Local Structure Plan No. 3

BROOME NORTH



Prepared for **DevelopmentWA**

Prepared by **Taylor Burrell Barnett**

September 2022

DOCUMENT HISTORY AND STATUS

Broome North

Local Structure Plan No. 3

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ENDORSEMENT

This structure plan is prepared under the provisions of the Shire of Broome Town Planning Scheme No. 4

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

19 FEBRUARY 2016

In accordance with Schedule 2, Part 4, Clause 28 (2) and refer to Part 1, 2. (b) of the *Planning and Development (Local Planning Schemes) Regulations 2015*.

Date of Expiry: **19 FEBRUARY 2036**

TABLE OF AMENDMENTS

Amendment No.	Summary of Amendment	Amendment Type	Date approved by WAPC
1	Amendment No. 1 proposes to introduce a District Centre in the southern portion of the site, adjacent to Gubinge Road which would provide for development of a range of retail uses such as a supermarket, speciality shops, café/restaurants, as well as office / commercial uses, to align with the Shire of Broome Local Commercial Strategy (2017)	Standard	27 September 2022

PART ONE
IMPLEMENTATION

1.1 LOCAL STRUCTURE PLAN AREA

This Local Structure Plan (LSP) applies to the land contained within the inner edge of the red line on the Local Structure Plan (**Plan 1**).

1.2 CONTENT

This LSP report comprises:

Part One – Implementation

This section contains the Local Structure Plan Map (**Plan 1**), Movement Network Plan (**Plan 2**) and statutory planning provisions and requirements.

Part Two – Explanatory

This section is to be used as a reference guide to interpret and justify the implementation of Part One.

Appendices

Technical reports and supporting plans and maps.

1.3 INTERPRETATION

All words and expressions used in this LSP have the meaning given to them in the Shire of Broome Local Planning Scheme No.6 (the Scheme).

1.4 RELATIONSHIP TO SCHEME

1.4.1 This LSP is prepared in accordance with Schedule 2 - Deemed provisions for Local Planning Schemes of the *Planning and Development (Local Planning Schemes) Regulations 2015*.

1.4.2 Land Use permissibility within the LSP shall be in accordance with the corresponding zone or reserve under the Scheme. Until such time as the Scheme is reviewed and an appropriate District Centre Zone is introduced, land use permissibility for the District Centre site shall be as defined by the Local Centre Zone.

1.4.3 This LSP is to be read in conjunction with the Broome North District Structure Plan.

1.4.4 All development on land within the LSP area shall be in accordance with the requirements outlined on Plans 1 and 2 and contained within Part 1 of this LSP.

1.4.5 Where a development requirement or requirement of this LSP is inconsistent with a standard or requirement of the Scheme that is subject to a discretion to permit the variation, then pursuant to Clause 27 of Schedule 2 – Deemed provisions for *Local Planning Schemes of the Planning and Development (Local Planning Schemes) Regulations 2015*, the Council may have due regard to the standards and requirements in this LSP in exercising discretion and may apply the standards and requirements of this LSP instead of the standards and requirements of the Scheme to the extent that the provisions of the Scheme permit that variation.

1.4.6 Notwithstanding clause 4.2.2 of the Scheme, the following variations to the Residential Design Codes constitute Acceptable Development:

a) Setbacks complying with the standards detailed in **Tables B-D** of this LSP.

1.4.7 The local government may adopt a minor change to or departure from the development requirements of this LSP, including the addition of new development requirements, if, in the opinion of the local government, the change, departure or addition:

a) Is consistent with the objectives for the relevant zone in which it is situated as detailed at Clause 6.3 of Part One of the Broome North District Structure Plan (DSP) Report; and

b) Does not materially alter the intent of this LSP.

1.5 OPERATION

The date the Structure Plan comes into effect is the date the Structure Plan is approved by the WAPC.

1.6 RESIDENTIAL DENSITY

1.6.1 Plan 1 identifies the residential density ranges that apply to the indicative locations within the LSP area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan approved by the WAPC.

1.6.2 A Residential Density Code Plan is to be submitted at the time of subdivision to the WAPC and will indicate the Residential Density Coding applicable to each lot within the subdivision, generally consistent with the Residential Density Ranges identified on Plan 1 and the location criteria set out at Clause 1.7.

1.6.3 The Residential Density Code Plan is to include a summary of the proposed dwelling yield of the respective subdivision.

1.6.4 Approval of the Residential Density Code Plan will be undertaken at the time of determination of the subdivision application by the WAPC. The approved Residential Density Code Plan will then form part of LSP and will be used for the determination of future development applications. Variations to the Residential Density Code Plan will require further approval from the WAPC.

1.6.5 Residential Density Code Plans are not required if the WAPC considers that the subdivision is for one or more of the following:

a) The amalgamation of lots;

b) Consolidation of land for 'superlot' purposes to facilitate land assembly for further development;

c) The purposes of facilitating the provision of access, services or infrastructure; or

d) Land which by virtue of its zoning or reservation under the LSP cannot be developed for residential purposes.

1.7 LOCATIONAL CRITERIA

The allocation of residential densities on the Residential Density Code Plan will generally be in accordance with the following criteria:

a) Residential R2-R10:

i. To provide a sensitive visual interface between areas of cultural significance and residential development;

ii. To promote a graduation of development between the natural landscape, major roads and medium and higher residential densities;

iii. To enable the protection of remnant vegetation/ trees where possible;

iv. To provide a lifestyle choice enabling residents to live in close proximity to high amenity natural areas; and/or

v. To provide a greater diversity of housing options in the Broome North locality.

b) Residential R12.5-R25:

i. To promote a graduation of development between the natural landscape, major roads and non-residential facilities and variable residential densities;

ii. To provide housing options for new residents seeking to capitalise on the Broome lifestyle;

iii. To provide housing for families that is well connected and in proximity to open space; and/ or

iv. To enable the protection of remnant vegetation/ trees where possible.

c) Residential R25-R40:

i. Adjacent to areas of higher amenity such as public open space and the natural environment;

ii. Adjacent to public transport connections and significant pedestrian and cycle linkage;

iii. In response to the need to promote housing diversity and provide affordable housing; and/or

iv. Other suitable locations as contextually relevant.

1.8 DEVELOPMENT REQUIREMENTS

1.8.1 The design and construction of roads within the LSP area shall occur generally in accordance with the standards specified in **Table A**. Variations to the standards outlined in Table A will be subject to negotiation with the Shire of Broome at the detailed subdivision design stage.

1.8.2 All dwellings shall be developed in accordance with the standards specified within **Tables B-D,** which constitute variations to the 'Acceptable Development' criteria of the Residential Design Codes. Where there is an inconsistency between the standards specified in Tables B-D and the Residential Design Codes, the standards specified in Tables B-D shall prevail to the extent of the inconsistency.

1.8.3 Notwithstanding Clause 1.8.2, the standards specified in Tables B-D and the Residential Design Codes may be amended with the preparation and approval of a Local Development Plan, to the satisfaction of the Shire of Broome. Any variations must comply with the requirements of the Bushfire Management Plan where applicable.

1.8.4 Where two or more lots coded R30/R40 are amalgamated, the resulting lot may be developed for grouped or multiple dwellings at the higher R40 coding.

1.8.5 In addition to the requirements of the Residential Design Codes, the development of single, grouped and multiple dwellings shall comply with the following design criteria:

i) No buildings, including outbuildings, greater than 9m^2 will be permitted to be constructed in the side or rear setback areas required as breezeways in accordance with setback controls detailed in Tables B-D.

ii) In relation to i) above, open carports and roofed outdoor living areas may encroach up to 50% into the breezeways, so long as the structure does not cause any obstruction to airflow;

iii) Vehicle access points to each lot are minimised;

iv) Communal parking areas (excluding visitor parking) are to be located out of public view;

v) Each dwelling is to be provided with safe, convenient pedestrian access;

vi) Outdoor living areas are to be located adjacent to breezeways; and

vii) Refuse, storage and external drying areas are to be fully screened from public view.

1.8.6 A Local Development Plan (LDP) is to be prepared and approved by the Shire of Broome, in accordance with Clause 3.42.1 (b) of the Scheme, prior to the development of any land zoned Tourism within this LSP. The LDP/s shall, inter alia, limit the amount and location of any existing vegetation to be retained. Areas of vegetation proposed to be retained shall not be greater than 2,500m^2 and not located within 20m of proposed or existing dwellings.

1.8.7 A Local Development Plan shall be prepared and approved by Council prior to a development application being considered for any site within the District Centre Site identified as Local Centre on the LSP. LDPs are required to address the matters listed in Clause 48 of the Deemed Provisions of the Planning and Development (Local Planning Schemes) Regulations of 2015, and more specifically in relation to the District Centre, as follows:

i) Site design and layout

ii) Built form

iii) Public realm and landscaping

iv) Access and parking

v) Bushfire management

vi) Acoustics

1.8.8 All new lots created within the Permanent Bushfire Building Attack Level (BAL) 12.5 area on Plan 1 shall have a notification, pursuant to Section 70A of the *Transfer of Land Act 1893*, placed on the Certificate of Title alerting purchasers to the existence of a Fire Management Plan and the requirement to construct habitable buildings in accordance with AS3959-2009.

1.8.9 The requirements of Clause 1.8.7 shall apply to all new lots created within the Temporary Bushfire Building Attack Level (BAL) 12.5 area on Plan 1 if the Tourism zoned sites remain uncleared of the existing vegetation. If the Tourism zoned sites have been cleared in accordance with the requirements of Clause 1.8.6 at the time of the creation of the new lots, then Clause 1.8.7 shall not apply.

1.8.10 Development will have regard to the BAL Assessment contained in the addendum, and be determined in accordance with Schedule 2, Part 10A of the Planning and Development (Local Planning Schemes) Regulations 2015 and Section 6.3 of SPP 3.7 Planning in Bushfire Prone Areas. The Council shall recommend to the WAPC that a condition be imposed on the grant of subdivision approval for a notification to be placed on the Certificate of Title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: "This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is/may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land." (Western Australian Planning Commission).

1.8.11 As a condition of subdivision approval, the developer will prepare a Local Development Plan which address the following:

a. Vehicle access and parking;

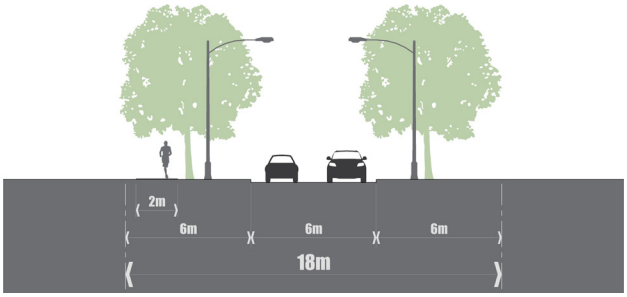
b. Orientation of dwellings to address adjacent streets and Public Open Space;

c. Fencing controls;

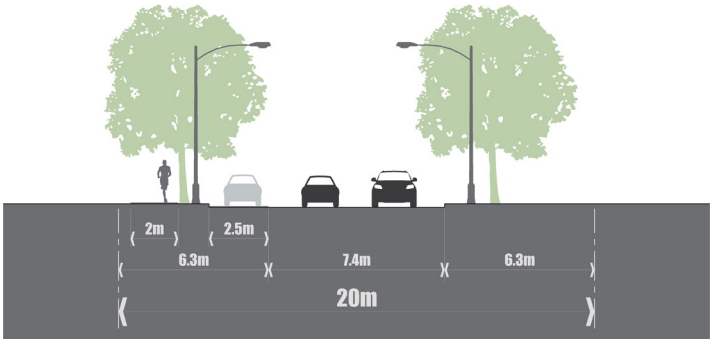
d. Response to climatic conditions.

TABLE A: MINIMUM ROAD DESIGN REQUIREMENTS

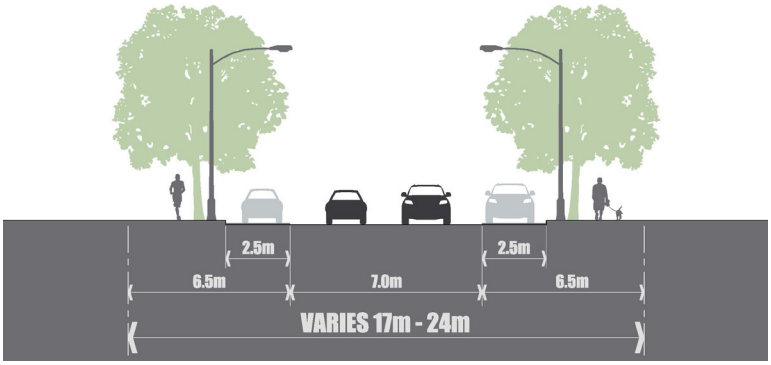
	Local Access Street	Major Access Street	Main Street	Neighbourhood Connector	Integrator Arterial B
Reserve Width	18m Abutting POS - 14.75m Green Link Street - 22m	20m Abutting POS - 16.45m	Varies 17m to 24m	24m Abutting POS - 20m Green Link Street - 24m	40m
Travel Lane Width	6m	7.4m	7.0m	7.4m	5m per carriageway (3.5m travel lane & 1.5m bike lane)
Parking	N/A	2.5m embayed on one side, where warranted (i.e. abutting local open space, for visitor parking, etc.)	2.5m embayed where determined at detailed design stage	2.5m embayed on both sides, where warranted (i.e. abutting local open space, for visitor parking, etc.)	2.5m embayed on both sides, where warranted (i.e. abutting local open space, for visitor parking, etc.)
Median	N/A	N/A	N/A	N/A	6m with street trees
Verge Width (inclusive of paths)	6m both sides (can be reduced to 2.75m where abutting POS) Green Link Street – 6m on one side, 10m on other side	6.3m on both sides (can be reduced to 2.75m where abutting POS)	4m minimum on both sides	8.3m on both sides (24m reserve) Green Link Street – 6.6m on one side, 10m on other side	12m on both sides
Path Location	Offset 0.5m from property boundary Green Link Street – mid-verge, between double row of trees	Offset 0.5m from property boundary	Between kerb line and property boundary	Offset 0.5m from property boundary Green Link Street – mid-verge, between double row of trees	Offset 0.5m from property boundary
Path Width	2m footpath on one side only Green Link Street – 2.5m on one side only	2m footpath on one side. Additional paths may be provided where warranted	Between kerb line and property boundary	2.5m shared path on one side. 2m footpath on other side	2.5m shared paths on both sides



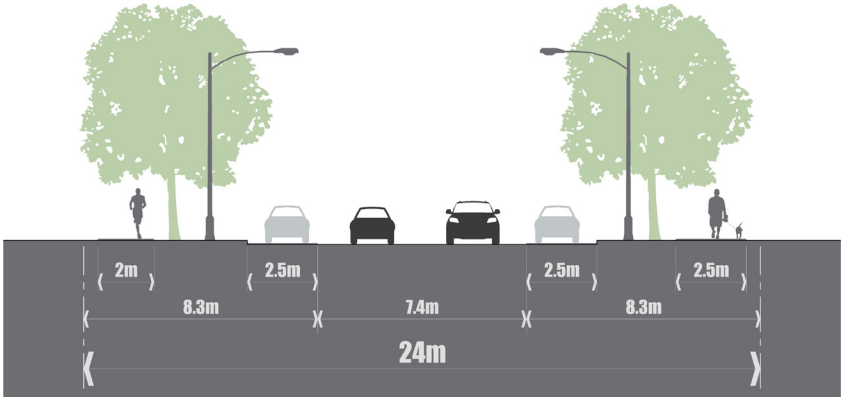
LOCAL ACCESS STREET



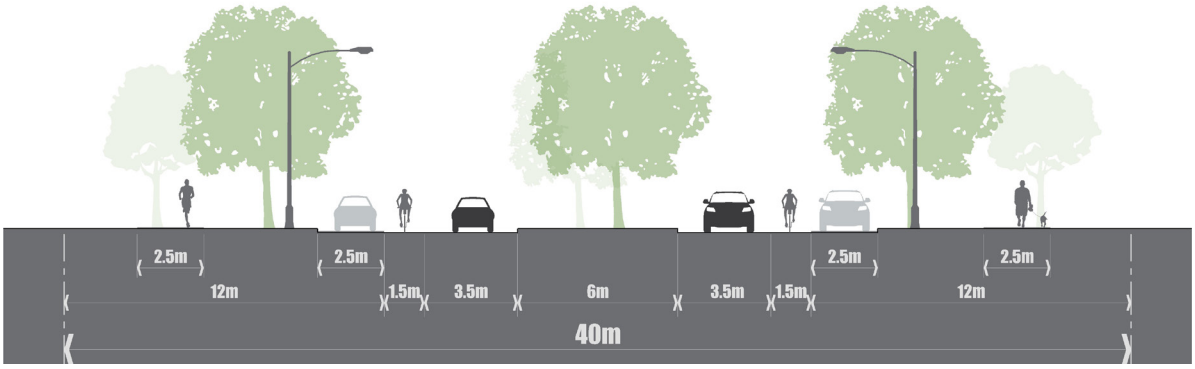
MAJOR ACCESS STREET



MAIN STREET



NEIGHBOURHOOD CONNECTOR



INTEGRATOR ARTERIAL B

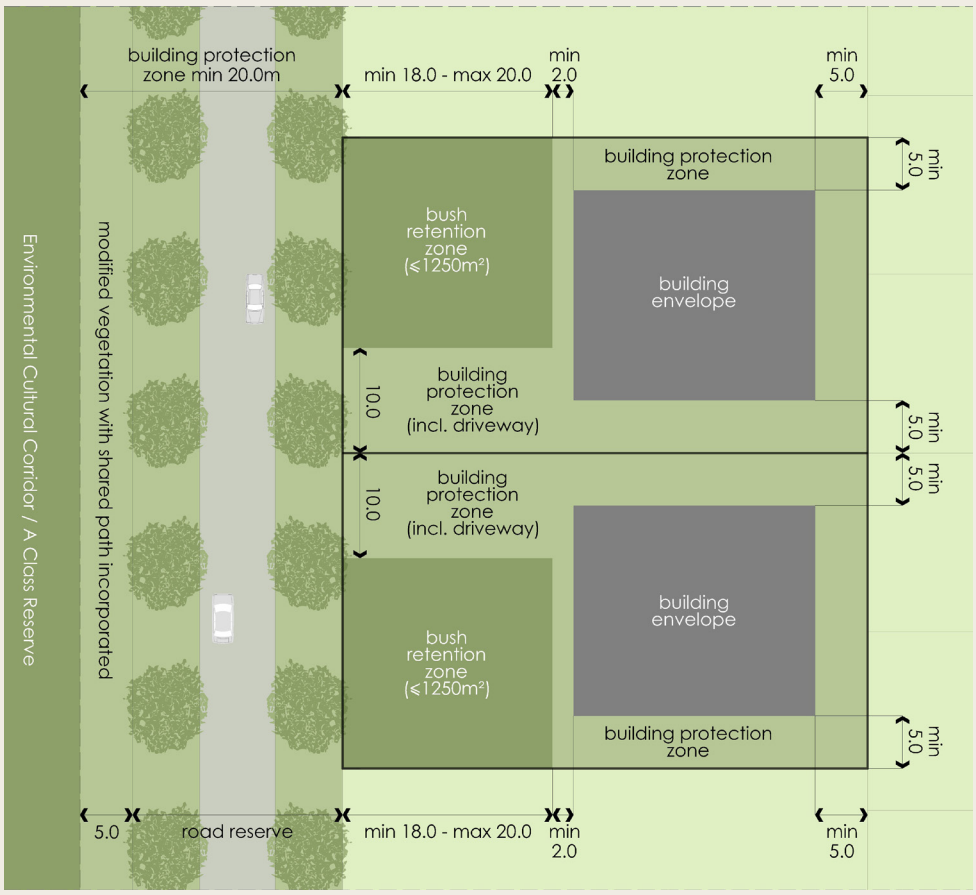
TABLE B: RESIDENTIAL R2-R10 DEVELOPMENT REQUIREMENTS

Residential R2-R10		
Building Types	Single House	
Building Setbacks[1]		
Front	R2-R10:	20m minimum (averaging not permissible)
Side[2]	R2-R10:	5m minimum (averaging not permissible)
Rear	R2-R10:	5m minimum (averaging not permissible)
Specific Development Requirements		
A Bush Retention Zone shall be included within the front setback area of all Bush Living lots. The Bush Retention Zone shall not have a depth greater than 20m (as measured from the Primary Street frontage) and shall not exceed 1,250m² in area on a single lot. A minimum dwelling setback of 2m shall be provided from the Bush Retention Zone.		

[1] *The primary purpose for the proposed side and rear setbacks is to maintain breezeways for breeze access to dwellings.*

[2] *Does not apply to secondary street boundaries (R-Codes prevail).*





RESIDENITAL R2-R10

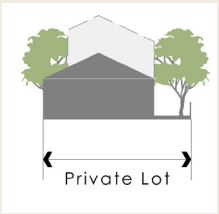
TABLE C: RESIDENTIAL R12.5-R25 DEVELOPMENT REQUIREMENTS

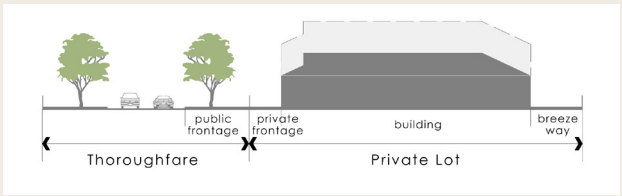
Residential R12.5-R25		
Building Types	Single House Grouped Dwelling	
Building Setbacks[1]		
Front	R12.5: R15-R25:	6m minimum (averaging permissible) 4m minimum (averaging permissible)
Side[2]	R12.5-R20: R25 (East-West): R25 (North-South):	3m minimum one side (all levels), nil permissible other side for ground level only 3m minimum south side (all levels), nil permissible north side for ground level only 3m minimum east side (all levels), nil permissible west side for ground level only
Rear	R12.5-R25:	5m minimum (averaging permissible to 4m)
Open Space/Drainage	R12.5-R25:	2m minimum (averaging not permissible)
Building Frontage		
Dwellings are to be orientated to address adjacent POS areas and any public street. All dwellings fronting POS are to have visually permeable fencing, have a clearly definable entry point accessed from the POS and major openings overlooking the POS area.		
Corner lots are to equally articulate both street frontages, avoiding long blank walls and including major openings to habitable rooms on each street-facing facade.		

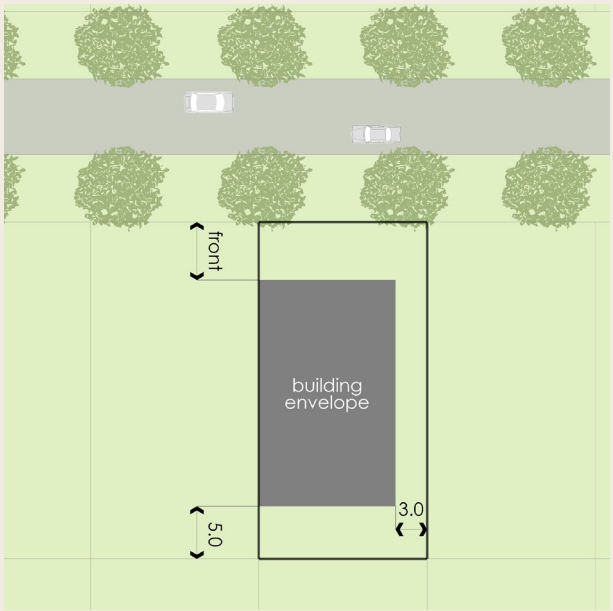
[1] *The primary purpose for the proposed side and rear setbacks is to maintain breezeways for breeze access to dwellings.*

[2] *Does not apply to secondary street boundaries (R-Codes prevail).*

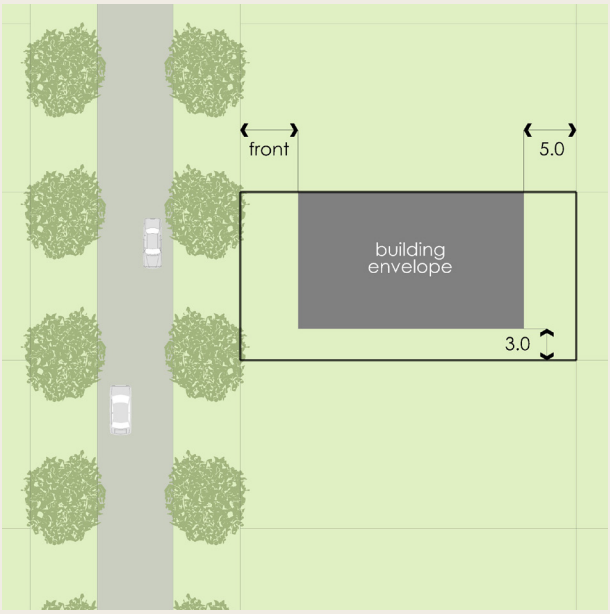
[3] *Where a building is built up to the boundary, upper level setbacks shall be in accordance with the R-Codes.*







RESIDENTIAL R12.5-R25 - NORTH-SOUTH



RESIDENTIAL R12.5-R25 - EAST-WEST

TABLE D: RESIDENTIAL R25-R40 DEVELOPMENT REQUIREMENTS

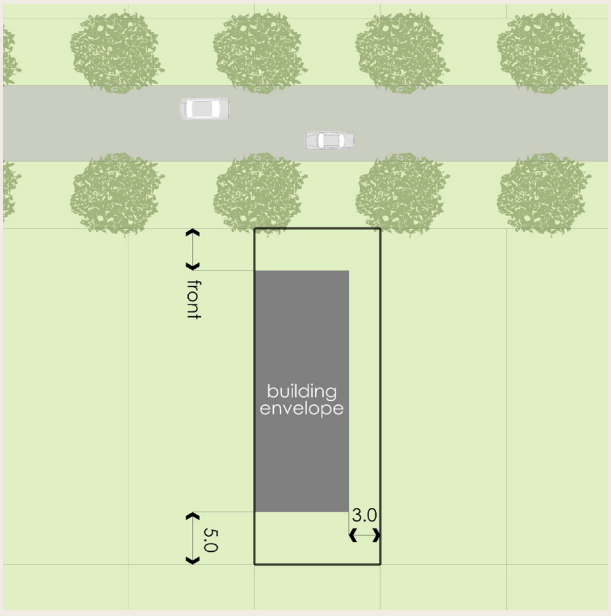
Residential R25-R40		
Building Types	Single House Grouped Dwelling Multiple Dwelling	
Building Setbacks[1]		
Front	R25-R40:	4m minimum (averaging permissible)
Side[2,3]	R25-R30 (East-West): R25-R30 (North-South): R40:	3m minimum south side (all levels), nil permissible north side for ground level only 3m minimum east side (all levels), nil permissible west side for ground level only 3m minimum either side (all levels), nil permissible other side for ground level only
Rear[4]	R25-R40:	5m minimum (averaging permissible to 4m)
Open Space/Drainage	R12.5-R25:	2m minimum (averaging not permissible)
Building Frontage		
Dwellings are to be orientated to address adjacent POS areas and any public street. All dwellings fronting POS are to have visually permeable fencing, have a clearly definable entry point accessed from the POS and major openings overlooking the POS area.		
Corner lots are to equally articulate both street frontages, avoiding long blank walls and including major openings to habitable rooms on each street-facing facade.		

1 *The primary purpose for the proposed side and rear setbacks is to maintain breezeways for breeze access to dwellings.*

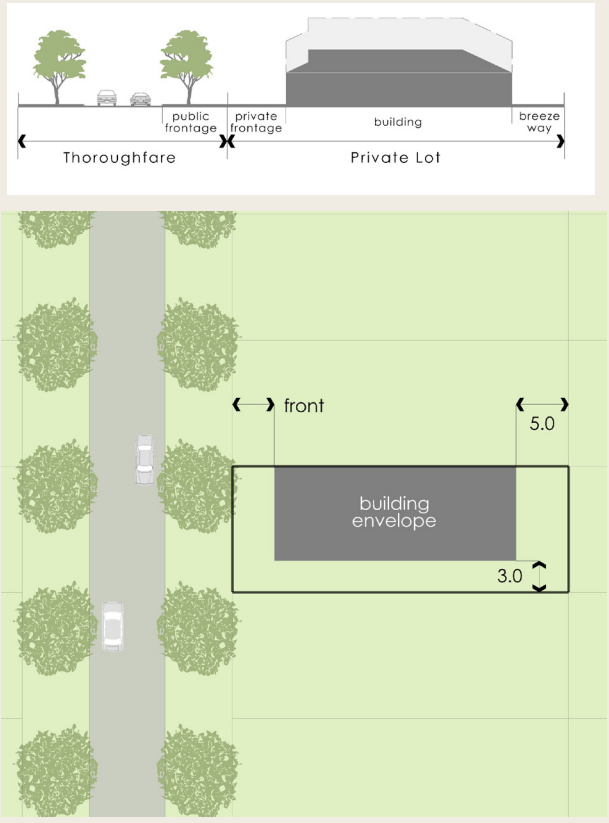
2 *Does not apply to secondary street boundaries (R-Codes prevail).*

3 *Where a building is built up to a boundary, upper level setbacks shall be in accordance with the R-Codes.*

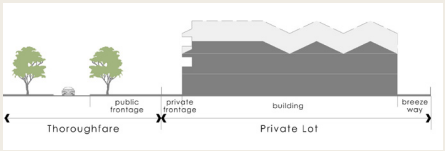
4 *Although laneways are not generally supported, setbacks will be subject to negotiation with the Shire of Broome where laneways are provided.*

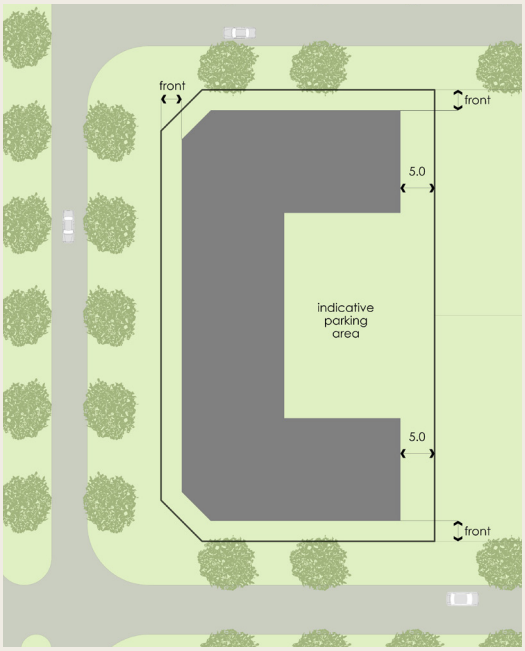


RESIDENTIAL R25-R40 - NORTH-SOUTH

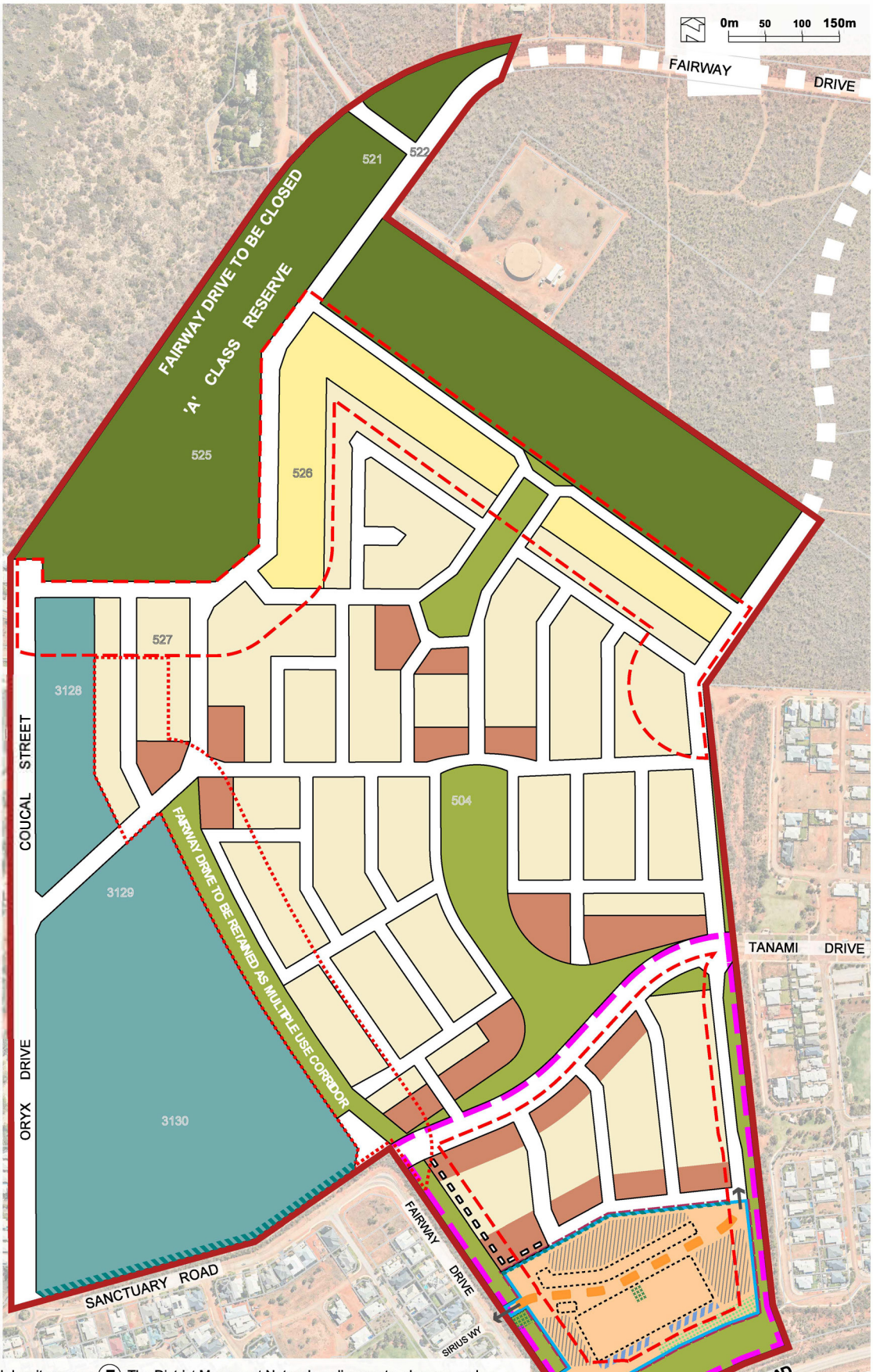


RESIDENTIAL R25-R40 - EAST-WEST





RESIDENTIAL R25-R40 - GROUPED/MULTIPLE



LEGEND

- APPROVED LOCAL STRUCTURE PLAN 3 BOUNDARY
- AMENDMENT AREA

LOCAL SCHEME RESERVES

- ENVIRONMENTAL AND CULTURAL CORRIDOR RESERVE
- PARKS, RECREATION AND DRAINAGE

ZONES

- RESIDENTIAL R2-R10
- RESIDENTIAL R12.5-R25
- RESIDENTIAL R25-R40
- TOURIST
- LOCAL CENTRE

OTHER

PUBLIC REALM AND ENVIRONMENT

- PERMANENT BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5 (refer to BMP)
- TEMPORARY BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5 (refer to BMP)
- LANDSCAPE BUFFER (minimum 5.0m in Local Centre Zone)
- STORMWATER DRAINAGE SWALE (indicative location)
- LANDSCAPED PUBLIC SPACE (indicative location)

MOVEMENT

- MAIN STREET (indicative location)
- KEY VEHICLE ACCESS POINT
- KEY PARKING AREA (indicative location)
- KEY AREA FOR SERVICING AND DELIVERIES TO CORE RETAIL BUILDINGS (indicative location)
- NO VEHICLE ACCESS PERMITTED
- PROVISION OF A PUBLIC ROAD RESERVE IF GREEN TITLED SINGLE - LOT SUBDIVISION OCCURS WITHIN THIS SUB - PRECINCT

BUILT FORM

- INDICATIVE ZONE FOR MAIN STREET BUILDINGS

NOTES

(A) The Plan identifies indicative residential density ranges with the Local Development Plan 3 Area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan submitted as the time of subdivision for approval by the WAPC.

(B) The Plan depicts the indicative location of Public Open Space, which will be subject to further refinement and modification at the subdivision stage.

(C) The requirements associated with the Permanent and Temporary Bushfire Building Attack Level (BAL) 12.5 areas are outlined in Clauses 1.8.7 and 1.8.8.

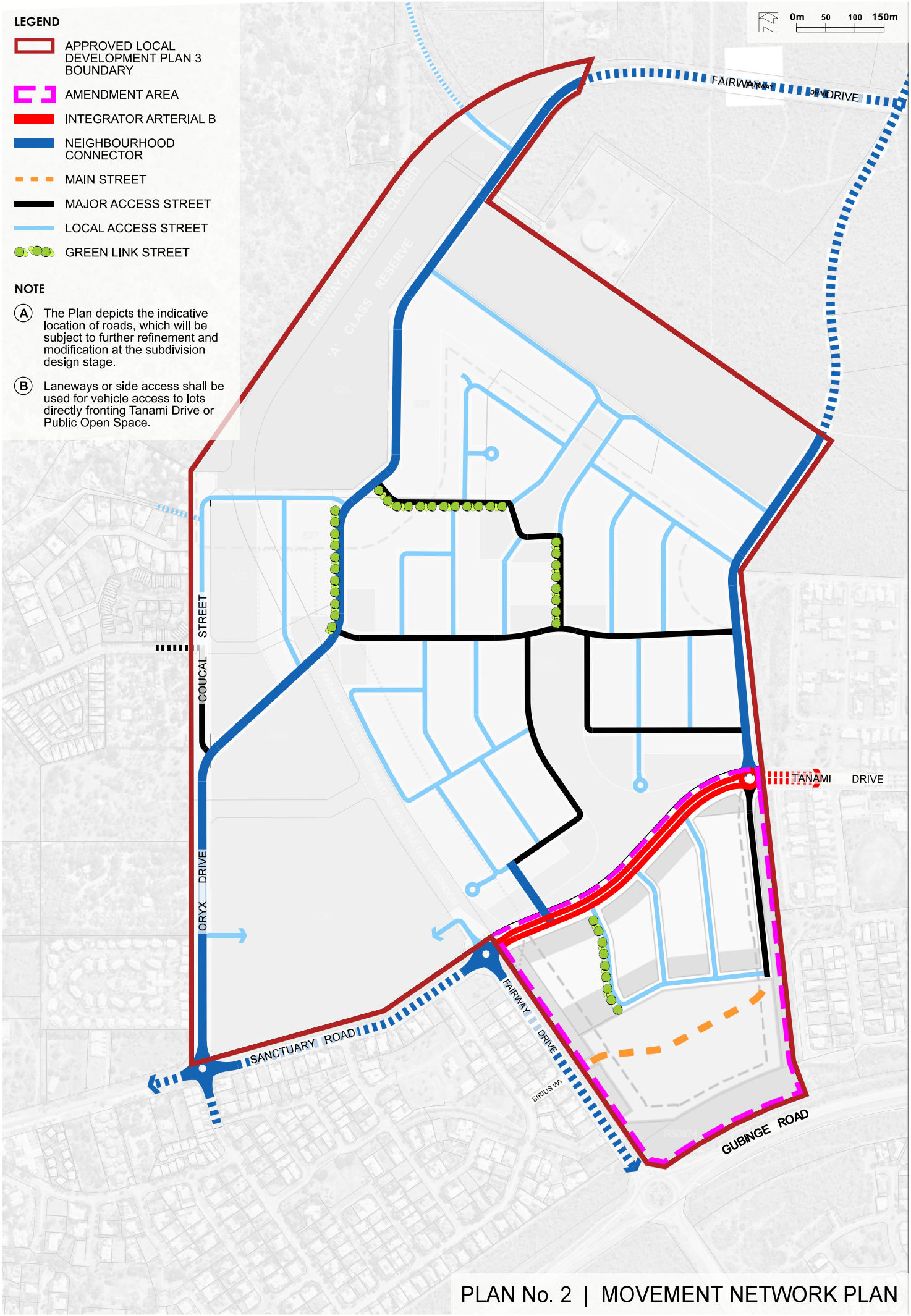
(D) Appropriate land tenure arrangements are to be made for the protection and ongoing access to the Water Corporation's infrastructure contained adjacent to the Environmental and Cultural Corridor Reserve.

(E) The District Movement Network realignments, closures and construction, including the roundabout access to the future Caravan Park on Fairway Drive and Sancturary Road is to be at the developer's cost.

(F) Broome town site experiences problems with nuisances and disease carrying mosquitoes. Strategies to minimise the breeding of mosquitoes in on-site infrastructure and constructed water bodies should be identified within the Urban Water Management Plan or a Mosquito Management Plan.

(G) Transport and traffic related issues to be addressed in the detailed planning of the District Centre include: updated trip generation, intersection design, swept paths for large vehicles, performance and separation distances of intersections and standards of proposed roads in accordance with WAPC Transport Impact Assessment Guidelines (2016). Detailed consideration is to be given to these matters at the subdivision and development stages. These requirements are subject to the satisfaction of Main Roads Western Australia (MRWA), the Shire of Broome, and the Department of Planning, Lands, and Heritage.

PLAN No. 1
LOCAL STRUCTURE PLAN No. 3



PLAN No. 2 | MOVEMENT NETWORK PLAN

PART TWO
EXPLANATORY

1 SITE CONTEXT

1.1 LAND DESCRIPTION

The subject site comprises the land generally bound by Gubinge Road to the south, Fairway Drive and Sanctuary Road to the south-west, Oryx Road/Coucal St to the west, Public Purposes – Water Supply facility to the north and the Broome North LSP 1 area to the east. LSP 3 has a total area of 131.28 ha.

The legal description of the lots covered by LSP 3 is outlined in **Table 1** below and depicted on **Figure 1**:

TABLE 1: LAND OWNERSHIP DETAILS

Lot No.	Volume	Folio	Survey Document	Owner	Reserve	Primary Interest Holder
504	2763	447	DP69436	LandCorp	N/A	
510	LR3163	383	DP75546	Crown	50974	
521	LR3161	66	DP71095	Crown	50994 A-Class	Yawuru Native Title Holders
522	LR3163	378	DP76577	Crown	UCL	
525	LR3161	70	DP71095	Crown	50994 A-Class	Yawuru Native Title Holders
526	LR3163	379	DP76577	Crown	UCL	
527	LR3161	72	DP71095	Crown	UCL	
3127	LR3128	59	DP32082	Crown	UCL	
3128	LR3128	60	DP32082	Crown	UCL	
3129	LR3128	61	DP32082	Crown	UCL	
3130	LR3128	62	DP32082	Crown	51028	Shire of Broome
Pt 2646	LR3004	483	DP217578	Crown	41562	Water Authority of WA
Portions of existing Fairway Drive, Oryx Road and Coucal St road reserves.						

1.2 SITE ANALYSIS

The subject site slopes gently from higher areas in the north (~18-20m AHD) to the south-east (~14-15m AHD) and is currently vegetated.



FIGURE 1: SITE PLAN

2 STATE PLANNING FRAMEWORK

2.1 STATE PLANNING STRATEGY

Prepared by the Department of Planning, under the guidance of the Western Australian Planning Commission, the Strategy presents a vision for Western Australia to 2050 and beyond based on a framework of planning principles, strategic goals and State strategic directions.

The Strategy defines planning for sustained prosperity in terms of a:

- **Diverse state**; offering a diversity of ecosystems, landscapes, enterprises, people and cultures.
- **Liveable state**; the place of choice for the brightest and best.
- **Connected state**; as connected to the rest of the world as any other place.
- **Collaborative state**; enabling alignments that progress the State's sustained growth and prosperity.

The Strategy envisages that by 2050 Western Australia will double its current population and will have a diverse range of interconnected and vibrant communities and regional centres that are healthy, resilient, active, prosperous, respectful of difference and participate in the public domaon.

The Strategy identifies the rapidly growing importance of the North-West sector (Kimberley and Pilbara regions) in national and global trade, investment and commerce. Specifically, the Strategy states:

"Harmony must be found between conservation of the northern sector's unique environment and its opportunities for economic development.

Mining, oil and gas enterprises will continue to support local supply chains. To ensure the continued strength and resilience of the northern sector it is important that regional centres have a local construction industry and higher education facilities that lead to enhanced employment opportunities.

A key challenge is to secure, attract and retain people and businesses not necessarily involved in the mining, oil and gas industries and to deliver a reasonable standard of social services."

LSP 3 will provide additional housing to accommodate workers attracted to the region for employment opportunities associated with resource industries, whilst also facilitating the development of a new local community with suitable services and facilities. LSP 3 also provides for the retention and celebration of the important aboriginal heritage features of the subject land.

3 LOCAL PLANNING FRAMEWORK

3.1 SHIRE OF BROOME LOCAL PLANNING SCHEME NO.6

The majority of the subject land is zoned "Development" under the Shire of Broome's Local Planning Scheme No.6 (LPS 6). The north-west portion of the LSP 3 area is reserved as "Environmental and Cultural Corridor Reserve", "Public Purposes – Water Supply" and "Parks, Recreation and Draiange". Lot 3130 within the south-west corner of the LSP area is zoned "Special Use" under LPS6. "Local Roads" reserves are also included on the western and southern boundaries of the LSP 3 area.

The land to the north and east is also zoned "Development" and forms a part of the Broome North DSP area. Gubinge Road abuts the subject land to the south and is reserved for "Highways & Major Roads".

The existing Fairway Drive & Sanctuary "Local Roads" reserves abut the south-western boundary of the LSP 3 area. The area to the south-west of LSP 3 (Sunset Park estate) is zoned "Residential", with R Codes ranging from R10-R50. The area to the west of LSP 3 is zoned "Tourist".

Clause 4.44.1(c) of LPS 6 states that, *"Development within the Development zone is to be in accordance with the adopted structure plan".*

LPS 6 outlines that the purpose and objectives of the Development Zone are as follows:

4.16.1 The purpose of the Development Zone is:

(a) to identify areas requiring comprehensive planning prior to subdivision and development; and

(b) to coordinate subdivision, land use and development in areas requiring comprehensive planning.

4.16.2 The objectives of the Development Zone are to:

(a) provide for a range of mixed land uses and subdivision in accordance with an adopted structure plan;

(b) enable the preservation and management of areas of cultural and environmental significance;

(c) provide for the coordinated provision of infrastructure, facilities and developable land through relevant structure plans and associated development contribution plans.

Schedule 4 – Special Use Zones of LPS 6 identifies Lot 3130 Sanctuary Road as having a Caravan Park as a Special Use, with development conditions subject as determined by Council.



3.2 BROOME NORTH DISTRICT STRUCTURE PLAN

The Broome North DSP was endorsed by the Shire and WAPC in 2010 and puts in place the strategic services and infrastructure framework to guide future development. Two Local Structure Plans (1 & 2) have been prepared for the initial stages of development of the DSP area. The DSP adopts a transect-based approach to planning for new development, with different transects characterised by varying residential densities and landscape forms. The zones depicted in the DSP form the basis for the zones identified on LSP 3. The objectives for each zone are outlined in Part 1, Section 6.3 and Part 2, Section 1.2 of the DSP.

Amendment 1 to the DSP was endorsed by the WAPC on 7 August 2014. The purpose of this amendment was to accommodate the realignment of Fairway Drive and associated movement network modifications.

Amendment 2 to the DSP was endorsed by the WAPC on 8 September 2022. The purpose of the amendment was to provide for a District Centre in the southern portion of the DSP area south of Tanami Drive.

Figure 2 outlines the DSP zoning applicable to the LSP 3 area.



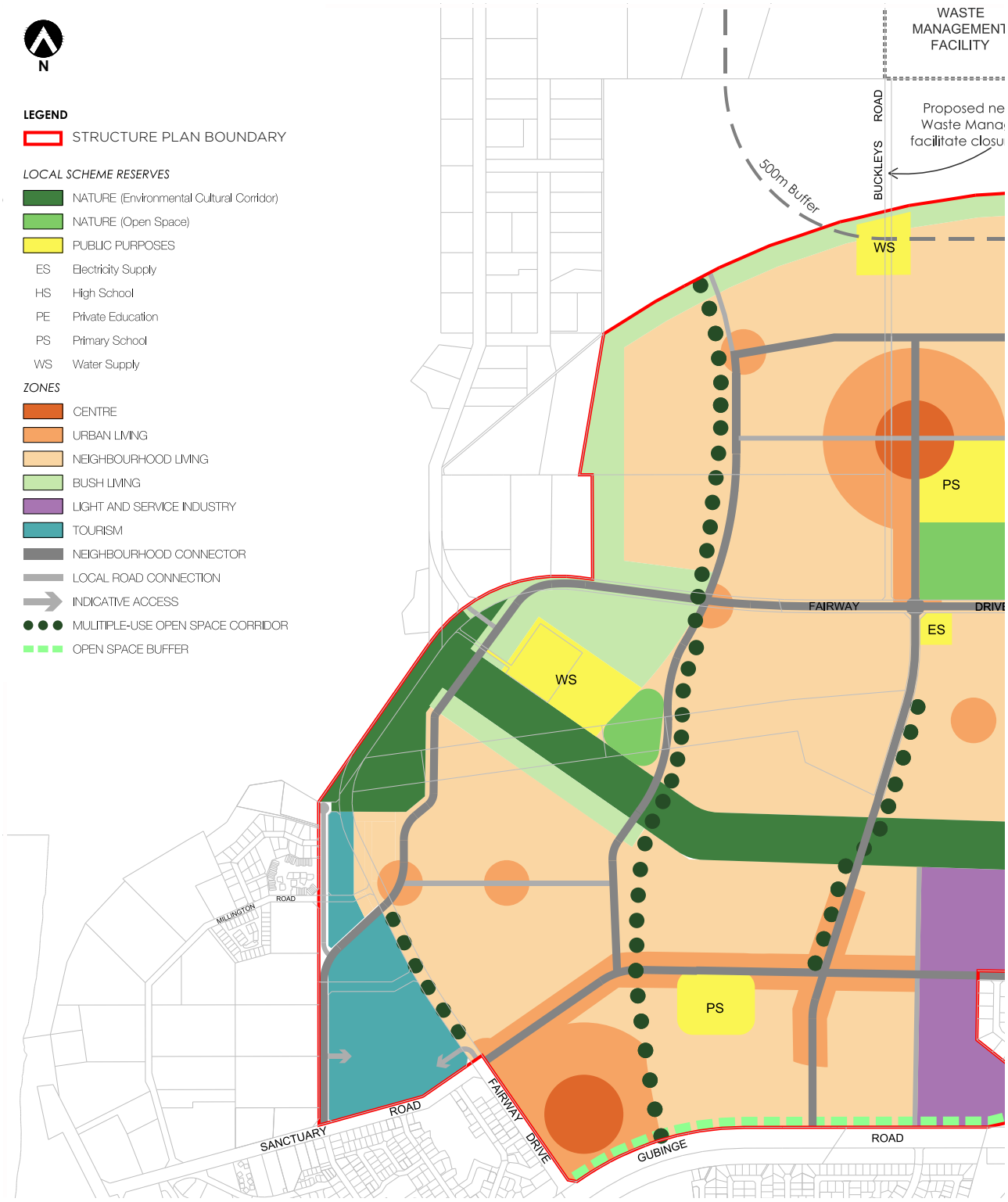


FIGURE 2: BROOME NORTH DISTRICT STRUCTURE PLAN EXTRACT

3.3 REPORT OF THE BROOME PLANNING STEERING COMMITTEE

The Broome Planning Steering Committee (BPSC) prepared and issued a report in 2005 to address planning issues facing Broome and to develop strategies to manage growth over the subsequent 10 to 15 year period. The BPSC report identified land that might be available to accommodate housing, tourism, commercial and industrial uses, whilst also maintaining important and unique cultural, natural resource and lifestyle elements that contribute to Broome being a highly desired destination and place to live.

The BPSC developed a land use framework to accommodate the needs of the Broome community, whilst protecting important cultural areas and maintaining a strong open space network. In this way, the BPSC report served as an interim local planning strategy, prior to the preparation of a formal document.

The BPSC report notes that "residential land demand will be met over the next five years through remaining areas of Roebuck Estate and Sunset Rise, together with lot release in the approved Herbert Street development and the planned release of Cable Beach 5B/5C residential neighbourhoods. Beyond the next five years, the community's needs will be met through the Cable Beach 5D/5E residential neighbourhoods, the area to the west of Roebuck Estate, sections of lot 833 (now Lots 3150, 3128, 3129, & 3130), the area north of Fairway Drive and eventually through the relocation of the Broome airport."

The Roebuck Estate, Sunset Rise and LandCorp's Januburu Estate do not have sufficient capacity to accommodate residential demand, making it necessary to progress the planning for Broome North as to provide additional residential facilities.

In reference to the Broome North DSP area (formerly Lot 833), the BPSC report identifies the following items to be provided in the development of land:

- 100m environmental cultural corridor;
- New high school;
- District retail centre;
- Mixed use area; and
- Aboriginal needs housing.

LSP 3 includes the provision of Environmental and Cultural Corridor Reserves and includes land owned by the Yawuru Native Title Holders Aboriginal Corporation which will be developed for housing. The high school, retail and mixed use facilities were identified in the Broome North DSP and have been provide for in LSPs 1 & 2.



3.4 LOCAL PLANNING STRATEGY

The Shire of Broome has prepared a Local Planning Strategy (LPS) to set out the long term planning directions for the Shire, apply State and regional planning policies, and provide the rationale for the zones and other provisions in LPS6.

The subject land is categorised as "Future Development Area" and "Environmental Cultural Corridor" in the LPS. Section 3.3.1.12 – Precinct 12 (Broome North) of LPS outlines the following objective and guidelines for the subject land:

"Objective:

Establish Precinct 12 as a low/medium density residential precinct and provide for the expansion of Blue Haze light and service industrial estate in the south-east.

