	<i>Eucalyptus platypus var heterophylla</i>	10	500	10-12	Acceptable - Good	Acceptable - Good	4	Old specimen. Some signs of decay in its main stem structure. Canopy relatively sparse.	10-20	3

## Company Information

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Company Name:



A.C.N.:

107 194 061

A.B.N.:

66 566 369 687

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### **Insurance Details:**

General Liability

QBE Insurance Ltd

\$20 million

Professional Indemnity:

Dual Australia Pty Ltd

\$5 million

Workers Compensation:

QBE Australia

As per 'Acts'