Guidelines:

- *Zone Future Development Area 1 appropriately under the Local Planning Scheme to facilitate future development of residential and light and service industrial uses.*
- *An Environmental Cultural Corridor of a minimam depth of 150 metres shall be provided to link the proposed A-class reserve adjacent to the dunal system in the west to the mangroves of Roebuck Bay.*



3.5 LOCAL HOUSING STRATEGY

The Shire of Broome Local Housing Strategy (LHS), prepared in 2009, outlines that the provision of a ready supply of housing lots in Broome is essential to meet existing and continuing strong demand for housing. The strategy indicates that the town currently faces a number of key challenges including:

- Reduced housing affordability and a imbalance between demand and supply due to insufficient land release as a result of development constraints (environmental, infrastructure etc) and an inability of the government to provide sufficient public housing;
- High cost of housing and land development;
- Increasing difference between the type of housing stock and the type of housing in demand, given demographic changes;
- Shortage of suitable accommodation and high rents are affecting the ability of businesses to attract and retain staff;
- Protecting heritage areas while taking up opportunities for infill and mixed use;
- Resolving housing design for aesthetics and response to climate, especially for medium density developments; and
- Reinforcing sustainability outcomes, with appropriate variations for Broome's climate and character.

The LHS proposes to meet the demand for land/housing over the medium term via changes to the Shires' planning framework, with the identification of targeted areas for both new and infill development.

A number of the LHS' key elements that are relevant to Broome North include the following:

- Formulation of a lot layout to enable building orientation to respond to Broome's climate;
- Facilitation of regional variations to the R-Codes that recognise local climatic conditions;
- Provision of easily accessible pedestrian and cycle networks for all residents;
- Provision of suitable lot sizes for a mixture of housing product needs that match demand;
- Provision of a minimum of 30% social and community housing in new developments; and
- Provision of affordable, low cost temporary employee accommodation.





3.6 LOCAL COMMERCIAL STRATEGY

The Shire of Broome Local Commercial Strategy (Strategy) was prepared in October 2017 and reinforces Broome's role as a strategic centre for the Kimberley and the importance of economic and population growth to maintain and expand this role. The Strategy provides the following recommended strategic objectives for commercial land in Broome:

- Establish a sustainable mix, distribution and scale of additional retail and commercial uses to accommodate the projected floorspace demand to 2031 and 2051, whilst being mindful of the long-term uncertainty;
- Maintain the integrity of 'Chinatown – Town Centre' as the primary commercial centre for Broome;
- Identify modifications required to the established planning framework to deliver the recommendations of the Strategy.

The Strategy concludes that the Broome North and wider catchment area, can support one District Centre and one Local Centre. The Strategy also provides guidance regarding the design principles to be considered for local and district centres.

Of relevance to the LSP 3 area, the Strategy requires District Centres to ensure:

- Centres are highly accessible.
- Centres do not have adverse impacts on adjoining residential areas.
- Ensure a mix of commercial and residential development.
- Provides for activity and accessibility at the street level.
- Supports the provision of public transport and pedestrian links.
- Provide for a wide range of different types of residential accommodation, including high density residential, to meet the diverse needs of the community.

Similarly, the Strategy requires Local Centres to ensure:

- Easily accessible to immediate neighbourhoods.
- Centres do not have adverse impacts on adjoining residential areas.
- Encourage high quality, pedestrian friendly, street orientated development.
- Provide a focus for medium density housing.
- Design and landscaping of development provide a high standard of safety, convenience and amenity.
- Design contributes towards a sense of place and community.

LSP 3 has been prepared in accordance with the Shire's requirements as documented in the Local Commercial Strategy.

3.7 LOCAL PLANNING POLICY 8.1 (LPP 8.1) – PROVISION & DEVELOPMENT OF OPEN SPACE RESERVES MANAGED BY THE SHIRE OF BROOME

LPP 8.1 seeks to ensure that a variety of open space reserves are provided to serve the community's recreational and environmental needs in an economically, socially and environmentally sustainable manner. The policy also provides guidance to a) applicants regarding matters to be considered by the Shire when evaluating landscape development proposals for public open space and b) the Shire in prioritising the development of public open space with appropriate landscaping according to specific criteria.

Of relevance to the LSP 3 area, LPP 8.1 requires the following:

- Provision of Local Parks (minimum 2000m^2, maximum 3000m^2) within 300m of all residential lots; and
- Provision of Neighbourhood Parks (minimum 5000m^2), located towards the edge of neighbourhoods and within 400m of most residential lots.

LPP 8.1 also encourages stormwater drainage to be controlled where possible through the use of swales and depressions. POS may be used for the management of stormwater in accordance with LN, where it is part of an overall drainage management system providing temporary detention during storm events.

LPP 8.1 states that it is desirable to have public streets on all sides of POS areas, however where this is not possible, private lots shall be developed to address abutting POS areas with visually permeable fencing to facilitate passive surveillance of the area.

LSP 3 has been prepared in accordance with the Shire's requirements as documented in LPP 8.1. The provision of POS is documented in section 5.4.5. Detailed landscape drawings will be prepared and submitted to the Shire at the subdivision clearance stage in accordance with LPP 8.1.



4 OPPORTUNITIES & CONSTRAINTS ANALYSIS

An Opportunities and Constraints Analysis exercise was undertaken in August 2013 in preparation for the first Technical Advisory Group (TAG) meeting on 22 August 2013. The TAG consisted of representatives of the Shire of Broome, Department of Planning, LandCorp and the Broome North project team. The TAG process sought to bring the key relevant stakeholders together to identify and discuss the relevant planning and development considerations applicable to the site in order to inform the design formulation process. The TAG subsequently acted as a 'sounding board' for the preliminary concept plans for the LSP 3 area.

The Opportunities and Constraints Analysis undertaken is documented on **Figure 3** and serves as a summary of the relevant considerations at that point in time. Following its preparation, items such as the extent of the LSP, the alignment of key roads and land use distributions have been investigated and modified where necessary.

OPPORTUNITY AND CONSTRAINTS ANALYSIS PLAN DESCRIPTIONS

LANDUSE

- L1 Provide diverse lifestyle opportunities and living typologies
- L2 Locate increased housing density in locations of high amenity
- L3 Consolidate open space and drainage links for efficient land use and functionality
- L4 Leverage from proximity to desirable Cable Beach precinct
- L5 Consider including development areas into Structure Plan extent to consolidate and integrate development
- L6 Consider appropriate interface with all adjoining boundaries - LDP 1 and 2 development, and Yawuru.
- L7 Interface considerations to proposed Shire Caravan Park

BUILT FORM

- B1 Opportunity for diverse building typologies via introduced amenity and assorted densities in key landmark locations
- B2 Provide unique estate interface to prestigious Sunset Park with large homestead lots with botanical edge
- B3 Resort themed architecture flanking botanical open space linkage at estate main entry
- B4 Cardinal street orientation will aid excellence in building orientation and sustainability outcomes
- B5 Building interfaces with adjoining open space areas must be controlled to achieve appropriate character setting

ENVIRONMENTAL | LANDSCAPE | OPEN SPACE

- E1 Promote key open space linkages throughout site integrating ECC into core amenity.
- E2 Opportunity for a major botanical central park maximising accessibility, functionality and exposure
- E3 Investigate linear open space promenade to maximise outdoor activity and health benefits to residents
- E4 Botanical character opportunities investigate opportunities for potential flora retention in Central park
- E5 Orientation and location of open space shall respect natural topography to also maximise drainage conveyance
- E6 Flora and Fauna analysis required

INFRASTRUCTURE

- IN1 Consolidated drainage design and opportunities to utilise generous adjoining road reserve widths for required swales
- IN2 Natural drainage flow paths are consistent with desirable street orientation
- IN3 Opportunity to collaborate with Yawuru development to obtain good development interface outcomes eg. drainage
- IN4 Limited drainage detention (on-site) at Sunset Park
- IN5 Swale widths (potentially 30m) - Investigate ability to be co- located within generous road reserves for land efficiencies (investigate location if Fairway Drive realigned)
- IN6 Investigate implications of major service alignments if Fairway Drive realigned

MOVEMENT

- M1 Investigate potential for realignment of Neighbourhood Connector to consolidate and integrate the internal area of the estate
- M2 Consider the final alignment of this road connection and intersection location with realigned Fairway Drive
- M3 Public transport bus route opportunities for neighbourhood connectors in Estate
- M4 Promote pedestrian activity via key linkages integrating open space with unique streetscape routes
- M5 Investigate meandering Tanami Drive extension for benefits of character and traffic management
- M6 Traffic considerations with adjoining development of LDP 1 and 2, Fairway Drive and Millington Road
- M7 Investigate ultimate alignment of Fairway Drive and detailed implications

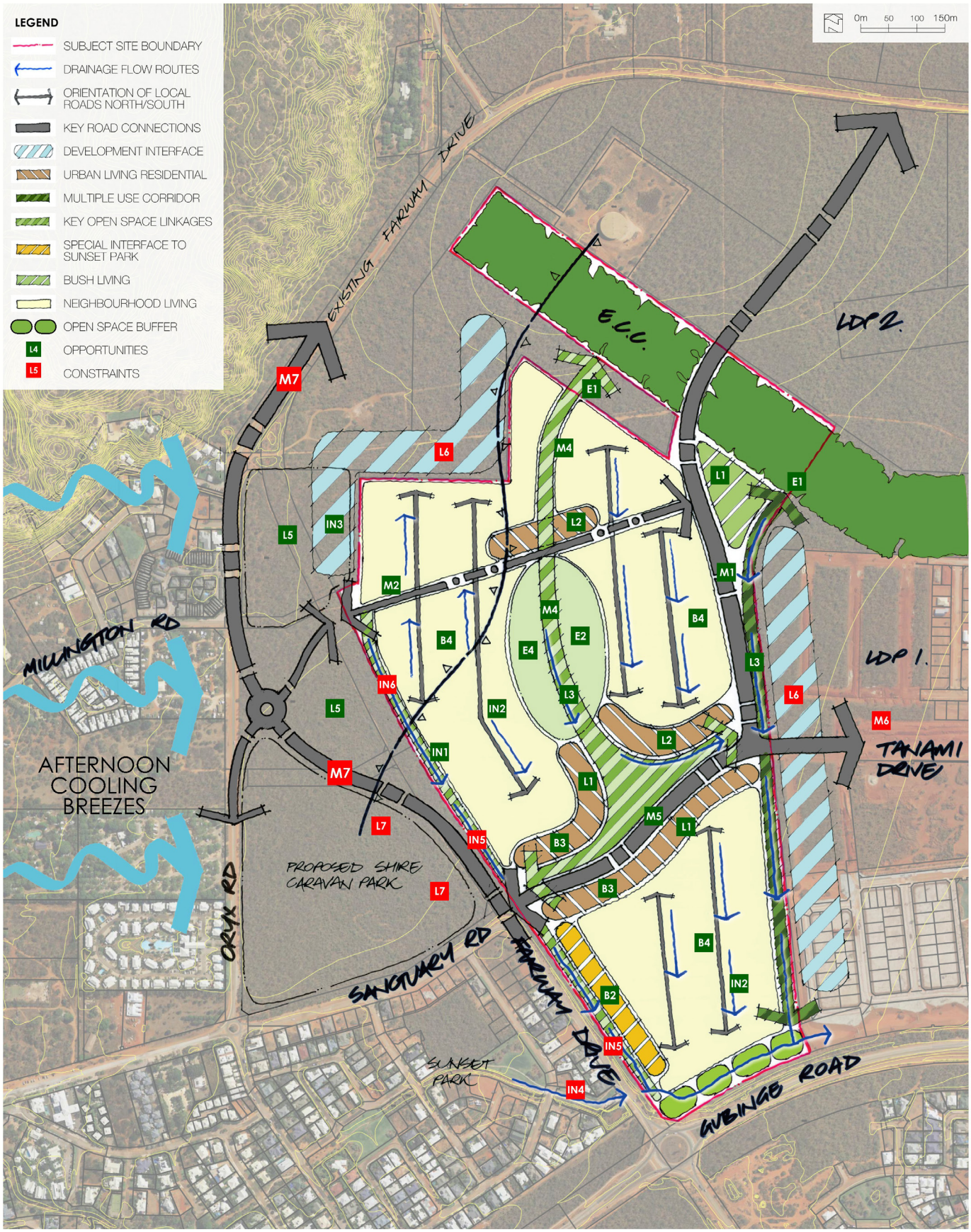


FIGURE 3: OPPORTUNITIES AND CONSTRAINTS ANALYSIS

5 NEIGHBOURHOOD DESIGN

5.1 LOCAL STRUCTURE PLAN NO. 3 (LSP 3) SUMMARY

The key elements of proposed LSP 3 for Broome North are as follows:

- Provision of a variety of residential densities, enabling the construction of a diverse range of housing types to accommodate different housing demands;
- Retention of existing culturally significant bushland;
- Provision of a low density residential interface between areas of retained bushland and new residential areas;
- Integration of the surrounding existing natural environment into the development area with linear open space and green spine connections;
- Provision of attractive, safe and convenient pedestrian and cyclist connections and informal active recreation spaces throughout;
- Provision of significant areas of land to accommodate new tourism accommodation uses to meet future demand; and
- Requirement for building setbacks that respond to the local climate (i.e. allowance for cross-breezes).

In addition to the LSP Plans 1 and 2 included within Part 1 – Statutory Section of this report, a Masterplan (refer **Figure 4**) has been prepared to provide an illustration of the development intent. This graphical representation is indicative only; however, it gives an indication of how the public spaces may be developed and the relationship of the public/private interface between the public spaces and new residential areas. A summary of the key elements of LSP 3 are outlined in **Table 3** below.

TABLE 3: SUMMARY TABLE

Total LSP 3 Area	**130.5 ha**
Total Residential Land	*47.8 ha*
Residenital R2-R10	5.6 ha
Residential R12.5-R25	35.7 ha
Residential R25-R40	6.5 ha
Total Tourist Land	*20.9 ha*
Total Open Space Land	*34.0 ha*
Environmental and Cultural Corridor Reserve	22.2 ha
Multiple Use Corridor, Open Space & Drainage	11.8 ha
Overall Dwelling Yield	*857*
Estimated approximate population (assuming 2.7 persons per dwelling)	*2300*

MASTERPLAN NOTES

1. **Homestead Retreat**: large vegetated Bush Living properties with an outlook to the ECC.
2. **Central Park**: a major botanical park, incorporating drainage with active and passive recreation, which is easily accessible and fills the daily life of the estate's residents.
3. **The Parkway**: a long, continuous route for pedestrians, cyclists and drivers along a series of open space experiences from the ECC to Fairway Drive.
4. **Tanami Drive extension**: with a curved alignment to open up vistas into Central Park, which are framed by villas and cottages, and enabling the wide northern verge to be integrated and maintained as part of Central Park.
5. **Eastern parkland**: a consolidated MUC that builds on the existing formal parks in the neighbouring development area.
6. **The Resort Welcome**: 'Club'-style villas and apartments in a botanical parkscape setting that frames the estate's western gateway, tying into the abutting tourism precinct and emphasising the proximity to Cable Beach.
7. **The Promenade**: a double row of closely-spaced trees with a central, wide shared path for pedestrians and cyclist amenity and accessibility.
8. **Pearlers Row**: 'quarter-acre' properties that encapsulate the grand Broome residence in a botanical garden setting.
9. **Tourism**: New tourism facilities in keeping with the existing Cable Beach character.



FIGURE 4: MASTERPLAN

5.2 LAND USE

5.2.1 RESIDENTIAL

A total of 47.8 ha is proposed to be developed for new residential development, which represents approximately 36% of the total LSP 3 area. The proposed residential land uses are identified in **Figure 5**.

RESIDENTIAL R2-R10

Low density (bush living) residential development, consisting of large lots (~2000m^2), is proposed at the northern edge of the residential development area within LSP 3. These large lots will enable the provision of a suitable interface between the culturally sensitive bushland to the north and the proposed residential development further to the south.

These lots will feature an area of retained vegetation at the front of each lot, with the dwelling to be setback a minimum of 18m and maximum of 20m. A cleared area on one side of the lot will facilitate vehicle access from the Primary Street to the dwelling. These driveway areas will be paired where possible, to facilitate consolidated vegetation retention at the front of the lots.

The proposed development control requirements for these lots incorporate the necessary fire management requirements (due to their BAL 12.5 rating), whilst simultaneously achieving the Yawaru people's desire for a suitable natural interface to the majority of the estate.

RESIDENTIAL R12.5-R25

The vast majority of new residential land in the LSP 3 area will be developed as Residential R12.5-R25 lots. Final lot sizes will be determined during the detailed subdivision design phase, but may vary in size from approximately 400m^2 to 800m^2. These lots will predominantly accommodate single dwellings; however grouped dwelling development may occur. A nil side setback will be permitted to one boundary for these lots, with opposite side (3m) and rear (5m) boundary setbacks providing for cross breeze ventilation.

RESIDENTIAL R25-R40

Discrete areas of the LSP 3 area have been identified as Residential R25-R40 lots. These areas will be developed to accommodate a mixture of small single residential dwellings and grouped and multiple dwellings. These areas are generally proposed in locations that capitalise on open space amenity. The inclusion of these lots within the LSP 3 area provides the opportunity for the delivery of greater dwelling diversity, which have positive social (i.e. 'aging in place' potential) and financial (i.e. affordability) benefits.

YIELD

The proposed residential yield for the LSP 3 area is documented in **Table 4** below. The yield figures have been calculated using the average lot sizes listed in the table and are preliminary at this stage. Final yields will be determined during the detailed subdivision design process. In undertaking the calculations, it has been assumed that discrete portions of the Residential R12.5-R25 areas will be developed for larger lots to provide product diversity across the LSP 3 area. LSP 3 has a nett residential density of approximately 17 dwellings per hectare.

TABLE 4: YIELD SUMMARY

Residential Typology	Total Dwellings
Residential R2-R10 – Ave 2000m^2	24
Residential R12.5-R25 – Ave 600m^2	461
Residential R12.5-R25 – Ave 1000m^2	21
Residential R25-R40 – Ave 220m^2	284
Total	**790**

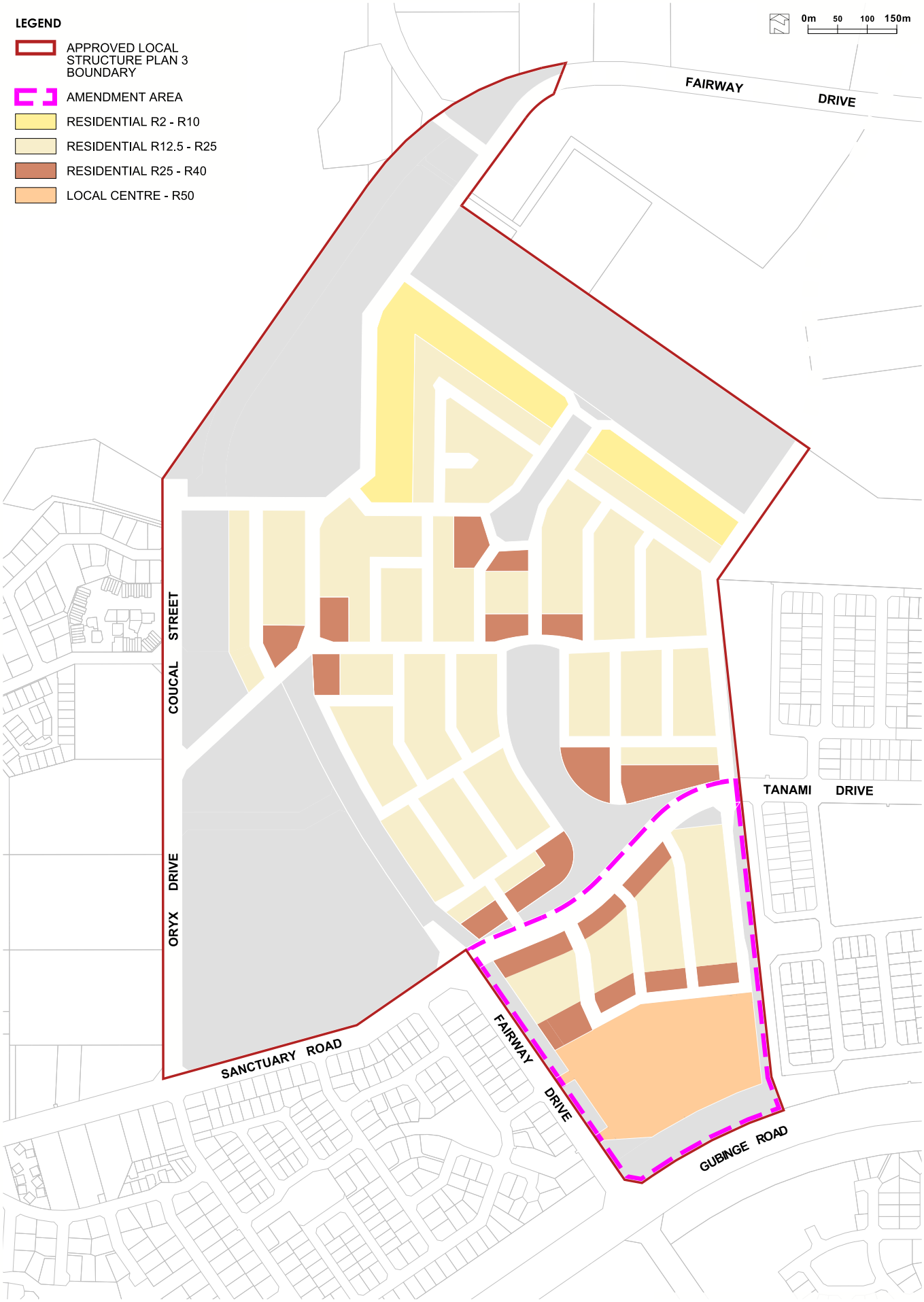


FIGURE 5: RESIDENTIAL DENSITIES



5.2.2 TOURIST

Two large tourist development sites are proposed on the western boundary of LSP 3. A total of 20.9 ha is proposed to be developed for tourist purposes, which represents approximately 16% of the total LSP 3 area. These sites form a logical extension of the tourism uses located to the west of Oryx Road/Coucal Street. The retention of portion of the existing Fairway Drive road reserve for drainage and landscape purposes serves to provide a suitable interface between the tourist and residential uses proposed within LSP 3.

A Local Development Plan (LDP) is to be prepared and approved by the Shire of Broome prior to the development of the areas zoned Tourist. The LDP(s) shall consider, amongst other items as determined by the Shire, matters relating to access, building orientation and interface with surrounding land uses.

The LDP(s) shall also specify that any areas of vegetation to be retained on site shall not be greater than 2,500m^2 and not located within 20m of proposed or existing dwellings for fire hazard risk mitigation purposes.



5.3 MOVEMENT NETWORK

A Traffic Report has been prepared by Riley Consulting to support LSP 3, which assesses traffic generation and distribution, road reserve requirements, intersection capacity and path and public transport needs. This report is included as **Appendix A**. A Traffic Report prepared by GHD dated 3 February 2022 is included as an addendum to Appendix A.

5.3.1 ROADS

The different types of proposed roads are illustrated on Plan 2 – Movement Network within Part 1. The standards and requirements associated with each type of road in the hierarchy are outlined within Table A of Part 1. A brief summary of each of the road types is provided below.

INTEGRATOR ARTERIAL B

LSP 3 proposes the extension of Tanami Drive and Sanctuary Road to provide a continuous thoroughfare. This will be the major east-west road in the area. The link is proposed with a 40m wide reserve, in line with previous planning for the locality.

NEIGHBOURHOOD CONNECTOR

Two north-south Neighbourhood Connectors are identified on LSP 3, in accordance with the approved DSP planning framework. Both roads will link to the east-west portion of Fairway Drive to the north of the LSP 3 area. The westernmost Neighbourhood Connector will follow the existing alignment of Orxy Drive, before diverting east to run alongside the edge of the existing A-Class reserve. An additional Neighbourhood Connector is identified on LSP3 and will provide a main entry to the estate north of Tanami Drive.

MAIN STREET

LSP3 proposes the introduction of a Main Street-based District Centre, in the location adjacent to the intersection of Fairway Drive and Gubinge Road. It seeks to facilitate small-scale mixed use development and street-edge land use activity and accessibility on each side of the street.

MAJOR ACCESS STREETS

Major access streets have been identified in specific locations where warranted by traffic demand, based on modelling undertaken by Riley Consulting. These roads will feature a slightly larger pavement width (i.e 7.4m rather than 6m).

An east-west major access street is proposed through the northern portion of LSP 3, which will link the two north-south Neighbourhood Connectors. Additional major access streets are proposed to accommodate internal traffic within the northern and southern portions of the LSP 3 area.

LOCAL ACCESS STREETS

The majority of new roads within the LSP 3 area will be local access streets, with 18m wide road reserves (consisting of a 6m pavement and two 6m wide verges). Pavement widths may be larger in some locations to accommodate overland drainage flow. These roads will be determined at the detailed design stage.

GREEN LINK STREETS

A number of special access streets are proposed across the LSP 3 area that feature a wide road reserve (i.e. 22m rather than 18m). These streets have specifically been identified to provide an amenity connection between the proposed POS areas and linear green spines throughout the LSP area. The green link street will feature a widened verge (10m) on one side, with a shared path situated between a double row of trees.

ROADS ABUTTING OPEN SPACE

Roads (of all types) that abut open space will feature a reduced road reserve width, given that a full verge width will not be required for servicing purposes. Reduced roads reserves abutting open space will facilitate improved land use efficiency. All roads will be documented at the detailed design stage for approval by the Shire of Broome.

5.3.2 PATH NETWORK

A Path Network & Public Transport Plan (**Figure 6**) has been prepared to outline where higher order (i.e. shared) paths will be required across the LSP 3 area, based on an assessment of demand and likely movement patterns. Figure 6 identifies the indicative location of shared paths within open space areas and within proposed road reserves. The exact location and the provision of footpaths will be determined at the detailed design stage, to the satisfaction of the Shire of Broome. Provision should be made for new paths to connect to the existing path network in Fairway Drive to Sunset and Maritana Parks.

5.3.3 PUBLIC TRANSPORT

There is an existing private bus service within Broome that accesses Cable Beach, although the service is predominantly provided for tourists. Given the rural nature of Broome, it is unlikely that a full public transport service would be justified. However, planning for a bus service in the long term has been considered. Figure 6 identifies that the Tanami Drive/Sanctuary Road connection would be suitable to accommodate a future public transport service.

Local school bus services are to utilise major access streets.









FIGURE 6: PATHS AND PUBLIC TRANSPORT

5.4 PUBLIC OPEN SPACE

5.4.1 LANDSCAPE PHILOSOPHY

The landscape intent for the LSP 3 area is to provide a local, cultivated landscape aesthetic, using lawn, existing trees, local earthy materials and public art features. While this aesthetic draws from the more formalised gardens of the nearby resorts, the parklands maintain a strong local theme through the use of the local vernacular. Key aspects guiding the landscape design include the following:

- Maintaining connections and linkages through the site via Multiple Use Corridors (MUC) and Environmental and Cultural Corridor Reserves (ECC) for cultural, community and habitat purposes;
- Protecting and repairing natural systems so traditional practices and a continued 'lifestyle' can occur alongside urban development;
- Design to experience the coastal bushland location and the rich culture of the stunning Kimberley landscape;
- Bushfire management implementation via design;
- Minimal existing landform reshaping;
- Maximum existing vegetation retention and supplementation on site;
- Combining recreation, preservation, education/ interpretation and linking urban/natural drainage systems through Multiple Use corridors;
- The inclusion of interpretation and art opportunities within public open space as part of an overall open space strategy; and
- Incorporating site specific solutions (such as the provision of shade amenity through consistent street tree planting in medians and alongside roads and pedestrian connections).

Further detailed information regarding the landscape philosophy and specific design elements is included within **Appendix B** – **Landscape Report** (UDLA).



5.4.2 ENVIRONMENTAL AND CULTURAL CORRIDOR RESERVE

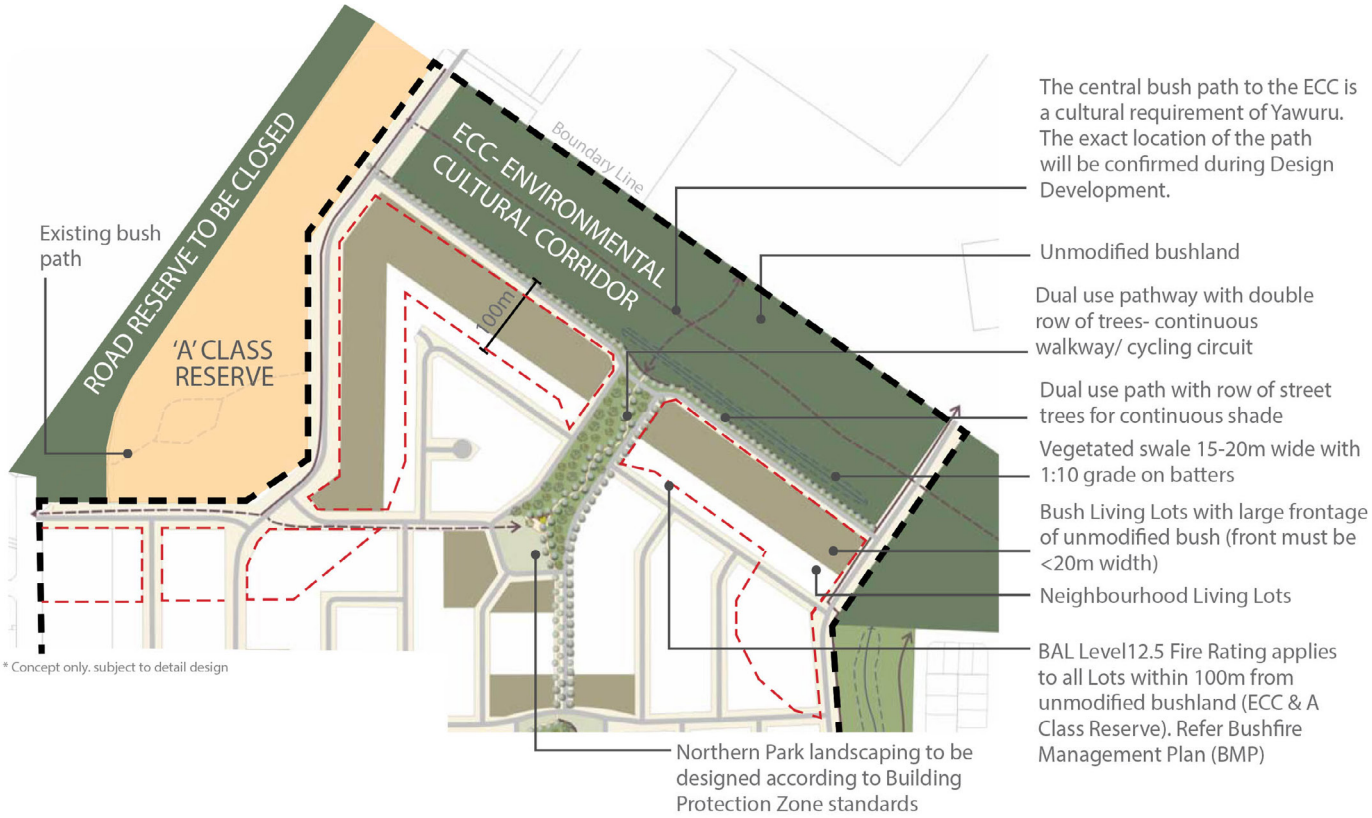
The 150m wide ECC running east-west across the site is an initiative used previously within developments in Broome and was born out of extensive consultation with the Yawuru people. It is essentially a tract of naturally vegetated land set aside to be retained without development.

The ECC will provide a buffer between residential development and significant cultural areas; a habitat for flora and fauna; an opportunity to support biodiversity and natural drainage networks; an important cultural connection with country; and contribute to the establishment of a strong sense of place as part of the new development.

The ECC will feature a simple network of low maintenance cleared pindan tracks to enable appropriate and managed access only. A rural-style perimeter fence around the ECC will also discourage trail bikes and vehicles from entering. Areas that have been degraded through earlier land uses and weed infestation shall be monitored and managed. Vegetated swales within the ECC will be designed in consultation with representatives from Yawuru.

A CLASS RESERVE

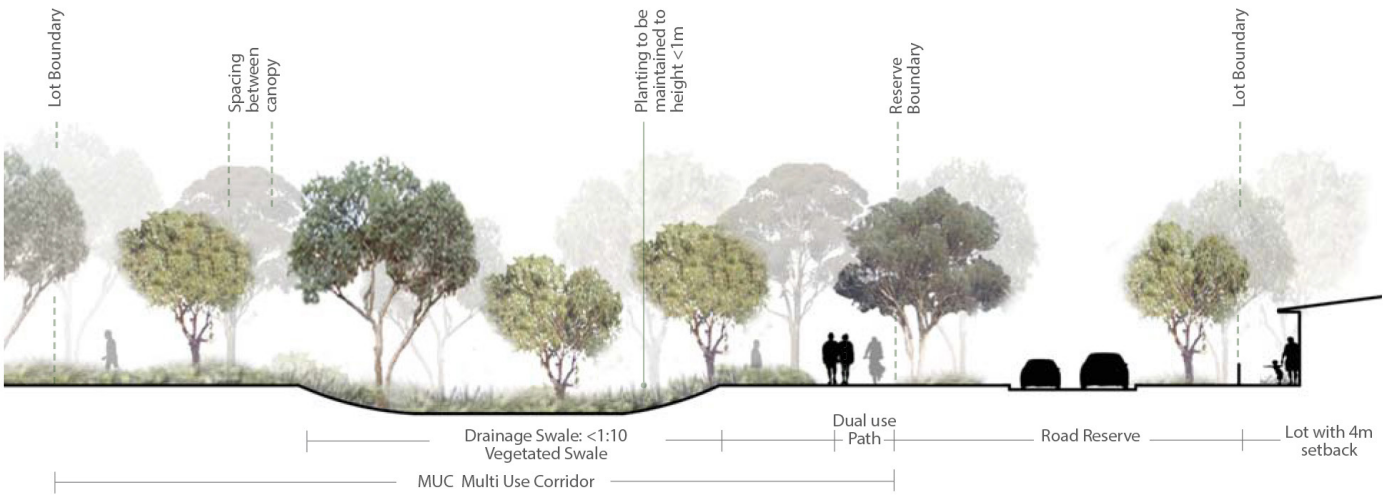
The existing A Class reserve (Lots 521 & 525) will be retained in LSP 3 and maintained in a natural vegetated state. A portion of the existing Fairway Drive road reserve will ultimately be closed and used for open space and/or drainage.



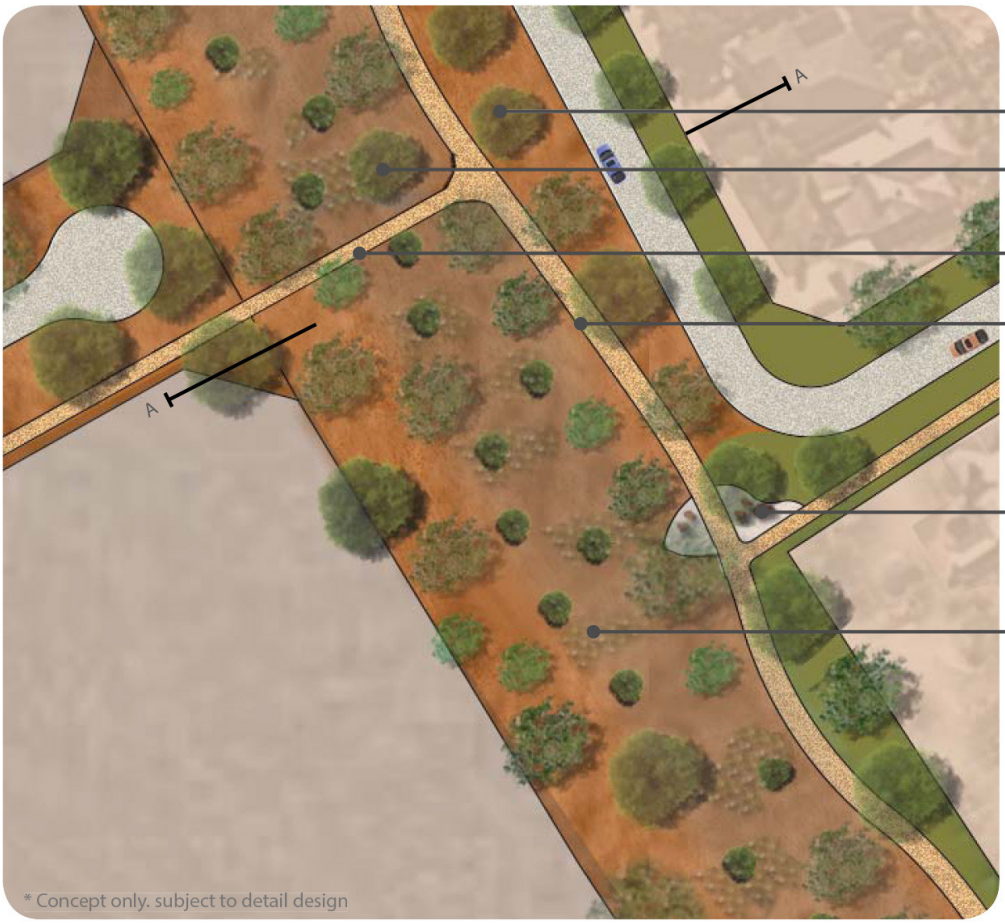
5.4.3 MULTIPLE USE CORRIDORS

The MUCs comprise a combination of retained existing vegetation, drainage swales, vegetated buffers and parks. They provide a number of functions including:

- An informal connection to 'country' (through the use of local planting, materials and linkages to the ECC);
- Urban drainage and flood management, including holistic management of upstream and downstream conveyance;
- Flora and fauna habitat and linkages;
- Passive and active open space with informal (grassed kick-about) areas and formally programmed, built play areas;
- Shared paths suitable for walking, jogging and cycling, with rest areas and water fountains; and
- Opportunities for cultural and environmental interpretation including intergenerational education and community art projects.



* Concept only. subject to detail design



Garden Bed with local shade trees and low vegetation

Retained tree

Connector path

Dual- use path

Gravel break- out area with informal boulder seating areas

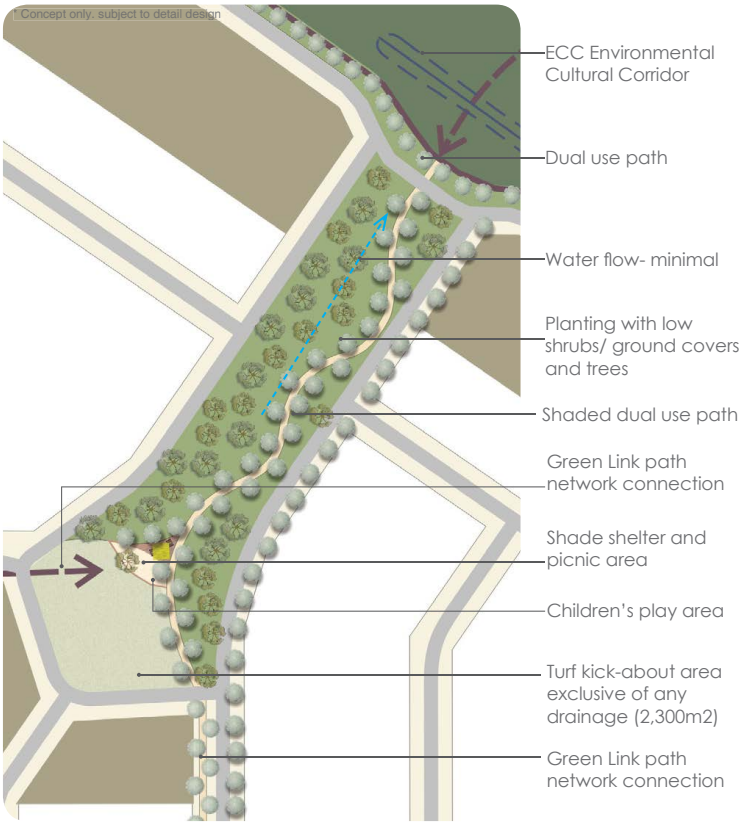
Vegetated swale- finger planting of trees and groundcover tubestock

5.4.4 NEIGHBOURHOOD & LOCAL PARKS

A number of new parks will be created as part of the development of the LSP 3 area. These parks will feature the following amenity:

- Formal play areas with play equipment, shade structures, seating and picnic facilities, resting places;
- Nature Play Areas;
- Grassed open space areas for active and passive recreation;
- Areas of retained mature existing vegetation (providing existing shade and visual amenity);
- Interesting topographical changes that form part of the larger drainage swale network and the landscaped areas;
- Landscapes incorporating local sandstone boulders and boulder formations;
- Strong path networks that link to the immediate community and beyond via the connected MUCs and ECC;
- Exercise, walking, dog walking, running and cycling networks;
- Pindan paths that connect to grasses areas and the larger path network;
- Hard-stand areas which use local aggregates, with further rest areas consisting of local gravels and/or compacted, stabilised pindan;
- Local species and 'bushtucker' planting;
- Opportunities for lawn irrigation hydro-zoning according to active and passive uses; and
- Interpretation and art opportunities as developed with the Traditional Owners, in line with the proposed art and strategy.

LOCAL PARK



Northern Park | Plan I Scale 1:1000 @ A1

NEIGHBOURHOOD PARK



Shaded dual use path meanders through the POS

Active play/lawn area adjacent to drainage area (2,000m2)

Parallel on road parking

Pedestrian walkway bridge over the swales connect two sides of the POS and provide access. The swale batter is edged with a low, dry stone wall

Interactive play includes a lookout to the bush and public art work as an entry feature and play element

Play elements meander through areas of retained bush. Picnic area set on the top of the swale allowing views over the open, vegetated swale

Lawn and kick-about area (free of drainage) adjacent to swale (4,400m2)

Shaded Dual-Use path

Opportunity to install Art Work to create points of interest along the entry road; Tanami Drive

Low shrubs/ ground cover planting under, trees and existing trees

Low planting established to the base, views through the park. Swale batters minimum 1:4 to 1:6

Path network links spaces within the estate and intersects with the Green Link

Shade Shelter and Picnic Area

Urban Living Lots

Turf kick-about area

Low vegetation to swale. Batters 1:40 Allows views through park

Dual use path

Lawn extends to edge

Double row trees to dual use path provides a continuous walking and cycling circuit

Central Park | Plan I Scale 1:1000 @ A1

5.4.5 POS PROVISION

A variety of Public Open Space areas are proposed across the LSP 3 areas, which will serve a combination of recreation, amenity, drainage, conservation and cultural functions. The provision of open space and its crediting is outlined in **Table 5** below.

TABLE 5: PUBLIC OPEN SPACE SCHEDULE

	ha	ha
Gross Site Area		**131.2762**
Deductions		
D1 - Tourist	20.9471	
D2 - Existing A-Class Reserve	8.3787	
D3 - Fairway Dr Closure	3.7673	
D4 - Lot 3127	0.3784	
D5 - Water Supply Infrastructure	0.0764	
D6 - Environmental and Cultural Corridor Reserve	10.2615	
D7 - Existing Oryx Dr Road Reserve	1.3350	
D8 - Existing Coucal St Road Reserve	1.7226	
D9 - Retained Fairway Dr Reserve Multiple Use Corridor	1.9995	
D10 - Additional Road Reserve (Non-Residential)	1.0242	
D11 - Local Centre	6.8208	
D12 - Drainage Land (1:1 ARI)	2.3175	
Total Deductions	**58.0468**	
Gross Subdivisible Area		**73.2294**
Required Public Open Space (10%)		**7.3229**
PUBLIC OPEN SPACE PROVISION		
Unrestricted Open Space (minus 1 in 5 year, inclusive of 1 in 1 year)		
A - Public Open Space (not impacted by drainage)	0.0907	0.0907
B - Public Open Space (1 in 5 = 0.455ha)	1.1145	0.6595
C - Public Open Space (not impacted by drainage)	0.0761	0.0761
D - Public Open Space (1 in 5 = 1.5715ha)	4.1032	2.5317
E - Public Open Space (not impacted by drainage)	0.1194	0.1194
F - Public Open Space (not impacted by drainage)	0.0527	0.0527
G - Public Open Space (1 in 5 = 0.2346ha)	0.2456	0.0110
H - Public Open Space (1 in 5 = 0.3475ha)	0.7724	0.4249
I - Mulitple Use Corridor (not impacted by drainage)	0.1047	0.1047
J - Mulitple Use Corridor (1 in 5 = 0.1675ha)	1.0285	0.0000
K - Mulitple Use Corridor (1 in 5 = 0.5404ha)	0.5658	0.0254
L - Mulitple Use Corridor (1 in 5 = 1.632ha)	1.7127	0.0807
Total Unrestricted POS		4.1767
Restricted Open Space		
Total Restricted POS		**2.4740**
Total Public Open Space Provision		**6.6507**
Percentage of Public Open Space Provided		**9.1%**

Note: Active grassed areas not affected by 1:1 ARI and 1:5 ARI.

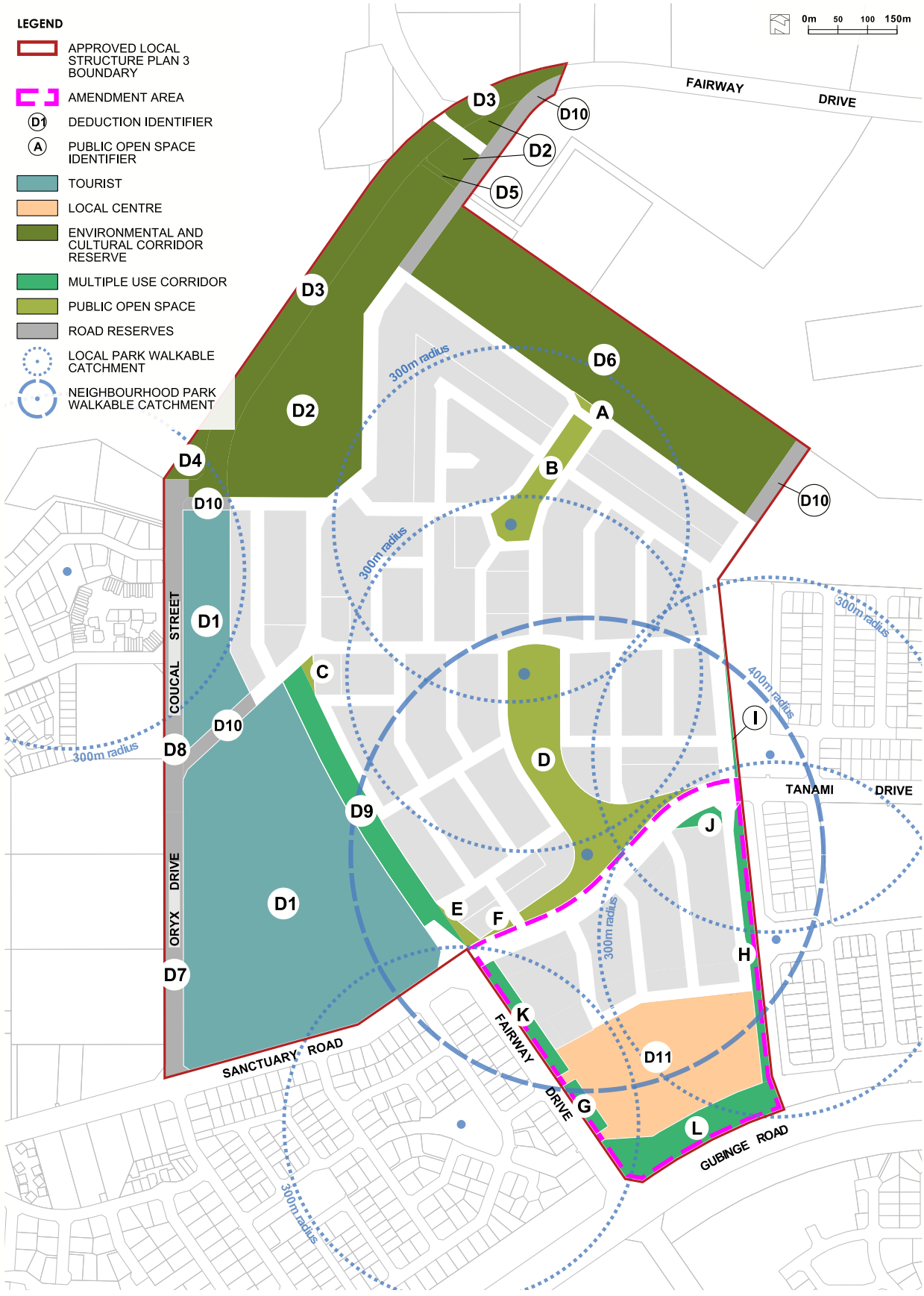


FIGURE 7: PUBLIC OPEN SPACE

5.5 BUSHFIRE MANAGEMENT

A Fire Management Plan (BMP) has been prepared by Fire Plan WA and is included within **Appendix C**. The FMP has been prepared in accordance with the acceptable solutions detailed in Appendix 2 of Planning for Bush Fire Protection Guidelines (Edition 2, 2010) and outlines specific mitigation and management measures required to reduce the identified bush fire hazard risk.

The Bush Fire Hazard Assessment documented in the FMP identifies a "Moderate" risk in the Pindan Woodland area, however the majority of the LSP 3 area will be cleared (with the exception of some vegetation in POS areas, the ECC and A Class reserve, portions of the Residential R2-R10 lots and possibly portions of the tourist sites).

A permanent Bushfire Attack Level (BAL) of 12.5 has been identified for lots within 100m of the ECC and A Class reserve at the northern edge of the site. A temporary (refer below) BAL of 12.5 has been identified for lots within 100m of the proposed tourist sites on the western boundary of the LSP 3 area. Dwellings within the areas the subject of the BAL 12.5 rating will need to be constructed in accordance with AS 3959-2009. All dwellings within the 100m distance will require a Section 70A 'Notification' on each new Certificate of Title to alert purchasers of land and successors in Title of the existence of the FMP and the requirement to construct habitable buildings in accordance with AS 3959-2009.

The temporary BAL 12.5 rating for proposed lots within 100m of the tourist sites is required whilst existing vegetation remains on site. If the nearby residential areas are developed prior to the development and clearing of the tourism sites, then a bushfire risk would exist that necessitates mitigation (notwithstanding the potential for the risk to be short-term in nature until the development and clearing of the tourism sites).

If, however, the tourist sites are cleared and developed in accordance with an approved LDP that limits the extent of vegetation retention for fire management purposes, then the requirement to build to a higher construction standard would no longer exist. As such, the higher AS 3959-2009 construction standard would not apply and the requirement for a notification on title (implemented through the subdivision process) would not be needed. The need for a notification on title is to be considered at the subdivision stage, taking into consideration the status of development of the adjacent tourist sites.

A Bushfire Management Plan has been prepared by Bushfire Prone Planning in April 2022, and is included as an Addendum to **Appendix C**. The Bushfire Management Plan outlines management requirements, including the management of residential lots to a low bushfire threat state as per the Shire of Broome Fire Break & Fuel Hazard Reduction Notice. It is also expected that the Local Centre lot will be managed and maintained to a low bushfire threat state.

Landscape design and management of the stormwater swale within the Local Centre, to a low bushfire threat state, will be established and agreed with the Shire of Broome. Similarly, the small triangular area of POS which abuts residential lots near the north-eastern corner of the proposed development is expected to be managed and maintained to a low bushfire threat state. The landscaping design and management of this area is to be established by consultation and agreement with the Shire of Broome.



5.6 LOCAL WATER MANAGEMENT

A key feature of the development of the Broome North area to date has been the incorporation of linear swale detention drainage within the landscape, with the intention of creating linear multi-use corridors for active and passive recreation whilst activating the water sensitive urban design treatment train high in the catchment. The LSP 3 area continues the linear swale drainage elements, with further linkages to the ECC, which provides an important east west linkage across the Broome Peninsula from Cable Beach through to Dampier Creek and Roebuck Bay, and connection with the LSP 1 open space elements.

The key principles of integrated urban water management for LSP 3 are as follows:

- Minimise total water use in the development area;
- Protect infrastructure and assets from inundation and flooding;
- Manage groundwater levels to protect infrastructure and assets; and
- Protect environmental values of receiving water bodies.

A comprehensive Local Water Management Strategy (LWMS) has been prepared by GHD to support the development of the LSP 3 area and is included within **Appendix D.**

5.6.1 POTENTIAL WATER SOURCES

Review of the Broome Groundwater Management Plan supported the expansion of the town water supply borefield in a northerly direction to meet future potable water demand for Broome townsite. This is the preferred water source for the LSP 3 area since there is sufficient sustainable yield to provide for the development with substantial existing infrastructure in place.

5.6.2 WATER CONSERVATION & EFFICIENCY

The LWMS seeks to achieve the sustainable management of all aspects of the water cycle within the development and achieve efficient use of potable water. The specific objectives for integrated urban water management for the development are as follows:

- Potable water use outside of buildings should be limited and as efficient as possible;
- Encourage the installation of 5 Star Plus provisions for all new fittings;
- Encourage the planting of native gardens;
- Use of endemic species within the development that require a local climate based low water-use and nutrient use regime; and
- Minimising water use in public open space through use of low water use landscaping treatments and retention of native vegetation where possible.

5.6.3 MANAGING WASTEWATER

Wastewater in Broome is collected via a traditional gravity sewer and transferred to the wastewater treatment plant owned and operated by the Water Corporation. Expansion of the existing gravity system to include the Broome North LSP3 area will be required.

Collected wastewater will be transferred to the new Water Corporation wastewater treatment plant (WWTP) constructed to the north east of the town at Crab Creek. The wastewater will be treated at this WWTP and treated wastewater will be managed by irrigating Rhodes Grass adjacent to the new WWTP. Water Corporation plans to undertake a review of wastewater management options for the longer term prior to the implementation of Stage 2 of the WWTP (in approximately 2021).

5.6.4 WATER QUALITY MANAGEMENT

The principle for water quality management is to maintain and, if possible, improve the quality of water leaving the LSP 3 area to maintain and restore ecological systems in the sub catchment in which the development is located. The following criteria have been incorporated to achieve this principle:

- Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual (Department of Water, 2004-2007).
- Protect groundwater as a resource.

5.6.5 WATER QUANTITY MANAGEMENT

The principle for water quantity management is the maintenance of discharge volume and peak flow relative to pre-development conditions. To achieve this principle the following criteria have been incorporated for LSP 3:

- **Ecological Protection** – The stormwater drainage system begins high in the catchment to retain flows near source. In particular, for the critical one year average recurrence interval event, the design of the stormwater drainage system has aimed to maintain post development discharge volume and peak flow rates relative to pre-development conditions in all parts of the catchment.
- **Flood Management** – The stormwater drainage system has been designed to manage the catchment runoff for up to the 1 in 100 year ARI event in the development area to pre-development peak flows.
- **Protect infrastructure and assets from inundation and flooding** – The stormwater drainage system has been designed to ensure the system conveys flows and ensures protection of infrastructure and assets during flooding events.



5.7 ENGINEERING & SERVICING

The following information is based on preliminary advice from the various service authorities, which has informed the preparation of LSP 3 and may be subject to change as development proceeds. Full details of engineering and servicing considerations are included in **Appendix E** – Engineering Infrastructure Report (TABEC).

5.7.1 SITE CHARACTERISTICS

LANDFORM/TOPOGRAPHY

The topography is relatively flat with a small ridge running northeast-southwest dividing the site and a steeper ridge along the northern portion of LSP 3. The majority of the site has a grade between 0% and 0.8%, though there is a small section of the northern portion where the grade is up to 2%. The site predominantly falls from an approximate level of RL 17.2m on the dividing ridge to RL 13.8m in the southeast and to a lesser degree to RL 15.4m in the northwest. There is also a high point of approximately RL 20.0m located in the proposed ECC along the northern boundary of the site.

GROUND CONDITIONS

The Broome-Roebuck Plains 1:50,000 Environmental Geology Series Map indicates red-brown silty sand generally underlie the LSP 3 area. The geological unit is the same as in the LSPs 1 and 2. Review of the soil conditions encountered within previous Broome North geotechnical investigations, which occurred within the same geological unit as the LSP 3 site indicate the following shallow soils;

- Topsoil – generally to a depth of 0.1m;
- Sand – medium dense, light brown sand encountered below the topsoil to a maximum depth of 0.5m in limited locations;
- Silty Sand – very loose to medium dense, red-brown silty sand with a trace of clay up to 5.0m; and
- Sandy Silty Clay – clay content may increase below 5.0m to red-brown sandy silty clay.

The soil unit described above is locally identified as 'Pindan Sand'. Due to the occurrence of Pindan sands, based on the recommendations of AS2870 a class "P" classification is associated to the site. An improved classification can be targeted and achieved with suitable soil preparation.

GROUNDWATER

A desktop study of the groundwater levels undertaken by Coffey Geotechnics for the Broome North DSP indicated the average annual maximum groundwater level (AAMGL) is approximately RL 2.5m AHD and an estimated maximum probably groundwater level (MPGL) 2.0m higher at RL 4.5m AHD. Groundwater levels are not expected to impact adversely on the development of LSP 3.

5.7.2 SITEWORKS

Siteworks required for urban development generally comprises the clearing of existing vegetation and the earthworking of existing ground surfaces to facilitate the required form of development. Notwithstanding this, there is a growing appreciation of the importance of retaining significant existing vegetation and topography to provide a sense of place within development areas and to meet sustainability objectives.

Earthworking of the site will be required to ensure the positive drainage of the lots to the road reserves for disposal. There will be a focus on minimising earthworks on Residential R2-R10 lots to ensure the amenity and integrity of the vegetation on these lots remains. Finished development levels within LSP 3 will need to account for the existing road levels of Tanami Drive, Gubinge Road, Fairway Drive, Sanctuary Road, Lulfitz Drive (Oryx Drive) and Coucal Street as well as existing ground levels for the MUC along the eastern boundary and A-Class Reserve on the northern boundary.

It is anticipated that siteworks will be undertaken such that foundations for residential development on the new lots can be designed for the Australian Standard Classification "S", as set out in AS2870-1996.

5.7.3 STORMWATER DRAINAGE

The design principle for stormwater management in Broome uses the roads to carry the majority of flow for all events. Overland flow is preferred to a piped system to slow flows, potentially enabling some infiltration and treatment of stormwater through vegetative uptake and contact with sediment. Runoff will discharge from the lots into the road system, from where it then discharges into and is stored in the open unlined swale/detention system as high as possible in the catchments in order to manage flood events and to improve water quality.

5.7.4 WASTEWATER

The Water Corporation has existing planning that covers the LSP 3 area and has advises that it can be serviced pending augmentation and upgrades to Water Corporation headworks components and reticulation mains. Subject to orderly planning, staging and scheduling of LSP 3, the Corporation will fund headworks and the developer will be responsible for funding reticulation works.

To facilitate development of the southern wastewater catchment and majority of LSP 3, current Water Corporation planning indicates an extension of the existing DN225 sewer mains that terminate on the LSP 1 western boundary in Tanami Drive and Ibasco Crescent is required. The smaller northern wastewater catchment that is part of the greater Cable Beach wastewater catchment will be served by a DN150 sewer reticulation extension of the existing DN225 sewer reticulation in Millington Road. A conventional reticulated gravity sewer system will provide connections to individual lots throughout LSP 3.

5.7.5 WATER SUPPLY

The Water Corporation is currently in the early stages of scoping for the provision of an additional DN600 distribution main along Fairway Drive, Sanctuary Road and Coucal Street that will connect an existing DN450 and DN500 distribution mains.

The project known as CW02432 Cable Beach Fairway Drive DM is considered a fast track project by the Corporation. Planning for the expansion of the Cable Beach Tank site is also expected to commence in 2015. Further upgrading of services is proposed as development and demand in Broome proceeds.

LSP 3 will include a standard water reticulation network in accordance with Water Corporation requirements. Initially, connection to the existing DN450/DN300 mains to the west and/or an extension of the existing DN250 main in Tanami Drive to the east are likely to service the development of the LSP 3. At subdivision stage, Water Corporation will provide further advice on the required reticulation main sizes throughout the LSP 3 area.

5.7.6 POWER SUPPLY

There are existing underground high voltage infrastructure located in Tanami Drive, Sanctuary Road, Fairway Drive and overhead 11Kv aerial transmission lines which run along the western side of Lulfitz Drive (Oryx Drive) and Coucal Street.

There are some power constraints on the current high voltage network configuration. The existing high voltage network cannot support the LSP 3 development, hence the requirement for a new zone substation. The new zone substation is to be located on the existing Fairway Drive site at the northern intersection with Magabla Road in the northwest corner of LSP 2. The zone substation is planned for possible construction in 5 years; once constructed, the power supply for LSP 3 will emanate from this substation.

Initially, Horizon Power has proposed to transfer loads between zone substation feeders to balance the load to LSP 3, thus allowing the development to connect to the high voltage network. Supply by the existing network of the estimated 9MVA load required for LSP 3 should occur through Horizon Power upgrades over the next few years.

Connection to the existing high voltage underground cables in Tanami Drive and Fairway Drive/Sanctuary Road can initially serve LSP 3. An internal underground electrical distribution system will be provided in accordance with the requirements of Horizon Power to supply allotments within the LSP 3 area. This will include both high and low voltage cables and the necessary transformers and switchgear to be installed throughout the development.

Ultimately high voltage interconnection to the existing cables in Fairway Drive north of LSP 3 and the aerials in Lulfitz Drive (Oryx Drive) and Coucal Street will be necessary to complete a high voltage ring as required by Horizon Power. Staging of the development of LSP 3 will influence the timeframes for the construction of the high voltage ring.

According to the Horizon Power Network Asset Policy, aerial power lines that abut a development may have to be undergrounded as part of the development. Current indications are that the aerials along Lulfitz Drive (Oryx Drive) and Coucal Street that abut the development will require undergrounding as part of the adjacent stage of development.

5.7.7 GAS

The LSP 3 area will not be serviced by gas, as reticulation to lots is not currently provided in Broome.

5.7.8 TELECOMMUNICATIONS

Existing NBN Co fibre optic infrastructure is currently located in the Broome North LSP 1 development to the east of LSP 3. The Broome North development has been accepted as part of the NBN Co Fibre footprint.

The LSP 3 telecommunication network will be an extension of the existing NBN Co infrastructure in Broome North LSP 1. A telecommunication pit and pipe network will be installed, including a service conduit to each lot to facilitate the fibre connection to each premise in LSP 3 in accordance with the NBN Co guidelines and specifications.

The telecommunication network will require a number of strategically placed Fibre Distribution Hubs (FDH). FDH are a street-side cabinet that provide an optical connection point between the distribution and local networks. An FDH provides connectivity for a maximum of 172 premises; a number of FDH will be required due to the expected yield within LSP 3. The placing and positioning will be determined at the subdivision stage in conjunction with the pit and pipe design.



5.8 DEVELOPER CONTRIBUTION ARRANGEMENTS

The Shire of Broome is currently considering the possibility of preparing a Developer Contribution Plan for traditional and community infrastructure that may include the Broome North development. Given the uncertainty at this point in time, it is considered premature to include details of possible cost items until such time as the draft Developer Contribution Plan is available.

5.9 INDICATIVE STAGING

The indicative staging for the LSP3 area has been developed to ensure the timely delivery of key infrastruture items and public amenity. Staging would generally progress from the south and move north as identified in **Figure 8**. More detailed staging plans will be prepared as part of the subdivision of the land which will consider the rollout of relevant sub-stages included in the LSP3 area.

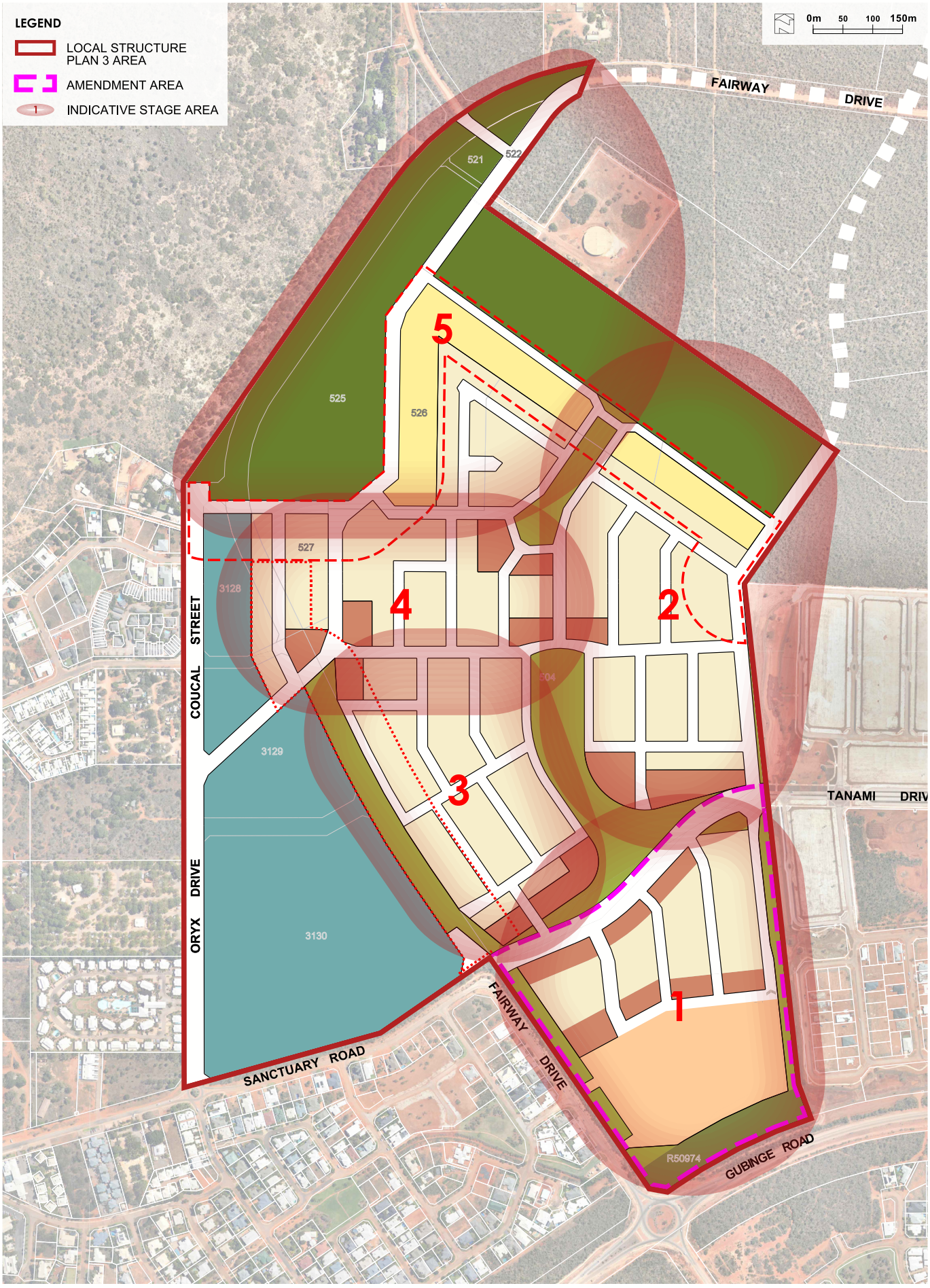


FIGURE 8: INDICATIVE STAGING PLAN

APPENDIX A
TRAFFIC REPORT

DevelopmentWA

Broome North Local Structure Plan 3 Amendment
Traffic Addenda

17 August 2022

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Appendix A - (Broome North LSP3 Amendment)

1. Introduction

1.1 Background

DevelopmentWA has an interest in the development of a 700-hectare (ha) area identified as Broome North, four kilometres (km) north of the Broome town centre. The current approved Broome North District Structure Plan (DSP), shown in Figure 1, and two local structure plans require updating to incorporate a new district shopping centre, residential development of the existing local centre site and relocation of district playing fields and future school sites.

DevelopmentWA is undertaking a planning review which will include the amendment of the DSP, Local Structure Plan 1 (LDP1) and LDP3 Structure Plans (marked as 1, 3 & Stage 6 Gujarri Estate respectively in Figure 1) as well as subdivision approval application for the LDP1 local centre site for residential development.

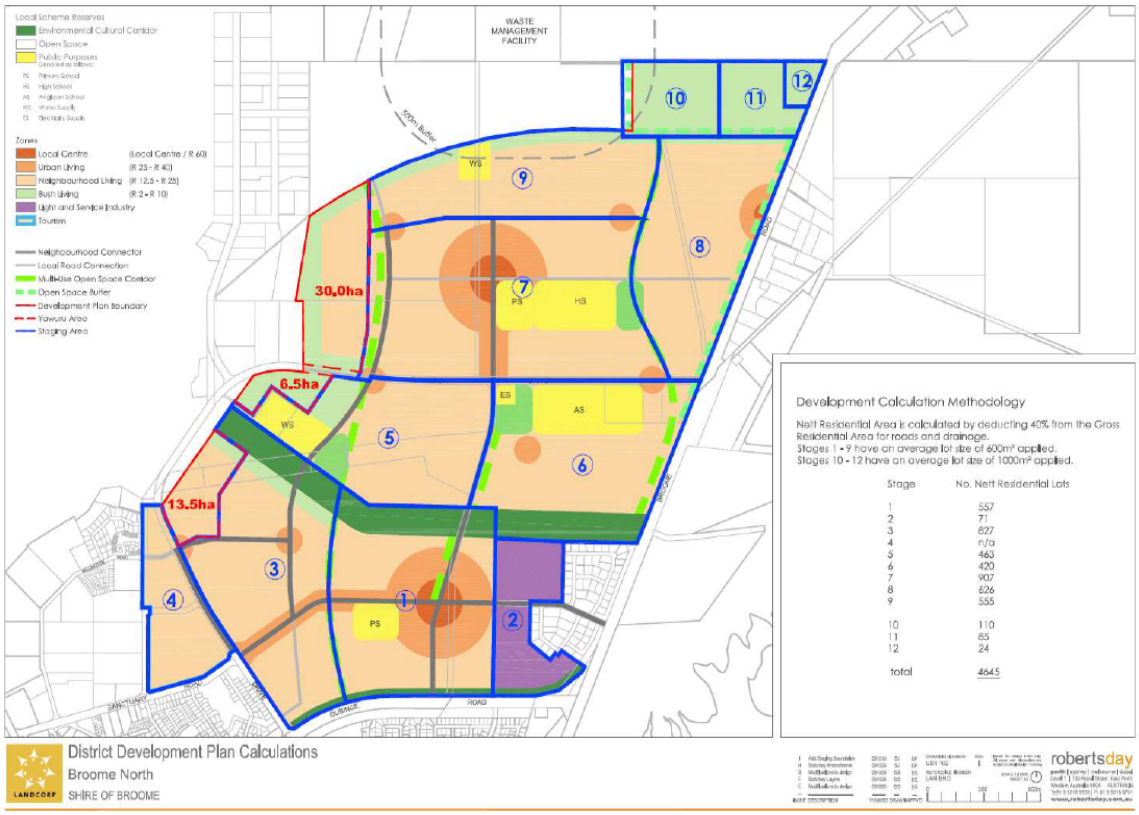


Figure 1 Current approved Broome North DSP

Figure 2 shows the proposed Broome North DSP.

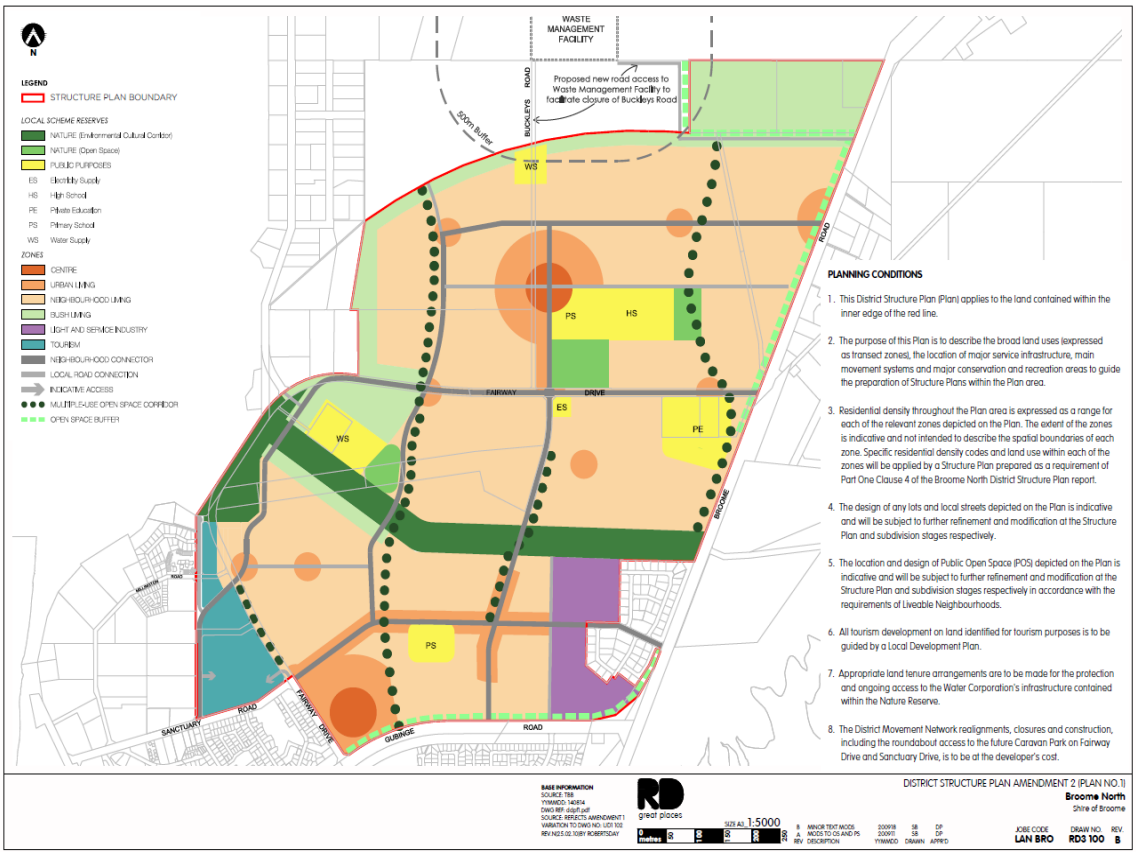


Figure 2 Proposed Broome North DSP

It is understood the Shire of Broome has agreed in principle with the submission of succinct addenda to each of the technical reports accompanying the DSP. The addenda need to comment on the two major structural changes, being:

1. Removal of the local centre in the DSP and addition of a district centre in LDP3, consistent with the Shire's Local Commercial Strategy; and

2. Relocation of District Open Space per previous agreement as part of the Gujarri Estate LDP process.

This document provides traffic commentary on the proposed changes to the LDP3 area incorporating the District Centre.

1.2 Assumptions

The traffic assessment is based on the following assumptions:

- Floor areas and lot yields as advised by the client are correct.
- Traffic distribution assumptions are suitable for analysis purposes.

1.3 Scope and limitations

This report has been prepared by GHD for Development WA and *may only be used and relied on by Development WA for the purpose agreed between GHD and the Development WA as set out in this report. GHD otherwise disclaims responsibility to any person other than Development WA arising in connection with this report.*

GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Development WA and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. DSP changes

2.1 Relocation of local centre

To ensure consistency with the Shire's Local Commercial Strategy, the local centre in the DSP has been removed and a district centre has been added to LDP3. Figure 3 and Figure 5 refer.

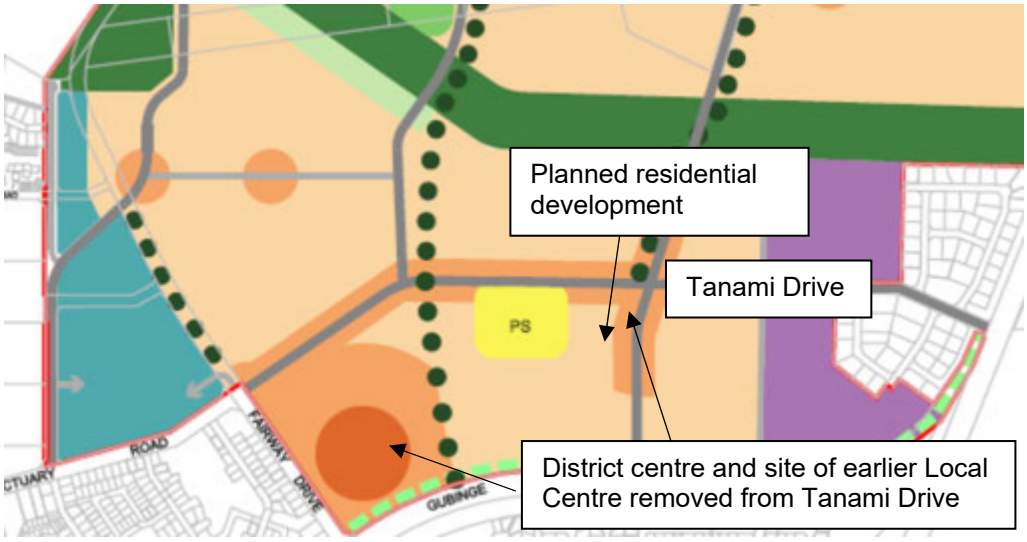


Figure 3 Removal/relocation of local centre

The previously approved LDP3 is shown in Figure 4. A further LDP3, as shown in Figure 5, is now superseded by the Draft Proposed Revised Plan No.1 (extract) and is shown in Figure 6. The plan in Figure 6 is the subject of this report.

The main change results from liaison with the Shire about refining the District Centre site to incorporate a dedicated a public Main Street, as opposed to an informal private accessway, that would extend east-west through the site (as per the previous concept).



Figure 4 Local Structure Plan 3 – Approved (Riley Report)



Figure 5 Draft LSP3 Amendment Plan No 1 (Extract) - Advertised

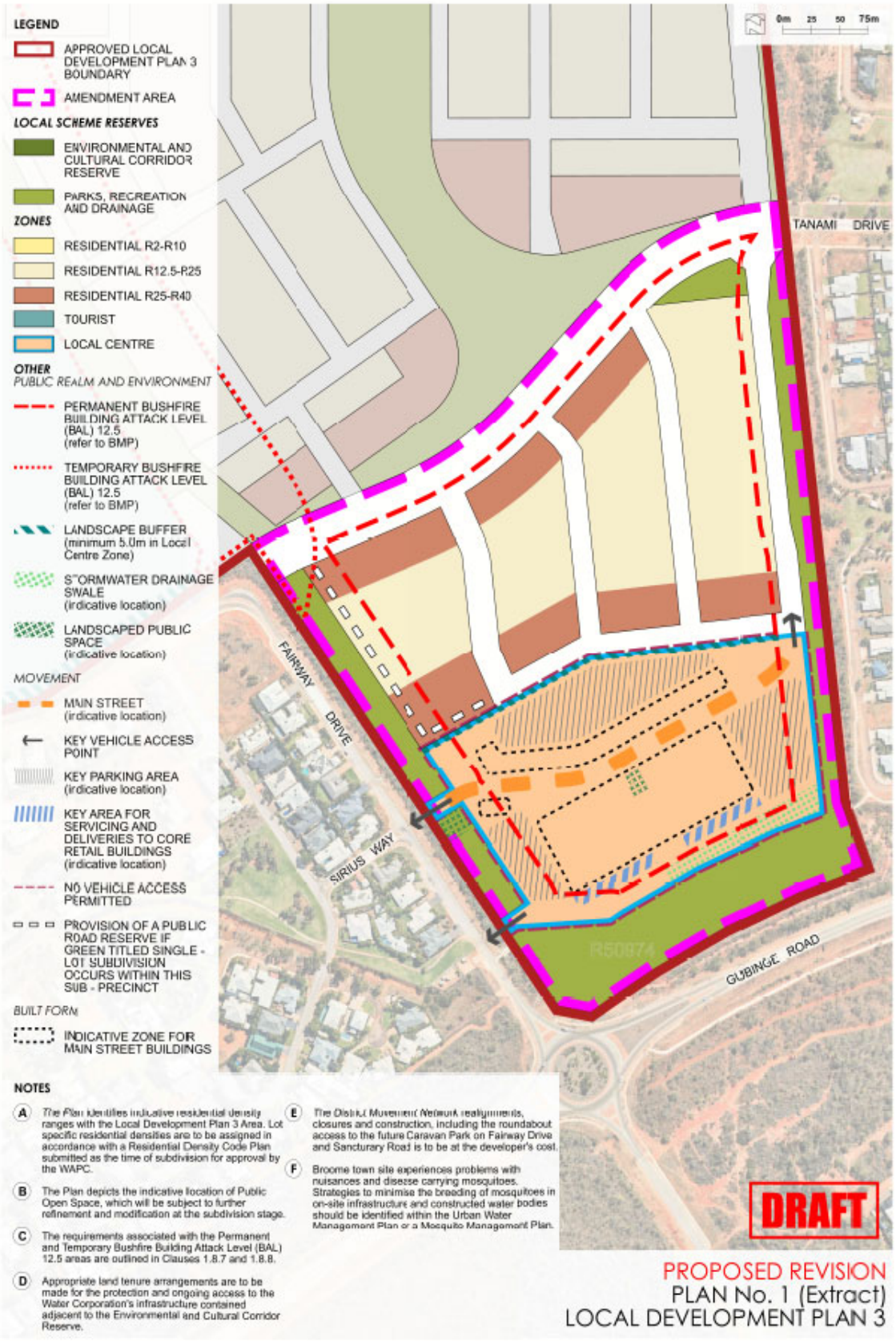


Figure 6 Draft LSP3 Amendment Plan No.1 (Extract) – Proposed revision following public advertising

2.2 Movement network

A previous traffic study was undertaken by Jacobs in 2016 (Broome Traffic Study), which modelled the Broome road network to 2051 for various scenarios. Riley Consulting prepared a Structure Plan Report in 2014 for LDP3 as residential development. The southern part of this area will now become a Centre in accordance with the Local Commercial Strategy. The relocation of the Centre to LDP3 and traffic impacts is considered further. Reference is made to the aforementioned traffic reports.

2.2.1 Base traffic on external network

A review of limited available traffic data from Main Roads WA Traffic Map indicates a general decline in traffic volumes since 2016 on select roads as follows:

- Cable Beach Road: -10% per annum
- Gubinge Road: -2% per annum

The Broome Traffic Study adopts a linear growth based on population growth and it is concluded that this report remains valid for use in informing subsequent assessment.

2.2.2 Traffic generation

Relocation of Local Centre

Figure 7 indicates the site of the relocated Centre.

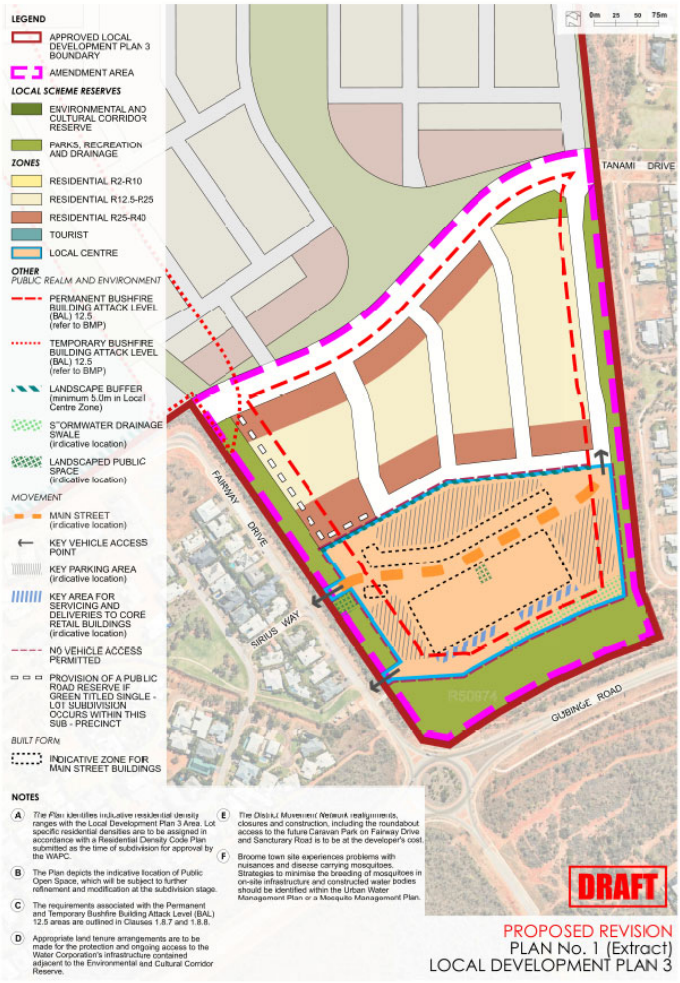


Figure 7 Local Structure Plan 3 – Site of relocated centre

Table 1 indicates the total lot yields and the reduction due to the proposed Centre. There will be a reduction of approximately 67 dwellings within the overall LSP3 area due to the provision of the district centre.

Note: Figures in Tables 1 and 2 are indicative and will be confirmed as part of relevant local subdivision planning processes.

Table 1 Revised residential lot yields

LSP3 (Residential Scenario)	Yield
Total Yield (previous)	857 dwellings (estimated in 2015 approved LSP3 report)
Southern Cell (area subject to LSP Amendment) (previous)	167 dwellings (estimated portion of the overall yield calculated for the 2015 LSP3 report)
District Centre Concept	
Current Residential Yield	Approx. 100 dwellings (based on the Plan of Subdivision lodged in December 2021 plus additional dwellings achievable in Grouped Housing sites and future development stages)
Difference in Residential Yield	**67 dwellings less within the LSP3 Amendment area**
Amended overall LSP3 total yield	**790 dwellings**

A review of the Deep End Retail Review report indicates a Stage 1 District Centre with proposed tenancies and lettable areas as shown in Table 2.

Table 2 Stage 1 District Centre (Deep End Retail Review)

Tenant	GLA m^2
Supermarket	3,700
Liquor	200
Bakery	80
Café	100
Takeaway food/restaurant (#4)	350
Pharmacy	300
News/Lottery/Gifts	100
Hairdresser/other beauty (#2)	180
Total	5,010
Non-Retail	
Medical centre	280
Gym	200
Pad sites	N/A
Childcare	N/A
Fuel/fast food/car wash	N/A

The Deep End Retail Review report adds "*It would seem appropriate to formalise the LCS recommendation by amending LDP3, as proposed. The general layout of the site in the TBB drawing gives enough flexibility to develop a range of options and configurations over time, as demand warrants.*"

Therefore, for analysis purposes, an ultimate GFA of 11,110 m^2 has been adopted as previously proposed to 2051. As previously indicated in this report, this is indicative and will be confirmed as part of relevant local structure planning processes.

Trip rates used in the Broome Traffic Report are shown in Table 3.

Table 3 Trip Rates (Broome Traffic Report)

Land Use	Daily trip rate
Residential	13.81/dwelling
Local Centre	75.88/100 m^2 GFA

For this assessment, a residential daily trip rate of 9.2 (Riley Report) has been adopted in view of the limited public transport opportunities and consistency with the *NSW Guide to Traffic Generating Development* which indicates nine trips per dwelling per day. The resulting trip generation is shown in Table 4.

Stage 1

It is acknowledged that development will occur in stages and the **first stage** of the Centre development is 6,000 m^2 GFA (after ten years). Residential lots are likely to be developed at a rate of 50 per year for the LDP2 and LDP3 areas.

If it is assumed that 50 lots are developed per year over ten years, this represents a traffic generation of 4,600 vehicles per day (vpd) (9.2 trips per day x 500) A Centre development of 6,000 m^2 is forecast to generate 4,800 vpd (6,000/100 x 80[1]).

For the first stage of Centre development, it is assumed that the full 'Main Street' will be created, with a connection to Fairway Drive and a connection to Tanami Drive via the north-south street that provides a link from the north-eastern corner of the district centre site to Tanami Drive. A roundabout is proposed at the main Fairway Drive access and a secondary access will operate right-in/left-in/left-out.

A distribution of 40% to the main roundabout access (40% x 4,800 vpd = 1,920 vpd) and 10% at the southern access (10% x 4,800 vpd = 480 vpd) and 50% to Tanami Drive (50% x 4,800 vpd = 2,400 vpd). Note: Traffic accessing Tanami Drive includes retail trips for Waranyjarri.

The Broome Traffic Study forecasted 5,962 vpd (477 vph) on Fairway Drive by 2031. Adding Stage 1 traffic (70% assumed to/from the north) at main access indicates around 7,300 vpd on Fairway Drive.

The proposed roundabout at the Centre access will accommodate forecast traffic volumes (SIDRA analysis was undertaken at both Fairway Drive accesses for ultimate development).

Liveable Neighbourhoods recommends that on streets with daily vehicle volumes above 5,000, lot layout must ensure that vehicle egress will not involve reversing into the street. Appropriate egress may be achieved by an embayment as part of a Boulevard cross section as proposed.

The Structure plan proposed a roundabout at the intersection of Fairway Drive and Tanami Drive. A broad assessment of required intersection configuration using the matrix developed by the Institute of Highways and Transport UK indicates a roundabout is required when the major flow reaches levels of service worse than D/E, i.e., the major flow exceeds around 10,000 vpd and minor flow around 4,000 vpd. Figure 8 refers.

[1] A rounded trip rate of 80/100 m^2 of GFA (rather than 75.88) has been assumed for the District Centre for robust assessment. A peak hour trip rate of 8/100 GLFA is used in subsequent SIDRA analysis

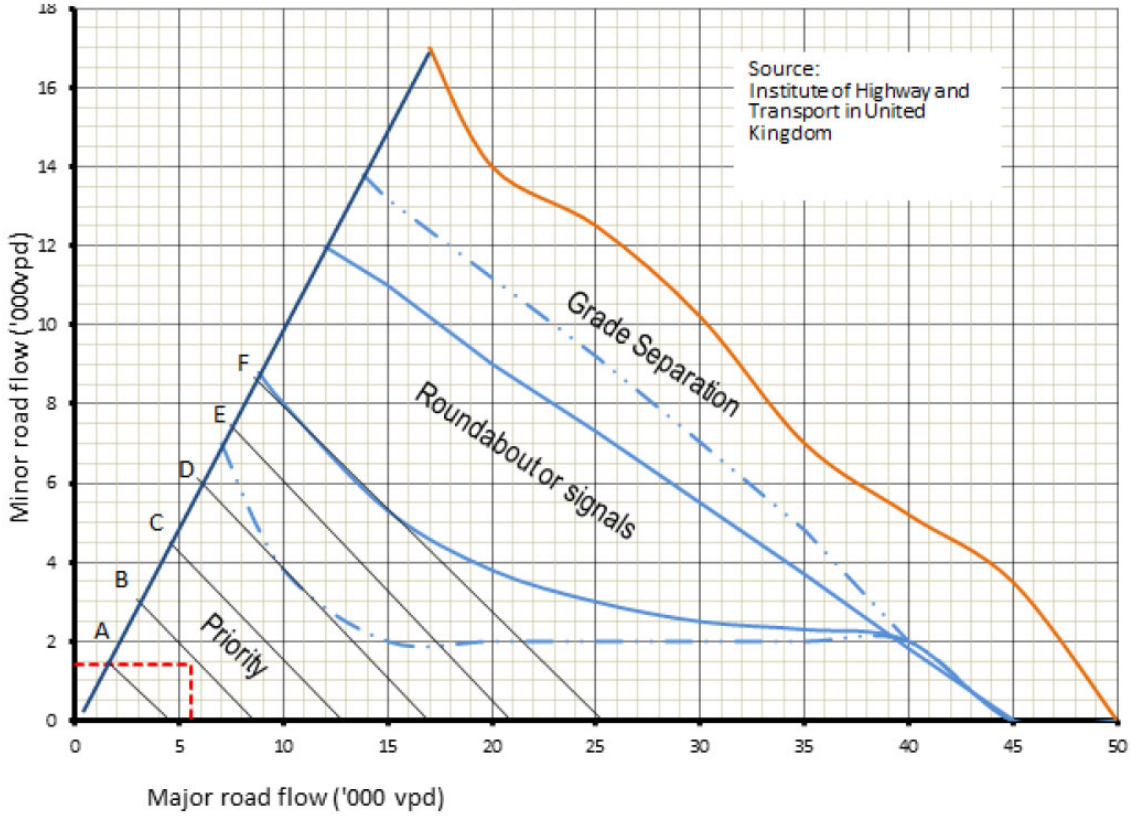


Figure 8 Institute of Highways and Transport UK Intersection requirements

A review of forecast traffic volumes on Fairway Drive and Tanami Drive (Stage 1) indicates around 7,500 vpd and 7,000 vpd respectively by 2031. The chart indicates that a roundabout is likely to be required at some stage after 2031 as surrounding development, including the Centre, occurs. There will also be safety benefits if a roundabout is installed at this intersection by reducing traffic speed and controlling traffic movements.

Ultimate development

The following sections consider the longer-term ultimate development.

Table 4 District Centre Traffic Generation LDP3

Land use	Trip Rate/Day	Vehicles per day (ultimate)
Proposed: approximately 790 dwellings *(previous 857 dwellings)*	9.2 (Riley Report)	7,268 *(previous 7,884)*
Proposed Local Centre: 11,110 m^2	80/100 m^2 (a)	8,888
Total		**16,156**

(a) A rounded trip rate of 80/100 m^2 of GFA (rather than 75.88) has been assumed for the District Centre for robust assessment. A peak hour trip rate of 8/100 GLFA is used in subsequent SIDRA analysis

The traffic generation from the LDP3 precinct (ultimate development) is forecast to increase from 7,884 vpd to 16,156 vpd, which represents a nett gain of approximately 8,272 vpd.

For robust analysis purposes, traffic volumes are estimated assuming three access points to the Centre (noting an additional access to the north west of the site is indicated *"a public road reserve if green title single lot subdivision occurs within this sub-precinct"*).

Access to the Centre is via Fairway Drive (two accesses) and one access point at the eastern end of the 'Main Street' at the north-eastern corner of the district centre site is analysed to determine highest forecast volumes.

A distribution of the 8,888 vpd to/from the Centre between the three access locations is estimated as follows:

- 40% main roundabout access to Fairway Drive – (40% x 8,888 vpd) = 3,555 vpd
- 10% at the southern access to Fairway Drive – (10% x 8,888 vpd) = 888 vpd
- 50% at the north eastern access to Tanami Drive – (50% x 8,888 vpd) = 4,444 vpd

To reflect surrounding development, a broad distribution of 70% of trips to the north and 30% to the south has been adopted.

If it is assumed 70% of traffic to/from the Centre travel to/from the north, this represents 6,220 vpd. This will be shared between Fairway Drive (around 1,720 vpd) and Road D (around 4,500 vpd).

30% of traffic to/from the Centre from the south and west represents 2,666 vpd.

The Broome Traffic Study forecasts 7,775 vpd (622/8% in the peak hour) on Fairway Drive by 2051. Based on this assessment, relocation of the Centre could add up to around 1,720 vpd) to Fairway Drive, increasing volumes to around 9,500 vpd.

The proposed treatment of Fairway Drive is a boulevard cross section (Neighbourhood Connector) with embayed parking adjacent to the existing residential properties facilitating access to properties. Table 5 indicates levels of service for various types of roads based on daily traffic volumes.

Table 5 Levels of Service by Road Type (Source Riley Report LDP3)

LOS	Single Carriageway[1]	2-Lane Boulevard[2]	Dual Carriageway (4-Lanes)[3]	Dual Carriageway (4-lane Clearway)[3]
A	2,400vpd	2,600vpd	24,000vpd	27,000vpd
B	4,800vpd	5,300vpd	28,000vpd	31,500vpd
C	7,900vpd	8,700vpd	32,000vpd	36,000vpd
D	13,500vpd	15,000vpd	36,000vpd	40,500vpd
E	22,900vpd	25,200vpd[4]	40,000vpd	45,000vpd
F	>22,900vpd	>25,200vpd[4]	>40,000vpd	>45,000vpd

[1] Based on Table 3.9 Austroads - Guide to Traffic Engineering Practice Part 2
[2] Based on single carriageway +10% (supported by Table 3.1 Austroads - Guide to Traffic Engineering Practice Part 3) – Boulevard or division by medians.
[3] Based on RRR Table 3.5 - mid-block service flow rates (SF.) for urban arterial roads with interrupted flow. Using 60/40 peak split.
[4] Note James Street Guildford passes 28,000vpd.

Table 5 indicates the ultimate level of service of Fairway Drive by 2051 is forecast to be C/D for a daily volume of 9,500 vpd which is considered acceptable.

Traffic on Tanami Drive just east of Fairway Drive was previously forecast to be around 8,500 vpd (Broome Traffic Study). Forecast traffic volumes are not anticipated to change the road

cross section requirement due to the relocation of the Centre. A proportion of the northern traffic to/from the Centre will use Tanami Drive, forecast to be up to +1,720 vpd. A Neighbourhood Connector road cross section will accommodate the forecast volumes.

A proportion of external traffic from the east is anticipated to travel along Gubinge Road to access the Centre via Fairway Drive.

2.3 Intersection analysis

2.3.1 Fairway Drive/Centre access (ultimate)

A roundabout is proposed at the main Fairway Drive/Centre access intersection.

SIDRA analysis (PM peak period) has been undertaken for the operation of the Fairway Drive/ Centre access for 2051, assuming a worst-case scenario (50% of all traffic use the roundabout, 888 vph x 50%). It is acknowledged that two other accesses are available, one further south to Fairway Drive and one leading on to Tanami Drive and results are therefore likely to be better than shown. A good level of service of A/B is forecast for all movements with no significant queueing or delay. Figure 9 refers.

Fairway Drive Centre/ Access Roundabout PM 2051 70% N and 20% S + 10% west
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Fairway Drive south														
1	L2	10	2.0	11	2.0	0.398	4.1	LOS A	2.8	20.0	0.49	0.49	0.49	46.3
2	T1	400	2.0	421	2.0	0.398	4.0	LOS A	2.8	20.0	0.49	0.49	0.49	47.4
3	R2	44	2.0	46	2.0	0.398	8.6	LOS A	2.8	20.0	0.49	0.49	0.49	37.8
Approach		454	2.0	478	2.0	0.398	4.5	LOS A	2.8	20.0	0.49	0.49	0.49	46.2
East: Centre access														
4	L2	44	2.0	46	2.0	0.208	1.5	LOS A	1.2	8.4	0.45	0.46	0.45	35.7
5	T1	22	2.0	23	2.0	0.208	1.4	LOS A	1.2	8.4	0.45	0.46	0.45	36.2
6	R2	155	2.0	163	2.0	0.208	4.3	LOS A	1.2	8.4	0.45	0.46	0.45	36.5
Approach		221	2.0	233	2.0	0.208	3.4	LOS A	1.2	8.4	0.45	0.46	0.45	36.3
North: Fairway Drive north														
7	L2	155	2.0	163	2.0	0.287	3.3	LOS A	1.8	13.0	0.29	0.40	0.29	36.7
8	T1	207	2.0	218	2.0	0.287	3.3	LOS A	1.8	13.0	0.29	0.40	0.29	48.3
9	R2	10	2.0	11	2.0	0.287	7.8	LOS A	1.8	13.0	0.29	0.40	0.29	48.5
Approach		372	2.0	392	2.0	0.287	3.4	LOS A	1.8	13.0	0.29	0.40	0.29	42.7
West: Sirius Way														
10	L2	20	2.0	21	2.0	0.080	6.3	LOS A	0.5	3.3	0.66	0.68	0.66	45.1
11	T1	22	2.0	23	2.0	0.080	7.1	LOS A	0.5	3.3	0.66	0.68	0.66	34.9
12	R2	20	2.0	21	2.0	0.080	10.8	LOS B	0.5	3.3	0.66	0.68	0.66	46.3
Approach		62	2.0	65	2.0	0.080	8.0	LOS A	0.5	3.3	0.66	0.68	0.66	41.2
All Vehicles		1109	2.0	1167	2.0	0.398	4.1	LOS A	2.8	20.0	0.42	0.46	0.42	42.4

Figure 9 Fairway Drive/Centre access 2051 PM peak analysis

The Broome Traffic Study has analysed the Fairway Drive/Gubinge Road intersection to 2051 and indicates levels of service of A-C and worst degree of saturation as 0.58. The increased traffic due to the relocation of the Centre is not anticipated to significantly impact this intersection.

A proportion of northbound traffic will use the T intersection and residential road from the north east corner of the Centre, with forecast daily traffic of around 4,600 vpd. This will be shared should the additional northern accesses eventuate.

The proposed intersection at the northeast corner of the Centre site should be designed to restrict large vehicles from accessing the residential streets to the west.

2.3.2 Southern access (ultimate)

The southern access with Fairway Drive is located approximately 97 metres (m) from the roundabout at Gubinge Road and the start of the turn lane is located approximately 30 m from Gubinge Road. This secondary access will operate right-in/left-in/left-out to distribute traffic along Fairway Drive and enables effective entry/exit for delivery vehicles and service vehicles. Analysis has been undertaken to determine forecast operation and queue lengths assuming access by a semi-trailer to service the Centre.

For analysis purposes, it is assumed that 10% of all traffic generated by the Centre will use the southern access (888 vpd), with 8% occurring in the peak hour and 10% being trucks. A level of service of A is forecast. A sensitivity analysis assuming all flows are doubled indicates a level of service of C (right in/left out) and a queue length in Fairway Drive south (within the turn lane) of 11 m.

Analysis indicates the intersection will operate adequately.

A check of the Stopping Sight Distance (SSD) to the start of the turn lane is calculated from the following:

$$SSD = \frac{R_T V}{3.6} + \frac{V^2}{254(d + 0.01a)}$$

where

R_T = reaction time (sec)

V = operating speed (km/h)

d = coefficient of deceleration (longitudinal friction factor)

a = longitudinal grade (%, + for upgrades and – for downgrades)

Rt = 2 seconds

V = 30 km/h approaching from the roundabout

d = 0.36

a = 0%

SSD = 27 m

A distance of 30 m between the roundabout and the start of the right turn lane is therefore considered acceptable.

2.4 Through traffic in residential streets (ultimate)

The Centre will draw traffic from the surrounding northern development. Three main accesses are ultimately proposed to the Centre as indicated in Figure 10. These will distribute traffic generated by the Centre via Tanami Drive and Fairway Drive. A T intersection is proposed at the north east corner of the Centre site (1) and will be designed with a tight radius/geometry to the west to discourage truck movement. The roundabout at the north-south road/Tanami Drive intersection (2) will facilitate good access to the Centre reducing the need to use other

residential streets. The three north-south roads (A, B, C) could have traffic calming measures to further discourage traffic accessing the Centre via these roads, however it is considered unlikely to be necessary as there is no direct access to the Centre from these roads.

The main north-south residential road (D) is forecast to carry around 4,600 vpd on full development including Centre and residential traffic.

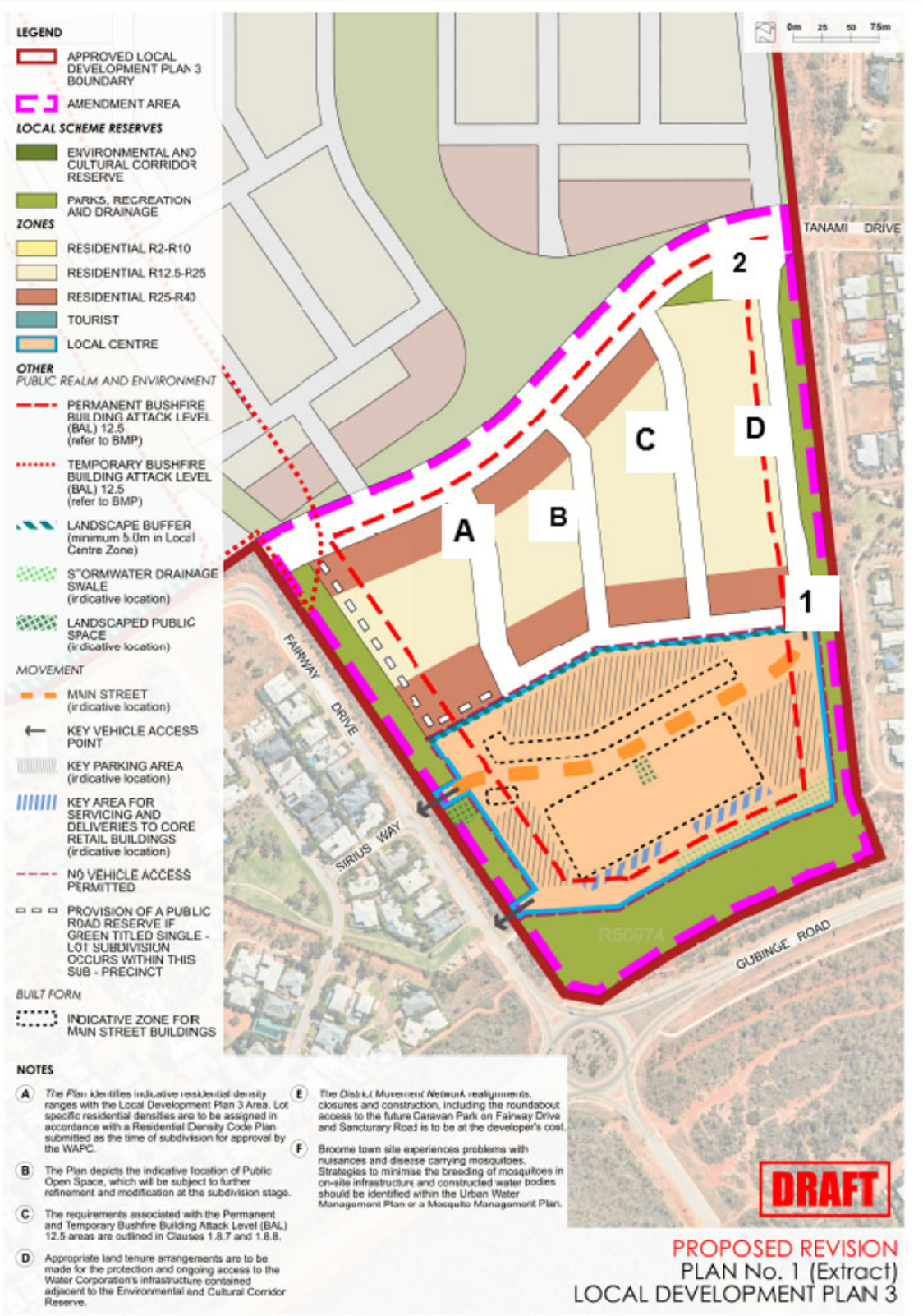


Figure 10 Centre access

Liveable Neighbourhoods recommends that on streets with daily vehicle volumes above 5,000, lot layout must ensure that vehicle egress will not involve reversing into the street. Appropriate egress may be achieved by an embayment as part of a Boulevard cross section as proposed. Figure 11 refers.

The road cross section for Road D is proposed as follows:

Western verge 5 m (with 2 m path); 3 m western parking lane; 3.5 m carriageway; 3 m median (hard and soft); 3.5 m carriageway; 2 m eastern verge = 20 m.

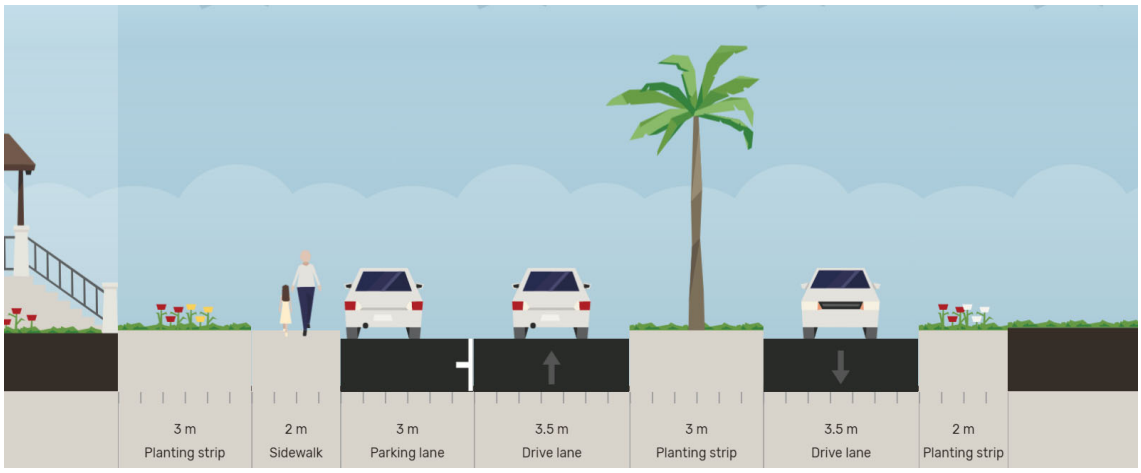


Figure 11 Road D Recommended Cross section

Table 5 indicates the road will operate at a good level of service of B on full development.

2.5 Sunset Park

Behaviour will change as residents of Sunset Park access the Centre. The roads are typically 6-7 m wide and are classified as Access Streets.

The Shire of Broome have been contacted regarding any available traffic data within the Sunset Park Estate. Limited 2013 data is provided as follows:

- Sirius Way – 514 vpd
- Kapang Drive – 353 vpd

WAPC document Liveable Neighbourhoods indicates anticipated volumes of 1,000 vpd for an Access Street.

Approximately 16% of all trips from a dwelling are shopping trips (Transport for NSW, Household Travel Survey Report: Sydney 2012/13). There are approximately 270 dwellings within Sunset Park within the catchment of the Centre, of which approximately 50% may access the Centre via Sirius Way. Assuming nine trips per dwelling per day, this would result in 194 shopping trips per day (270 x 9 x 16% x 50%). If it is assumed that 200-250 vpd access the Centre (20-25 vph) via Sirius Way, the impact is considered to be negligible and within anticipated volumes and well within the physical capacity of the roads. It should also be noted that shopping trips within the precinct are already likely to be on the network.

The Local Access roads within the adjacent Sunset Park estate to the west of Fairway Drive are designed and built to a suitable standard to accommodate any change in traffic behaviour within this estate given the main entry point to the District Centre is the roundabout on Sirius Way. No capacity issues exist or are anticipated.

A review of the crash data for the last five years from Main Roads WA Crash Analysis Reporting System indicates one minor collision at the Sirius Way/Fairway Drive intersection and one minor

collision within the estate. No current safety issues are apparent on Fairway Drive or within the estate.

2.6 Main Street

The Planning team have had discussion with the Shire about refining the District Centre site to incorporate a dedicated public Main Street, as opposed to an informal private accessway that would extend east-west through the site (as per the previous concept). 3,555 vpd are forecast to use the western section of the Main Street on full development and 4,444 vpd the eastern section. The detail shown in Figure 12 refers.



Figure 12 Indicative Concept Plan- District Centre and Main Street

The proposed Main Street characteristics are as follows:

1. A road reserve width of approximately 21 m in the central section (northern verge – 4 m; parking – 2.5 m; carriageway – 7 m; parking – 2.5 m; southern verge 5 m).
2. Eastern section would be about 17.5 m (northern verge – 4 m, parking - 2.5 m, carriageway – 7 m, southern verge – 4 m.
3. The western end would be about 24 m (northern verge – 4 m, parking - 2.5 m, carriageway – 2 x 3.5 m, median – 3 m, parking – 2.5 m, southern verge 4 m.
4. The 7 m carriageway would facilitate a possible bus service. The central section (coloured brown) would ideally be designed with no kerbs, shared-surface environment with vehicle speeds at 10-20 kilometres per hour (km/h). The eastern and western sections would ideally be set at 30 km/h.

The surface treatment and pedestrian crossing facilities will support the planned function and low speed environment for this road. Pedestrian crossing facilities will be placed at desire lines to facilitate good access to the Centre from the parking areas.

Parking and landscaping along the Main Street will be carefully considered to ensure adequate sight distance is available for traffic accessing the parking areas.

The road cross section can accommodate forecast traffic volumes.

2.7 Provision for cyclists

End of trip facilities should be provided at the District Centre to accommodate cyclist requirements and encourage/facilitate access by this mode.

Cycle lanes can ultimately be included on Fairway Drive when this is constructed as a Boulevard type treatment.

Cycle lanes on Road D are not considered to be required, however a 2.5 m shared path in the eastern verge and POS would be suitable to accommodate likely demand.

The road can be shared in the early stages of development. Cycling Aspects of Austroads indicates roads that have low traffic speeds and relatively low volumes (< 3000 vpd) generally enable cyclists to safely share the road with other traffic. A shared path developed in the early stage nevertheless would be desirable.

2.8 General comments

1. The southern access with Fairway Drive is located approximately 97 m from the roundabout at Gubinge Road and the start of the turn lane is located approximately 30 m from Gubinge Road. Intersection spacing is considered suitable.
2. Analysis of the roundabout at Fairway Drive/Sirus Way/Centre access indicates it is forecast to operate satisfactorily with full development.
3. Should a northern access to the Centre with Tanami Drive (approximately 50 m east of Fairway Drive roundabout) be constructed ultimately, it would need to operate left in/out.
4. A series of speed humps could be used to deter through traffic on the east-west access road to the south of the Shopping Centre.
5. As part of the detailed design, the access road should be tracked for two opposing semis to pass each other to ensure adequate width is provided. This will include along the road and at the access with Fairway Drive.
6. As part of the detailed design of the Main Street, the access road should be tracked for two opposing design vehicles to pass each other to ensure adequate width is provided.
7. Truck deterrence from local streets – the proposed T intersection adjacent to the north-east corner of the Centre site should have a tight radius to accommodate a single unit from south to west but not a semi + threshold treatment in the side road to deter trucks.
8. Access to service areas at the Centre should be tracked to ensure a 19 m semi can access.
9. A roundabout at the Tanami Drive/North-South residential road will require the Tanami Drive/Said Bend to operate left in/out.

Fairway Drive

10. The Structure Plan continues to support the future upgrade of Fairway Drive as a boulevard-type street. The recommended road classification is an Integrator B as indicated in *Liveable Neighbourhoods*. The recommended cross section is shown in Figure 13.

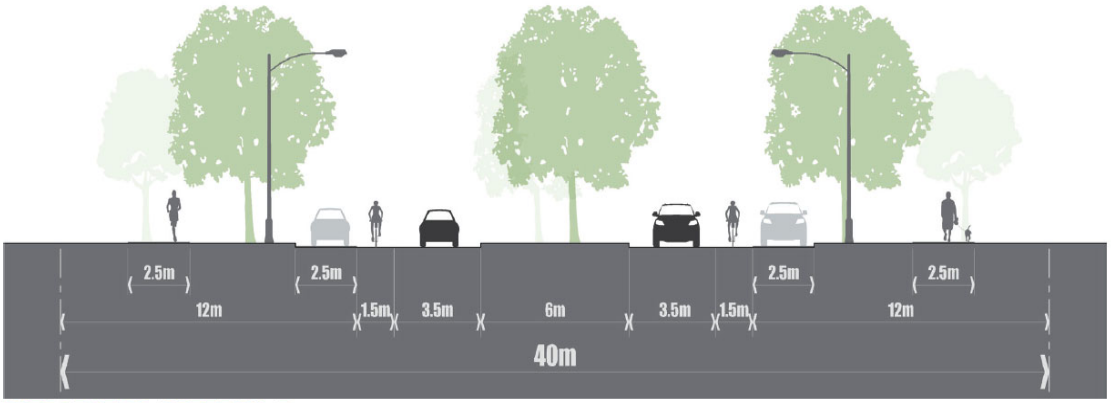


Figure 13 Fairway Drive – Recommended Cross Section

11. Main entry: four-way roundabout intersection created with Sirius Way to maximise ease of access to and from the District Centre; announce the arrival to the Centre; and to support future ease of movement to and from Fairway Drive for Sunset Park residents, particularly when Fairway Drive traffic volumes increase.

12. Secondary entry: right-in/left-in/left-out intersection to distribute traffic along Fairway Drive; enables effective entry/exit for delivery vehicles and service vehicles. This will overcome the need for truck access through residential roads to the north.

Movement and Landscape

a. The existing Gubinge Road landscaped corridor (Reserve 50974) provides a dual drainage and landscape function; screens views of the District Centre from Gubinge Road; and accommodates an existing east-west shared path, with scope for future path connections between the District Centre and Gubinge Road.

b. A landscape buffer (minimum 5 m wide) along the northern boundary of the site could be combined with the adjacent street verge to provide a wide transition between the car park and the adjacent residential development to reduce the visual impact on residential amenity.

c. Car park areas should be landscaped in accordance with Council policy – with wide-canopy shade trees, to provide amenity for customers and to reduce the carpark's visual impact on residential amenity.

d. A local access street along the northern boundary provides an appropriate interface to the District Centre, with vehicle access into the site through the northern boundary only provided via the north-eastern corner of the site.

e. Access to the site from the north is proposed via a proposed new roundabout at Tanami Drive to reduce the impact of through traffic movements on the residential streets and Fairway Drive.

f. Residential streets are aligned and designed to support good pedestrian/cycle access to the District Centre from Tanami Drive, whilst limiting non-local through-traffic.

g. Numerous pedestrian/cycle connections and crossings can be provided to and through the site, linking surrounding residential areas. The locations of the path connections would be confirmed at subdivision stage.

2.9 Recommendations

Following assessment of the Broome North Local Structure Plan 3 amendment, the following recommendations are made:

Stage 1

Two proposed access points to Fairway Drive and via Road D are suitable to accommodate forecast traffic volumes. A roundabout is recommended at the main access with Fairway Drive and secondary access further south should operate left in/out and right in.

Full construction of Main Street is recommended.

No significant changes are recommended for the transport network as previously approved.

A roundabout at the intersection of Tanami Drive/Fairway Drive is likely to be required around 2031 as the Centre develops.

A Boulevard treatment for Fairway Drive on completion of the Centre development is recommended when volumes approach 7,900 vpd.

Cycle lanes on Road D are not considered required, however a 2.5 m shared path in the eastern verge and POS would be suitable to accommodate likely demand.

Ultimate

The proposed treatment of Fairway Drive as a Boulevard, together with a roundabout at the access to the Centre, is recommended. As indicated, this is recommended when volumes approach 7,900 vpd.

A roundabout at the Fairway Drive/Centre access is forecast to operate satisfactorily on full development and is recommended.

The proposed southern access to Fairway Drive incorporating left in/out and right in, is considered suitable and is forecast to operate adequately. This secondary access is recommended.

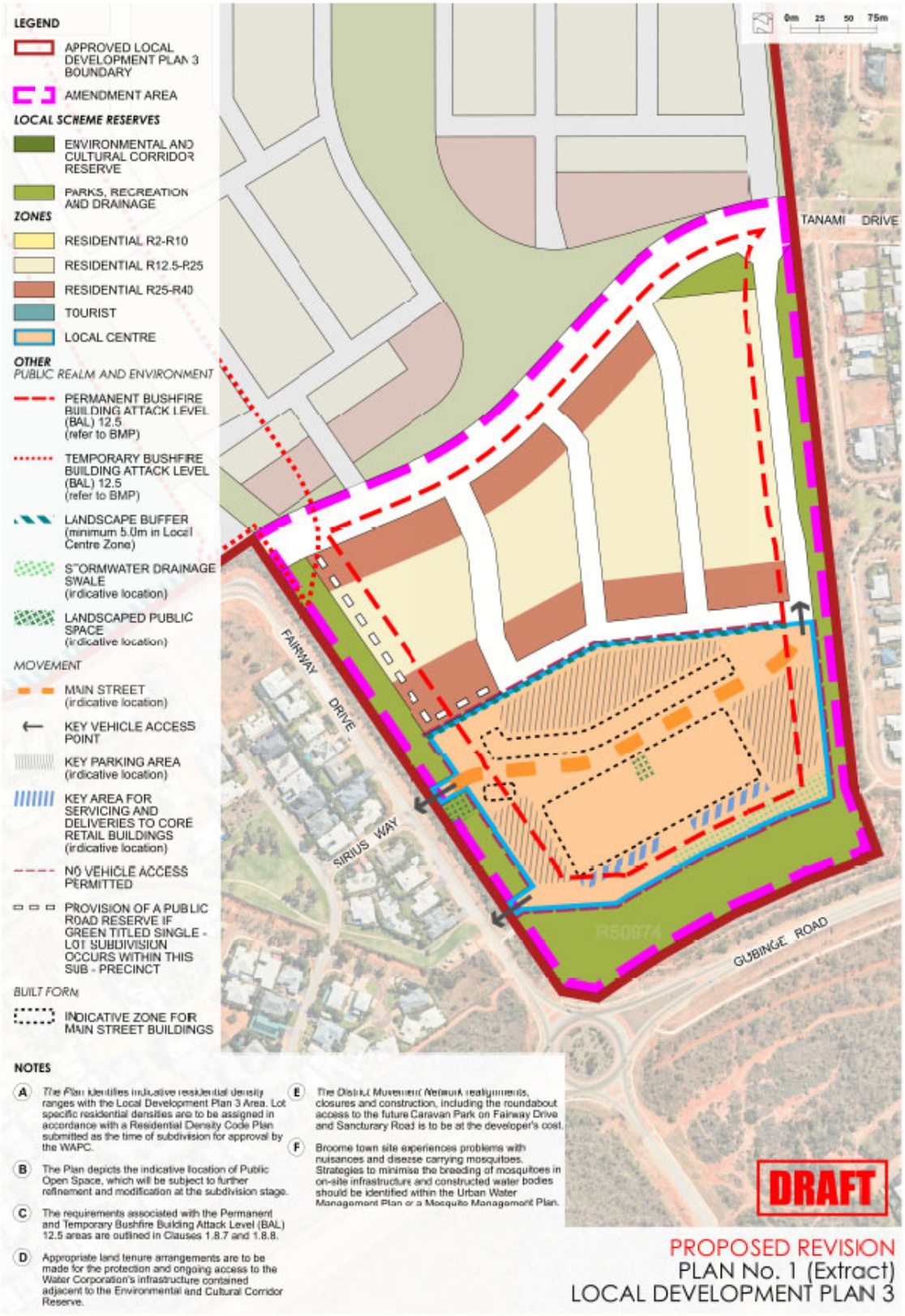
The proposed roundabout at the Tanami Drive/North-South residential road will facilitate access to the Centre. It is recommended the adjacent intersection at Tanami Drive/Said Bend should operate left in/out.

It is recommended the proposed T intersection at the northeast corner of the Centre site should be designed to restrict large vehicles from accessing the residential streets to the west.

It is recommended the southern access road of the Centre from Fairway Drive should be traffic calmed to restrict through movement and traffic speed.

Appendices

Appendix A - (Broome North LSP3 Amendment)



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C	M Baetge	S Barlow		S Barlow		17/08/2022

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BROOME NORTH LDP3

STRUCTURE PLAN TRAFFIC REPORT

July 2014

Riley Consulting

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Issued on	8 July 2014	Amendments	Date
Version	V4A	V2 Plan revised	24-03-14
		V3 Plans updated	12-05-14
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1.0 EXECUTIVE SUMMARY

Riley Consulting has been commissioned by Landcorp to consider the traffic and transport impacts of LDP 3, Broome North. The key findings of the traffic investigations are:

- The land area can be expected to yield about 857 residential lots and could generate up to 7,900 vehicle movements per day. Assessment of the development of LDP3 shows no detrimental impact is expected to occur to the surrounding road network.

- Assessment of the long-term traffic demands has been undertaken to determine future impacts once Broome North is fully developed. The assessment of LDP3 in isolation indicates that no widening of roads external to the subject land would be required.

- Fairway Drive (future northern link) has been reviewed in regard to the future classification and use. In liaison with the Shire of Broome, road network planning sets out to create Fairway Drive (north) as a lower order street with daily traffic volumes appropriate to its desired cycle route function and cognisant of conservation outcomes.

- The internal road network of LDP3 has been appropriately planned with regard to the requirements of *Liveable Neighbourhoods*. The intersection of Fairway Drive / Sanctuary Road / Tanami Drive is recommended to be controlled by a roundabout.

2.0 THE SITE AND SURROUNDING ROAD NETWORK

The land parcel known as LDP3 sits to the western end of the suburb of Broome North. To the west of LDP3 lies the suburb of Cable Beach. The location of the subject site is shown in Figure 1.

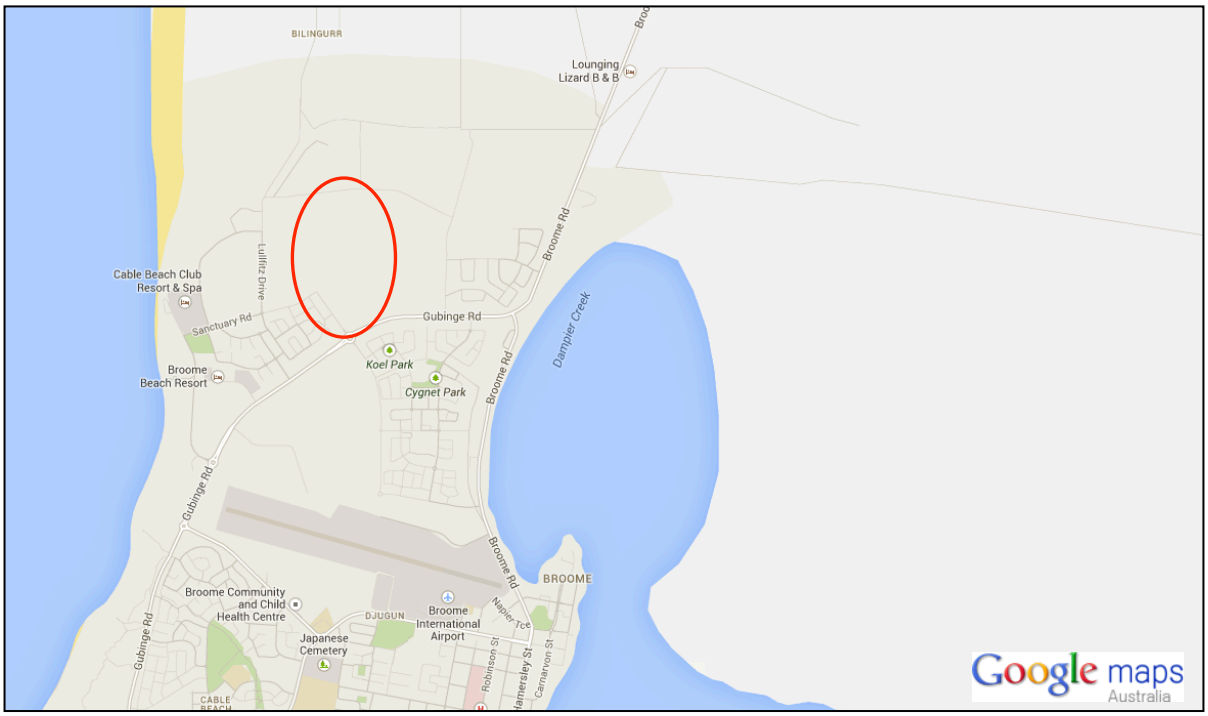


Figure 1 Site Location (Indicative)

Roads potentially affected by the development of the site are considered below.

Broome Road

Broome Road is the major arterial road linking Broome to the North West Coastal Highway. It is presently constructed as a single carriageway road with a standard 7.2 metre carriageway. Traffic data provided through the Main Roads Western Australia (MRWA) website indicates 5,340 vehicles per day (vpd) to the south of Tanami Drive. The current Level of Service would be C, indicating good traffic flow conditions on this link. The Levels of Service are shown in Appendix A.

Gubinge Road

Gubinge Road is a major arterial road linking Broome Port to Broome Road and thence the North West Coastal Highway. It is presently constructed as a single carriageway road comprising of a standard 7.2 metre carriageway and 1.9 metre sealed shoulders. Traffic data provided through the MRWA website indicates 2,672vpd to the east of Fairway Drive.

The current Level of Service would be B (refer Appendix A), indicating very good traffic flow conditions on this link.

Sanctuary Road

Sanctuary Road provides the main east-west connection to Cable Beach and is constructed with a 7.0 metre carriageway in a 40 metre reservation. Traffic data is not available for Sanctuary Drive, but current flows shown on Fairway Drive adjacent to Gubinge Road show 2,720vpd. As Fairway Drive is the continuation of Sanctuary Drive at the present time, this flow reflects the maximum flow on Sanctuary Road. The current Level of Service is B (refer Appendix A).

Fairway Drive

Fairway Drive provides a short north-south link between Sanctuary Road and Gubinge Road. It is constructed with a 7.0 metre carriageway to the north of Gubinge Road provided within a 30 metre reservation. The daily traffic flow is 2,720vpd north of Gubinge Road. A road reservation exists to the north of Sanctuary Road that would connect Fairway Drive through to Lulfitz Drive, although no pavement has been constructed. Figure 2 shows the future links of Fairway Drive that are notated as “Fairway Drive link”, “Fairway Drive link north” (connection to Lulfitz Drive) and “Fairway Drive north” (the east – west section linking Lulfitz Drive to Broome Road). Further discussion on Fairway Drive is provided later in this report.

Coucal Street (signed as Lulfitz Drive and may become Oryx Drive)

Coucal Street provides a north-south connection from Sanctuary Road to Millington Road and Lulfitz Drive. It is constructed with a 6.2 metre pavement within a 20 metre road reservation. The carriageway reduces to 6.0 metres north of Millington Road. Current traffic flows would be in the order of 500vpd to its northern end increasing to about 1,000vpd to the north of Sanctuary Road.

For the purpose of this report, Coucal Street is the road section between Sanctuary Road and Frangipani Drive. The link to Lulfitz Drive is referred to as Fairway Drive link north. As part of the new road re-alignments, Coucal Street will terminate at the Fairway Drive link. The new link road is expected to be called Oryx Drive.

Lulfitz Drive

Lulfitz Drive provides a north-south connection from Fairway Drive and services about 35 constructed dwellings. It is constructed with a 6 metre pavement within a 20 metre road reservation. Current traffic flows would be in the order of 350vpd.

Oryx Road

Oryx Road is an existing road reservation between the unconstructed Fairway Drive road reservation and Coucal Street. No road is currently constructed.

Millington Road

Millington Road is a local Access Street providing a link between Coucal Street and Sanctuary Road. It is constructed with a 6.8 metre pavement in a 20 metre reservation. Locally it is considered as a constrained road unsuited to significant increases in traffic movement. It is used by the local bus service and its width is slightly less than current road standards would recommend. The road services a high proportion of tourist accommodation. There are some bends that restrict forward visibility, but do not present a problem for slow moving traffic (<50kph). Traffic data is not available for Millington Road, but it is estimated to carry about 500vpd at its northern end, with traffic flows increasing towards Sanctuary Road as a result of the tourist accommodation provided.

For the purpose of this study, Figure 2 shows the names used to reference each road in this report.

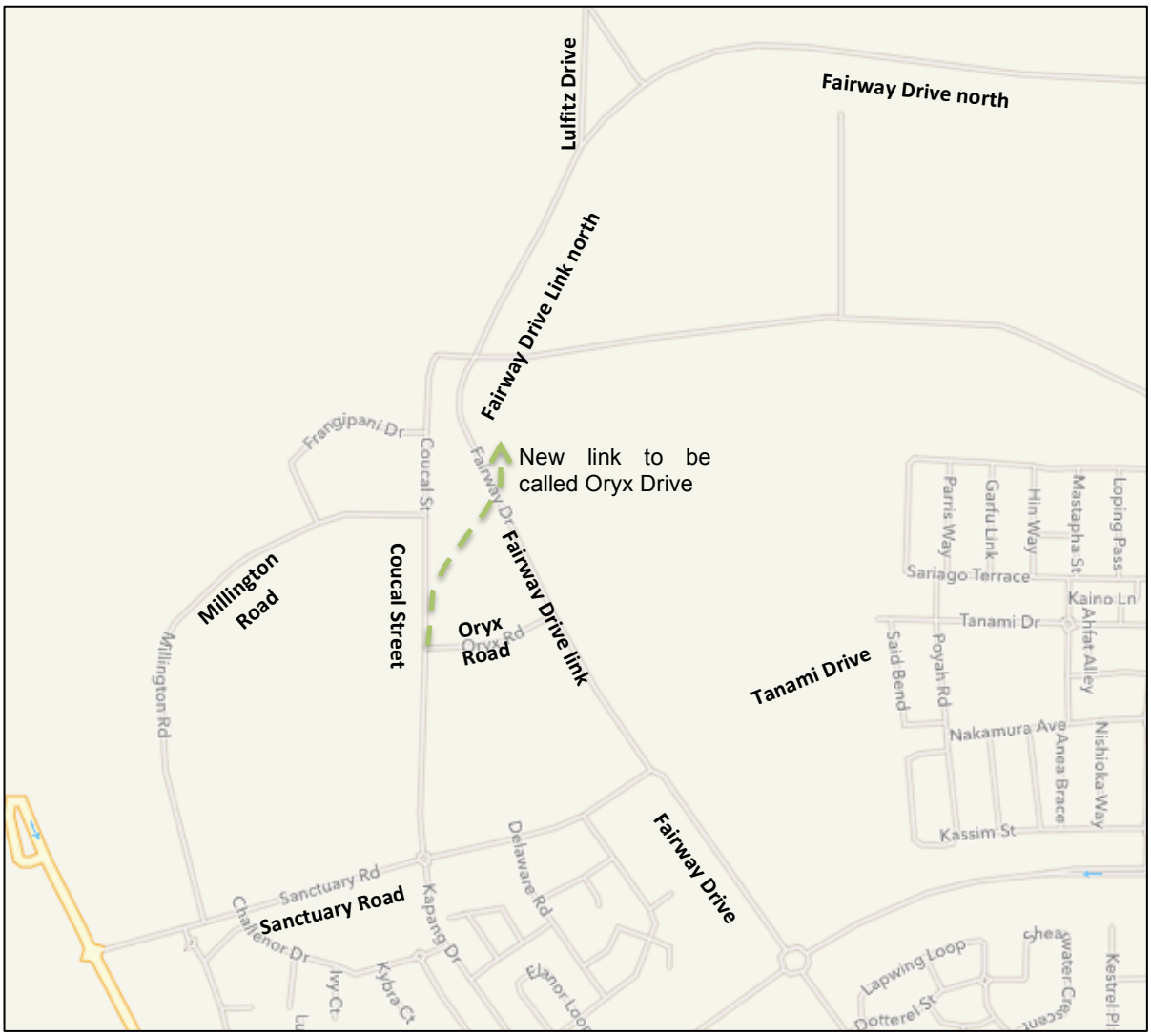


Figure 2 Local Roads

Figure 3 shows the concept plan for the Local Development Plan location 3 (LDP3).



Figure 3 **Site Concept Plan (**refer to planners for detail)

3.0 TRAFFIC GENERATION AND DISTRIBUTION

The development of residential land within the LDP3 area is expected to yield 857 dwellings, comprising a mixture of urban, suburban and bush style lots.

Reference to trip generation source documents suggests that the trip generation of a typical household can vary from 5 trips to 11 trips per day. Previous studies for the locality have used a trip rate equal to about 9.2 trips per dwelling per day, which is a reasonable assumption for the locality. A lower trip rate may mature, but the use of a higher level of trips will provide a robust assessment.

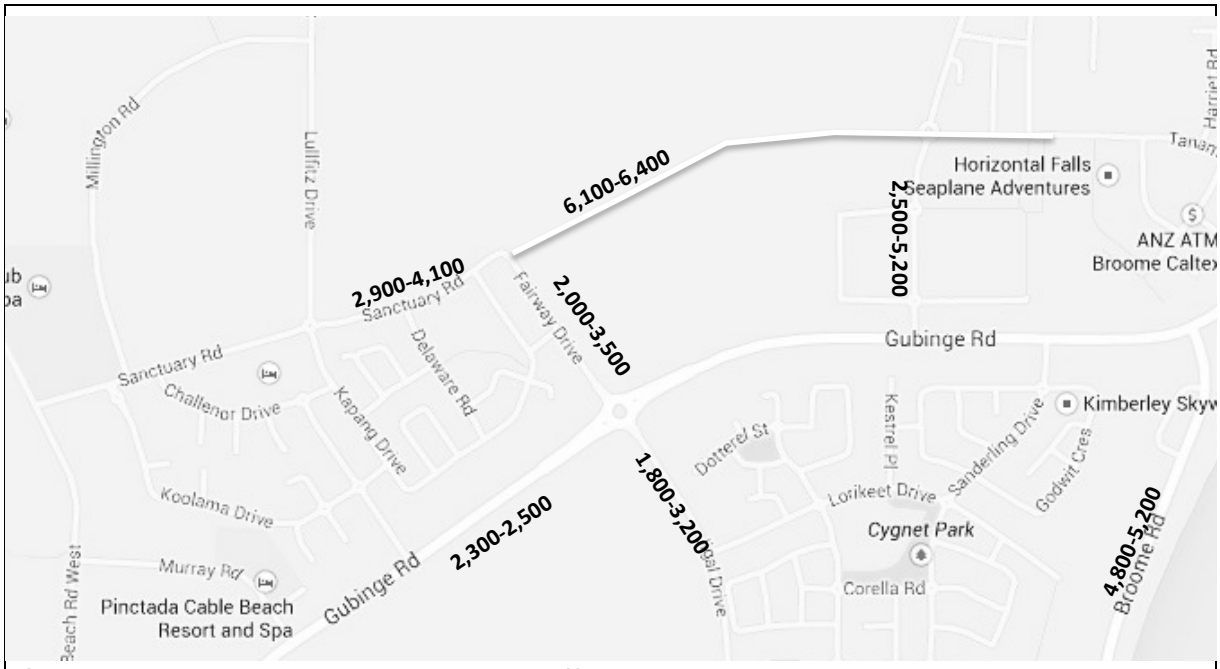
The concept plan indicates a yield of 857 residential lots and on the basis of 9.2 trips per lot, can be expected to generate (857 x 9.2) 7,884 vehicle movements per day.

Distribution

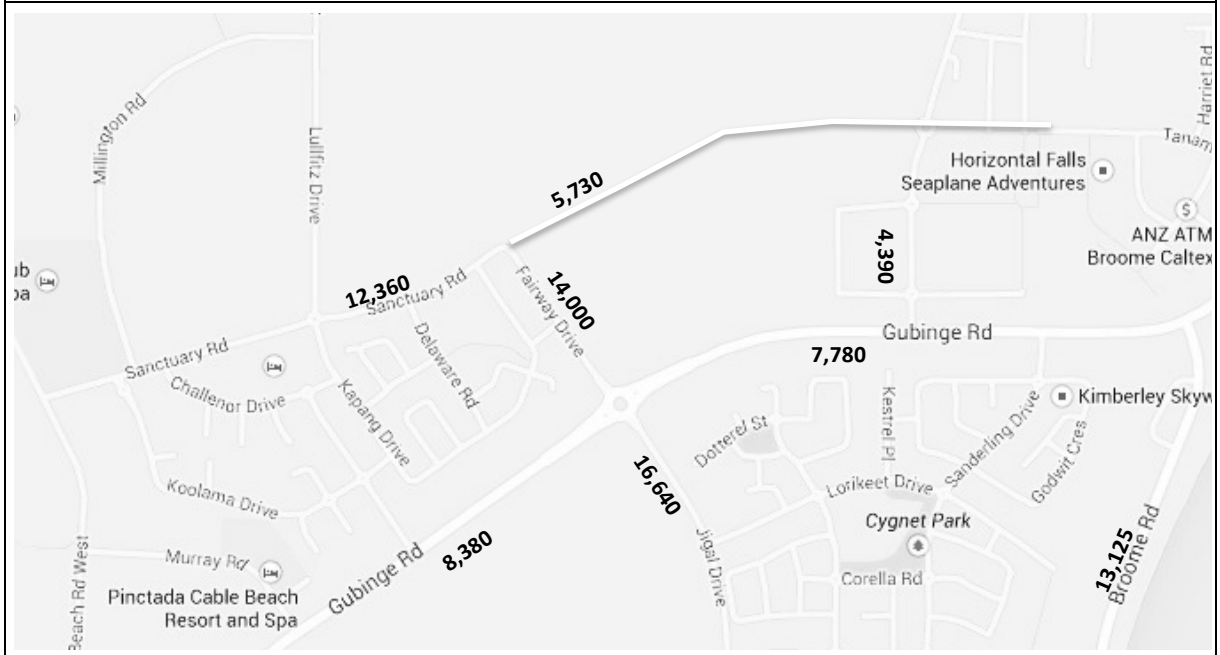
The distribution of traffic generated by the development of new dwellings in Broome North is based on the assumptions used in the District Development Plan. For the purpose of modelling, the trip purpose is used and traffic assigned to internal or external zones using a distance / speed / capacity model. The model assigns education based trips at 0.55 trips per lot to primary schools and 0.25 trips per lot to secondary schools. Local commercial activity is included as well as internal attraction to the industrial area developed as part of LDP1. 5% of the development traffic generation is assigned to Cable Beach and the remaining external trips to LDP3 are assigned: 5% to Broome Road / North West Coastal Highway; 60% to the town; and 30% to the port locality.

4.0 LONG TERM TRAFFIC DEMANDS

Assessment of the District Development Plan (DDP) has previously been undertaken by SKM and Uloth and the traffic forecasts for 2031 and 2051 are reproduced as Figure 4 and extracts attached in Appendix B. The forecasts include the full development of Broome North (including LDP3) as indicated by the structure plan attached as Appendix B.



SKM Recommended 2031 Forecast Traffic Ranges



SKM 2051 Ultimate Development Traffic Forecasts

Figure 4 DDP Traffic Forecasts (See attachments at Appendix B)

The DDP indicates that Fairway Drive will be continued north from Sanctuary Road to provide a connection through to Lulfitz Drive and thence east to service the northern area of Broome North. Initial traffic modelling as part of this study has been undertaken with the indicated alignment of Fairway Drive in the DDP. The model identified a major traffic attraction. Indicatively, the alignment shown in the DDP (refer Appendix B) would result in about 7,000vpd using Fairway Drive adjacent to the bush living and conservation area.

To the north of LDP3 future development will occur and Fairway Drive would be the primary beach access road. The project team considered that there are significant benefits in limiting the traffic demand on Fairway Drive, so that a safe pedestrian / cycle route can be developed to Cable Beach. Following discussions with the Shire of Broome, the concept plan shown as Figure 3 was developed to address local and district level issues.

5.0 DEVELOPMENT TRAFFIC IMPACTS

The final concept plan developed for LDP3 as indicated in Figure 3 and has been input into the model to derive the forecast daily traffic movements. The traffic model includes the current and future developments of Broome North so that all external through movements from future development can be identified that will affect internal roads to LDP3.

The modelling of LDP3 is shown as Figure 5[1]. Figure 5 does not show the long-term traffic movements external to LDP3.

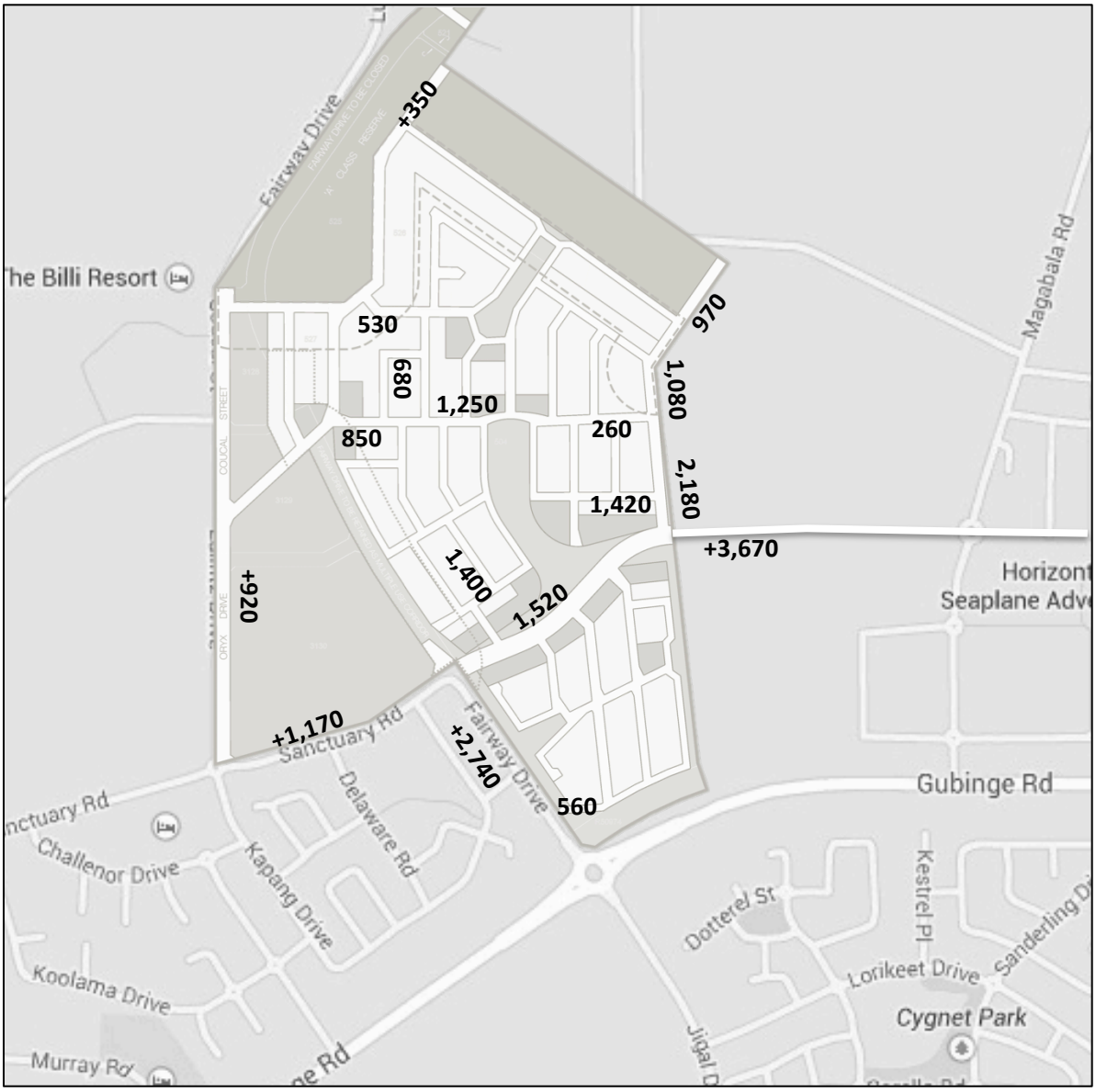


Figure 5 LDP3 Traffic Volumes (2031 and 2051)

[1] The modeling is based on the indicative DDP road layout and may change with future planning.

Table 1 shows the potential impacts of LDP3 to the road network in terms of Levels of Service (LoS).

Table 1 LDP3 Traffic Impacts to Current Levels of Service

Road	Daily Flow	LoS	LDP3	LoS
Gubinge Road east	2,672	B	+3,630	C
Gubinge Road west	2,672	B	+2,020	B
Fairway Drive (south)	2,720	B	+2,740	C
Sanctuary Road	2,720	B	+1,170	B
Tanami Drive	-	-	+3,670	B
Coucal Street (Oryx Drive)	@1,000	A	+920	A
Millington Road	@500	A	0	A

The LoS is based on Appendix B

Table 1 indicates that acceptable Levels of Service can be maintained on all roads. The only road that can be expected to experience a decrease to present day Levels of Service is Fairway Drive north of Gubinge Road. As the primary access road to the Cable Beach precinct, the increase is expected and acceptable Levels of Service are retained.

Long Term Traffic Forecasts for LDP3

Although the DDP has assessed the external road network in regard to the ultimate volumes anticipated by 2051, it is known that the development of LDP3 and the reduced focus on Fairway Drive can be expected to result in other traffic passing through the study area. Attached as Appendix C is an extract of the traffic model showing the full impact of the DDP development upon LDP3.

The traffic modelling indicates a potential for traffic to use internal higher order streets within LDP3 to reach Gubinge Road. Assessment of the internal road requirements is based upon the long-term traffic forecasts to ensure a robust and appropriate road network. Figure 6 shows the long-term traffic volumes within LDP3 with the full development of Broome North.

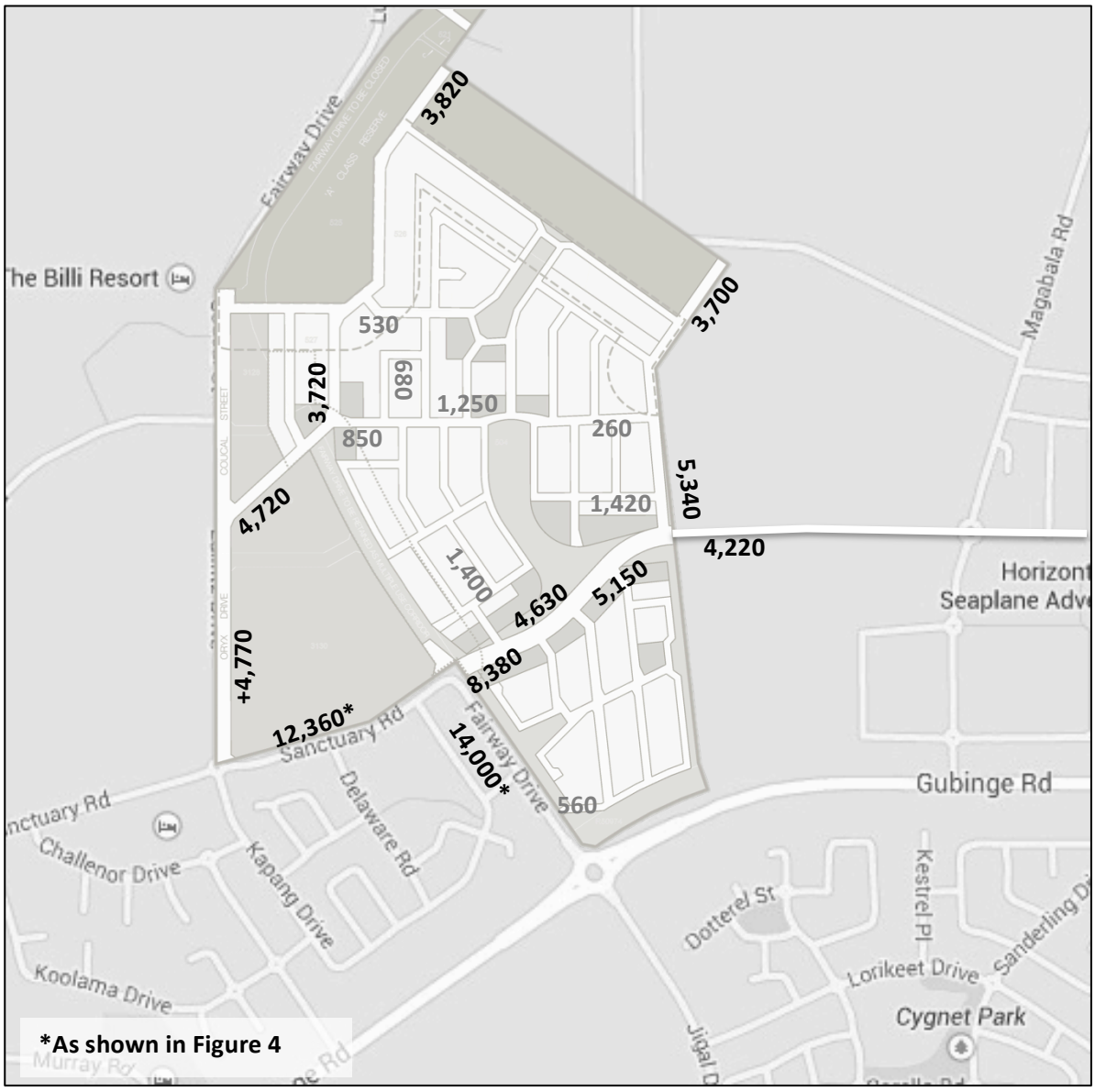


Figure 6 Ultimate Development of Broome North Traffic Volumes (2051)

6.0 ACCESS

Access to LDP3 will be taken (initially) from Tanami Drive and the future Fairway Drive / Oryx Drive link. Affected intersections are assessed as follows.

Fairway Drive / Tanami Drive / Sanctuary Road

The extension of Tanami Drive through LDP3 to Sanctuary Road will result in a three-way intersection at Fairway Drive. The location of this future intersection is currently a 90^0 bend between Fairway Drive and Sanctuary Road.

The addition of a third approach will be an extension of Sanctuary Road and it would be expected that traffic travelling north on Fairway Drive would yield (this movement is currently uninterrupted). However, traffic demands would result in a high right turn movement from Sanctuary Road to Fairway Drive and Austroads suggests priority should be retained by the major movement. On this basis, Tanami Drive should yield to traffic on Sanctuary Road / Fairway Drive. It is considered that such an intersection arrangement would be detrimental to local road safety.

To the north of Fairway Drive (on the old road alignment) access to a tourism site has been proposed and such access would result in a four-way intersection. It is evident therefore that the Tanami Drive / Sanctuary Road intersection will be best served by the introduction of a roundabout. A standard MRWA design roundabout to cater for buses would be a suitable layout. An indicative layout is shown as Appendix D.

Appendix E shows Sidra analysis of the suggested roundabout based on the long term traffic projections indicated in Appendix C. The analysis indicates excellent Levels of Service (LoS A) can be expected on all approaches during both peak periods.

A roundabout at Fairway Drive / Tanami Drive is shown to operate with excellent Levels of Service based on long-term traffic forecasts.

Coucal Street (Oryx Drive) / Sanctuary Road

The intersection of Coucal Street (noted as Oryx Drive in LDP3) and Sanctuary Road is already provided with a roundabout of a suitable standard. The forecast traffic increases indicate an increase of about 920vpd passing through this intersection. Based on the analysis of the Fairway Drive / Tanami Drive roundabout, which is shown to cater for higher traffic demands, it can be taken that excellent Levels of Service will remain at the Sanctuary Road / Coucal Street roundabout.

Tanami Drive / Neighbourhood Connector #1

As part of the LDP3 development, Tanami Drive will be extended and connected to Sanctuary Road. The main neighbourhood connector of LDP3 will access Tanami Drive to the west of the existing adjacent development. An intersection spacing of 60 metres is provided to the adjacent constructed street in accordance with *Liveable Neighbourhoods* intersection spacing guidelines.

It is proposed to provide a roundabout at this intersection to control traffic flow and speeds along Tanami Drive.

7.0 THE INTERNAL ROAD NETWORK

The traffic model has been used to determine the anticipated daily traffic flows on local streets with the full development of LDP3 and Broome North so that external movements through LDP3 are identified. Appendix C shows the modelled forecast flows and based on *Liveable Neighbourhoods* traffic flow ranges, the model has been used to identifiy suitable street types to determine a suitable road hierarchy for LDP3.

The forecast traffic flows provide a basis to develop an internal road hierarchy for LDP3 that is cognisant of all future development within Broome North. Table 2 reproduces the advice on road types recommended by *Liveable Neighbourhoods.*

Table 2 *Liveable Neighbourhoods* Road Hierarchy

Indicative Daily Traffic Flow*	**Designation**	**Street Characteristics**
< 1,000 vpd	Access Street type D	*Narrower access streets with a pavement of 5.5m to 6m are appropriate in locations further away from centres where traffic flows are generally less than 1,000 vpd and a low on-street parking demand exists.*
Up to 3,000 vpd	Access Street Types A-C	*Wider access streets with a pavement of 7.2m+ cater for higher traffic volumes and are located closer to neighbourhood centres.*
Up to 7,000 vpd	Neighbourhood Connectors	*Ideally 2-lane undivided roads. These are 'special' streets and their design needs to have regard to context, function and adjacent land uses.*
Up to 20,000 vpd	Integrator Type B	*Typically will have 1 clear lane of travel in each direction and a parking / manoeuvring lane.*

* Function of streets needs to be considered as well as traffic volume.

The road hierarchy considers those streets that have a connective function and assigns an appropriate classification based on volume and continuity of movement.

Figure 7 shows the suggested road hierarchy for LDP3.

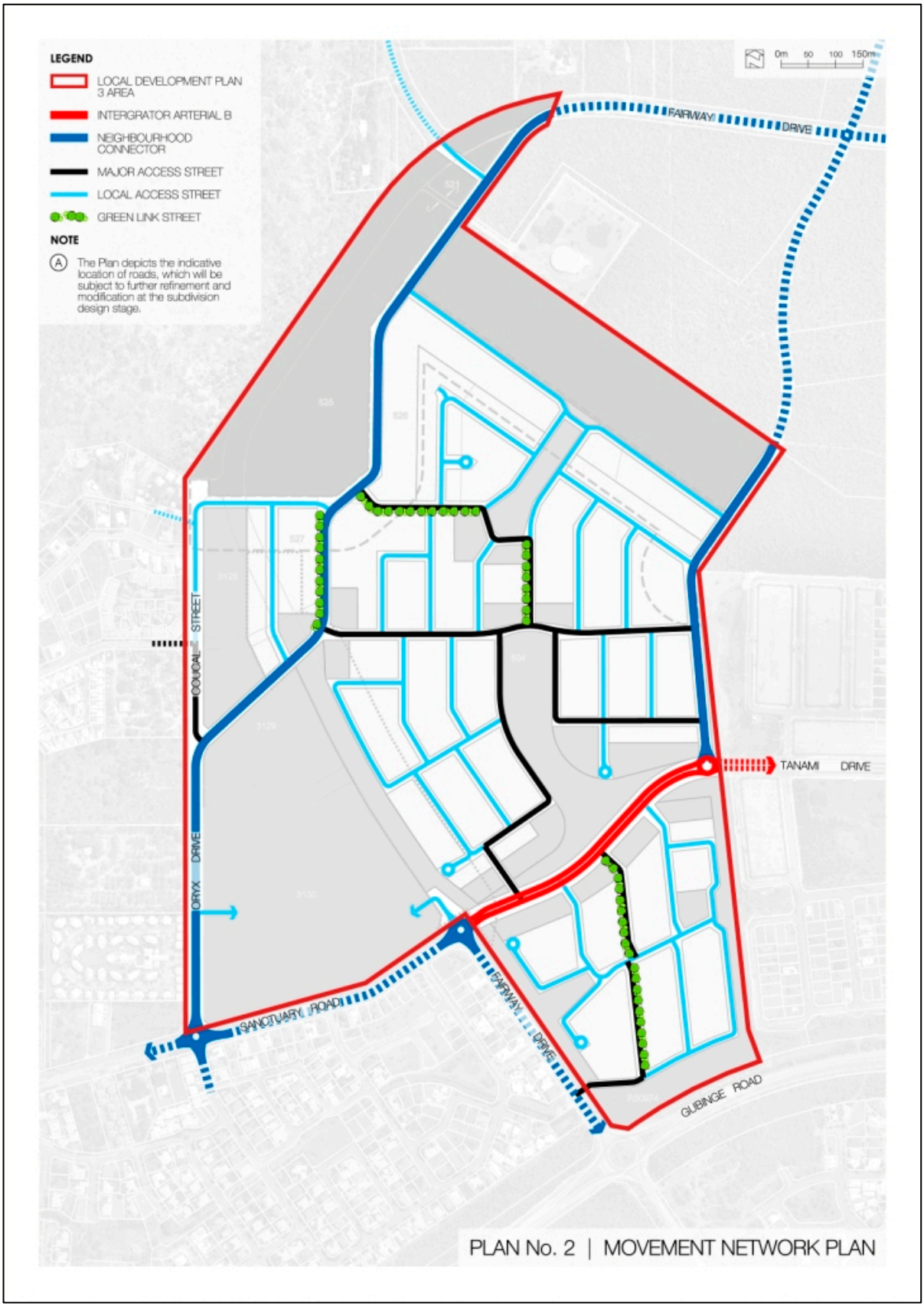


Figure 7 Broome North LDP3 Road Hierarchy

The following section provides guidance on the suggested hierarchy with regard to reserves and cross-sections. The cross-sections indicated are the minimum widths recommended for the various street types. The philosophy of providing constrained streets is to encourage a slower speed environment, although a wider reservation may be used to suit the character of the development and increase the opportunity for landscaping and frontage activity. Within the LDP3 precinct, local road reservations may vary at subdivision to accommodate drainage requirements.

Integrator Arterials

Trafic forecasts on Tanami Drive are generally within the ranges suited to a neighbourhood connector. However, previous planning of the locality has identified Tanami Drive as an Integrator Arterial street linking to Sanctuary Road (this implies Sanctuary Road will also be an intergator road).

The extension of Tanami Drive, shown red in Figure 11, will be an integrator street and a minimum road reservation of 29.2 metres would be required under the *Liveable Neighbourhoods* guidelines. Tanami Drive will be provided with a 40.0 metre road resveration. Figure 8 shows the indicative cross section for Tanami Drive.

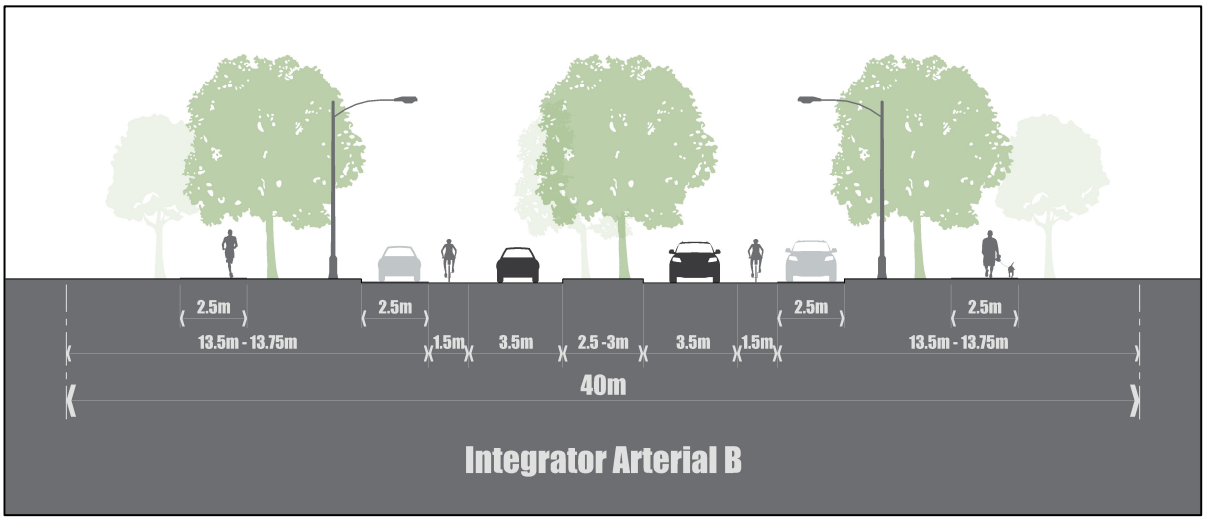


Figure 8 Tanami Drive Cross Section

Neighbourhood Connectors

Liveable Neighbourhoods provides the following comment on neighbourhood connectors:

> *"Neighbourhood connectors link neighbourhoods and towns, are carefully designed to calm traffic, limit noise and facilitate pedestrian use. They have frequent local street connections. They should not attract substantial long distance through traffic,*

but provide for safe and convenient local travel to and from arterial routes, usually at signal controlled intersections".

Roads shown dark blue in Figure 11 are considered as neighbourhood connectors as they provide the primary access to the Local Development Plan area. Daily traffic flows on these roads are well within the 7,000 vehicles per day recommended. *Liveable Neighbourhoods* requires that a road reservation between 19.2 metres and 24.4 metres be provided. Figure 9 shows a typical cross-section for neighbourhood connectors in LDP3.

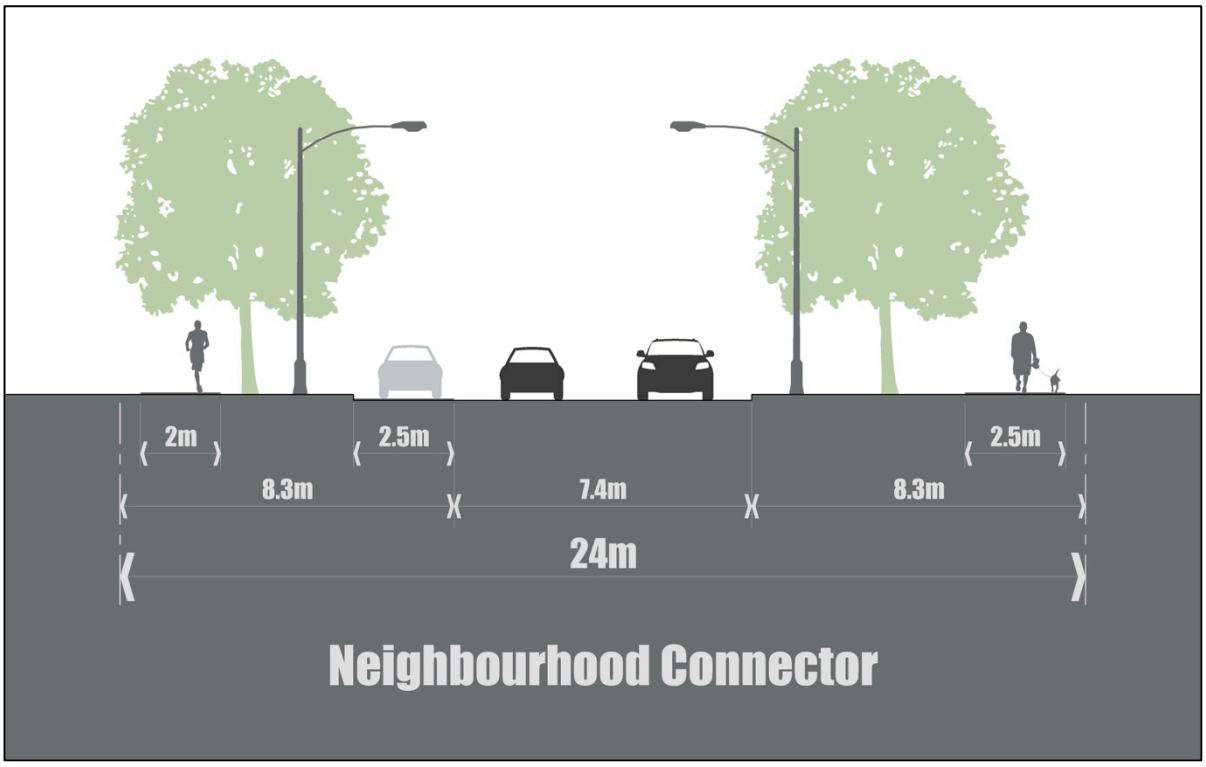


Figure 9 Neighbourhood Connector Cross Section

Where required at intersections, median islands of 2.0 metres width would be desirable to provide safer pedestrian crossing points and to highlight the intersection. A residual verge width of an appropriate standard is maintained.

Access Streets

Access streets are the main residential streets within the development and provide direct lot access. A typical access street would be provided with a 6.0 metre to 7.4 metre carriageway depending on bus routes and Local Government requirements. It is recommended however, that the lower carriageway width be provided to encourage a slower speed environment as many streets with 7.0+ metre carriageways and low density lots frequently experience traffic

speeds well in excess of the posted 50kph limit. A reduced carriageway width will assist in achieving a more appropriate 40kph typical travel speed.

Liveable Neighbourhoods requires access streets to be provided with a road reservation of 14.2 metres to 24 metres, depending on the function and density of the adjacent built form. Figure 10 shows a typical cross section for a major access street in a 20 metre road reservation.

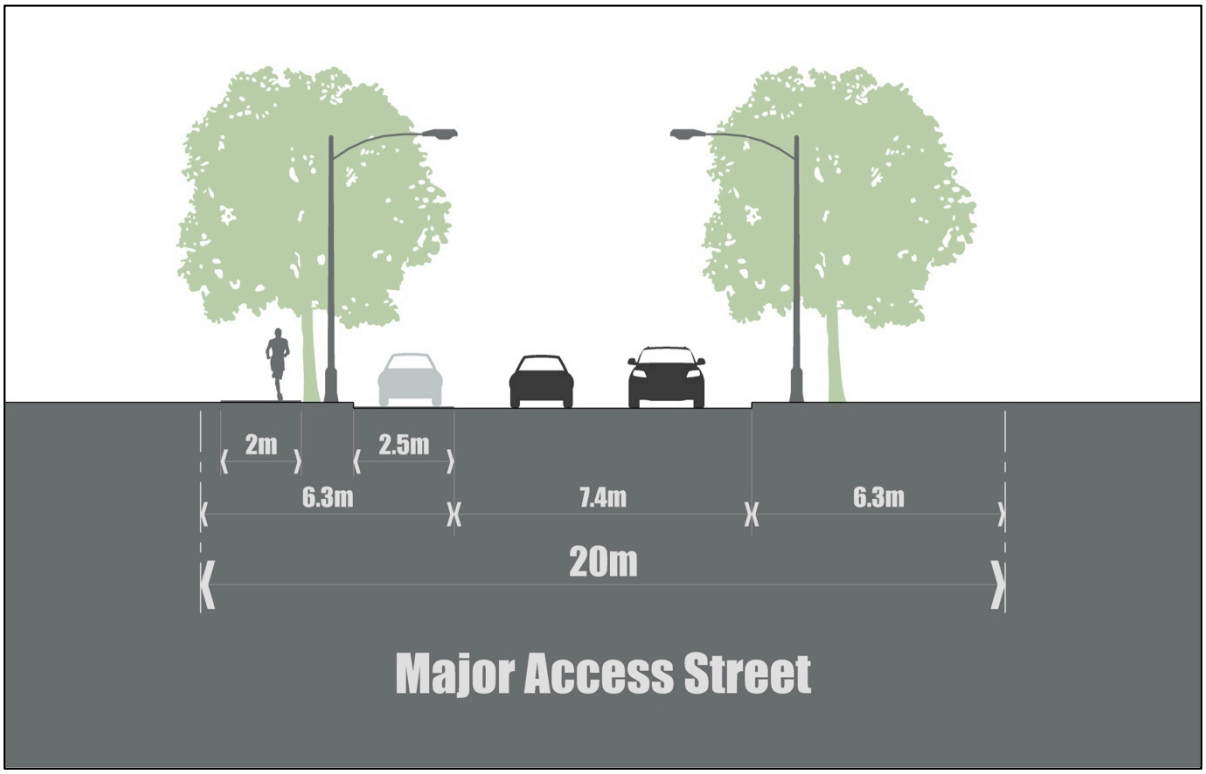


Figure 10 Access Street 20 Metre Road Reservation

Access streets with daily traffic flows of less than 1,000 vehicles are suited to a 6.0 metre carriageway. There should be no need to provide medians in these low volume streets. Should a wider carriageway be required of 7.2 metres (not recommended), then on-street parking should not need to be embayed, unless adjacent lot densities are greater than R40.

Whilst *Liveable Neighbourhoods* permits a road reservation of 14.2 metres for these streets, it is understood that the Shire of Broome prefers an 18 metre road reservation. Figure 11 shows a typical cross section for an access street with an 18 metre road reservation.

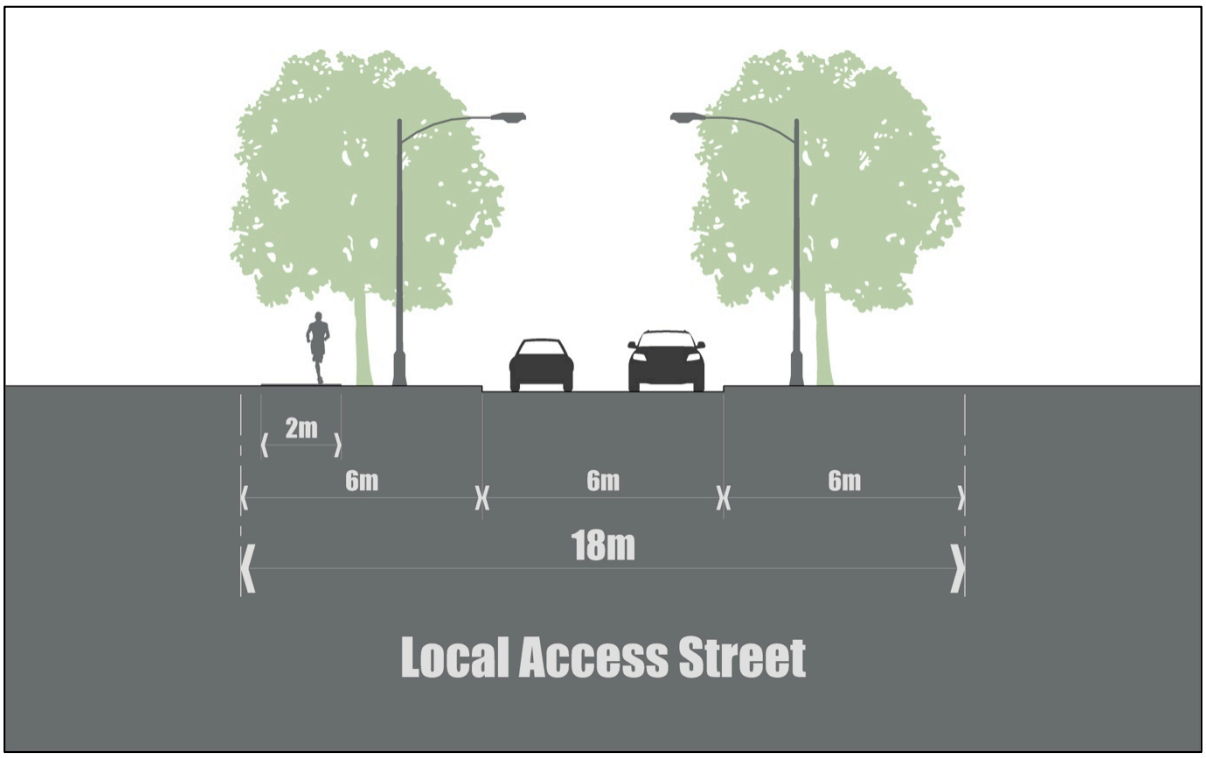


Figure 11 Access Street 18 Metre Road Reservation

Roads Adjacent to Open Space

Where the road reservation abuts POS or bushland etc., there is limited need to provide a verge. The verge may be reduced where parking and/or services are not required and should be considered at the time of subdivision. A minimum verge of 1.0 metre is allowed under *Liveable Neighbourhoods* but a 2.75 metre minimum verge has been used in Broome North and will be used in LDP3. Footpaths do not need to be adjacent to the road where POS is provided, but must be provided in a safe and appropriate manner.

Four-way Intersections

Within the Local Development Plan area daily traffic volumes are shown to be low and the use of four-way intersections is appropriate. Figure 12 shows an extract from *Liveable Neighbourhoods* on the preferred treatment of four-way intersections.

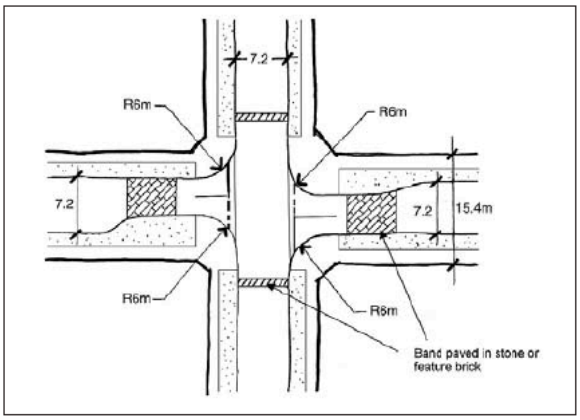


Figure 29A: Access street to access street with-four way and stagger.

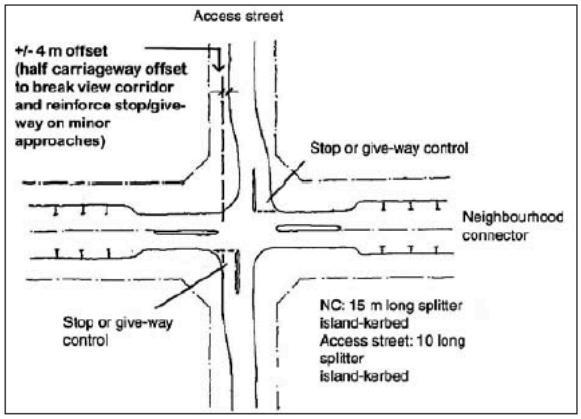


Figure 31: Left-right minor offset four-way on neighbourhood connector (derived from Austroads Guide to traffic engineering, Part 5 Intersections, Figure 5-8).

Figure 12 *Liveable Neighbourhoods* Four-way Intersections

Liveable Neighbourhoods suggests that four-way intersections are an appropriate treatment at the meeting of two access streets and where daily flows through the intersection are less than 2,000vpd. Approach legs should be limited to a maximum length of 160 metres with some form of speed reducing feature where the length is greater than 80 metres.

Access streets meeting neighbourhood connectors and some arterial streets are considered acceptable, but will generally require a treatment as indicated in Figure 12. However, introducing four-way priority intersections on arterial streets is not recommended.

Traffic Management

Assessment of the internal road layout indicates that street blocks generally conform to guidance set out in *Liveable Neighbourhoods*. Access streets are typically less than 200 metres and intersections appropriately controlled. There are no road sections that would require the introduction of traffic management to control traffic movements. However, it is recognised that over the LDP3 precinct some form of traffic management may be required to higher order streets. This matter is to be discussed with the Shire of Broome at the time of subdivision.

Corner Treatments

To reduce the opportunity for speeding it is recommended that corner radii advised by *Liveable Neighbourhoods* be used within the subdivision. The recommended radii are:

- 6.0 metres - access street / access street intersections
- 9.0 metres - access street / neighbourhood connector

Where larger vehicles are expected, such as buses accessing the school, larger radii may be required and should be considered at subdivision stage.

All streets are of relatively short lengths and high traffic speeds would not be expected. Further, the narrower carriageway widths proposed in low traffic residential streets will assist in reducing the attraction for speeding making a safer environment for local children.

8.0 PEDESTRIANS, CYCLISTS AND PUBLIC TRANSPORT

Broome North provides for a primary school to the east of LDP3, which is a short walk for the majority of households. Tanami Drive will provide for local facilities and should be provided with footpaths to both sides of the street.

Current planning guidelines suggest that all streets should be provided with a footpath wherever possible. Where traffic flows exceed 1,000 vehicles per day, a footpath to both sides of the road is highly desirable. Figure 13 shows those streets where a footpath is required to both sides and / or a shared path.

Cycling

Cycling would be safe on the majority of local streets where traffic flows are less than 1,000 vehicles per day. On the neighbourhood connectors shared paths should be provided to provide a safe alternative to on-road cycling.

Off-street cycle routes are desirable to provide recreational cycling opportunities in the region.

Public Transport

There is an existing private bus service within Broome that accesses Cable Beach, although the service is predominantly provided for tourists. Given the rural nature of Broome, it is unlikely that a full public transport service would be justified. However, planning for a long-term bus service should be considered. Figure 13 shows a long-term route for buses and a 7.2 metre wide carriageway should be provided to these streets.

Local school bus services are expected to be provided and routes should be confirmed with local operators and investigated at the time of local school development.

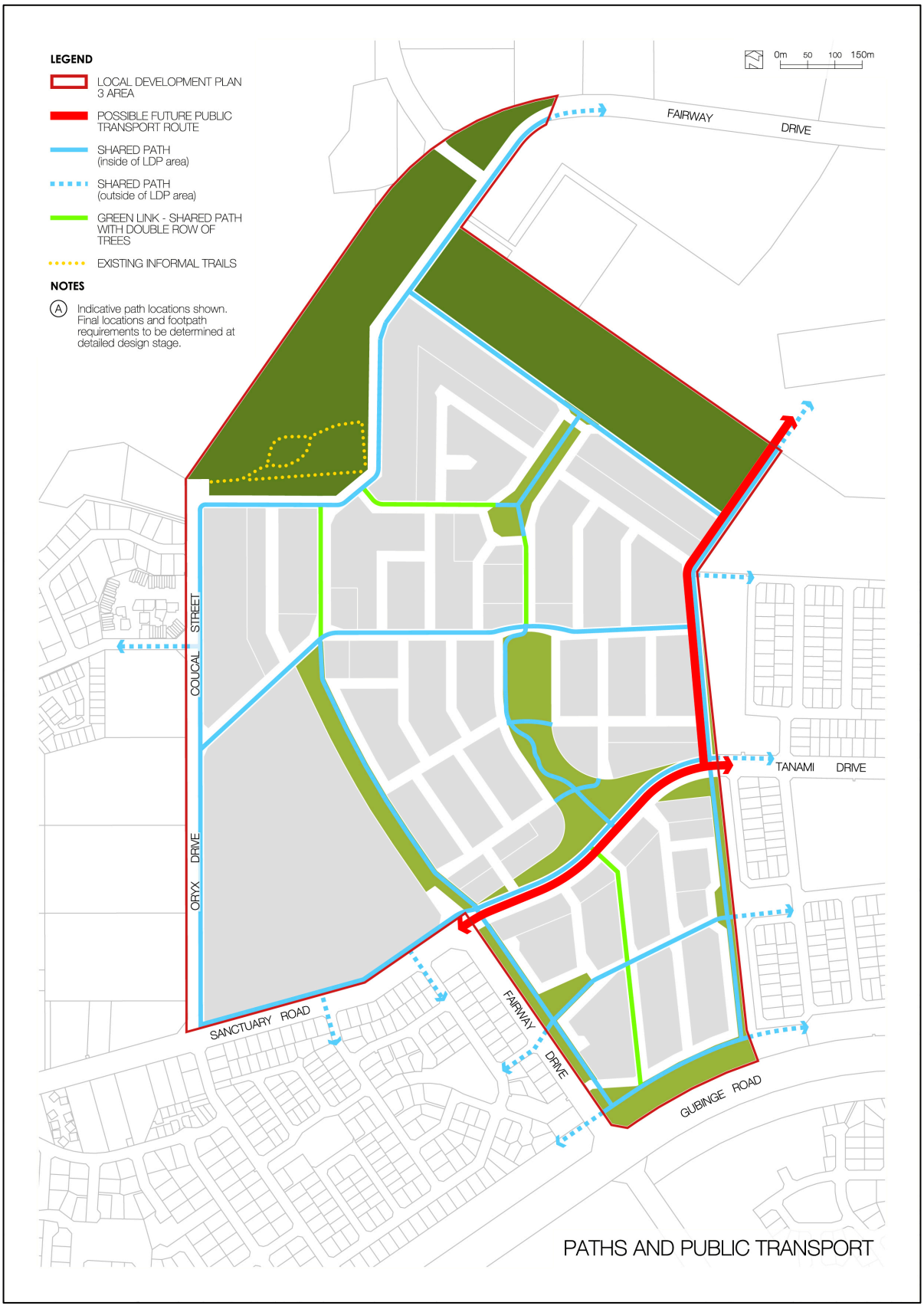


Figure 13 Shared Paths and Future Bus Route

APPENDIX A

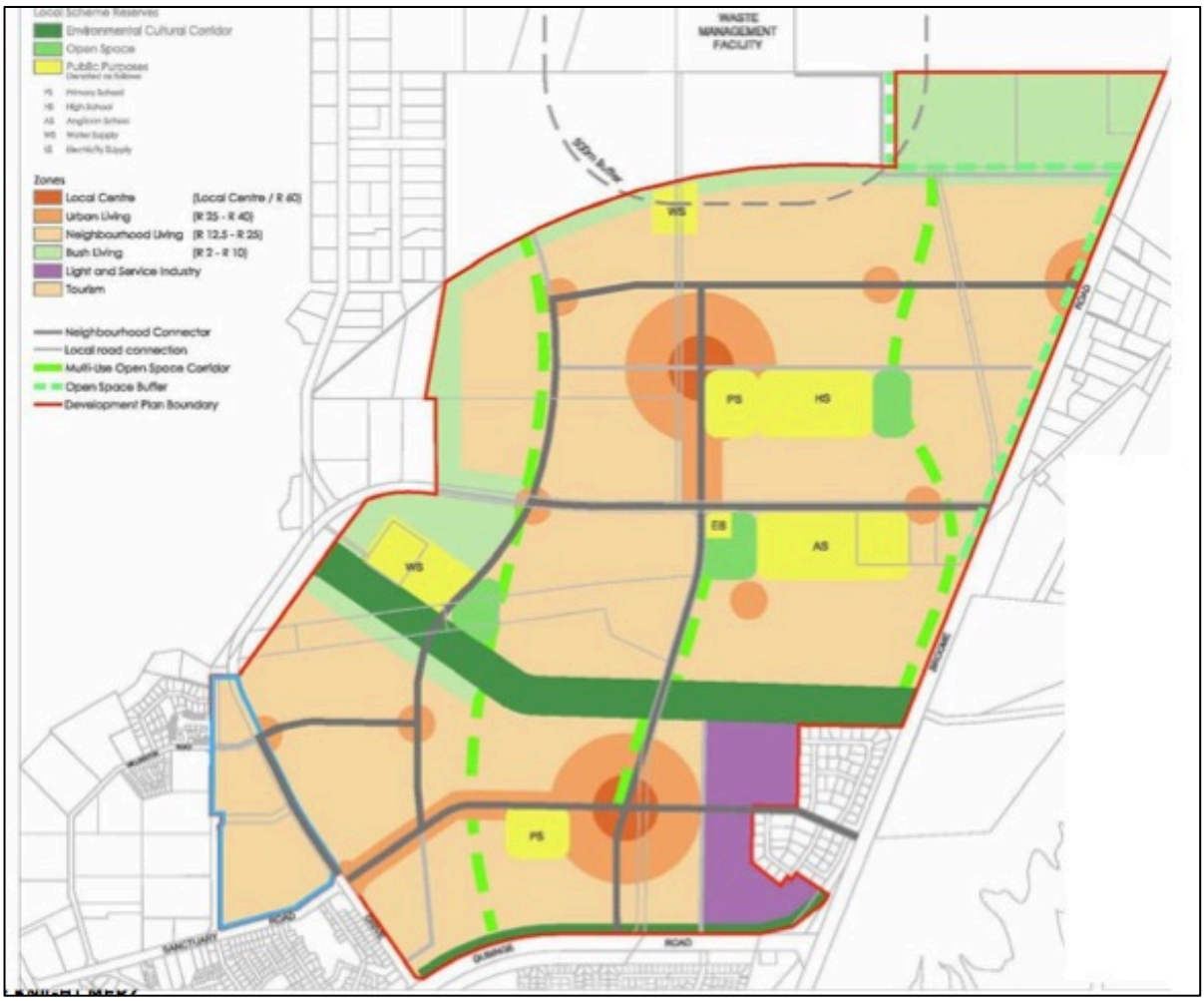
Levels of Service by Road Type

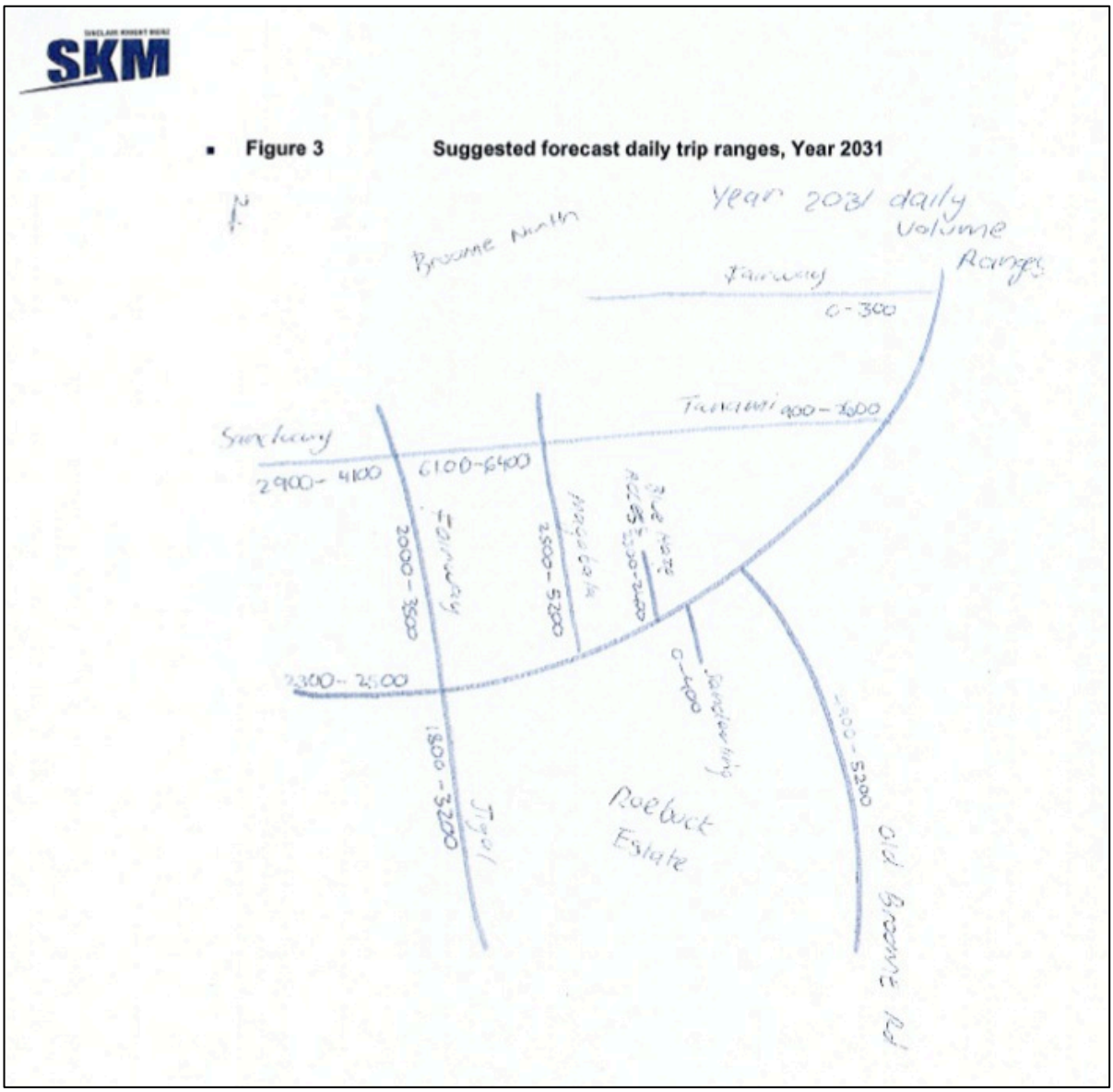
LOS	Single Carriageway[1]	2-Lane Boulevard[2]	Dual Carriageway (4-Lanes)[3]	Dual Carriageway (4-lane Clearway)[3]
A	2,400vpd	2,600vpd	24,000vpd	27,000vpd
B	4,800vpd	5,300vpd	28,000vpd	31,500vpd
C	7,900vpd	8,700vpd	32,000vpd	36,000vpd
D	13,500vpd	15,000vpd	36,000vpd	40,500vpd
E	22,900vpd	25,200vpd[4]	40,000vpd	45,000vpd
F	>22,900vpd	>25,200vpd[4]	>40,000vpd	>45,000vpd

[1] Based on Table 3.9 Austroads - Guide to Traffic Engineering Practice Part 2
[2] Based on single carriageway +10% (supported by Table 3.1 Austroads - Guide to Traffic Engineering Practice Part 3) – Boulevard or division by medians.
[3] Based on RRR Table 3.5 - mid-block service flow rates (SF.) for urban arterial roads with interrupted flow. Using 60/40 peak split.
[4] Note James Street Guildford passes 28,000vpd.

APPENDIX B

Broome North District Development Plan (Roberts Day)

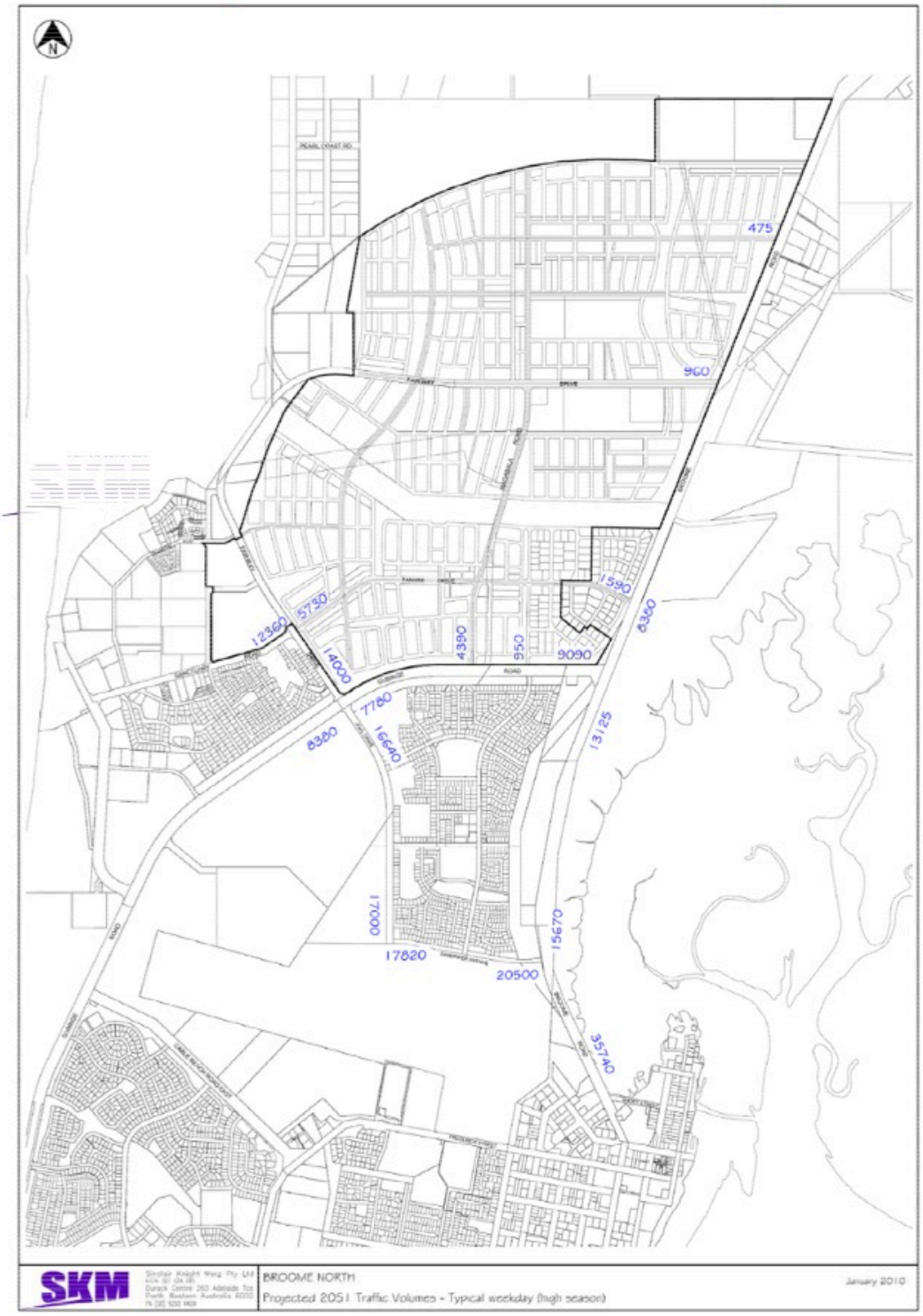




SKM / Uloth Recommended traffic flow ranges 2031 – reproduced as Figure 4

Traffic and Access report

- **Figure 7-3 2051 Forecast Traffic Volumes at Ultimate Development**



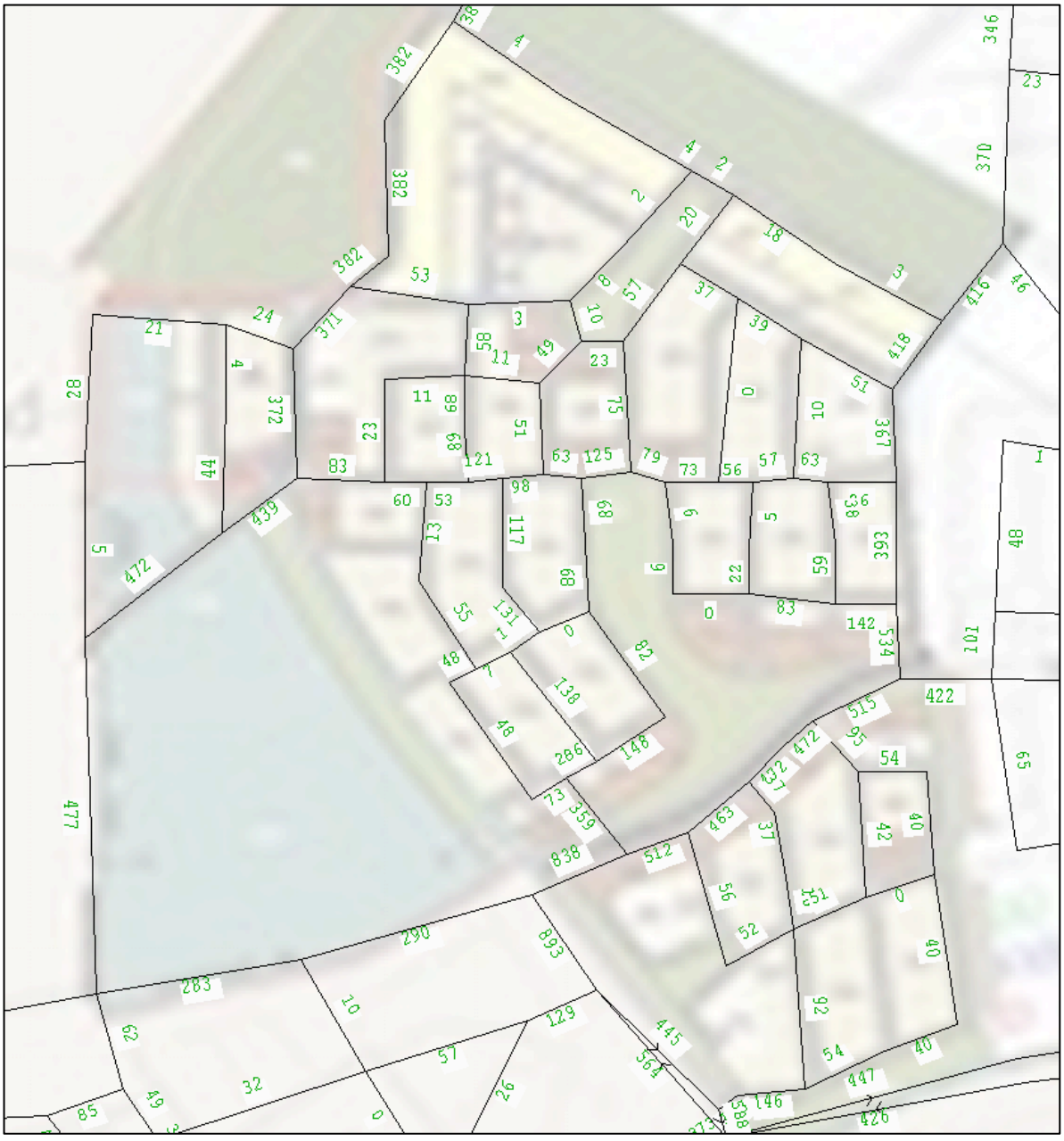
SINCLAIR KNIGHT MERZ

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SKM 2051 traffic forecasts – reproduced in Figure 4.

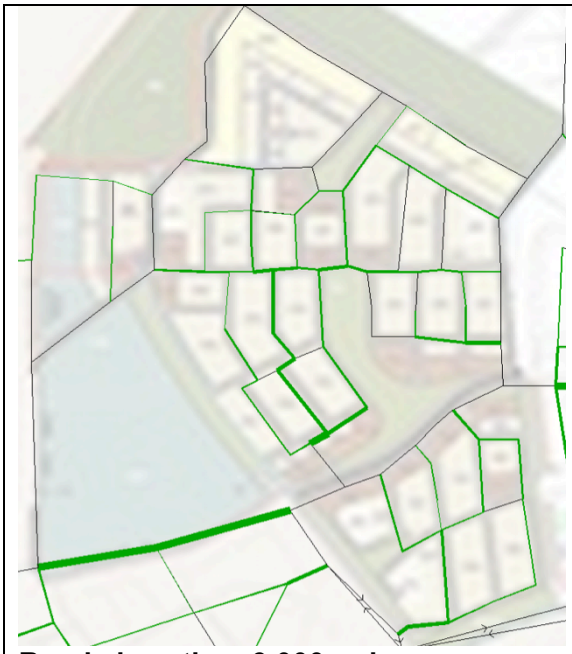
APPENDIX C

LDP3 Modelling with Broome North Fully Developed

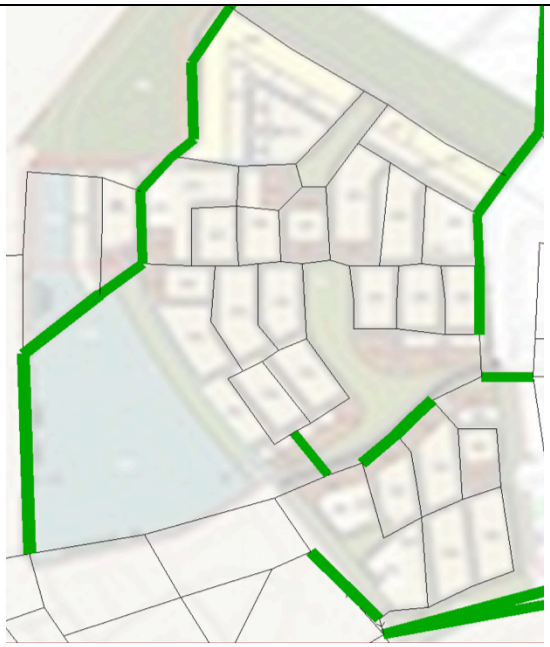


Daily volumes x 10.
Note that the road network is indicative of lower order streets

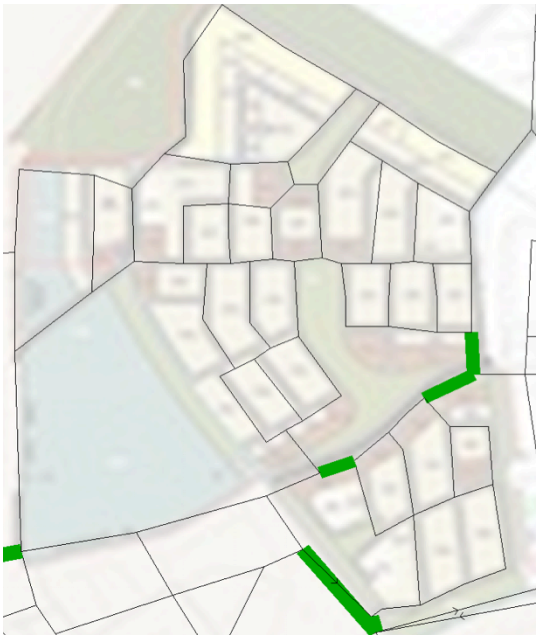
The traffic forecasts shown above are for the full development of Broome North (as indicated by the DDP) and LDP3. The forecasts are used to determine the long term traffic demands on local streets to ensure a robust road hierarchy is provided. The model has identified those streets expected to operate within the traffic ranges set out in *Liveable Neighbourhoods*.



Roads less than 3,000vpd



Roads 3,000-5,000vpd



Roads 5,000 – 7,000vpd

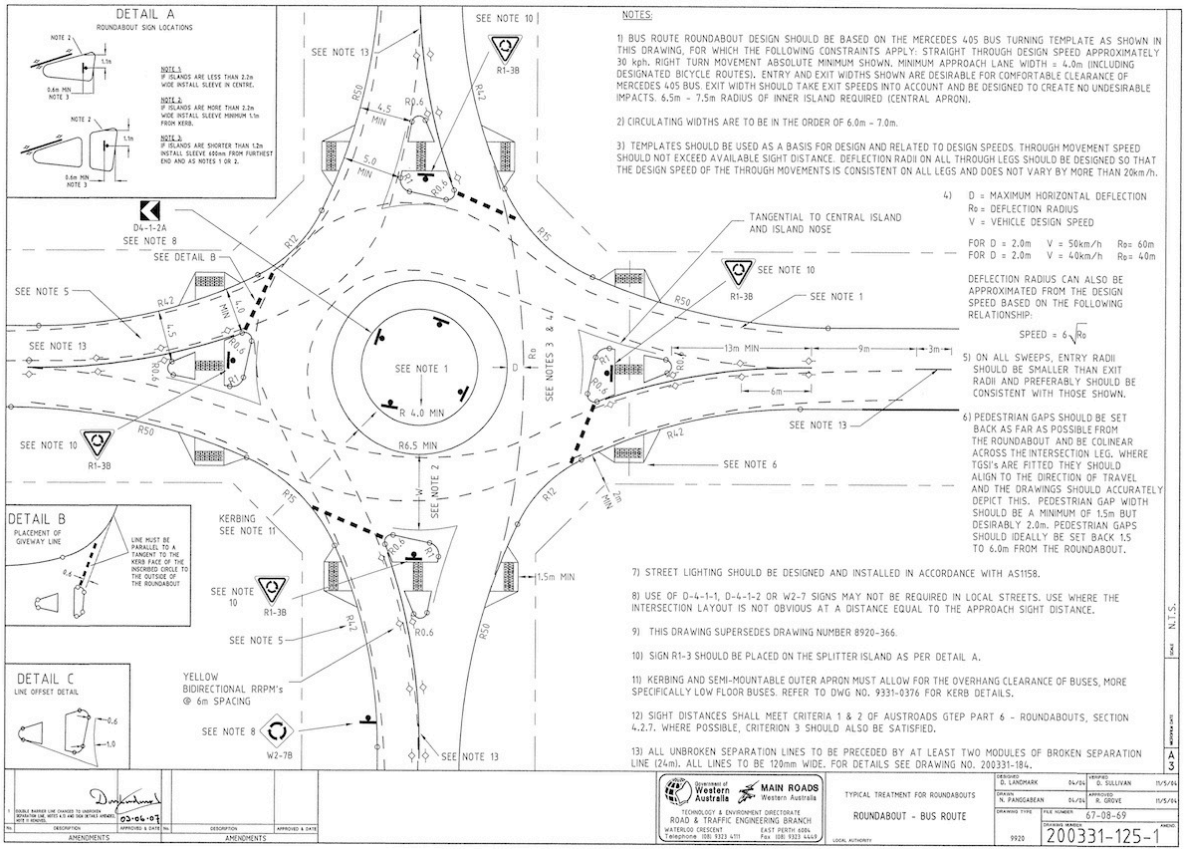


Roads greater than 7,000vpd

Traffic demands based on full development of Broome North (indicative at 2051)

External to LDP3, the forecasts should be considered as expected increases to local traffic volumes. The volumes would apply to the forecast years of 2031 and 2051 if full development has occurred by such years.

APPENDIX D
Standard MRWA Design Roundabout



APPENDIX E
SANCTUARY ROAD / TANAMI DRIVE ANALYSIS

MOVEMENT SUMMARY

Site: Sanctuary AM

Sanctuary Road / Fairway Drive
LDP3 Assessemnt
AM Peak @2031
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Fairway Drive											
1	L	26	0.0	0.120	7.2	LOS A	0.8	5.4	0.17	0.53	49.3
2	T	5	0.0	0.120	6.5	LOS A	0.8	5.4	0.17	0.45	49.8
3	R	134	0.0	0.119	11.2	LOS A	0.8	5.4	0.17	0.68	45.9
Approach		165	0.0	0.119	10.4	LOS A	0.8	5.4	0.17	0.65	46.5
East: Tanami Drive											
4	L	240	0.0	0.209	7.3	LOS A	1.5	10.4	0.23	0.56	49.1
5	T	44	0.0	0.209	6.6	LOS A	1.5	10.4	0.23	0.49	49.5
6	R	1	0.0	0.211	11.3	LOS A	1.5	10.4	0.23	0.74	46.0
Approach		285	0.0	0.209	7.2	LOS A	1.5	10.4	0.23	0.55	49.1
North: Tourist Site Access											
7	L	1	0.0	0.010	8.0	LOS A	0.1	0.4	0.37	0.55	48.3
8	T	5	0.0	0.010	7.3	LOS A	0.1	0.4	0.37	0.49	48.5
9	R	5	0.0	0.010	12.0	LOS A	0.1	0.4	0.37	0.70	45.6
Approach		12	0.0	0.010	9.5	LOS A	0.1	0.4	0.37	0.59	47.1
West: Sanctuary Road											
10	L	5	0.0	0.091	7.6	LOS A	0.6	4.0	0.30	0.56	48.7
11	T	42	0.0	0.091	6.9	LOS A	0.6	4.0	0.30	0.50	49.0
12	R	63	0.0	0.091	11.6	LOS A	0.6	4.0	0.30	0.72	45.7
Approach		111	0.0	0.091	9.7	LOS A	0.6	4.0	0.30	0.63	47.0
All Vehicles		573	0.0	0.209	8.7	LOS A	1.5	10.4	0.23	0.59	47.9

MOVEMENT SUMMARY

Site: Sanctuary PM

Sanctuary Road / Fairway Drive
LDP3 Assessemnt
PM Peak @2031
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Fairway Drive											
1	L	63	0.0	0.247	7.1	LOS A	1.8	12.4	0.12	0.53	49.6
2	T	5	0.0	0.251	6.4	LOS A	1.8	12.4	0.12	0.45	50.2
3	R	313	0.0	0.247	11.1	LOS A	1.8	12.4	0.12	0.69	46.0
Approach		381	0.0	0.247	10.4	LOS A	1.8	12.4	0.12	0.66	46.6
East: Tanami Drive											
4	L	103	0.0	0.088	7.1	LOS A	0.6	4.0	0.15	0.56	49.5
5	T	19	0.0	0.088	6.4	LOS A	0.6	4.0	0.15	0.47	50.1
6	R	1	0.0	0.088	11.1	LOS A	0.6	4.0	0.15	0.76	46.2
Approach		123	0.0	0.088	7.1	LOS A	0.6	4.0	0.15	0.54	49.6
North: Tourist Site Access											
7	L	1	0.0	0.011	8.5	LOS A	0.1	0.5	0.45	0.58	47.9
8	T	5	0.0	0.011	7.9	LOS A	0.1	0.5	0.45	0.52	48.0
9	R	5	0.0	0.011	12.6	LOS A	0.1	0.5	0.45	0.70	45.3
Approach		12	0.0	0.011	10.1	LOS A	0.1	0.5	0.45	0.61	46.7
West: Sanctuary Road											
10	L	5	0.0	0.048	8.4	LOS A	0.3	2.1	0.44	0.60	47.9
11	T	18	0.0	0.048	7.8	LOS A	0.3	2.1	0.44	0.55	48.0
12	R	27	0.0	0.048	12.5	LOS A	0.3	2.1	0.44	0.72	45.3
Approach		51	0.0	0.048	10.4	LOS A	0.3	2.1	0.44	0.65	46.5
All Vehicles		566	0.0	0.247	9.6	LOS A	1.8	12.4	0.16	0.63	47.2

APPENDIX B
LANDSCAPE REPORT

BROOME NORTH LOCAL DEVELOPMENT PLAN 3

Landscape Report REV E JULY 2014





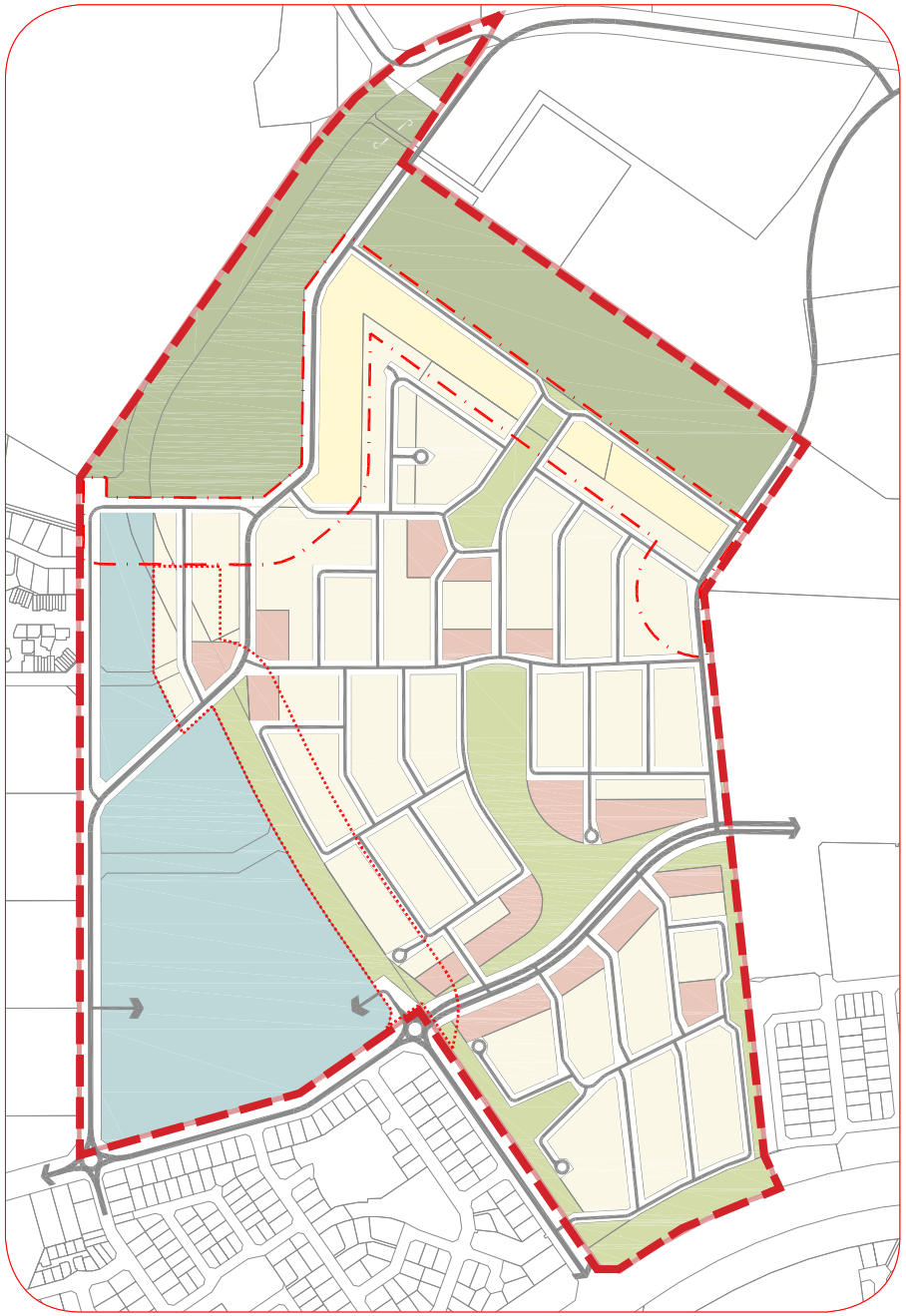
Level 1A 1-3 Josephson Street, Fremantle WA 6160 t +61 (08) 9336 7577 w udla.com.au





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2	CULTURAL ASPECTS	7
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4	WATER CONSERVATION STRATEGIES	9
5	VEGETATION RETENTION	9
6	WEED CONTROL	9
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8	BUSHFIRE MANAGEMENT DESIGN IMPLEMENTATION	10
9	MULTI-PURPOSE CORRIDORS	12
10	LDP3 PARKLANDS	13
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12	PLANT PALETTE	18
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LANDSCAPE

- ECC- Environmental Cultural Corridor
- POS- Public Open Space & Drainage
- Extent of LDP 3

LAND USE

- Bush Living
- Neighbourhood Living
- Urban Living
- Tourism
- Temporary Bush fire Building Attack Level (BAL) 12.5
- Permenant Bush fire Building Attack Level (BAL) 12.5

1 INTRODUCTION

LDP3, the latest LandCorp Estate in Broome North takes full advantage of its idyllic Cable Beach location, nestled into the red soils and rich culture of the stunning Kimberley landscape. Developed in a collaboration with the Traditional Custodians - the Yawuru, the estate aims to form a coastal community seamlessly connected to culture and country. Major bushland tracts define the estate including a 150m wide Environmental Cultural Corridor that runs east - west, across the Broome Peninsula.

The landscape intent of the LDP3 area is to provide a local, cultivated landscape aesthetic, using lawn, existing trees, local earthy materials and public art features. While this aesthetic draws from the more formalised gardens of the nearby resorts, the parklands maintain a strong local theme through the use of the local vernacular. Lawn will be minimised and used to connect and contrast the bushland settings of trees and low planted understory.

A Central Park filled with a myriad of recreational possibilities, including adventure play, cycle and pedestrian networks is situated at the heart of the Estate and a series of Open Spaces are linked to this. All parkland provides prime access to the Kimberley bushland, and experience of living in this rich coastal country Open Space design will use white trunked Cable Beach Ghost Gums, architectural Pandanus and earthy sandstone boulders as a common aesthetic thread/ striking natural element throughout the Estate. Recreational paths will circumnavigate and meander through the estate providing shaded 'Green Links' throughout and beyond the Estate.

This Landscape Report specifically focuses on the provision of new public open space within Local Development Plan 3 (LDP3) through developing unique streetscapes, parklands and multiple-use corridors that sensitively integrate the local drainage condition. The report focuses on retention and supplementation of existing vegetation for cultural, fauna and water quality purposes, and fire management strategies.

Key aspects guiding the landscape design report include:

- Maintaining connections and linkages through the site via multi-purpose and ECC corridors for cultural, community and habitat uses;
- Protecting, diversifying and repairing natural systems so traditional practices and a continued 'lifestyle' can occur alongside urban development;
- Design to experience the coastal bushland location and the rich culture of the stunning Kimberley landscape;
- Bushfire Management Design Implementation;
- Minimise changes to the existing landform;
- Maximise existing vegetation retention and diversify through supplementation;
- Combining recreation, preservation, education/ interpretation and linking urban/ natural drainage systems through multi-purpose corridors;
- The inclusion of interpretation and art opportunities within public open space as part of an overall open space strategy,and;
- Incorporating site specific solutions (such as the provision of shade amenity through consistent street tree planting in medians, alongside roads and pedestrian connections).



2 CULTURAL ASPECTS

The Yawuru people are the Native Title Holders of 530,000Ha of land within the Broome region and for thousands of years their ancestors have lived and travelled along the foreshores of Roebuck Bay, across the pindan plains and along the fringes of the Great Sandy Desert. It is understood that the Broome North development including the LDP3 is an important part of a broader cultural landscape which needs to be cared for and respected.

Respecting and retaining the Yawuru's strong connection and relationship to 'country' is therefore an essential consideration of the streetscape and public open space design. Through ongoing dialogue with local Yawuru people initiatives to maintain an unbroken traditional 'lifestyle' with continual access to the land will be established.

Sensitive cultural design include locally empowered initiatives such as:

- The creation of an Environmental Cultural Corridor (ECC) for continual connection and movement east west across the Broome Peninsular connects the significant Cable Beach dunes with Dampier Creek and Roebuck Bay;
- Local Yawuru artists and cultural/environment custodians informing open space design outcomes and the use of local materials;
- Engaging local Traditional Custodians to instruct on retention and supplementation of vegetation including species selection; and,
- Instruct on maintaining existing drainage systems within and downstream of the development.

The non-indigenous community identify with a specific character for Broome which involves climate, an outdoor lifestyle, multiculturalism and tourism. Responding to these characteristics involves 'open plan' designs which allow for breezeways, multi-purpose active and passive open spaces, shaded, dual-use walkways to encourage community interaction, and activated streetscapes. All of these features capitalise on the outdoor lifestyle and coupled with adopting sustainable engineering practices, promotes the local environment and visual experience of Broome.

The streetscape and public open space design is to be further informed through consultation and engagement with key members of the community. This not only ensures the views and requirements of the community are addressed, however aids to foster local pride and ownership, with the public open spaces less likely to fall victim to vandalism and neglect as a result.

3 URBAN WATER MANAGEMENT

The streetscape and public open spaces of LDP3 form an integral part of the water management strategy of the Broome North development.

In broad terms, the excess urban water run-off is directed from housing lot frontages directly onto the pavement where it is then transferred via kerbing and outlet devices into endemically vegetated swales within multiple-use open space drainage corridors.

The specialised Northwest designed swale system's main purpose is to transport water across the site and deliver downstream run-off water at a similar quality, velocity and volume as per pre-development. A vegetated retarding swale system reduces the amount of nutrient binding sedimentation leaving the site and the transportation of contaminates such as invasive weeds.

Built structures are utilised to retard and slow water volumes within these swales and include concrete or stone gabion weirs that feature low flow devices such as V notches and low-flow apertures (average 300mm dia.). These weirs are constructed to contain up to 1:10 events with 1:100 events allowed to overflow the structures and prevent upstream flooding. In addition, drop structures are located along the swale floor thus reducing water velocity.

Re-vegetation of the swale systems is a critical factor for Northwest drainage conveyance. Planting plans include Bushfire Management design principles and insure the following;

- Erosion control through stabilisation swale bases and batters;
- Additional bio-filtering of urban nutrients;
- The capture of fine silts that effect the downstream nutrient balance and protect fowling downstream drainage conveyances and waterways;
- Aids in providing natural drainage 'roughness' which reduces the velocity of overland flows; and
- Reduces the distribution of potential contaminates and exotic weeds.

Also vital to water quality, revegetation and protection of the drainage swale system is the use of the local site mulch and topsoil collected prior to site bulk earthworks. Use of local site mulch and topsoil includes an endemic seed bank. This, along with appropriate supplemental planting, is fundamental to maintaining local biodiversity within the development area.





4 WATER CONSERVATION STRATEGIES

Commitment to water conservation is inherent in the design and management of the streetscapes and public open spaces of LDP3 area. Landscape Water Management strategies Include the following:

- Use of endemic species within the development that require a local climate based low water-use and nutrient use regime;
- 80% percent of planting is mostly re-vegetation with temporary drip irrigation and discontinued once planting is established (2 years);
- Lawn areas are minimised. The lawn species is indigenous to the Broome Peninsula (Roebuck Bay Couch) and has low water and nutrient use requirements;
- The irrigation schedule for most planting is daily during a 13 week establishment period and then reduced to irrigating twice a week or less, as required;
- During the maintenance period the assessment of water needs of the plants will be amended on a regular basis and the watering adjusted accordingly;
- Should a residential rebate package be provided, the irrigation to residential street trees shall be established as part of the rebate package and it would be the responsibility of the residence for watering and establishment; and,
- The irrigation systems will be designed in accordance with Shire of Broome Requirements and Specification for pracability and ease of future maintenance.

5 VEGETATION RETENTION

The LDP3 site area features existing vegetation typical of a low and open Pindan Woodland plant ecology with scattered trees and dominate *Spinifex* species grassland. Some *Corymbia paractia* have been identified on site. Retaining as much of this vegetation as possible while adhering to the Bushfire Management Design Guidelines, has many benefits such as:

- Reduced erosion and a reduction in soil run-off into adjacent sites, waterways and the downstream marine ecology;
- Weed control;
- Maintaining flora and fauna biodiversity, including the critical specialised Broome Peninsula habitat;
- Immediate site maturity and a local sense of place;
- Shade and visual amenity;
- Cost savings on clearing;
- Respect of Traditional Owners (Yawuru) ethno-biological connection to 'country' and continuing 'lifestyle'; and
- Allowing for the fast creation of multiple-use open space areas for recreation, drainage, flood control, dual use pathways & linkages etc.

In order to realise these benefits, significant individual trees and low vegetation areas within the LDP3 site area will be identified, surveyed and where possible, integrated into the design of the public open space areas.

6 WEED CONTROL

Any introduced weed species that are identified across the LDP3 site area will be managed under a weed control program. The weed control program is to be developed as part of the landscape management plan. The existence of weeds reflect the extent of disturbance throughout Broome as a result of land clearing, vehicle access, rubbish dumping and surrounding exotic gardens. To reduce the increase and spread of weed species, the following management and control actions should be adopted:

- Minimising clearing where possible (during the construction period);
- Where possible, using existing tracks and roads, preventing uncontrolled access to the site and minimising the number of new tracks required;
- Ensuring cleared vegetation and topsoil (if contaminated with weed seed) is removed and disposed of at Shire approved dump-sites;
- Ensuring all vehicles and machinery are cleaned of plant material and soil before and after entering the site (in particular when working along the perimeter of the site or in areas noted to have an invasive weed presence);
- Imported soils and materials should be certified weed free; and;
- All litter and waste materials should be contained and removed off-site regularly.

General weed mitigation for the area would include the following:

- Manual/ physical selective removal of weeds;
- Weed spraying using the industry's best practice and appropriate regimes (e.g. use non-residual glysophate based herbicide sprays, limit herbicide overspray, herbicide only applied by a by qualified technician, use of an appropriate herbicide near waterways etc.);
- Regular verge slashing of invasive grasses/low shrubs before seeding occurs, and;
- Controlling declared plants under the Agriculture and Related Resources Protection Act, 1976, using recommended methods .

7 ENVIRONMENTAL CULTURAL CORRIDOR

The 150m wide Environmental Cultural Corridor (ECC) running east-west across the site is a Yawuru planning initiative used previously within developments in Broome and was born out of extensive consultation with the Yawuru people. Essentially it is a tract of naturally vegetated land set aside to be retained without development.

The Broome North ECC is intended to provide:

- A buffer between the development and existing infrastructure, or significant cultural areas;
- A habitat for flora and fauna and an opportunity to support biodiversity and natural drainage networks;
- An important cultural and community connection to 'country'. The retention of a substantial portion of local bushland that traverses west to east across the Broome Peninsula provides a mostly unhindered bush connection from the culturally significant Cable Beach dunes to the equally significant Dampier Creek marine wetlands and Roebuck Bay.
- This link provides Traditional Owners (Yawuru) with the opportunity to continue a 'lifestyle' passing on cultural education and traditional practices as historically and presently practiced on this land; and
- A strong sense of place for the development by maintaining this important open space green bushland buffer.

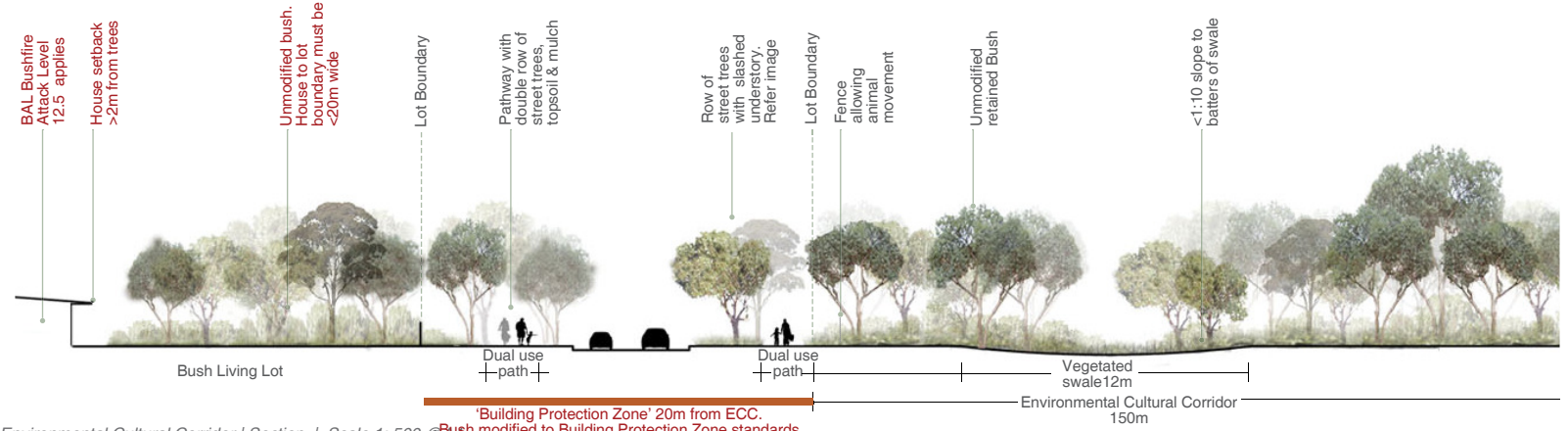
The ECC area will comprise a simple network of low maintenance cleared pindan tracks to enable low key 'lifestyle' and management access only. A rural style perimeter fence around the ECC will also discourage trail bikes and vehicles, considered inappropriate use. Areas that have been degraded through earlier land uses and weed infestation shall be monitored and managed.

This low-key approach also allows for the design of 'creek style' drainage swales within the ECC. The Yawuru have provided permission for drainage to be contained within the ECC but only along the boundaries and to a maximum width of 20m within either side of the ECC boundaries.

8 BUSHFIRE MANAGEMENT DESIGN IMPLEMENTATION

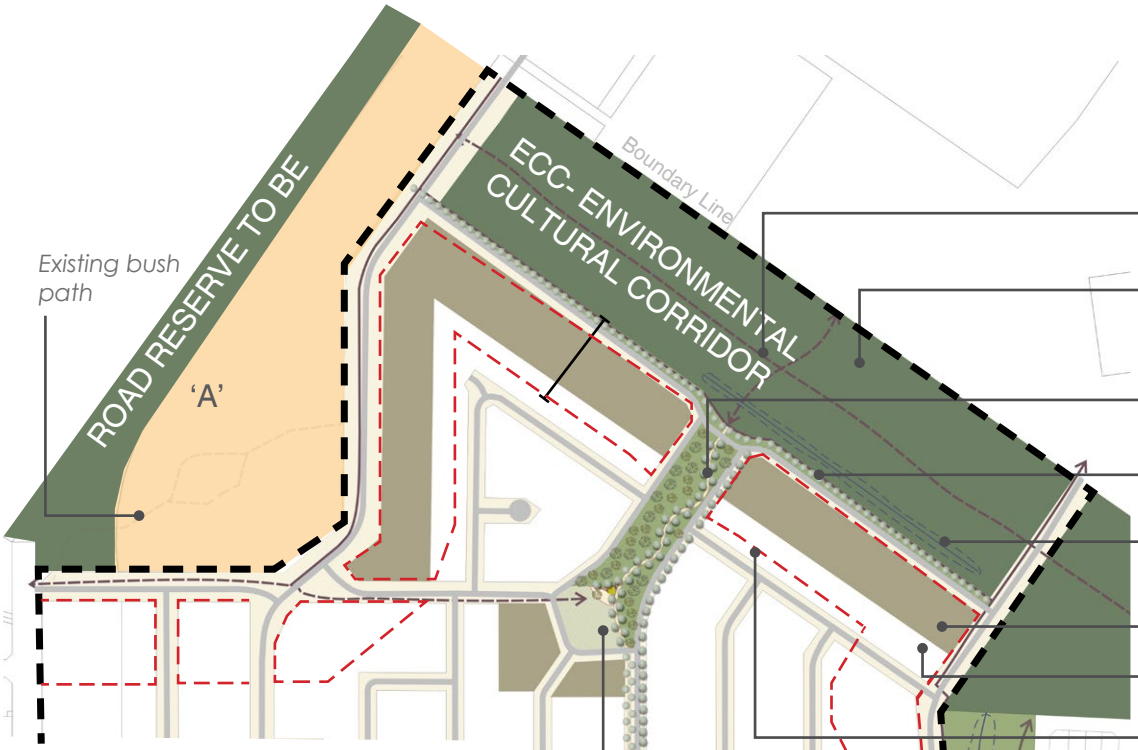
Current bushfire policy and guidelines state that BAL Bushfire Attack Level 12.5 must be applied to all buildings within 100m of unmodified bushland and vegetation is to be modified to create a Building Protection Zone between the ECC and Residential Lots. The dual use pathway running along the ECC lot boundary marks the Building Protection Zone boundary, 20m the from the residential lot boundary. All vegetation(existing and proposed) not in the ECC or in the front of Bush Living Lots must be designed according to Building Protection Zone standards: Trees to be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers. Alternatively, groundcover/ shrubs are not to exceed total fuel load of 2 tonnes per ha (this allows for larger shrubs to be included in planting design). The bush at the front of the Bush Living Lots may remain unmodified if the width of the retained bush does not exceed a maximum of 20m. If this maximum is exceeded, Building Protection Zone Standards must be applied.





Environmental Cultural Corridor | Section | Scale 1: 500 @A4

* Concept only. subject to detail design



* Concept only. subject to detail design

The central bush path to the ECC is a cultural requirement of Yawuru. The exact location of the path will be confirmed during Design Development

Unmodified bushland

Dual use pathway with double row of trees- continuous walkway/ cycling circuit

Dual use path with row of street trees for continuous shade

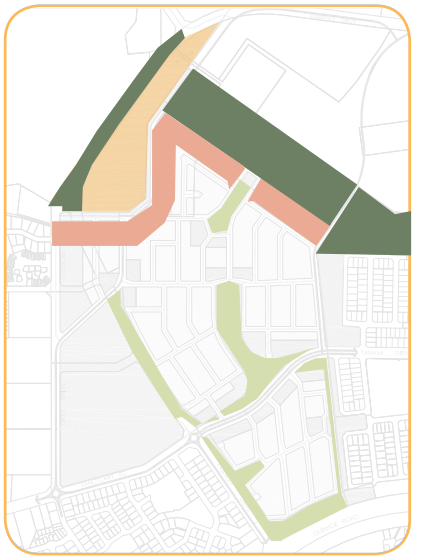
Vegetated swale 15-20m wide with 1:10 grade on batters

Bush Living Lots with large frontage of unmodified bush (front must be <20m width)

Neighbourhood Living Lots

BAL Level12.5 Fire Rating applies to all Lots within 100m from unmodified bushland (ECC & A Class Reserve). Refer Bushfire Management Plan (BMP)

Northern Park landscaping to be designed according to Building Protection Zone



* Concept only. subject to detail design

Environmental Cultural Corridor

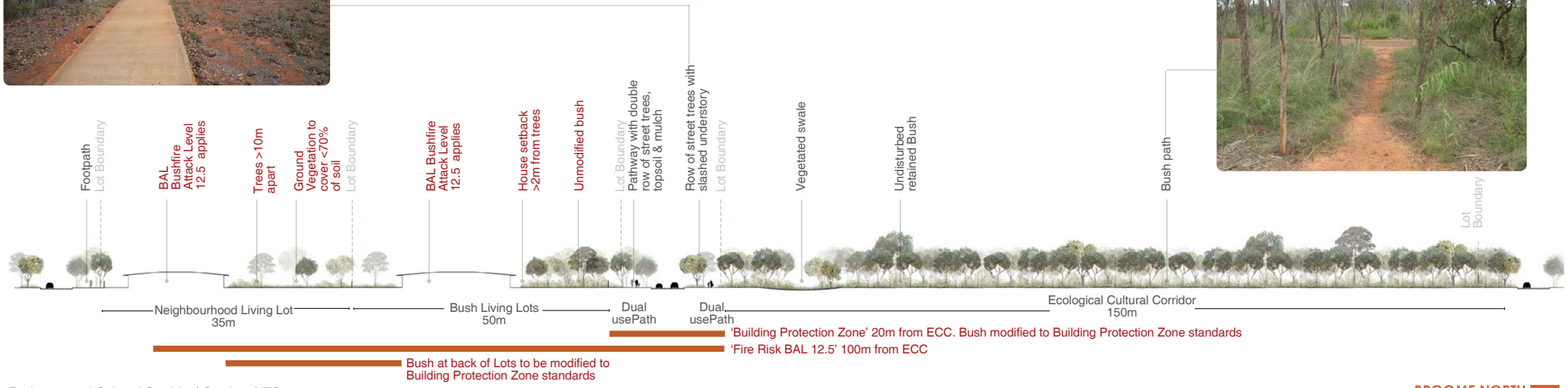
'A' Class Reserve

Lots to have BAL12.5 Fire Rating. Refer Bushfire Management Plan. Vegetation at back of lots is to to be designed according to Building Protection Zone principles

POS Areas- All to be treated as a 'Building Protection Zone'- All trees (existing and proposed) must be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers. Or groundcover/ shrubs are not to exceed total fuel load of 2 tonnes per ha

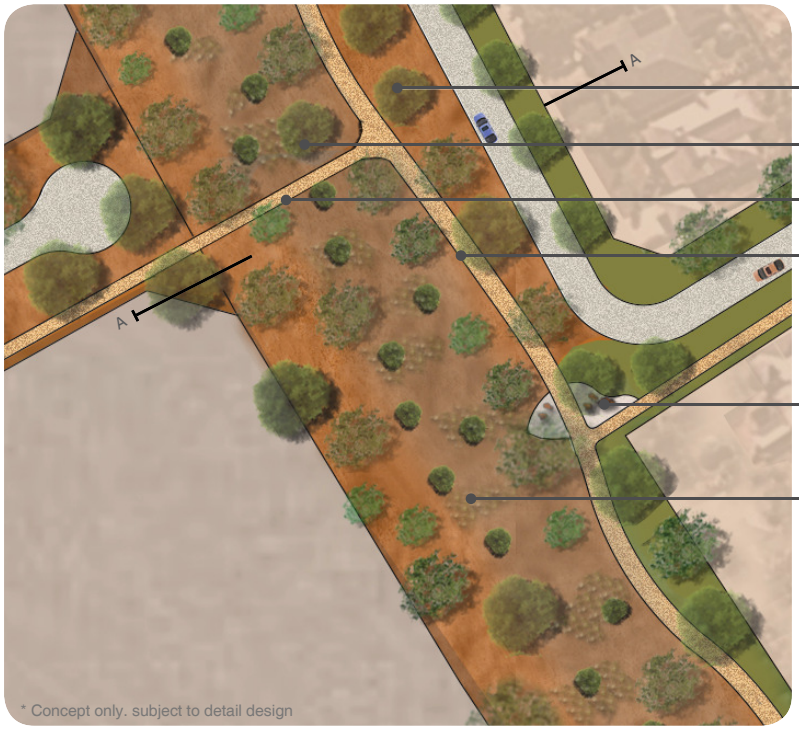






Environmental Cultural Corridor | Section NTS

* Concept only. subject to detail design



Garden Bed with local shade trees and low vegetation

Retained tree

Connector path

Dual- use path

Gravel break- out area with informal boulder seating areas

Vegetated swale- finger planting of trees and groundcover tubestock

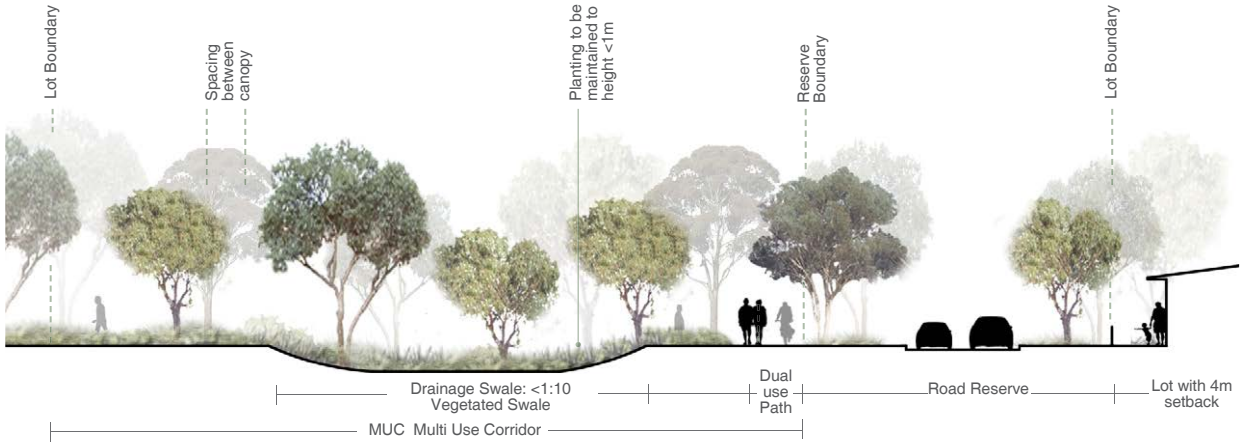
Western Parkland Multiple Use Corridors | Plan

Not to Scale

9 MULTI-PURPOSE CORRIDORS

Multi-purpose corridors comprise a combination of retained existing vegetation, drainage swales, vegetated buffers and parks. They provide a number of integrated functions including:

- An informal connection to 'country' (through the use of local planting, materials and linkages to the ECC);
- Urban drainage and flood management including holistic management of upstream and downstream conveyance;
- Flora and fauna habitat and linkages;
- Passive and active open space with informal (grassed kick-about) areas and formally programmed, built play areas;
- Dual use paths suitable for walking, jogging, cycling etc. with rest areas and water fountains,
- Opportunities for cultural and environmental interpretation including inter generational education and community art projects, and;
- Building Protection Zone to minimise the risk of fires spreading along the MUCs. All trees must be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers.
- Bushfire Management by Design



Western Parkland Multiple Use Corridors | Section AA | Scale 1: 500 @A4

*Concept only. subject to detail design





Multiple Use Corridors | Location Plan

10 LDP3 PARKLANDS

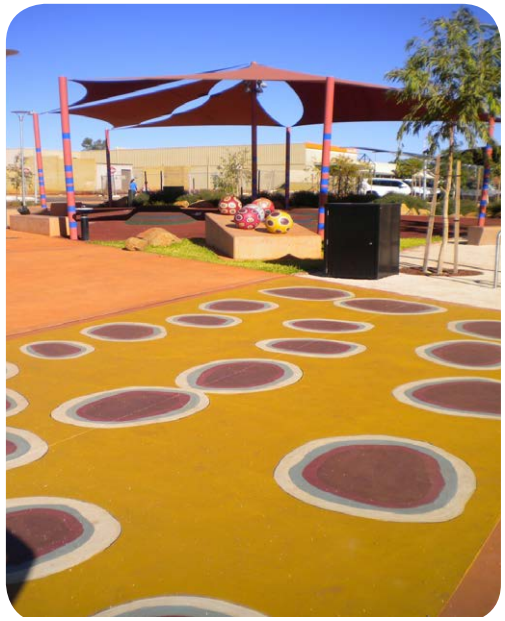
CENTRAL PARK AND NORTHERN PARK

Central Park is the primary 'spine' of LDP3, centrally located within the development area. To the north, the park links to the Northern Park and ECC via the Green Link path network, to the south the park borders Tanami Drive which runs East- West, where there is opportunity for a dual use Art Path connecting Central Park to the future school and civic centre.

There is a connection with LDP3 and LDP1 Parklands and community. Tomarito Park (LDP! Stage 10) and Ibasco Park (LDP! Stage 8) are connected by a dual use shaded pathway. This connection allows residents to access the amenity of the neighbouring parks.

The collection of Parks feature the following amenity:

- Formal play areas with play equipment, shade structures, seating and picnic facilities, resting places;
- Nature Play Areas;
- Grassed open space areas for active and passive recreation;
- Areas of retained mature existing vegetation (providing existing shade and visual amenity);
- Interesting topographical changes that form part of the larger drainage swale network and the landscaped areas;
- Landscapes incorporating local sandstone boulders and boulder formations;
- A walkway bridge crosses over the most narrow section of the swale and thereby allows ongoing connection with the immediate surrounding community.
- Strong path networks that link to the immediate community and beyond via the connected multiple-use corridors and ECC;
- Exercise, walking, dog walking, running and cycling networks;
- Pindan paths provide secondary paths and connect to grasses areas and the larger path network;
- Hard-stand areas which use local concrete and aggregates, with rest areas consisting of local gravels and/or compacted, stabilised pindan;
- Bushtucker planting;
- Local species planting and
- Opportunities for lawn irrigation hydro-zoning according to active and passive uses, and:
- Interpretation and art opportunities as developed with the Traditional Owners's, community and within the proposed art and strategy.









Shaded dual use path meanders through the POS

Active play/lawn area adjacent to drainage area (2,000m2)

Parallel on road parking

Pedestrian walkway bridge over the swales connect two sides of the POS and provide access. The swale batter is edged with a low, dry stone wall

Interactive play includes a lookout to the bush and public art work as an entry feature and play element

Play elements meander through areas of retained bush. Picnic area set on the top of the swale allowing views over the open, vegetated swale

Lawn and kick-about area (free of drainage) adjacent to swale (4,400m2)

Shaded Dual-Use path

Opportunity to install Art Work to create points of interest along the entry road; Tanami Drive

Low shrubs/ ground cover planting under, trees and existing trees

Low planting established to the base, views through the park. Swale batters minimum 1:4 to 1:6

Path network links spaces within the estate and intersects with the Green Link

Shade Shelter and Picnic Area

Urban Living Lots

Turf kick-about area

Low vegetation to swale. Batters 1:40 Allows views through park

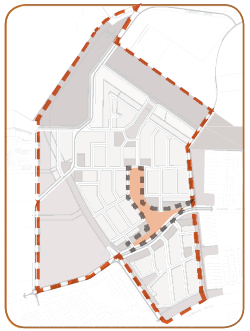
Dual use path

Lawn extends to edge

Double row trees to dual use path provides a continuous walking and cycling circuit

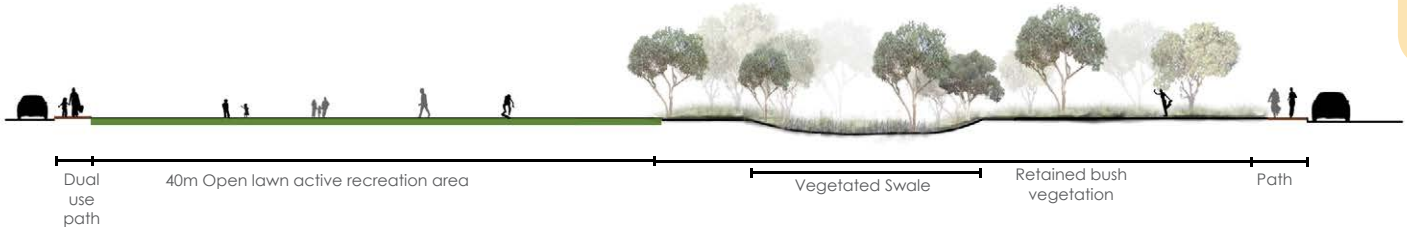
* Concept only, subject to detail design

Central Park | Plan I Scale 1:1000 @ A1



Central Park | Location Plan

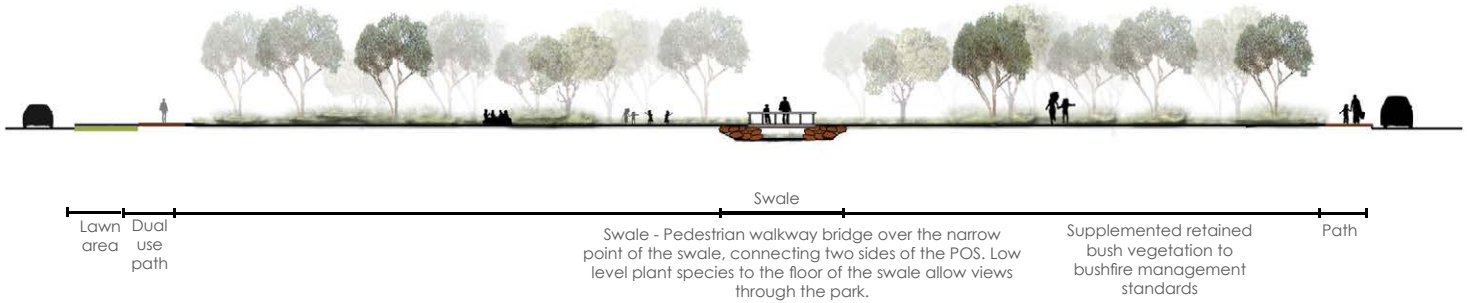
Active play and lawn areas to area of minimum of 2,000 m2 are on higher ground above the swale



Central Park | Lawn public open space, active recreation | Section AA

* Concept only. subject to detail design

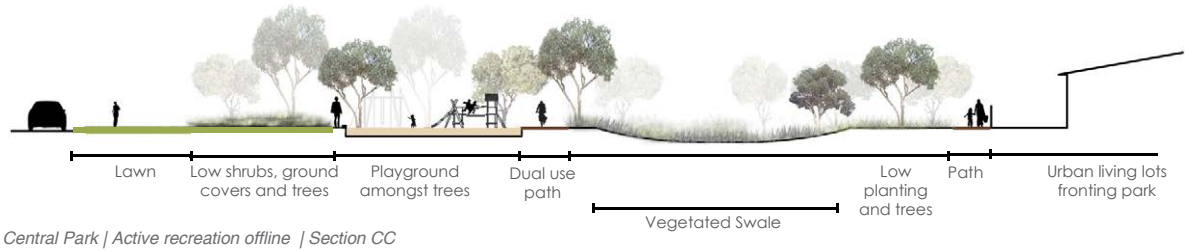
A pedestrian walkway bridge over the narrow point of the swale links the POS and allows access for the local community



Central Park | Connecting pedestrian walkway bridge over the swale, informal recreation | Section BB

* Concept only. subject to detail design

Play area amongst trees, adjacent to the swale and drainage free grass area

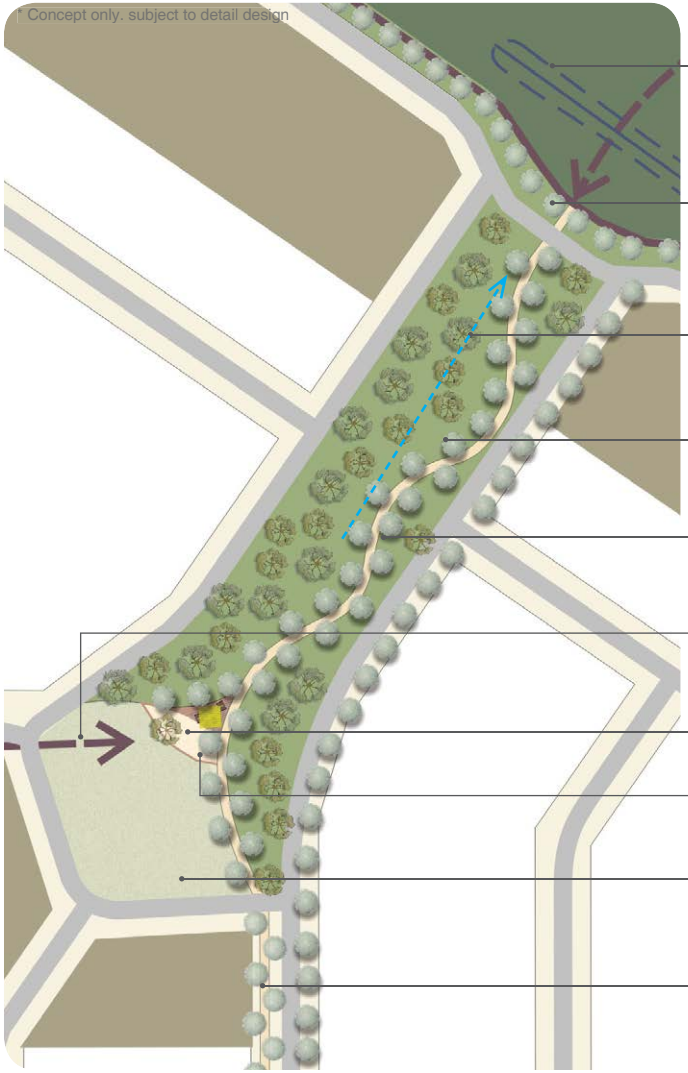


Central Park | Active recreation offline | Section CC

Scale 1: 500 @A4

* Concept only. subject to detail design

† Concept only. subject to detail design



Northern Park | Plan I Scale 1:1000 @ A1

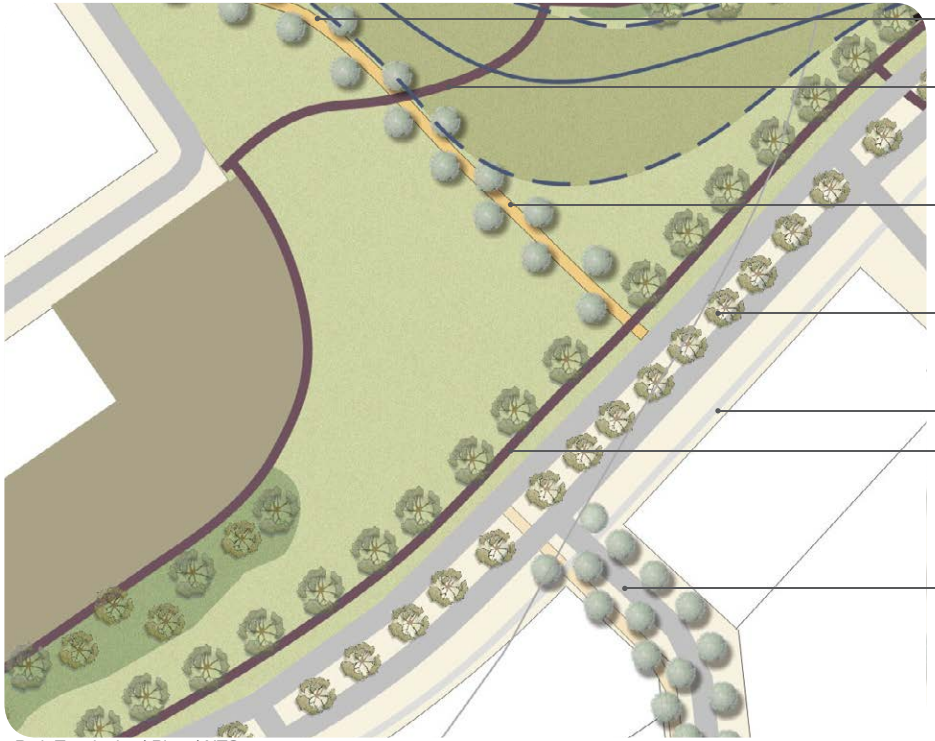
* Concept only. subject to detail design



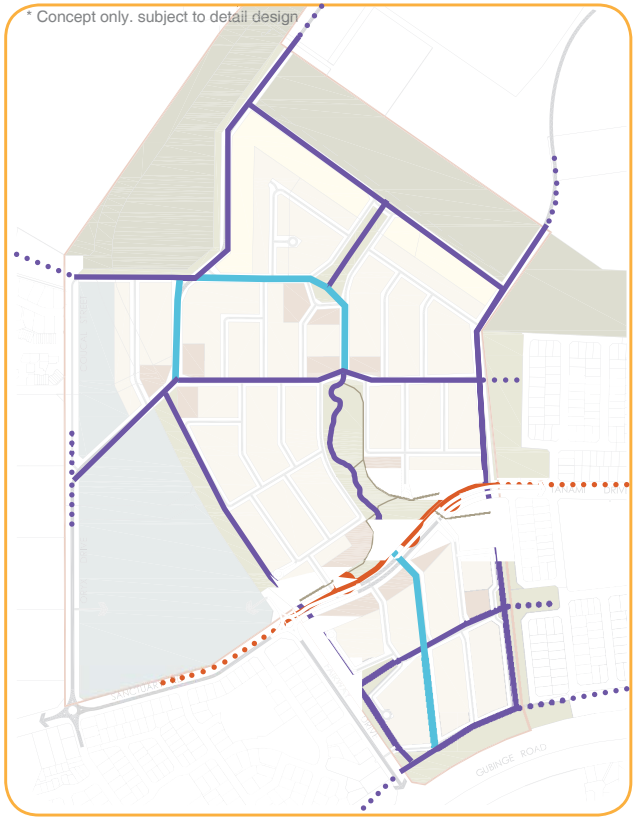




Northern Park | Location Plan



Path Typologies | Plan | NTS



Path Network | Plan | NTS

Dual use path and Art Strategy along Tanami Drive (road suitable for buses)

Green Link- dual use pathway with double row of trees- continuous walkway/ cycling

Dual use pathway

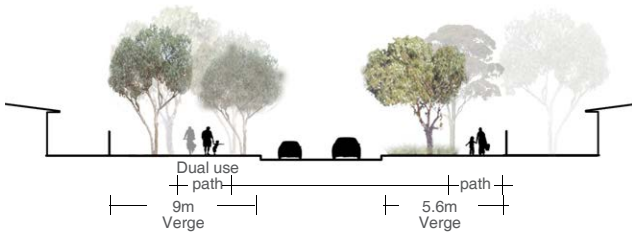
Possible future connections

11 CENTRAL BOULEVARD, GREEN LINK & STREETSCAPES

Within LDP3 there is an opportunity to create shaded central boulevards. While not spatially designed to be used as parkland, the shaded boulevards will provide adjacent lot owners, pedestrians and visitors with shade and natural amenity. Within these central medians, a row of trees will be formally planted to provide this amenity with mulch and lawn ground cover. Robust bollards/guards within the medians are proposed as a means of increasing the perceived value of the trees and protecting them from vandalism and damage from large vehicles (particularly during residential construction). Endemic tree species, Corymbia paractia is proposed to edge these boulevards and reinforce local characteristics and provide shade. Integrator Arterial B and Neighborhood Connector Streets will have street trees as part of the landscape works and should be part of the Minimum Design Requirements. Should a residential rebate package be provided; it will be the responsibility of the lot owner for the planting, irrigation and establishment of the street trees to lots on Major Access Streets and Access Links. These trees will be the species nominated in the Street Tree Masterplan (Refer Pg.20). The lawn is proposed to be a local Roebuck Couch variety, again using the balanced nutrient and water qualities found in this environment.







Green Link | Section AA | Scale 1: 500 @A4

* Concept only. subject to detail design

12 PLANT PALETTE

A plant palette consisting of local, endemic species has been largely adopted for the LDP2 development area. Endemic species are adapted to Broome's environmental conditions, require less ongoing maintenance and provide habitat for fauna. The requirements of a local plant palette will also support the growing Northwest landscape industry, by further establishing local plant awareness and stocks.

Local vegetation within the multiple-use corridors and parkland is environmentally crucial for maintaining local habitat and biodiversity. Retaining and supplementing local endemic vegetation supports Traditional Owners cultural practices and the opportunity to maintain a Broome 'sense of place' and 'lifestyle'.

The following is a locally proven street tree species list considered appropriate for use within the LDP2 area:

- *Bauhinia cunninghamii* - Jigal
- *Brachychiton diversifolius* - Northern Kurrajong
- *Corymbia ptychocarpa* - Swamp Bloodwood
- *Eucalyptus microtheca* - Coolibah
- *Eucalyptus miniata* - Woollybutt
- *Eucalyptus tectifica* - Darwin Box
- *Terminalia petiolaris x Terminalia ferdinandiana* - Red Gubinge

Endemic species which have performed well in Broome in establishing multiple-use corridors, open space parks and swale vegetation modules will include the following:

TREES

- *Bauhinia cunninghamii* - Jigal
- *Corymbia flavescens* - Cabbage Ghost Gum
- *Corymbia polycarpa* - Bloodwood
- *Eucalyptus jensenii* - Wandi Ironbark
- *Eucalyptus microtheca* - Coolibah
- *Eucalyptus tectifica* - Darwin Box
- *Ficus opposita* - Sandpaper Fig
- *Gyrocarpus americanus* - Coolamon
- *Santalum lanceolatum* - Tropical Sandalwood
- *Terminalia petiolaris x Terminalia ferdinandiana* - Red Gubinge

LARGE SHRUBS/ SMALL TREES

- *Acacia eriopoda* - Broome Pindan Wattle
- *Acacia monticola* - Scratchy Wattle
- *Acacia platycarpa* - Pindan Wattle
- *Dolichandrone heterophylla* - Lemonwood
- *Ehretia saligna* - Native Willow
- *Hakea aborescens* - Yellow Hakea
- *Hakea macrocarpa* - Boomerang Tree

MEDIUM SHRUBS

- *Acacia bivenosa* - Dune Wattle
- *Acacia translucens* - Poverty Bush
- *Caesalpina major* - Yellow Nicker
- *Carissa lanceolata* - Conkerberry
- *Crotalaria cunninghamii* - Green Birdflower
- *Dodonaea platyptera* - Hopbush
- *Flueggea virosa* - Snowball Bush

SMALL SHRUBS

- *Acacia adoxa* - Prostrate Acacia
- *Canavalia rosea* - Beach Bean
- *Dodonaea lanceolata* - Broad-winged w







- *Hybanthus aurantiacus* - Orange Spade Flower
- *Sida hackettiana* - Spiked Sida

GROUNDCOVERS/ GRASSES

- *Acacia hilliana* - Hills Tabletop Acacia
- *Enchylaena tomontosa* - Barrier Salt Bush
- *Ipomea pes-caprae* - Beach Morning Glory
- *Ptilotus exaltatus* - Tall Mulla Mulla
- *Triodia pungens* - Soft Spinifex





Hybanthus aurantiacus - Orange Spade Flower



Dodonaea lanceolata - Broad Winged Hopbush



Acacia bivenosa - Dune Wattle



Hakea arborescens - Yellow Hakea



Crotalaria cunninghamii - Green Birdflower



Acacia hilliana - Hills Tabletop Acacia



Ipomea pes-caprae - Beach Morning Glory

* Concept only. subject to detail design



STREET TREE MASTERPLAN

The overall Street Tree Masterplan allocates trees to different street typologies. This Masterplan will be amended after consultation with and approval from Traditional Owners. Choosing local species as street trees is another opportunity to create a unified bush aesthetic with local character and meaning specific to the site.


Terminalia cunninghamii- Inland Gubinge


Eucalyptus miniata - Woollybutt


Bauhinia cunninghamii - Jigal


Brachychiton diversifolius - Northern Kurrajong


Peltophorum pterocarpum - Yellow Flame Tree


Corymbia pychocarpa - Swamp Bloodwood


Eucalyptus microtheca - Coolibah


Corymbia paractia- Cable Beach Ghost Gum


Eucalyptus tectifica - Darwin Box


Terminalia petiolaris x Terminalia ferdinandiana - Red Gubinge

13 CONCLUSION

The LDP3 Landscape Report demonstrates that a sustainable and site specific landscape amenity for the future Broome North community can be achieved through understanding the Broome Peninsula's unique social, cultural and ecological condition. The report acknowledges the existing Broome 'lifestyle' and the Traditional Owners (Yawuru's) cultural relationship to the site and associated lands.





APPENDIX C
BUSHFIRE MANAGEMENT PLAN

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Broome North Development - Part LDP3, Gubinge Road and Fairway Drive, Bilingurr

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 14th Month July Year 2020

Report author or reviewer: Ian Macleod

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☑ Level 3 practitioner ☐

If accredited please provide the following.

BPAD accreditation number: 39131 Accreditation expiry: Month November Year 2020

Bushfire management plan version number: 1.1

Bushfire management plan date: Day 14th Month April Year 2022

Client/business name: DevelopmentWA

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?		✔
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?		✔

Is the proposal any of the following (see SPP 3.7 for definitions)?

	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✔
Strategic planning proposal (including rezoning applications)	✔	
High risk land-use		✔
Vulnerable land-use		✔

None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

This Bushfire Management Plan is to accompany a proposed amendment to a local structure plan.

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author or reviewer 

Date 14th April 2022

Bushfire Management Plan

Broome North Development – Part LDP 3

Portion of Lot 504 on Plan 69436
Gubinge Road & Fairway Drive, Bilingurr

Shire of Broome

Planning Stage:	Strategic Proposal - Local Planning Scheme and Amendment
Planning Development Type:	Amendment to Local Development Plan
Bushfire Policy – Specific Development or Use Type:	N/A

Job Number:	190520
Assessment Date:	14 July 2020
Report Date:	5 February 2021

BPP Group Pty Ltd t/a Bushfire Prone Planning
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VERSION HISTORY		
Version	**Version Details**	**Date**
1.0	Original document Issue	5 February 2021
1.1	Amendments per DFES/Shire of Broome, revised LDP.	14 April 2022

BMP (Subdivision) Template v8.4

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Person/Business: Kylie Coman/Development WA Email: Kylie.Coman@developmentwa.com.au	1.1		☐	☒

Limitation of Liability: The measures contained in this Bushfire Management Plan, are considered to be minimum requirements and they do not guarantee that a building will not be damaged in a bushfire, persons injured, or fatalities occur either on the subject site or off the site while evacuating. This is substantially due to the unpredictable nature and behaviour of fire and fire weather conditions. Additionally, the correct implementation of the required bushfire protection measures will depend upon, among other things, the ongoing actions of the landowners and/or operators over which Bushfire Prone Planning has no control.

All surveys, forecasts, projections and recommendations made in this report associated with the proposed development are made in good faith based on information available to Bushfire Prone Planning at the time. All maps included herein are indicative in nature and are not to be used for accurate calculations.

Notwithstanding anything contained therein, Bushfire Prone Planning will not, except as the law may require, be liable for any loss or other consequences whether or not due to the negligence of their consultants, their servants or agents, arising out of the services provided by their consultants.

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Figure 3.2: BAL Contour Map 26

EXECUTIVE SUMMARY

This Bushfire Management Plan (BMP) is to accompany a proposed amendment to the Broome North Local Development Plan 3. The proposed amendments are located to the south of the future extension of Tanami Drive.

Since the issue of the previous Bushfire Management Plan for this site, SPP 3.7 "Planning in Bushfire Prone Areas" and the "Guidelines for Planning in Bushfire Prone Areas" have been introduced. Additionally, the Australian Standard AS3959-2009 "Construction of buildings in bushfire prone areas" has been revised and updated. This BMP will reflect the introduction of SPP 3.7 and the associated Guidelines, and the new vegetation classification requirements of AS3959-2018.

The assessments and bushfire protection measures detailed in the BMP, assume that environmental approval will be achieved or clearing permit exemptions will apply.

This southern portion of the Local Development Plan 3 (LDP 3) contains the Local Centre zone. This area will provide retail, medical, fast food and other services to the local community. The remainder of the subject site will be residential lots and public open space. It is expected that narrow strips of native vegetation will be retained immediately inside the western, southern and eastern boundaries of the proposed development, providing a buffer from Gubinge Road and screening from nearby existing residential lots to the east and west.

Required Asset Protection Zones (APZs), and areas of vegetation management, will be constrained to within the subject site. Development of this section of LDP 3 will greatly reduce the amount of available bushfire prone vegetation that could affect existing residential lots to the east and west of the development site during a local bushfire event. Development of this site will also essentially close and existing corridor of bushfire prone vegetation which currently links larger areas of bushfire prone vegetation either side of Gubinge Road.

A small triangular area of POS which abuts residential lots near the north-eastern corner of the proposed development is expected to be managed and maintained to a low bushfire threat state. The landscaping design and management of this area will be established by consultation and agreement with the Shire of Broome.

All residential lots will be managed to a low bushfire threat state as per the Shire of Broome Fire Break & Fuel Hazard Reduction Notice. It is also expected that the Local Centre lot will be managed and maintained to a low bushfire threat state.

Landscape design and management of the stormwater swale within the Local Centre, to a low bushfire threat state, will be established and agreed with the Shire of Broome at a later planning stage.

The highest BAL rating for any residential lot within Blocks 2 to 4 is BAL-29 which is compliant with the requirements of SPP 3.7 and the Guidelines for Planning in Bushfire Prone Areas.

BAL-40 and BAL-FZ areas extend into Residential Lots – Block 1. Where Block 1 is to be a grouped development site, building will be restricted to areas of BAL-29 or lower by use of the Model Subdivision Condition F3 which requires a restrictive covenant over the lot(s) stating "No habitable buildings are to be built within areas identified as BAL-40 or BAL-FZ".

Where green titled subdivision occurs within Block 1, a public road will be provided as per Figure 1.1. This will provide enough separation from classifiable vegetation to achieve a BAL-29 rating for the lots.

BAL ratings in the Local Centre zone range from BAL-LOW to BAL-FZ. The greater portion of this zone has a BAL-LOW or BAL-12.5 rating. Construction of buildings and associated Asset Protection Zones to attain a BAL-29 or lower rating for future developments is achievable and must be demonstrated throughout the subsequent planning and subdivision processes.

Any future landscape plans should be designed so that the vegetation within the landscaped areas does not increase the indicative BAL rating, as shown in Figure 3.2, on any neighbouring or nearby residential, commercial or industrial lots.

Where the proposed development is staged each stage must comply with the requirements of the Guidelines for Planning in Bushfire Prone Areas and this Bushfire Management Plan. This may require the creation of roads or management of land or installation of water supply lines outside that particular stage to achieve compliance.

Vegetation on the balance lot(s) may adversely affect the indicative BAL ratings of lots being developed. This should be assessed prior to the sale of the lots and the required vegetation on the balance lot managed and maintained until developed, or the indicative BAL ratings for the affected lots amended.

The proposed roads provide safe access and egress in two different directions to two different destinations. As sealed public roads, they will be available to all residents and the public at all times and under all weather conditions.

Where battle-axe lots are proposed, justification must be provided that there is no alternative to the designed layout.

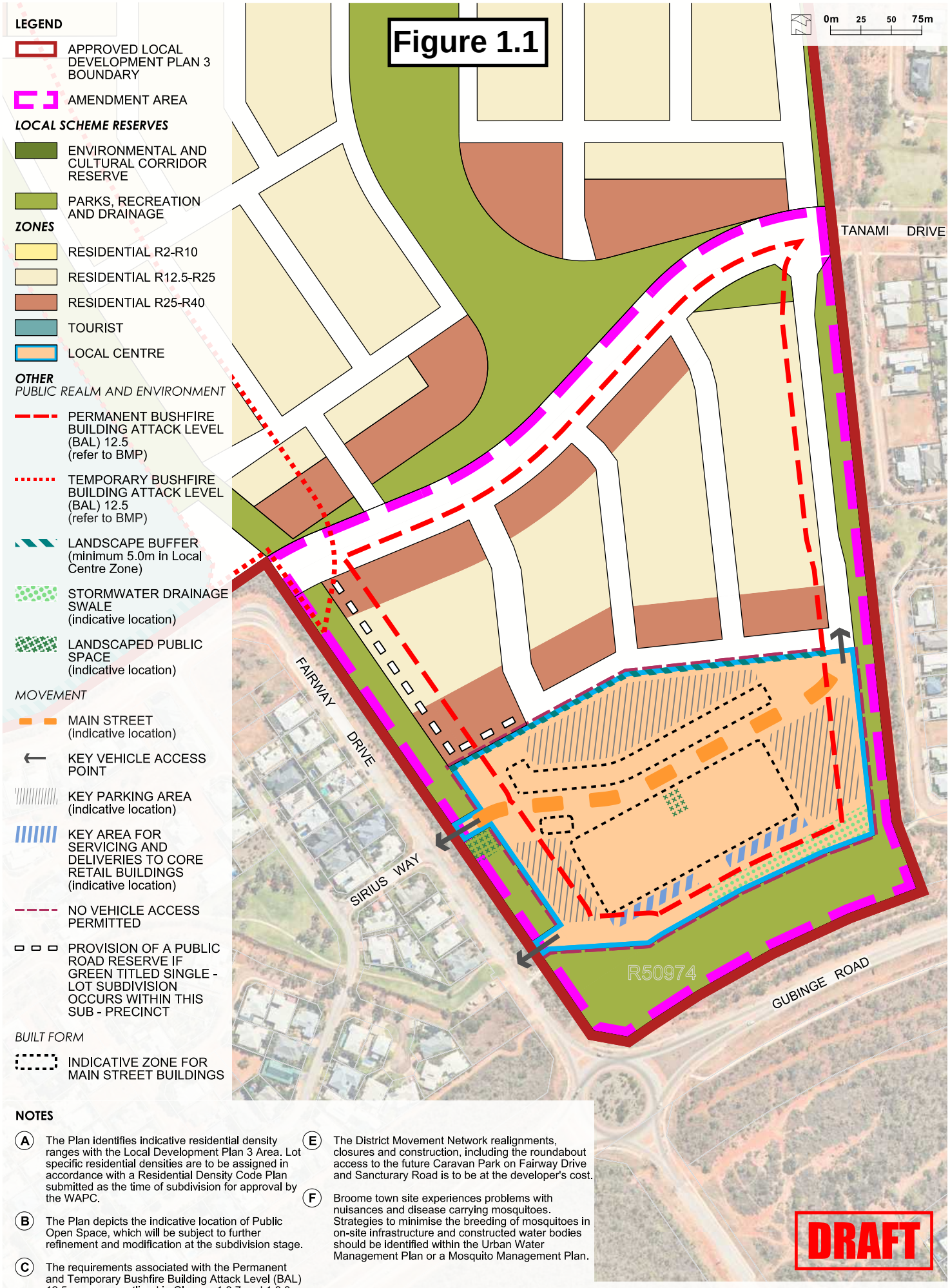
A reticulated water supply is available to the subject site and hydrants will be installed in locations as required by the relevant authorities.

1 PROPOSAL DETAILS

1.1 Description and Associated Plans and Maps

Proponent:	Development WA
Bushfire Prone Planning Commissioned to Produce the Bushfire Management Plan (BMP) By:	Development WA
For Submission To:	Shire of Broome
Purpose of the BMP:	To support a strategic planning assessment
'Development' Site Total Area:	Approximately 20 hectares
No. of Existing/Proposed Lots:	N/A
Description of the Proposed Development/Use:	
This Bushfire Management Plan is to accompany a proposed amendment to the Broome North Local Development Plan 3. The proposed amendments are located to the south of the future extension of Tanami Drive.	

Figure 1.1



LEGEND

- APPROVED LOCAL DEVELOPMENT PLAN 3 BOUNDARY
- AMENDMENT AREA

LOCAL SCHEME RESERVES

- ENVIRONMENTAL AND CULTURAL CORRIDOR RESERVE
- PARKS, RECREATION AND DRAINAGE

ZONES

- RESIDENTIAL R2-R10
- RESIDENTIAL R12.5-R25
- RESIDENTIAL R25-R40
- TOURIST
- LOCAL CENTRE

OTHER

PUBLIC REALM AND ENVIRONMENT

- PERMANENT BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5 (refer to BMP)
- TEMPORARY BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5 (refer to BMP)
- LANDSCAPE BUFFER (minimum 5.0m in Local Centre Zone)
- STORMWATER DRAINAGE SWALE (indicative location)
- LANDSCAPED PUBLIC SPACE (indicative location)

MOVEMENT

- MAIN STREET (indicative location)
- KEY VEHICLE ACCESS POINT
- KEY PARKING AREA (indicative location)
- KEY AREA FOR SERVICING AND DELIVERIES TO CORE RETAIL BUILDINGS (indicative location)
- NO VEHICLE ACCESS PERMITTED
- PROVISION OF A PUBLIC ROAD RESERVE IF GREEN TITLED SINGLE - LOT SUBDIVISION OCCURS WITHIN THIS SUB - PRECINCT

BUILT FORM

- INDICATIVE ZONE FOR MAIN STREET BUILDINGS

NOTES

(A) The Plan identifies indicative residential density ranges with the Local Development Plan 3 Area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan submitted as the time of subdivision for approval by the WAPC.

(B) The Plan depicts the indicative location of Public Open Space, which will be subject to further refinement and modification at the subdivision stage.

(C) The requirements associated with the Permanent and Temporary Bushfire Building Attack Level (BAL) 12.5 areas are outlined in Clauses 1.8.7 and 1.8.8.

(D) Appropriate land tenure arrangements are to be made for the protection and ongoing access to the Water Corporation's infrastructure contained adjacent to the Environmental and Cultural Corridor Reserve.

(E) The District Movement Network realignments, closures and construction, including the roundabout access to the future Caravan Park on Fairway Drive and Sancturary Road is to be at the developer's cost.

(F) Broome town site experiences problems with nuisances and disease carrying mosquitoes. Strategies to minimise the breeding of mosquitoes in on-site infrastructure and constructed water bodies should be identified within the Urban Water Management Plan or a Mosquito Management Plan.

PROPOSED REVISION
PLAN No. 1 (Extract)
LOCAL DEVELOPMENT PLAN 3

Figure 1.2

Amendment to LDP 3 Subject Site Map

Pt Lot 504 on Plan 69436
Gubinge Road & Fairway Drive
BILINGURR
SHIRE OF BROOME

BILINGURR
SHIRE OF BROOME
DJUGUN
CABLE BEACH
TANAMI DR
POVAH RD
SAID BEND
NAKAMURA AV
IBASCO CR
HUSSEN WAY
KASSIM ST
SANCTUARY RD
CITANA WAY
FAIRWAY DR
SIRIUS WAY
KAPANG DR
ALMA CT
DELAWARE RD
SULTAN WAY
ELEANOR LOOP
GUBINGE RD
SHEARWATER CR
DOTTEREL ST

------ LEGEND ------

- Subject Site
- Locality
- Cadastre

Land Use

- Local Centre
- Residential
- POS-Drainage
- Road

0 25 50 75 100 125 150

Metres

------ LOCALITY ------



AERIAL IMAGERY: Landgate/SLIP

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Merctaor Units: Metre
Map by: Ian Macleod 14-04-2022
SCALE (A3): 1 : 3000

BUSHFIRE PRONE PLANNING

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 1.3

Amendment to LDP 3 Spatial Context Map

Pt Lot 504 on Plan 69436
Gubinge Road & Fairway Drive
BILINGURR
SHIRE OF BROOME

WATERBANK
BROOME RD
Duncan Bore
Willagree Park
Morrell Park Community
LUILLFITZ DR
BUCKLEYS RD
LOCKE ST
BILINGURR
FAIRWAY DR
Station Hill
GUBINGE RD
Cable Beach
JIGAL DR
Nilir Irbanjin Community
DJUGUN
ROEBUCK
Bilgungurr Community
Dampier Creek
CABLE BEACH
Broome Airport
Burrgugun Community
REID RD
FREDERICK ST
BROOME VFRS
BROOME VMRS
Fishermens Bend
Whale Rock
BANU AV
PORT DR
ANNE ST
WELD ST
WALCOTT ST
Saddle Hill
REID RD
GUY ST
HUNTER ST
Buccaneer Rock
Swirl Rock
BROOME REGIONAL
BROOME SES
BFB
False Saddle Hill
GUBINGE RD
CLEMENTSON ST
Mangrove Point
Gantheaume Point
Red Point
Gantheaume Point Light
MINYIRR
KAVITE RD
PORT DR
Minyirr

------ LEGEND ------

- DFES Stations
- Subject Site
- Localities_Suburb
- Cadastre

DBCA - Legislated Lands and Waters

- Section 5(1)(h) Reserve

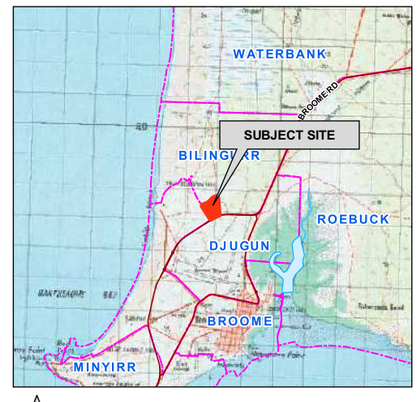
Reserves UCL

- Reserve
- Unallocated Crown Land

0 500 1000 1500 2000 2500

Metres

------ LOCALITY ------



AERIAL IMAGERY: Landgate/SLIP

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Merctaor Units: Metre
Map by: Ian Macleod 20-01-2021
SCALE (A3): 1 : 40000

BUSHFIRE PRONE PLANNING

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 1.4

Amendment to LDP 3
Bushfire Prone Areas Map

Pt Lot 504 on Plan 69436
Gubinge Road & Fairway Drive
BILINGURR
SHIRE OF BROOME

WATERBANK
BROOME RD
Duncan Bore
Willagree Park
Morrell Park Community
LULLFITZ DR
BUCKLEYS RD
LOCKE ST
BILINGURR
FAIRWAY DR
Station Hill
Cable Beach
GUBINGE RD
JIGAL DR
ROEBUCK
Nilir Irbanjin Community
DJUGUN
Bilgungurr Community
Dampier Creek
CABLE BEACH
Broome Airport
Burrgugun Community
REID RD
FREDERICK ST
BROOME VFRS
BROOME VMRS
Fishermens Bend
Whale Rock
BANU AV
PORT DR
ANNE ST
WALCOTT ST
WELD ST
Saddle Hill
REID RD
GUY ST
Buccaneer Rock
Swirl Rock
HUNTER ST
BROOME REGIONAL BFB
BROOME SES
False Saddle Hill
GUBINGE RD
CLEMENTSON ST
Mangrove Point
Gantheaume Point
Red Point
Gantheaume Point Light
PORT DR
MINYIRR
KAVITE RD
Minyirr

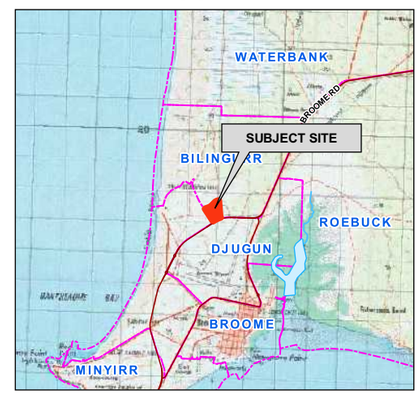
------ LEGEND ------

- DFES Stations
- Subject Site
- Bush Fire Prone Areas 2019
- Localities_Suburb
- Cadastre

0 500 1000 1500 2000 2500

Metres

------ LOCALITY ------



AERIAL IMAGERY: Landgate/SLIP

BUSHFIRE PRONE PLANNING

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Merctaor Units: Metre
Map by: Ian Macleod 20-01-2021
SCALE (A3): 1 : 40000

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

1.2 Existing Documentation Relevant to the Construction of this Plan

This section acknowledges any known reports or plans that have been prepared for previous planning stages, that refer to the subject area and that may or will impact upon the assessment of bushfire risk and/or the implementation of bushfire protection measures and will be referenced in this Bushfire Management Plan.

Table 2.1: Existing relevant documentation.

RELEVANT EXISTING DOCUMENTS		
Existing Document	Copy Provided by Client	Title
Structure Plan	Yes	13_022_061A_DEVL_LC_[042H]_(220117)- Extract (See Figure 1.1)
Environmental Report	No	
Landscaping (Revegetation) Plan	No	
Bushfire Risk Assessments	Yes	Fire Management Plan Broome North Local Development Plan 3 (FirePlan WA 2014)

The above structure plan has been adopted for the production of this Bushfire Management Plan.

Since the issue of the above Bushfire Management Plan the SPP 3.7 "Planning in Bushfire Prone Areas" and the "Guidelines for Planning in Bushfire Prone Areas" have been introduced. Additionally, the Australian Standard AS3959-2009 "Construction of buildings in bushfire prone areas" has been revised and updated. This BMP will reflect the introduction of SPP 3.7 and the associated Guidelines, and the new vegetation classification requirements of AS3959-2018.

2 ENVIRONMENTAL CONSIDERATIONS

2.1 Native Vegetation – Restrictions to Modification and/or Clearing

Many bushfire prone areas also have high biodiversity values. SPP 3.7 policy objective 5.4 recognises the need to consider bushfire risk management measures alongside environmental, biodiversity and conservation values (Guidelines s2.3).

There is a requirement to identify the need for onsite modification and/or clearing of native vegetation and whether this might trigger potential environmental impact/referral requirements under State and Federal environmental legislation. Confirmation that any proposed native vegetation modification and/or clearing is acceptable, should be received from the relevant agencies by the proponent and provided to the bushfire consultant for inclusion in the Bushfire Management Plan if it will influence the required bushfire planning assessments and outcomes. The following table details any potential environmental restrictions of which the author of this report is aware.

Table 2.2: Native vegetation and potential environmental considerations and restrictions.

NATIVE VEGETATION MODIFICATION / CLEARING - POTENTIAL ENVIRONMENTAL RESTRICTIONS IDENTIFIED				
Environmental Considerations / Features	Potential Mapping Data Source (SLIP / Local Planning)	Relevant to Proposed Development	Data Applied	Action Required
Onsite clearing of native vegetation is required.		Yes		
Environmental impact/referral requirements under State and Federal environmental legislation may be triggered.		Possible		
National Park / Nature Reserve	DBCA-011	No- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	None
Conservation Covenant	DPIRD-023	Not Known	Data Not Readily Available to Bushfire Consultant	Proponent to Seek Advice
Bush Forever Site	DPLH-019	No- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	None
RAMSAR Wetland	DBCA-010	No- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	None
Geomorphic and Other Wetland	DBCA-011-019, 040, 043, 044	No- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	None
Threatened and Priority Ecological Communities (TECs or PECs)	DBCA-038	Yes- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	Proponent to Seek Advice
Threatened and Priority Flora including Declared Rare Flora (DRFs)	DBCA-036	No- Confirmed by Bushfire Consultant	Relevant Database Reviewed by Bushfire Consultant	None

Land Identified as significant through a Local Biodiversity Strategy	LG - Intramaps	Not Known	Data Not Readily Available to Bushfire Consultant	Proponent to Seek Advice

Statement of how the identified environmental feature(s) is dealt with in this Bushfire Management Plan (and the location of relevant information):

The assessments and bushfire protection measures detailed in the BMP, assume that environmental approval will be achieved or clearing permit exemptions will apply.

It is advised that the proponent seek further advice from an Environmental Consultant or the WA Department of Biodiversity Conservation and Attractions for further information on the condition and species contained within the proposed development area and the requirement for referral of the proposal.

Development Design Considerations

Establishing development in bushfire prone areas can adversely affect the retention of native vegetation through clearing associated with the creation of lots and/or asset protection zones. Where loss of vegetation is not acceptable or causes conflict with landscape or environmental objectives, it will be necessary to consider available design options to minimise the removal of native vegetation.

Table 2.3: Development design.

MINIMISE THE REMOVAL OF NATIVE VEGETATION	
Design Option	Assessment / Action
Reduction of lot yield	N/A
Cluster development	N/A
Construct building to a standard corresponding to a higher BAL as per BCA (AS 3959:2018 and/or NASH Standard)	N/A
Modify the development location	N/A
This portion of the Local Development Plan 3 (LDP 3) contains the Local Centre area. This will provide retail, medical, fast food and other services to the local community. The remainder of the subject site will be residential lots and public open space. It is expected that narrow strips of native vegetation will be retained immediately inside the western, southern and eastern boundaries of the proposed development, providing a buffer from Gubinge Road and screening from nearby existing residential lots to the east and west.	
IMPACT ON ADJOINING LAND	
Is this planning proposal able to implement the required bushfire protection measures within the boundaries of the land being developed so as not to impact on the bushfire and environmental management of neighbouring reserves, properties or conservation covenants?	Yes
Required Asset Protection Zones (APZs), and areas of vegetation management, will be constrained to within the subject site. Development of this section of LDP 3 will greatly reduce the amount of available bushfire prone vegetation that could affect existing residential lots to the east and west of the development site during a local bushfire event. Development of this site will also essentially close and existing corridor of bushfire prone vegetation which currently links larger areas of bushfire prone vegetation either side of Gubinge Road. Compliance with required APZ management for the development will be regulated via the bushfire management plan for the site and the Shire of Broome Fire Break & Fuel Hazard Reduction Notice. Bushfire management measures external to the site are not required as part of this proposal.	

2.2 Retained Vegetation / Re-vegetation / Landscape Plans (including POS)

Riparian zones, wetland/foreshore buffers, road verges and public open space may have plans to re-vegetate or retain vegetation as part of the proposed development. Vegetation corridors may be created between offsite and onsite vegetation and provide a route for fire to enter a development area.

All retained/planned vegetation and its management will be considered in the development of this Bushfire Management Plan.

Is re-vegetation of riparian zones and/or wetland or foreshore buffers and/or public open space a part of this Proposal?	Yes
Public Open Space areas along the western, southern and eastern boundaries of the proposed development are expected to be undeveloped and will retain their native vegetation. A small triangular area of POS which abuts residential lots near the north-eastern corner of the proposed development is expected to be managed and maintained to a low bushfire threat state. The landscaping design and management of this area will be established by consultation and agreement with the Shire of Broome.	

Is the requirement for ongoing maintenance of existing vegetation in riparian zones and/or wetland or foreshore buffers and/or public open space a part of this Proposal?	Yes
As discussed above, the small triangular area of POS to the north-east of the proposed development site is to be managed and maintained to a low bushfire threat state.	
Has a landscape plan been developed for the proposed development?	No
N/A	

3 POTENTIAL BUSHFIRE IMPACT ASSESSMENT

3.1 Assessment Input

3.1.1 Fire Danger Index (FDI) Applied

AS 3959:2018 Table 2.1 specifies the fire danger index values to apply for different regions. The values used in the model calculations are for the Forest Fire Danger Index (FFDI) and for which equivalent representative values of the Grassland Fire Danger Index (GFDI) are applied as per Appendix B. The values can be modified if appropriately justified.

Table 3.1: Applied FDI Value

FDI VALUE			
Vegetation Areas	As per AS 3959:2018 Table 2.1	As per DFES for the Location	Value Applied
All Vegetation Areas	80	N/A	80

3.1.2 Vegetation Classification and Effective Slope

Classification: Bushfire prone vegetation identification and classification has been conducted in accordance with AS 3959:2018 s2.2.3 and the Visual Guide for Bushfire Risk Assessment in WA (DoP February 2016).

When more than one vegetation type is present, each type is identified separately, and the applied classification considers the potential bushfire intensity and behaviour from the vegetation types present and ensures the worst case scenario is accounted for – this may not be from the predominant vegetation type.

The vegetation structure has been assessed as it will be in its mature state (rather than what might be observed on the day). Areas of modified vegetation are assessed as they will be in their natural unmodified state (unless maintained in a permanently low threat, minimal fuel condition, satisfying AS 3959:2018 s2.2.3.2(f) and asset protection zone standards). Vegetation destroyed or damaged by a bushfire or other natural disaster has been assessed on its revegetated mature state.

Effective Slope: Refers to the ground slope under each area of classified vegetation and is described in the direction relative to the view from the building or proposed development site. Effective slope is not the same as 'average slope', rather it is the slope which most significantly influences fire behaviour. This slope has a direct and significant influence on a bushfire's rate of spread and intensity.

Where there is a significant change in effective slope under an area of classified vegetation, that will cause a change in fire behaviour, separate vegetation areas will be identified to enable the correct assessment.

When the effective slope, under a given area of bushfire prone vegetation, will be different relative to multiple proposed development sites, then the effective slopes corresponding to the different locations, are separately identified.

Planned Re-vegetation/Landscaping Considerations/Public Open Space Management

Public Open Space areas along the western, southern and eastern boundaries of the proposed development are expected to be undeveloped and will retain their native vegetation. A small triangular area of POS which abuts residential lots near the north-eastern corner of the proposed development is expected to be managed and maintained to a low bushfire threat state. The landscaping design and management of this area will be established by consultation and agreement with the Shire of Broome.

All residential lots will be managed to a low bushfire threat state as per the Shire of Broome Fire Break & Fuel Hazard Reduction Notice. It is also expected that the Local Centre lot will be managed and maintained to a low bushfire threat state. Landscape design and management of the stormwater swale within the Local Centre, to a low bushfire threat state, will be established and agreed with the Shire of Broome at a later planning stage.

Table 3.2: Vegetation classification and effective slope.

ALL VEGETATION WITHIN 150 METRES OF THE PROPOSED DEVELOPMENT				
Vegetation Area	Identified Vegetation Types [1] or Description if 'Excluded'	Applied Vegetation Classification [1]	Effective Slope (degrees)[2] (AS 3959:2018 Method 1)	
			Assessed	Applied Range
1	Open scrub D-14	Class D Scrub	0	upslope or flat
2	Closed scrub D-13 Open Scrub D-14	Class D Scrub	0	upslope or flat
3	Tussock Grassland G-22	Class G Grassland	0	upslope or flat
-	Existing managed residential lots, public open space and street verges	Excluded as per Section 2.2.3.2 (f) Low Threat Vegetation	N/A	N/A
Representative photos of each vegetation area, descriptions and classification justification, are presented on the following pages. The areas of classified vegetation are defined, and the photo locations identified on Figure 3.1, the vegetation and topography map.				
Note[1]: Described and classified as per AS 3959:2018 Table 2.3 and Figures 2.3 and 2.4 (A)-(H) Note[2]: Effective slope measured as per AS 3959:2018 Section 2.2.5 and Appendix B Part B4				

VEGETATION AREA 1	
AS 3959:2018 Vegetation Classification Applied:	Class D Scrub
Vegetation Types Present:	Open scrub D-14
Description/Justification:	Open drainage channel, scrub to 5 metres tall, shrubs, occasional small tree to 8 metres tall, grass understorey.



Photo ID: 1a



Photo ID: 1b

VEGETATION AREA 2	
AS 3959:2018 Vegetation Classification Applied:	Class D Scrub
Vegetation Types Present:	Open scrub D-14
Description/Justification:	Scrub to 5 metres tall, shrubs, occasional small tree to 8 metres tall, grass understorey.



Photo ID: 2a



Photo ID: 2b

VEGETATION AREA 2		
AS 3959:2018 Vegetation Classification Applied:	Class D Scrub	
Vegetation Types Present:	Closed scrub D-13	Open scrub D-14
Description/Justification:	Scrub to 5 metres tall, shrubs, occasional small tree to 8 metres tall, grass understorey. Large areas within the subject site recently burnt.	



Photo ID: 2c



Photo ID: 2d



Photo ID: 2e



Photo ID: 2f



Photo ID: 2g



Photo ID: 2h

<table>
<tr><th colspan="3">VEGETATION AREA 2</th></tr>
<tr><td colspan="2">AS 3959:2018 Vegetation Classification Applied:</td><td>Class D Scrub</td></tr>
<tr><td>Vegetation Types Present:</td><td>Closed scrub D-13</td><td>Open scrub D-14</td></tr>
<tr><td>Description/Justification:</td><td colspan="2">Scrub to 5 metres tall, shrubs, occasional small tree to 8 metres tall, grass understorey. Large areas within the subject site recently burnt.</td></tr>
<tr><td colspan="3">  </td></tr>
<tr><td colspan="2">Photo ID: 2i</td><td>  </td></tr>
<tr><td colspan="3">Photo ID: 2j</td></tr>
<tr><td colspan="3">  </td></tr>
<tr><td colspan="3">Photo ID: 2k</td></tr>
</table>

VEGETATION AREA 3	
AS 3959:2018 Vegetation Classification Applied:	Class G Grassland
Vegetation Types Present:	Tussock grassland G-22
Description/Justification:	Photo 3a: Grass in and alongside drainage sump. Photo 3b: Grass regrowth on vacant lots.



Photo ID: 3a



Photo ID: 3b

VEGETATION AREA 4	
AS 3959:2018 Vegetation Classification Applied:	Excluded as per Section 2.2.3.2 (f) Low Threat Vegetation
Vegetation Types Present:	Vegetation managed to a low bushfire threat state.
Description/Justification:	Photo 4a: Managed residential lots and street verges. Photo 4b: Managed public open space.



Photo ID: 4a



Photo ID: 4b

VEGETATION AREA 4	
AS 3959:2018 Vegetation Classification Applied:	Excluded as per Section 2.2.3.2 (f) Low Threat Vegetation
Vegetation Types Present:	Vegetation managed to a low bushfire threat state.
Description/Justification:	Photo 4c: Managed vacant residential lots. Photo 4d: Managed public open space.



Photo ID: 4c



Photo ID: 4d

Vegetation Area	Vegetation Class	Vegetation Type	Effective Slope
1	D	Scrub	0
2	D	Scrub	0
3	G	Grassland	0

Figure 3.1

Amendment to LDP 3 Existing Topography & Classified Vegetation Map

Pt Lot 504 on Plan 69436
Gubinge Road & Fairway Drive
BILINGURR
SHIRE OF BROOME

------ LEGEND ------

- Photos
- Hydrants
- Elevation (m)
- Subject Site
- 150m Assessment Area
- Locality
- Cadastre

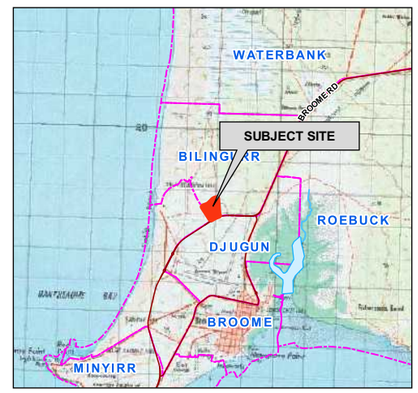
Classified Vegetation

- Class D - Scrub
- Class G - Grassland
- Exclusion 2.2.3.2

0 25 50 75 100 125 150 175 200

Metres

------ LOCALITY ------



AERIAL IMAGERY: Landgate/SLIP

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Merctaor Units: Metre
Map by: Ian Macleod 28-01-2021
SCALE (A3): 1 : 3500

BUSHFIRE PRONE PLANNING

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

3.1.3 Vegetation Separation Distance

The vegetation separation distance is the horizontal distance measured from the relevant parts of an existing building or a future building's planned location (within a lot), to the determined edge of an area of classified vegetation.

This separation distance applied to determining a Bushfire Attack Level (BAL) can be either:

- The *measured distance* – for which the location of the building relative to the edge of classified vegetation must be known. This will result in single determined BAL that will apply to a building. (The measured distance is a required calculation input); or
- A *calculated minimum and maximum distance (range)* that will correspond to each individual BAL. The calculated distances provide an indicative (or achievable) BAL for which the determined BAL will be dependent on the known location of the building relative to the edge of classified vegetation.

  The calculated range of distances corresponding to each BAL can be presented in different formats (tables or a BAL contour map), dependent on the form of information that is most appropriate for the proposed development/use. These distance ranges corresponding to BAL(s) will be presented in Section 3.2: 'Assessment Output".

For the proposed development/use, the applicable vegetation separation distances will be presented within the Bushfire Management Plan in this location:	In Section 3.2 'Assessment Output' as a table containing the calculated ranges of distance corresponding to each BAL and illustrated as a BAL Contour Map.

3.2 Assessment Output

UNDERSTANDING THE RESULTS OF THE BUSHFIRE IMPACT ASSESSMENT

Bushfire Attack Levels (BALs) – Their Application in the Building Environment is Different to the Planning Environment

In the building environment, a ***determined BAL*** is required for the proposed construction at the building application stage. This is to inform approval considerations and establish the bushfire construction standards that are to apply. An indicative BAL is not acceptable for a building application.

In the planning environment, through the application of SPP 3.7 and associated Guidelines, the deemed to satisfy requirement for a proposed 'development site' or sites (defined by the LPS Amendment Regulations 2015 as "that part of a lot on which a building that is the subject of development stands or is to be constructed"), is that a BAL-29 or lower rating can be achieved once all works associated with the proposal are completed. For planning approval purposes, an ***indicative BAL*** can provide the required information.

Determined Bushfire Attack Level

A determined BAL is to apply to an existing building or the 'development site' on which the building is to be constructed and not to a lot or building envelope. Its purpose is to state the potential radiant heat flux to which the building will be exposed, thereby determining the construction standard to be applied.

A determined BAL cannot be given for a future building whose design and position on the lot are unknown or the vegetation separation distance has not been established. It is not until these variables have been fixed that a determined BAL can be stated, and a BAL Certificate can be issued.

The one exception is when a building ***of any dimension*** can be ***positioned anywhere*** on a proposed lot (within R-Code building setbacks) or within a defined building envelope, and always remain subject to the same BAL, regardless of the retention of any existing classified vegetation either onsite or offsite.

Indicative Bushfire Attack Level

If a BAL is not able to achieve 'determined' status it will be an indicative BAL. It indicates the BAL that can be achieved by the proposed development/use. However, it is conditional upon an assessment variable(s) being confirmed at a later stage (e.g. the building location is established/changed, or vegetation is modified/removed to establish the vegetation separation distance).

A BAL certificate cannot be issued for an indicative BAL – unless that BAL cannot vary (refer to 'Determined BAL' above).

In table form, a single or a range of indicative BAL(s) may be presented. If a single indicative BAL is stated for a defined area (i.e. the lot or building envelope), this will be the highest indicative BAL impacting the defined area.

In BAL contour map form (refer to Section 3.2.1), the illustrated BAL contours visually identify areas of land for which if any part of an existing or proposed building is located on that land and within the BAL contours, then the highest BAL affecting that building (or part of the land on which the building will be constructed), will be the indicative BAL that is to apply.

The BAL can only become a determined BAL once the actual location of that building on the land is known and/or the required minimum vegetation separation distance corresponding to the relevant BAL contour is established (refer to Table 3.3).

3.2.1 Bushfire Attack Level Results - BAL Contour Map Format

INTERPRETATION OF THE BUSHFIRE ATTACK LEVEL (BAL) CONTOUR MAP

The contour map will present different coloured contour intervals extending from the areas of classified bushfire prone vegetation. These represent the different bushfire attack levels that will exist at varying distances away from the classified vegetation in the event of a bushfire in that vegetation.

The areas of classified vegetation to be considered in developing the BAL contours, are those that will remain as the intended end state of the subject development once earthworks, clearing and/or landscaping and re-vegetation have been completed.

Each bushfire attack level corresponds to a set range of radiant heat flux that is generated by a bushfire. That range is defined by the AS 3959:2018 BAL determination methodology.

The width of each shaded BAL contour is a diagrammatic representation of the separation distances from the classified vegetation that correspond to each BAL for each separately identified area of classified vegetation. They have been calculated by the application of the unique site variables including vegetation types and structure, ground slope and applied fire weather.

(Refer to Section 3.2 'Understanding the Results of the Bushfire Impact Assessment' for the explanation of how BAL(s) for buildings will be assessed from the BAL Contour Map).

Construction of the BAL Contours

VEGETATION AREAS APPLIED TO THE DEVELOPMENT OF THE BAL CONTOUR MAP

All identified areas of classified vegetation have been applied with the following exceptions:

1. For Figure 3.2, all POS areas within the subject site, with the exception of the small triangular area in the north-east corner of the site, are to remain in their current, native state. The triangular area is to be managed to a low bushfire threat state.
2. The remaining residential lots, local centre lots and road reserves are to be managed and maintained to a low bushfire threat state in perpetuity. The existing vegetation in these areas will be excluded from classification for the purpose of creating the BAL Contour Map.

This approach is applied to indicate the achievable bushfire attack levels within the subject site and the resultant area of developable land (i.e. subject to BAL-29 or less).

VEGETATION SEPARATION DISTANCES APPLIED

The distances that have been applied to illustrating the width of each BAL contour shown in Figures 3.2 and 3.3 are stated in Table 3.3. These correspond to each Bushfire Attack Level and are specific to the proposed development site.

Table 3.3: Vegetation separation distances applied to construct the BAL contours.

BAL CONTOUR MAP – APPLIED VEGETATION SEPARATION DISTANCES								
Derived from the Application of Method 1 BAL Determination Methodology (AS 3959:2018 Section 2, Table 2.5)[1]								
Vegetation Area	Vegetation Classification	Effective Slope (degree range)	BAL and Corresponding Separation Distance (m)					
			BAL-FZ	BAL-40	BAL-29	BAL-19	BAL12.5	BAL-LOW
1	Class D Scrub	upslope or flat	<10	10-<13	13-<19	19-<27	27-<100	>100
2	Class D Scrub	upslope or flat	<10	10-<13	13-<19	19-<27	27-<100	>100
3	Class G Grassland	upslope or flat	<6	6-<8	8-<12	12-<17	17-<50	>50
Note[1] All the assessment inputs applied are presented in Section 3.1, including Method 2 inputs if applied (for which calculation input/output summary data is presented for reference in Appendix?)								

Vegetation Area	Vegetation Class	Vegetation Type	Effective Slope
1	D	Scrub	0
2	D	Scrub	0
3	G	Grassland	0

Figure 3.2

Amendment to LDP 3 BAL Contour Map

Pt Lot 504 on Plan 69436
Gubinge Road & Fairway Drive
BILINGURR
SHIRE OF BROOME

------ LEGEND ------

- Hydrants
- Subject Site
- 100m BAL Buffer
- 150m Assessment Area
- Cadastre

LDP3 Zones

- Local Centre
- Residential
- POS-Drainage
- Road
- Building Zone (Indicative)
- Vegetation Outline

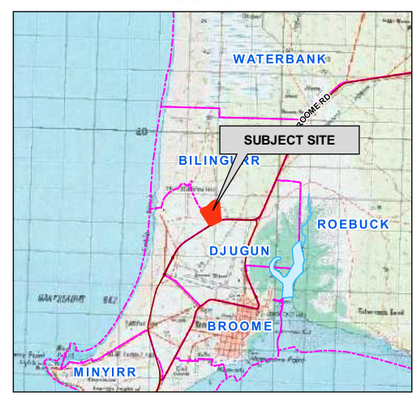
Bushfire Attack Levels

- BAL-FZ
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5
- BAL-LOW

0 25 50 75 100 125 150 175 200

Metres

------ LOCALITY ------



AERIAL IMAGERY: Landgate/SLIP

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Merctaor Units: Metre
Map by: Ian Macleod 14-04-2022
SCALE (A3): 1 : 3500

BUSHFIRE PRONE PLANNING

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3.2.2 Bushfire Attack Level Results - Derived from The BAL Contour Map

Table 3.4: Indicative BAL(s) for building works on future lots.

INDICATIVE BUSHFIRE ATTACK LEVEL FOR BUILDING WORKS ON FUTURE LOTS	
BAL Determination Methodology Applied[1]	Method 1 as per AS 3959:2018 s2.2.6 and Table 2.5.
LDP Zone	Indicative BAL ratings (refer to start of s3.2)
Local Centre	BAL-LOW to BAL-FZ
Residential Lots – Block 1	BAL-12.5 to BAL-FZ
Residential Lots – Block 2	To BAL-LOW to BAL-12.5
Residential Lots – Block 3	To BAL-LOW to BAL-12.5
Residential Lots – Block 4	BAL-12.5 to BAL-29
Note[1] Assessment inputs applied are presented in Section 3.1.	

The highest BAL rating for any residential lot within Blocks 2 to 4 is BAL-29 which is compliant with the requirements of SPP 3.7 and the Guidelines for Planning in Bushfire Prone Areas.

BAL-40 and BAL-FZ areas extend into Residential Lots – Block 1. Where Block 1 is to be a grouped development site, building will be restricted to areas of BAL-29 or lower by use of the Model Subdivision Condition F3 which requires a restrictive covenant over the lot(s) stating "No habitable buildings are to be built within areas identified as BAL-40 or BAL-FZ".

Where green titled subdivision occurs within Block 1, a public road will be provided as per Figure 1.1. This will provide enough separation from classifiable vegetation to achieve a BAL-29 rating for the lots.

BAL ratings in the Local Centre zone range from BAL-LOW to BAL-FZ. The greater portion of this zone has a BAL-LOW or BAL-12.5 rating. Construction of buildings and associated Asset Protection Zones to attain a BAL-29 or lower rating for future developments is achievable and must be demonstrated throughout the subsequent planning and subdivision processes.

4 IDENTIFICATION OF BUSHFIRE HAZARD ISSUES

In response to the Bushfire Management Plan requirements established by Appendix 5 of the Guidelines for Planning in Bushfire Prone Areas (WAPC 2017 v1.3), the following statements are made to assist in the understanding of whether the proposal is likely to be able to comply with the bushfire protection criteria now or in subsequent planning stages.

Spatial Context - Broader Landscape Considerations	
Wider road network and access constraints	Tanami Drive will be extended west to meet with Fairway Drive providing access/egress routes in two different directions for future occupiers and visitors to the subject site. This connection will also provide additional access/egress routes for residents in existing lots to the east and west of this proposal. There is no access constraint for the subject site with regard to what is considered acceptable from a planning perspective.
Proximity of settlements and emergency services	The subject site will join with existing residential developments to the east and west and a large residential development is located to the south of Gubinge Road. The main Broome townsite is located south of the Broome International Airport at a distance of approximately 4.5 kilometres by road. The Broome Volunteer Fire and Rescue Service is the closest fire emergency service and is located approximately 4.5 kms by road from the subject site. The Broome Volunteer Bush Fire Brigade and Broome state Emergency Service are also located within the Broome Townsite.
Bushfire prone vegetation types and extent (including conserved vegetation)	A significant extent of bushfire prone vegetation exists to the north of the proposed development site (generally assessed as scrub), with a smaller area located to the south on the opposite side of Gubinge Road.
Topography and fire behaviour interactions.	Topography in and around the proposed development site is generally flat and will not impact on bushfire behaviour.
Potential for extreme fire behaviour and pyro convective events.	Possible in large tracts of bushfire prone vegetation to the north of the subject site. These phenomena can influence the intensity, rate of growth and impact of bushfires. Although there are studies describing such behaviours and processes behind them, the understanding of the drivers of extreme fire behaviours (EFBs) and their occurrence is still limited.
Environmental Considerations	
Constraints to implementing required and/or additional bushfire protection measures	Some existing vegetation within the development site is to be retained as a visual buffer or within drainage swales to prevent scouring.
Provision of Access Within the Subject Site	
Potential constraints	No constraints to establishing the required access will exist.
Potential Bushfire Impacts	
Flame and radiant heat and ability to establish an APZ	The proposed residential lot locations will provide enough separation from classified vegetation to prevent flame contact. All residential lots will be managed to a low bushfire threat state. Application of the assessed bushfire construction standard will mitigate the risks from residual radiant heat impact to what is considered an acceptable level. For the Local Centre Zone, future buildings are to be located in areas where a BAL-29 rating is achievable, as a minimum, and the required APZ is to be established.

Embers/firebrands, smoke and fire-driven wind	These will be the major impacts to most of the subject site. The appropriate protection measures of building construction and strict management of APZs will mitigate the risk to what is considered an acceptable level.
Issues to be Considered at Subsequent Planning Stages (additional assessments/documents)	
Specific land uses to be addressed	Future planning for lots and buildings within the Residential Bocks and Local Centre Zone should consider availability of suitable areas on each lot for construction with respect to BAL ratings, APZs and application of bushfire construction standards.
Additional assessments	Once lot layout in known, each lot is to be assessed with respect to SPP 3.7 and the Guidelines for Planning in Bushfire Prone Areas.
Additional documents	N/A

5 ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA ESTABLISHED BY THE GUIDELINES

For a subdivision application to be considered compliant with SPP 3.7, it must satisfy (achieve) the intent of each of the four elements of the bushfire protection criteria. These criteria are established by the *Guidelines for Planning in Bushfire Prone Areas WAPC 2017 v1.3*). Compliance can be achieved by either:

- Meeting all applicable acceptable solutions corresponding to each element (i.e. the minimum bushfire protection measures that are deemed to satisfy planning requirements); or
- Where an acceptable solution cannot be met, by developing a performance solution that satisfies the established requirements.

5.1 Local Government Variations to Apply

Local governments may add to or modify the acceptable solutions of the Bushfire Protection Criteria (BPC) and/or apply technical requirements that vary from those specified in the Guidelines for Planning in Bushfire Prone Areas (WAPC). In such instances, this Proposal will be assessed against these variations and/or any specific local government technical requirements for emergency access and water. Refer to Appendices 2 and 3 for relevant technical requirements.

Will local or regional variations (endorsed by WAPC / DFES) to the applicable acceptable solutions established by the *Guidelines* or the *Position Statement: Tourism land uses in bushfire prone areas WAPC October 2019,* apply to this Proposal?	N/A

5.2 Summary of Assessment Against the Bushfire Protection Criteria

SUMMARISED OUTCOME OF THE ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA					
Element of the Bushfire Protection Criteria	Basis for the Proposal Achieving Full Compliance with SPP 3.7			The Proposal Cannot Achieve Full Compliance with SPP 3.7	
	Acceptable Solutions Met	Achieves the Intent of the Element			
	All applicable solutions are fully met	All applicable solutions are not fully met. A merit based assessment and/or a bushfire performance comparison of the proposals residual risk with that of the residual risk of the acceptable solution is conducted (refer Note 4)	A performance principle-based solution is applied	Bushfire planning development type that may not require full compliance is applied	An improvement in bushfire performance compared to the existing development is detailed (refer Note 4)
1. Location	✓			N/A	
2. Siting and Design of Development	✓				
3. Vehicular Access	✓				
4. Water	✓				

Note: The development proposal has been assessed:

1. Against the requirements established in Appendix 4 of the *Guidelines for Planning in Bushfire Prone Areas, WAPC 2017 v1.3 (Guidelines)*. The Guidelines are found at https://www.planning.wa.gov.au/8194.aspx; and
2. Applying the interpretation guidance provided in *Position Statement: Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design (WAPC Nov 2019)*.
3. Applying any endorsed variations to the Guideline's acceptable solutions and associated technical requirements that have been established by the local government. If known and applicable these have been stated in Section 5.1 with the detail included as an appendix if required by the local government.
4. When non-compliant with SPP 3.7 and when appropriate, by utilising additional compliance pathways that include the application of merit based assessment and comparative bushfire performance. The validity of this approach is derived from relevant decisions made by the responsible authorities (refer Appendix 2).

5.3 Assessment Detail

Element 1: Location	
Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.	
Compliance: How the proposed development achieves the intent of Element 1:	By fully meeting all applicable acceptable solutions established by the bushfire protection criteria (Guidelines v1.3 WAPC 2017)

ASSESSMENT (COMPLIANCE) STATEMENTS

For each applicable acceptable solution, the following statements present the results of the assessment of the proposed development/use against the requirements established by the *Guidelines (WAPC 2017 v1.3)* and apply the interpretation guidance established by the *Position Statement: Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design (WAPC Nov 2019)*.

Acceptable Solution: A1.1: Development Location

ASSESSMENT AGAINST THE REQUIREMENTS ESTABLISHED BY THE GUIDELINES

The proposed development will provide an area of land within each lot that can be considered suitable for development, as BAL-40 or BAL-FZ construction standards will not be required to be applied. This meets the requirements established by Acceptable Solution A1.1 and its associated explanatory note.

The highest BAL rating for any residential lot within Blocks 2 to 4 is BAL-29 which is compliant with the requirements of SPP 3.7 and the Guidelines for Planning in Bushfire Prone Areas.

BAL-40 and BAL-FZ areas extend into Residential Lots – Block 1. Where Block 1 is to be a grouped development site, building will be restricted to areas of BAL-29 or lower by use of the Model Subdivision Condition F3 which requires a restrictive covenant over the lot(s) stating "No habitable buildings are to be built within areas identified as BAL-40 or BAL-FZ".

Where green titled subdivision occurs within Block 1, a public road will be provided as per Figure 1.1. This will provide enough separation from classifiable vegetation to achieve a BAL-29 rating for the lots.

For the Local Centre Zone, where future lots have areas rated as BAL-FZ and/or BAL-40, building will be restricted on the lots by the application of a restrictive covenant (129BA Transfer of Land Act 189) as per the WAPC Model Subdivision Conditions Schedule (April 2020) Code F3.

ASSESSMENT AGAINST THE REQUIREMENTS ESTABLISHED BY THE POSITION STATEMENT

The position statement establishes that:

- The source of risk (the hazard) to be considered in Element 1 is the "level of bushfire exposure" from the type and extent of bushfire prone vegetation and the topography of the land on which it exists; and
- "Consideration should be given to the site context" which includes the land both "within and adjoining the subject site". The "hazards remaining within the site should not be considered in isolation of the hazards adjoining the site, as the potential impact of a bushfire will be dependent on the wider risk context."

The position statement also recognises:

- That the proposed development site and its surrounding land may be part of an area "identified for development or intensification of land use prior to the release of SPP 3.7"; consequently
- Consideration by decision-makers "should also be given to improving bushfire management of the site and surrounding area, thereby reducing the vulnerability of people property and infrastructure to bushfire"; and

Element 1: Location

- The application of mitigation measures to lessen the risk to the broader area would include improvements to the local road network (including emergency access ways), improvements/additions to firefighting water supply and increasing separation distance from the hazard.

The Hazard Within the Subject Site

The existing lot is entirely vegetated with native vegetation classified as Class D Scrub. However, with the exception of areas along the western, southern and eastern boundaries, onsite vegetation will be managed to a low bushfire threat state. The topography within and around the proposed development site is generally flat and a bushfire travelling through this vegetation will have no increased intensity or rate of spread.

Significantly intense bushfire behaviour is possible in the large area of native vegetation to the north of the site.

However, the ability to establish BAL-29 dimensioned APZs throughout the site removes the threat of greater levels of radiant heat or flame contact upon future dwellings or other buildings. Each residential lot will be managed to a low bushfire threat state in its entirety.

The primary bushfire threat from bushfire prone vegetation remaining within the proposed development site will be embers. This threat will be mitigated by the application of appropriate building design, bushfire construction standards and the ongoing maintenance of the APZs to ensure the buildings will not be impacted by consequential fire within combustible materials used, stored or accumulated within the APZ.

The Hazard Adjoining the Subject Site

- To the east and west the development site adjoins an existing high density built out residential area that presents a minimal bushfire hazard.
- The primary bushfire threat to the development site is from the south and north. To the south is an approximate 1 square kilometre area of scrub connected by a narrow strip of vegetation to a somewhat larger area south of Gantheaume Point Road. To the north of the site is generally undeveloped land able to hold a landscape type fire.

Consequently, there are limited scenarios in which the subject development site is likely to be subject to a significant bushfire event.

The Potential to Reduce Bushfire Risk to Existing Land Use

When considered in the broader context of existing land use within the surrounding area, the proposed development can potentially contribute to reducing the level of risk from bushfire to existing landowners.

Development of this section of LDP 3 will greatly reduce the amount of available bushfire prone vegetation that could affect residential lots to the east and west of the development site during a local bushfire event. Development of this site will also close and existing corridor of bushfire prone vegetation which currently links the areas of bushfire prone vegetation either side of Gubinge Road.

When the potential positive impact on the surrounding area is considered, there is merit in the broader impact of the proposed development that it is appropriate to consider.

Element 2: Siting and Design of Development

Intent: To ensure that the siting and design of development (note: not building/construction design) minimises the level of bushfire impact.

Compliance: How the proposed development achieves the intent of Element 2:	By fully meeting all applicable acceptable solutions established by the bushfire protection criteria (Guidelines v1.3 WAPC 2017)

ASSESSMENT (COMPLIANCE) STATEMENTS

For each applicable acceptable solution, the following statements present the results of the assessment of the proposed development/use against the requirements established by the *Guidelines (WAPC 2017 v1.3)* and apply the interpretation guidance established by the *Position Statement: Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design (WAPC Nov 2019)*.

Acceptable Solution: A2.1: Asset Protection Zone

THE APZ - DEVELOPMENT SITING AND DESIGN PLANNING REQUIREMENTS

The necessary outcome of bushfire planning for development siting and design, is to ensure that a building can be located within the developable portion of any lot (i.e. outside those parts of the lot that form the required R-Code building setbacks, or any other excluded area), and be subject to potential radiant heat from a bushfire not exceeding 29 kW/m^2 (i.e. a maximum BAL of BAL-29).

This will be achieved when the size of the "low fuel area immediately surrounding a building", the asset protection zone (APZ), is large enough. This requires a certain separation distance to exist between the building and areas of classified vegetation. These are the BAL-29 APZ dimensions and they will vary dependent on site specific parameters.

The APZ should be contained solely within the boundaries of each lot, except in instances where the neighbouring lot(s) or adjacent public land will be managed in a low-fuel state on an ongoing basis, in perpetuity.

Where possible, planning for siting and design should incorporate elements that include non-vegetated areas (e.g. roads/parking/drainage) and/or formally managed areas of vegetation (public open space/recreation areas/ services installed in a common section of land), as either part of the required APZ dimensions or to additionally increase separation distances to provide greater protection. These elements create robust and easier managed asset protection zones.

THE ASSESSMENT

Future buildings on the lot(s) of the proposed development can be surrounded by an APZ that will ensure the potential radiant heat impact of a bushfire does not exceed 29 kW/m^2 (BAL-29). The required APZ specifications of width, location and management can be achieved

APZ Width: The required APZ dimensions to ensure buildings are subject to a maximum BAL of BAL-29 (measured from any external wall or supporting post or column to the edge of the classified vegetation), has been determined in Section 3.2 of this BMP and are:

BAL-29 APZ Dimensions		
Applicable to all Lots:	Building to Vegetation Area 1	Minimum 13 metres
	Building to Vegetation Area 2	Minimum 13 metres
	Building to Vegetation Area 3	Minimum 8 metres

APZ Location: For larger lots the whole of the APZ can be established within the lot boundaries. For smaller and residential lots, the APZs can be partially established within each lots boundaries. The balance of the APZ's required dimensions will be contributed by an area on adjoining land that is either non-vegetated or assessed as being managed in a low-fuel state and which can most reasonably be expected to be managed this way in perpetuity (e.g. managed abutting lots, managed road reserves, managed public open space).

Element 2: Siting and Design of Development

APZ Management: All vegetation that will require modification/removal and future management is onsite and therefore under the control of the landowner.

Retained vegetation that is required to be managed to a low bushfire threat state will be managed in accordance with the technical requirements established by the Schedule 1: 'Standards for Asset Protection Zones (Guidelines). The APZ specifications are also detailed in Appendix 1 and the Shire of Broome may have additional requirements established by their Fire Break and Fuel Hazard Reduction Notice.

Note: For this proposed development it is expected that all residential lots, road reserves, Local Centre Lot(s) and the area of POS abutting residential lots will be managed and maintained to a low bushfire threat state in perpetuity.

THE APZ – REQUIRED DIMENSIONS TO SATISFY FUTURE BUILDING (AND ONGOING MANAGEMENT)

It is important for the landowner to be aware that the APZ dimensions that will be required to be physically established and maintained on each lot surrounding relevant future buildings, may be different to those stated above for the BAL-29 APZ - which is the minimum dimension a planning proposal needs to show can be established to comply with SPP 3.7.

The actual APZ dimensions to be physically established and maintained, will be based on which of the following establishes the larger APZ dimension:

- The dimensions corresponding to the determined BAL of a building (refer to Section 3.2 for explanation of the 'planning' versus 'building' requirements and 'indicative' versus 'determined' BAL); or
- The APZ dimensions established by the local government's Firebreak Notice.

If the dimensions of the APZ that are to be established are known at this time, they will be stated below.

Possible BAL ratings for future building range from BAL-LOW to BAL-29. Tables below show the minimum required APZ dimensions to achieve a particular BAL rating (Note: BAL-29 APZ dimensions shown in Table above).

BAL-19 APZ Dimensions		
Applicable to all Lots with determined BAL of BAL-19:	Building to Vegetation Area 1	Minimum 19 metres
	Building to Vegetation Area 2	Minimum 19 metres
	Building to Vegetation Area 3	Minimum 12 metres

BAL-12.5 APZ Dimensions		
Applicable to all Lots with determined BAL of BAL-12.5:	Building to Vegetation Area 1	Minimum 27 metres
	Building to Vegetation Area 2	Minimum 27 metres
	Building to Vegetation Area 3	Minimum 17 metres

BAL-LOW APZ Dimensions		
Applicable to all Lots with determined BAL of BAL-LOW:	Building to Vegetation Area 1	Minimum 100 metres
	Building to Vegetation Area 2	Minimum 100 metres
	Building to Vegetation Area 3	Minimum 50 metres

Consideration/Implementation of Proposed Landscape Plans

Any future landscape plans should be designed so that the vegetation within the landscaped areas does not increase the indicative BAL rating, as shown in Figure 3.2, on any neighbouring or nearby residential, commercial or industrial lots.

Element 2: Siting and Design of Development

Consideration/Implementation of Staged Development

Where the proposed development is staged each stage must comply with the requirements of the Guidelines for Planning in Bushfire Prone Areas and this Bushfire Management Plan. This may require the creation of roads or management of land or installation of water supply lines outside that particular stage to achieve compliance.

Vegetation on the balance lot(s) may adversely affect the indicative BAL ratings of lots being developed. This should be assessed prior to the sale of the lots and the required vegetation on the balance lot managed and maintained until developed, or the indicative BAL ratings for the affected lots amended.

Future Stage Planning Application – Additional Information Required

Tourism Land Uses proposed within the development site must demonstrate that they comply with the DPLH Position Statement: Tourism Land Uses in Bushfire Prone Areas.

High Risk or Vulnerable land uses must comply with the requirements of the Guidelines for Planning in Bushfire Prone Areas.

Element 3: Vehicular Access	
Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.	
Compliance: How the proposed development achieves the intent of Element 3:	By fully meeting all applicable acceptable solutions established by the bushfire protection criteria (Guidelines v1.3 WAPC 2017)
ASSESSMENT (COMPLIANCE) STATEMENTS For each applicable acceptable solution, the following statements present the results of the assessment of the proposed development/use against the requirements established by the *Guidelines (WAPC 2017 v1.3)*.	
Acceptable Solution: A3.1: Two Access Routes	
The proposed roads provide safe access and egress in two different directions to two different destinations. As sealed public roads, they will be available to all residents and the public at all times and under all weather conditions.	
Acceptable Solution: A3.2: Public Road	
The construction technical requirements established by the Guidelines will be complied with.	
Acceptable Solution: A3.3: Cul-de-sacs (including a dead-end road)	
N/A	
Acceptable Solution: A3.4: Battle-axe	
Where battle-axe lots are proposed, justification must be provided that there is no alternative to the designed layout. The construction technical requirements established by the Guidelines will be complied with. These requirements are set out in Appendix 2.	
Acceptable Solution: A3.5: Private Driveways	
Where a habitable building is greater than 50 metres from a public road the driveway(s) must comply with the technical requirements established by the Guidelines will be complied with. These requirements are set out in Appendix 2.	
Acceptable Solution: A3.6: Emergency Access Way	
N/A	
Acceptable Solution: A3.7: Fire Service Access Routes	
N/A	
Acceptable Solution: A3.8: Firebreak Width	
The future lots will comply with the requirements of the local government annual firebreak notice issued under s33 of the Bush Fires Act 1954. Firebreaks to be installed prior to subdivision clearance.	

Element 4: Water	
Intent: To ensure water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.	
Compliance: How the proposed development achieves the intent of Element 4:	By fully meeting all applicable acceptable solutions established by the bushfire protection criteria (Guidelines v1.3 WAPC 2017)
ASSESSMENT (COMPLIANCE) STATEMENTS For each applicable acceptable solution, the following statements present the results of the assessment of the proposed development/use against the requirements established by the *Guidelines (WAPC 2017 v1.3)*.	
Acceptable Solution: A4.1: Reticulated Areas	
A reticulated water supply is available to the subject site and hydrants will be installed in locations as required by the relevant authorities. (Required hydrant separation distances – 100m commercial, 200m residential) The construction technical requirements established by the Guidelines and/or the local government can and will be complied with.	
Acceptable Solution: A4.2: Non-Reticulated Areas	
N/A	
Acceptable Solution: A4.3: Non-Reticulated Areas – Individual Lots	
N/A	

6 RESPONSIBILITIES FOR IMPLEMENTATION AND MANAGEMENT OF THE BUSHFIRE PROTECTION MEASURES

Table 6.1: BMP Implementation responsibilities prior to the issue of titles.

Developer (Landowner) - Prior to Issue of Titles		
No.	Implementation Actions	Subdivision Clearance
Note: Planning approval may be conditioned with the requirements: 1. To place certain notifications on the certificates of title and the deposited plan, regarding the existence of this bushfire management plan and the obligations it creates; and 2. To provide certification of the implementation of certain bushfire protection measures established by this bushfire management plan.		
1	Condition (as per Code F1 of Model Subdivision Schedule, WAPC April 2020): Information is to be provided to demonstrate that the measures contained in Section 6; Tables 6.1 and 6.2 of this Bushfire Management Plan (version and date referenced in the condition), have been implemented during subdivisional works. This information should include a completed 'Certification by Bushfire Consultant' from the bushfire management plan. (Local Government) Or Information is to be provided to demonstrate that the measures contained in this bushfire management plan that address the following: (a) (b) (c) Have been implemented during subdivisional works. This information should include a notice of 'Certification by Bushfire Consultant'.	☐
2	Condition (as per Code F2 of Model Subdivision Schedule, WAPC April 2020): A notification, pursuant to Section 165 of the *Planning and Development Act 2005*, is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: *"This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is/may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land."* (Western Australian Planning Commission).	☐
3	Condition (as per Code F3 of Model Subdivision Schedule, WAPC April 2020): A plan is to be provided to identify areas of the proposed lot(s) that have been assessed as BAL-40 or BAL-FZ. A restrictive covenant to the benefit if the local government pursuant to section 129BA of the *Transfer of Land Act 1893*, is to be placed on the certificate(s) of title of the proposed lot(s) advising of the existence of a restriction on the use of land within areas that have been assessed a BAL-40 or BAL-FZ. Notice of this restriction is to be included on the diagram or plan of survey (deposited plan). The restrictive covenant is to state as follows:	☐

	"No habitable buildings are to be built within areas identified as BAL-40 or BAL-FZ". (Local Government).	
4	Construct the public roads to the standards stated in the BMP.	☐
5	Construct the private driveways and battle axes to the standards stated in the BMP.	☐
6	Install the reticulated water supply (hydrants) to the standards stated in the BMP.	☐

Table 6.2: BMP Implementation responsibilities prior to lot sale, occupancy or building.

Landowner (Developer) - Prior to Sale of Lot(s)	
No.	Implementation Actions
1	Prior to sale and post planning approval, the entity responsible for having the BMP prepared should ensure that anyone listed as having responsibility under the Plan has endorsed it and is provided with a copy for their information and informed that it contains their responsibilities. This includes the landowners/proponents (including future landowners where the Plan was prepared as part of a subdivision approval), local government and any other authorities or referral agencies ('Guidelines' s4.6.3).
2	Prior to sale of the subject lots, each individual lot is to be compliant with the Shire of Broome Fire Break & Fuel Hazard Reduction Notice issued under s33 of the Bushfires Act 1954. This may include specifications for asset protection zones that differ from the Guideline's APZ Standards, with the intent to better satisfy local conditions. When these are more stringent than those created by the Guidelines, or less stringent and endorsed by the WAPC and DFES, they must be complied with. Refer to Appendix 1.
3	Prior to occupancy, install the private driveways and battle axes to the standards stated in the BMP.
4	Prior to any building work, inform the builder of the existence of this Bushfire Management Plan and the responsibilities it contains, regarding the required construction standards. This will be: • The standard corresponding to the determined BAL, as per the bushfire provisions of the Building Code of Australia (BCA); and/or • A higher standard because the BMP establishes that the construction standard is to correspond to a higher BAL as an additional bushfire protection measure.
5	Where the proposed development is staged each stage must comply with the requirements of the Guidelines for Planning in Bushfire Prone Areas and this Bushfire Management Plan. This may require the creation of roads or management of land or installation of water supply lines outside that particular stage to achieve compliance. Vegetation on the balance lot(s) may adversely affect the indicative BAL ratings of lots being developed. This should be assessed prior to the sale of the lots and the required vegetation on the balance lot managed and maintained until developed, or the indicative BAL ratings for the affected lots amended.

Table 6.3: Ongoing management responsibilities for the Landowner/Occupier.

Landowner/Occupier - Ongoing	
No.	Ongoing Management Actions
1	Maintain the Asset Protection Zone (APZ) surrounding buildings within the Local Centre zone to the largest dimension as determined by either: • The dimensions corresponding to the determined BAL of a building (refer to Section 3.2 for explanation of the 'planning' versus 'building' requirements and 'indicative' versus 'determined' BAL); or • The dimensions corresponding to the local government's Firebreak Notice. Maintain the APZ to the above dimensions and to the standards established by the Guidelines (refer to Appendix 1) or as varied by the local government through their Firebreak Notice (refer to the following responsibility).
2	Comply with the Shire of Broome Fire Break & Fuel Hazard Reduction Notice issued under s33 of the Bush Fires Act 1954. This may include specifications for asset protection zones that differ from the Guideline's APZ Standards, with the intent to better satisfy local conditions. When these are more stringent than those created by the Guidelines, or less stringent and endorsed by the WAPC and DFES, they must be complied with. Refer to Appendix 1.
3	Maintain vehicular access routes within the lot to the required surface condition and clearances as stated in the BMP.
4	Ensure that any builders (of future structures on the lot) are aware of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to a determined BAL.
5	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: 1. the requirements of the WA Building Act 2011 and the bushfire provisions of the Building Code of Australia (BCA); and 2. with any identified additional requirements established by this BMP or the local government.

Table 6.4: Ongoing management responsibilities for the Local Government.

Local Government - Ongoing	
No.	Ongoing Management Actions
1	Monitor landowner compliance with the Bushfire Management Plan and the annual Fire Break and Fuel Hazard Reduction Notice.
2	Where control of an area of vegetated land is vested in the control of the local government and that area of land has influenced the assessed BAL(s) of the subject site(s) – and the BAL has been correctly assessed and considered all reasonable and likely future expectations for changes in vegetation classification - there is an obligation to consider the impact of any changes to future vegetation management and/or revegetation plans with respect to that area.

A1.1 Requirements Established by the Guidelines – Standards for Asset Protection Zones

(Source: Guidelines for Planning in Bushfire Prone Areas - WAPC 2017 v1.3 Appendix 4, Element 2, Schedule 1 and Explanatory Note E2.1)

DEFINING THE ASSET PROTECTION ZONE (APZ)

Description: An APZ is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level (by reducing fuel loads). The width of the required APZ varies with slope and vegetation and varies corresponding to the BAL rating determined for a building (lower BAL = greater dimensioned APZ).

For planning applications, the minimum sized acceptable APZ is that which is of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL-29). It will be site specific.

For subdivision planning, design elements and excluded/low threat vegetation adjacent to the lot(s) can be utilised to achieve the required vegetation separation distances and therefore reduce the required dimensions of the APZ within the lot(s).

Defendable Space: The APZ includes a defendable space which is an area adjoining the asset within which firefighting operations can be undertaken to defend the structure. Vegetation within the defendable space should be kept at an absolute minimum and the area should be free from combustible items and obstructions. The width of the defendable space is dependent on the space, which is available on the property, but as a minimum should be 3 metres.

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

The APZ may include public roads, waterways, footpaths, buildings, rocky outcrops, golf courses, maintained parkland as well as cultivated gardens in an urban context, but does not include grassland or vegetation on a neighbouring rural lot, farmland, wetland reserves and unmanaged public reserves.

[Note: Regardless of whether an Asset Protection Zone exists in accordance with the acceptable solutions and is appropriately maintained, fire fighters are not obliged to protect an asset if they think the separation distance between the dwelling and vegetation that can be involved in a bushfire, is unsafe.]

Schedule 1: Standards for APZ

Fences: within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

Objects: within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.

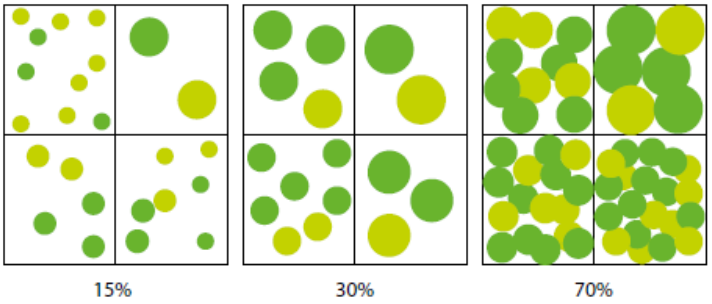
Fine Fuel Load: combustible dead vegetation matter less than 6 mm in thickness reduced to and maintained at an average of two tonnes per hectare (example below).



Example: Fine fuel load of 2 t/ha
(Image source: Shire of Augusta Margaret River's Firebreak and Fuel Reduction Hazard Notice)

Trees (> 5 metres in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy. Diagram below represents tree canopy cover at maturity.

Tree canopy cover – ranging from 15 to 70 per cent at maturity



(Source: Guidelines for Planning in Bushfire Prone Areas 2017, Appendix 4)

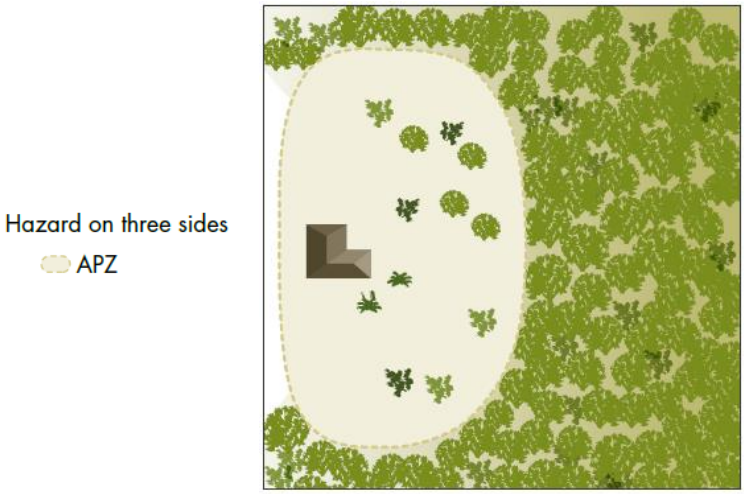
Shrubs (0.5 metres to 5 metres in height): should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees.

Ground covers (<0.5 metres in height): can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 mm in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.

Grass: should be managed to maintain a height of 100 mm or less.

The following example diagrams illustrate how the required dimensions of the APZ will be determined by the type and location of the vegetation.





A1.2 Requirements Established by the Local Government – the Firebreak Notice

The local government's current Firebreak Notice is available on their website, at their offices and is distributed as ratepayer's information. It must be complied with.

These requirements are established by the local government's Firebreak Notice created under s33 of the Bushfires Act 1954 and issued annually (potentially with revisions). The Firebreak Notice may include additional components directed at managing fuel loads, accessibility and general property management with respect to limiting potential bushfire impact.

If Asset Protection Zone (APZ) specifications are defined in the Firebreak Notice, these may differ from the Standards established by the Guideline's, with the intent to better satisfy local conditions. When these are more stringent than those created by the Guidelines, or less stringent and endorsed by the WAPC and DFES, they must be complied with.

The APZ dimensions to be physically established and maintained, will be based on which of the following establishes the larger APZ dimension:

- The dimensions corresponding to the determined BAL of a building (refer to Section 3.2 explanation of the 'planning' versus 'building' requirements and 'indicative' versus 'determined' BAL(s)); or
- The APZ dimensions established by the local government's Firebreak Notice.

A1.3 Requirements Recommended by DFES – Property Protection Checklists

Further guidance regarding ongoing/lasting property protection (from potential bushfire impact) is presented in the publication 'DFES – Fire Chat – Your Bushfire Protection Toolkit'. It is available from the Department of Fire and Emergency Services (DFES) website.

A1.4 Requirements Established by AS 3959:2018 – 'Minimal Fuel Condition'

This information is provided for reference purposes. This knowledge will assist the landowner to comply with Management Requirement No. 3 set out in the Guidance Panel at the start of this Appendix. It identifies what is required for an area of land to be excluded from classification as a potential bushfire threat.

"Australian Standard - AS 3959:2018 Section 2.2.3.2: Exclusions - Low threat vegetation and non-vegetated areas:

The Bushfire Attack Level shall be classified BAL-LOW where the vegetation is one or a combination of the following:

a) Vegetation of any type that is more than 100m from the site.

b) Single areas of vegetation less than 1ha in area and not within 100m of other areas of vegetation being classified vegetation.

c) Multiple area of vegetation less than 0.25ha in area and not within 20m of the site or each other or other areas of vegetation being classified vegetation.

d) Strips of vegetation less than 20m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20m of the site or each other, or other areas of vegetation being classified vegetation.

e) Non-vegetated areas, that is, areas permanently cleared of vegetation, including waterways, exposed beaches, roads, footpaths, buildings and rocky outcrops.

f) *Vegetation regarded as low threat due to factors such as flammability, moisture content or fuel load. This includes grassland managed in a* ***minimal fuel condition,*** *(means insufficient fuel available to significantly increase the severity of a bushfire attack – for example, recognisable as short cropped grass to a nominal height of 100mm), mangroves and other saline wetlands, maintained lawns, golf courses (such as playing areas and fairways), maintained public reserves and parklands, sporting fields, vineyards, orchards, banana plantations, market gardens (and other non-curing crops), cultivated gardens, commercial nurseries, nature strips and windbreaks (single row of trees)."*

APPENDIX 2: TECHNICAL REQUIREMENTS FOR VEHICULAR ACCESS

Each local government may have their own standard technical requirements for emergency vehicular access, and they may vary from those stated in the Guidelines.

When required, these are stated in Section 5.1 of this bushfire management plan.

Requirements Established by the Guidelines – The Acceptable Solutions

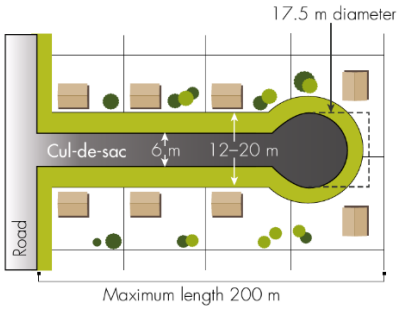
(Source: Guidelines for Planning in Bushfire Prone Areas WAPC 2017 v1.3, Appendix 4)

VEHICULAR ACCESS TECHNICAL REQUIREMENTS - PART 1

Acceptable Solution 3.3: Cul-de-sacs (including a dead-end road)

Their use in bushfire prone areas should be avoided. Where no alternative exists then the following requirements are to be achieved:

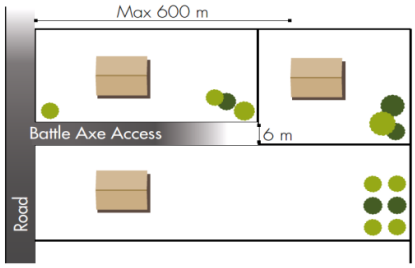
- Maximum length is 200m. If public emergency access is provided between cul-de-sac heads (as a right of way or public access easement in gross), the maximum length can be increased to 600m provided no more than 8 lots are serviced and the emergency access way is less than 600m in length;
- Turnaround area requirements, including a minimum 17.5m diameter head to allow type 3.4 fire appliances to turn around safely;
- The cul-de-sac connects to a public road that allows for travel in two directions; and
- Meet the additional design requirements set out in Part 2 of this appendix.



Acceptable Solution 3.4: Battle-axe

Their use in bushfire prone areas should be avoided. Where no alternative exists then the following requirements are to be achieved:

- Maximum length 600m and minimum width 6m; and
- Comply with minimum standards for private driveways.



VEHICULAR ACCESS TECHNICAL REQUIREMENTS - PART 1

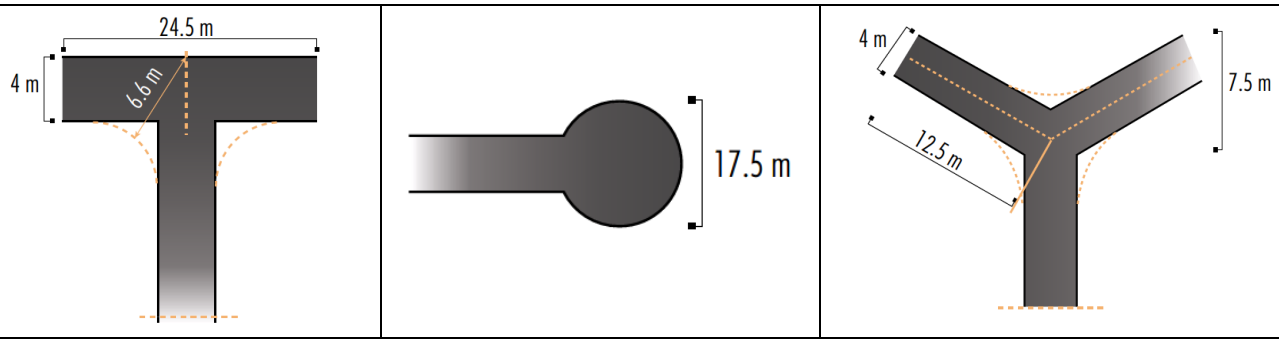
Acceptable Solution 3.5: Private Driveways

The following requirements are to be achieved:

- The design requirements set out in Part 2 of this appendix; and

Where the house site is more than 50 metres from a public road:

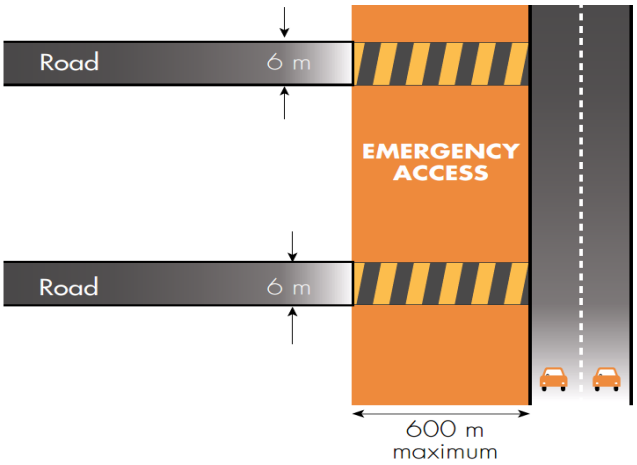
- Passing bays every 200 metres with a minimum length of 20 metres and a minimum width of two metres (ie combined width of the passing bay and constructed private driveway to be a minimum six metres);
- Turn-around areas every 500 metres and within 50 metres of a house, designed to accommodate type 3.4 fire appliances to turn around safely (ie kerb to kerb 17.5 metres);
- Any bridges or culverts are able to support a minimum weight capacity of 15 tonnes; and
- All weather surface (i.e. compacted gravel, limestone or sealed).



Acceptable Solution 3.6: Emergency Access Way

An access way that does not provide through access to a public road is to be avoided bushfire prone areas. Where no alternative exists, an emergency access way is to be provided as an alternative link to a public road during emergencies. The following requirements are to be achieved:

- No further than 600 metres from a public road;
- Must be signposted including where they ajoin public roads;
- Provided as a right of way or public access easement in gross;
- Where gates are used they must not be locked and they must be a minimum width of 3.6 metres with design and construction approved by local government (refer to the example in this appendix); and
- Meet the additional design requirements set out in Part 2 of this appendix.



VEHICULAR ACCESS TECHNICAL REQUIREMENTS - PART 1

Acceptable Solution 3.7: Fire Service Access Routes (Perimeter Roads)

Are to be established to provide access within and around the edge of subdivision and related development and to provide direct access to bushfire prone areas for firefighters and link between public road networks for firefighting purposes. Fire service access is used during bushfire suppression activities but can also be used for fire prevention work. The following requirements are to be achieved:

- No further than 600 metres from a public road (driveways may be used as part of the designated fire service access;
- Dead end roads not permitted;
- Allow for two-way traffic (i.e. two 3.4 fire appliances);
- Provide turn-around areas designed to accommodate 3.4 fire appliances and to enable them to turn around safely every 500m (i.e. kerb to kerb 17.5 metres);
- All weather surface (i.e. compacted gravel, limestone or sealed) and have erosion control measures in place;
- Must be adequately sign posted;
- Where gates are used, they must be a minimum width of 3.6 metres with design and construction approved by local government (refer to the example in this appendix) and may be locked (use a common key system);
- Meet the additional design requirements set out in Part 2 of this appendix;
- Provided as right of ways or public access easements in gross; and
- Management and access arrangements to be documented and in place.

Acceptable Solution 3.8: Firebreak Width

Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three meters or to the level as prescribed in the local firebreak notice issued by the local government.

VEHICULAR ACCESS TECHNICAL REQUIREMENTS - PART 2

Technical Component	Vehicular Access Types				
	Public Roads	Cul-de-sacs	Private Driveways	Emergency Access Ways	Fire Service Access Routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	4.5	4.5	4.5	4.5
Maximum grade <50 metres	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum cross-fall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5

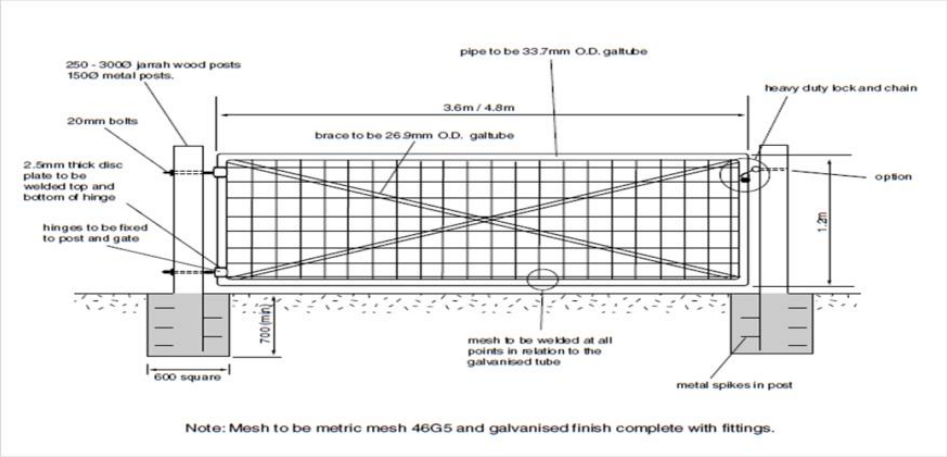
* A six metre trafficable surface does not necessarily mean paving width. It could, for example, include four metres of paving and one metre of constructed road shoulders. In special circumstances, where 8 lots or less are being serviced, a public road with a minimum trafficable surface of four metres for a maximum distance of ninety metres may be provided subject to the approval of both the local government and DFES.

VEHICULAR ACCESS TECHNICAL REQUIREMENTS – GATES AND SIGNS EXAMPLES

Gates

Design and construction to be approved by local government.

- Minimum width 3.6m
- Emergency access way gates must not be locked.
- Fire service access route gates may be locked but only with a common key that is available to local fire service personnel.
- Bollards will be to the local government specifications



Signs

Design and construction to be approved by the local government.

- Minimum height above ground of 0.9m.
- Lettering height to be 100mm.
- To display the words (as appropriate) "Emergency Access Only" or "Fire Service Access – No Public Access".
- Size 600mm x 400mm.
- Sign colour red, base (white) area is reflective background.
- Rounded corners, radius 20mm.
- White key-line 3mm wide, 3mm from outside edge.
- Suggested mounting hole 6mm diameter.



Reticulated Areas

[Source: Guidelines for Planning in Bushfire Prone Areas WAPC 2017 v1.3, Appendix 4, Element 4]

The Water Corporation's 'No 63 Water Reticulation Standard' is deemed to be the baseline criteria for developments and should be applied unless local water supply authority's conditions apply.

The requirement is to supply a reticulated water supply and fire hydrants, in accordance with the technical requirements of the relevant water supply authority and DFES.

Key specifications in the most recent version/revision of the design standard include:

- ***Residential Standard*** – hydrants are to be located so that the maximum distance between the hydrants shall be no more than 200 metres.
- ***Commercial Standard*** – hydrants are to be located with a maximum of 100 metre spacing in Industrial and Commercial areas.
- ***Rural Residential Standard*** – where minimum site areas per dwelling is 10,000 m^2 (1ha), hydrants are to be located with a maximum 400m spacing. If the area is further subdivided to land parcels less than 1ha, then the residential standard (200m) is to be applied.

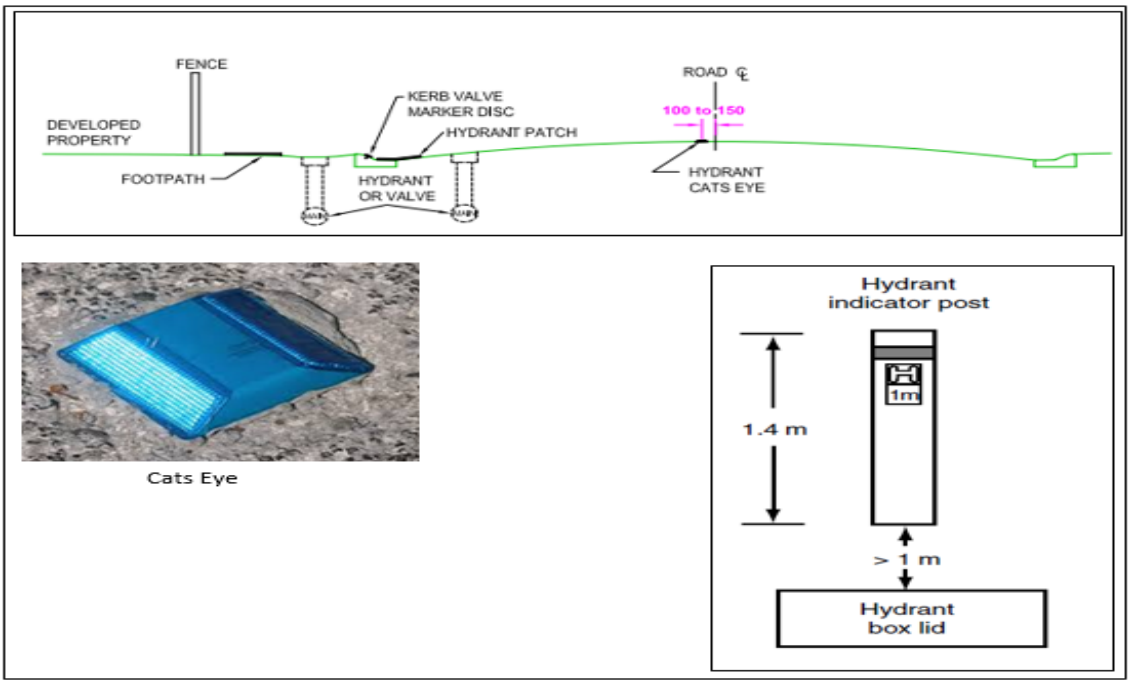


Figure A4.1: Hydrant Location and Identification Specifications

FIRE MANAGEMENT PLAN

Broome North

Local Development Plan 3

Fairway Drive, Sanctuary Drive

and Oryx Drive

Shire of Broome



FirePlan WA

March 2014

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Fire Management Plan Broome North Stage 3

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Version 1		BWH	25.02.14
Version 2	New Figure 5	BWH	23.03.14

Disclaimer: The measures contained in this fire management plan are considered to be minimum standards and they do not guarantee that a building will not be damaged in a bush fire. All surveys, forecasts, projections and recommendations made in this report associated with the project are made in good faith on the basis of information available to FirePlan WA at the time; and achievement of the level of implementation of fire precautions will depend among other things on the actions of the landowners or occupiers over which FirePlan WA has no control. Notwithstanding anything contained therein, FirePlan WA will not, except as the law may require, be liable for any loss or other consequences (whether or not due to the negligence of the consultants, their servants or agents) arising out of the services rendered by the consultants.

1.0 INTRODUCTION

The purpose of this Fire Management Plan is to detail the fire management methods and requirements that will be implemented for Broome Local Development Plan 3, refer Figure 1: Location Plan.

This Fire Management Plan complies with the requirements of the Shire of Broome and the Western Australian Planning Commission (WAPC) via *Planning for Bush Fire Protection* Edition 2 (WAPC and Department of Fire and Emergency Services 2010).

This fire management plan complies with the acceptable solutions detailed in Appendix 2 of *Planning for Bush Fire Protection* Edition 2 2010 and are summarised in Compliance Checklist for Performance Criteria and Acceptable Solutions at the end of this fire management plan Section 8.

This Fire Management Plan will likewise outline the responsibility and timing for implementing and maintaining the fire protection measures and strategies contained within, allocating these responsibilities between individual land owners, the developers and the Shire of Broome.

As fire management strategies may require altering to meet changing weather, environment and land use needs, it must be advised that the provisions of the *Bush Fires Act 1954* will still be enforced, in addition to this Fire Management Plan.

The Shire of Broome will be responsible for initiating a review of this fire management plan as it may seem necessary to do so.

In the event of large bushfires it is essential that landowners understand that fire appliances may not be available to protect each dwelling/building, so it is in the landowners best interest to provide adequate protection to their assets, the minimum requirements are detailed in this Fire Management Plan.

This Fire Management Plan for the Broome Local Development Plan 3 has been prepared in accordance with Acceptable Solutions detailed in *Planning for Bush Fire Protection* Edition 2 (2010) and when this Fire Management Plan is implemented the development will comply with all relevant requirements detailed in *Planning for Bush Fire Protection* Edition 2.

In the Foreword of AS 3959- 2009 it states that “It should be borne in mind that the measures contained in this standard cannot guarantee that a building will survive a bushfire event on every occasion. This is substantially due to the degree of vegetation management, the unpredictable nature and behavior of fire and extreme weather conditions.”

2.0 AIM

The aim of the Bushfire Management Plan is to reduce the occurrence of and minimise the impact of bush fires thereby reducing the threat to life, property and the environment.

The Fire Management Plan sets out to reduce this threat by:

- Identifying the objectives of this Fire Management Plan (Section 3)
- Describing the site's description, topography, cultural features and land use (Section 4);
- Identifying the site's potential bush fire issues (Section 5); and
- Outlining the fire mitigation strategies for the site that will reduce the risk of bush fires impacting on the proposed subdivision including potential threat and impact of bushfire to residents, fire fighters and environmental values, including the parties responsible for undertaking the mitigation strategies. Section 6.
- Allow easy access and egress of fire fighters and residents if a fire does occur.

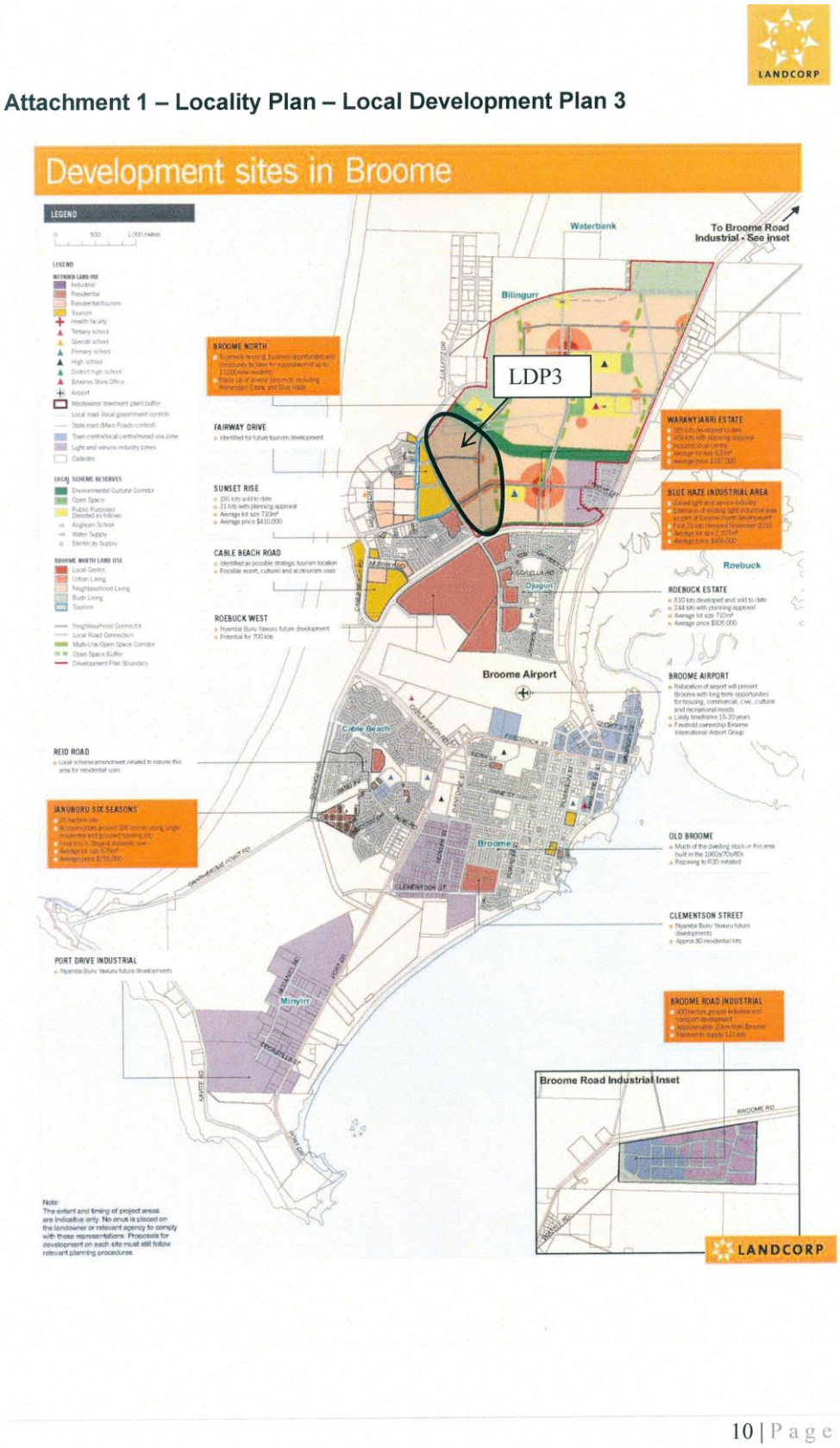
The Shire of Broome has the responsibility and powers under the Town Planning Scheme and the *Bush Fires Act 1954* to ensure that this Fire Management Plan, Shire of Broome Fire Control notice and any Special orders issued under the *Bush Fires Act 1954* are complied with.

3.0 OBJECTIVES

The objectives of this Fire Management Plan are to:-

- Identify bush fire hazards and propose bush fire prevention measures for the site.
- Define the building construction standards where lots interface vegetation within the site.
- Identify access and egress for firefighting operations and residents.
- Identify current and future landowner, developer and Shire of Broome responsibilities for various components of this fire management plan.
- Document in the Appendices section of this Fire Management Plan, the acceptable solutions adopted for the subdivision of Broome North Stage 3.

Figure 1. Locality Plan



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Figure 2 Development Layout



4.0 DESCRIPTION OF THE AREA

4.1 GENERAL

This Fire Management Plan applies to Broome North Stage 3 which is to be subdivided into Residential Lots, with Public Open Space (POS), Neighbourhood Living Lots and an adjacent Ecological Cultural Corridor to the north.

The Broome North Stage 1 is located to the south east of the site and LDP 2 to the east and south of Fairway Drive.

The proposed site is bounded in the west by Oryx Drive and Lullfitz Drive, to the northwest is Fairway Drive and the south is Sanctuary Rd which leads into Tanami Drive in Stage 1.

4.2 CLIMATE

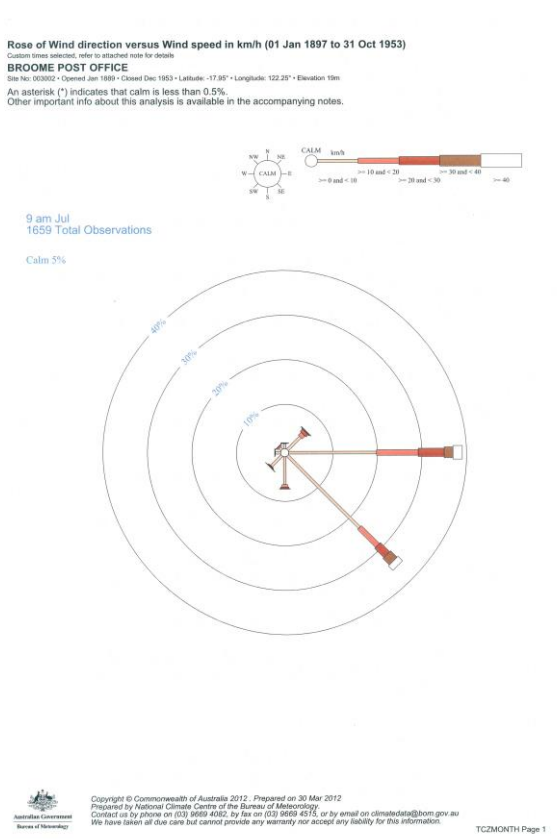
The project area is located within the Kimberley region of Western Australia. This region has a tropical climate with hot and humid summers and warm winters. There are two distinct seasons: the 'wet' usually from December to March and the 'dry' for the remainder of the year. Tropical cyclones can be experienced during the months from November to April, but are most common in January and February.

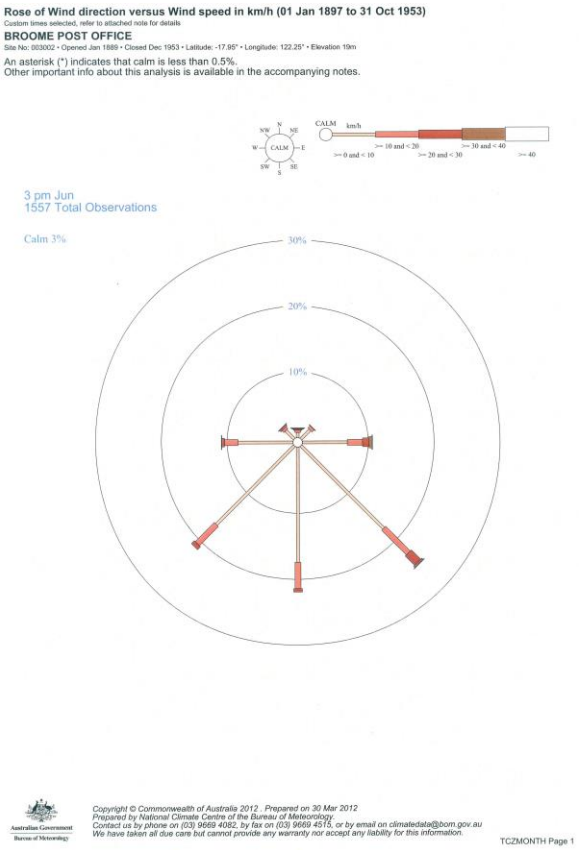
The bush fire season is generally from May to November, but is subject to seasonal changes and drought conditions.

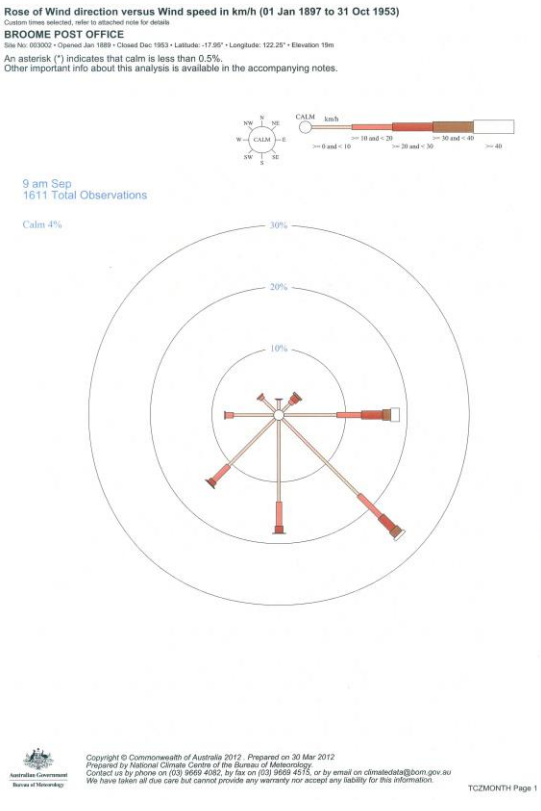
Table 1 Weather Data for Broome – 1939-2013 (BOM Website December 2013)

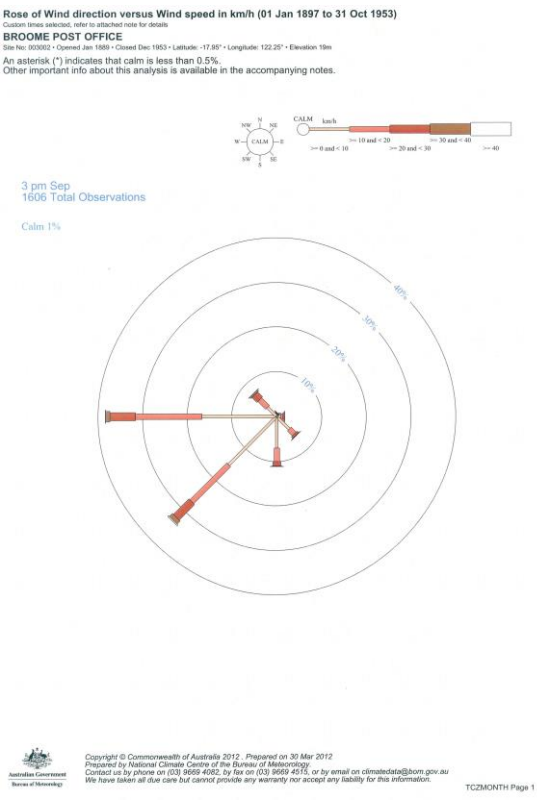
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max Temperature (°C)	33.3	32.9	33.9	34.3	31.5	29.1	28.8	30.3	31.8	32.9	33.6	33.9	
Mean 3pm Temperature (°C)	31.8	31.6	32.6	33.0	30.4	28.2	27.7	28.8	29.9	30.7	32.1	30.7	
Mean 9am Relative Humidity (%)	70	74	69	56	48	47	46	45	49	54	58	64	
Mean 3pm Relative Humidity (%)	65	67	60	45	38	36	33	35	45	54	57	61	
Mean Monthly Rainfall (mm)	178.7	179.8	101.7	26.2	27.3	19.9	7.1	1.7	1.4	1.5	9.2	56	606

Figure 3 Sample Wind Direction and Strength Broome.









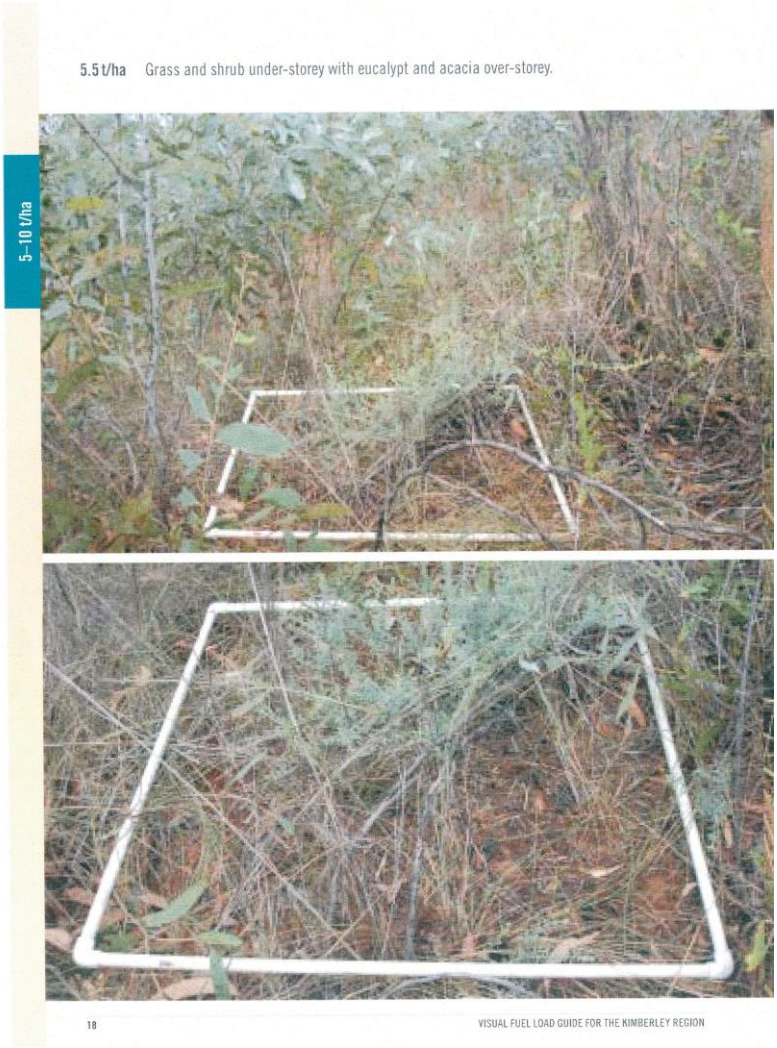
4.3 TOPOGRAPHY

The site is undulating with slopes of 0° to be used for determining BAL ratings for dwelling construction under AS 3959-2009.

4.4 BUSH FIRE FUELS

The vegetation in the LDP3 site features existing vegetation of low open Pindan Woodland with scattered trees and dominant Spinifex species grassland with Eucalyptus and Acacia overstorey.

Using FESA Visual Fuel Guide for the Kimberly 2007 fuel loads are estimated to be approximately 5.5 tonne/ha but may vary up to 10 tonnes/ha depending on the amount of Spinifex grass.





Photograph Taken 18.12.14 showing vegetation off Fairway Drive

4.5 LAND USE

Historical land use of the site has been grazing and natural vegetation. The Yawuru people are the Native Title holders of land around Broome and have a strong connection and relationship to the country. It is understood that the Broome North Development Plan 3 is an important part of a broader cultural landscape across the Pindan Plains. The proposed site is to be subdivided into Residential Lots, with Public Open Space (POS), Tourism, Environmental Cultural Corridor and Neighbourhood Living Lots.

4.6 ASSETS

The assets of the site is the land to be developed, the adjoining area covered with native vegetation (Pindan Woodland), Environmental Cultural Corridor (ECC), urban residential area, Neighbourhood Living areas, tourism areas (subject to a separate detailed DAP in the future) Public Open Space (POS) and drainage areas along with POS amenities.

4.7 ACCESS

Fairway Drive is to be realigned along the western portion of the urban area to link into Gubinge Road as shown in LDP3 Layout Plan – Figure 2. Sanctuary Road linking into Tanami Drive will provide a major east-west link from LDP3 to LDP1.

Sanctuary Road links westwards into Cable Beach Road and a portion of Fairway Drive links into Gubinge Road is the existing road system.

There are multiple proposed access and egress points to the existing road systems and those proposed in LDP2 area yet to be constructed.

4.8 WATER SUPPLIES

4.8.1 Domestic Water Supplies.

Water supplies for domestic use will be via a reticulated mains water supply

4.8.2 Water for Fire Fighting

Fire Hydrants and fire hydrant road and pole markings will comply with the *Water Corporation No 63 Water reticulation Standard*. Complies with acceptable solution A3.1. Fire hydrants are to be installed in the road that interfaces with the ECC and spacing of hydrants is to be measured along the road system. See Section 7.2 for Fire Hydrant road and pole marking standards

5.0 BUSH FIRE HAZARD ASSESSMENT

5.1 BUSH FIRE HISTORY

There was no documented fire history available. In discussions with the Shire staff December 2013) some hazard reduction burning is carried out in the Broome environs by traditional land owners . Bushfires do occur in the Broome environs.

5.2 BUSH FIRE RISK

There is a moderate risk of a bush fire starting in retained vegetation surrounding the proposed development or within the development in areas that have not been cleared as part of a stage of land release.

Hazard reduction burning is carried out successfully by the Yawuru people in conjunction with the Shire of Broome and local fire services. Hazard reduction burning will be carried out within (ECC AND Tourism Land until developed) and in land adjoining this development.

Fire mitigation will also include increase construction of habitable buildings adjoining retained vegetation areas with roads separating retained vegetation and habitable buildings.

5.3 BUSH FIRE HAZARD

In *Planning for Bush Fire Protection* Appendix 1 methodology for classifying bush fire levels is detailed. The methodology rates bush fire hazard using vegetation type. The methodology is also based on the underlying assumption that land in Western Australia is predominantly undulating. The methodology specifies three bush fire hazard levels “Low”, “Moderate” and “Extreme”.

This methodology has been used in this Fire Management Plan.

The assessment of fire risk takes into account existing site conditions which include:

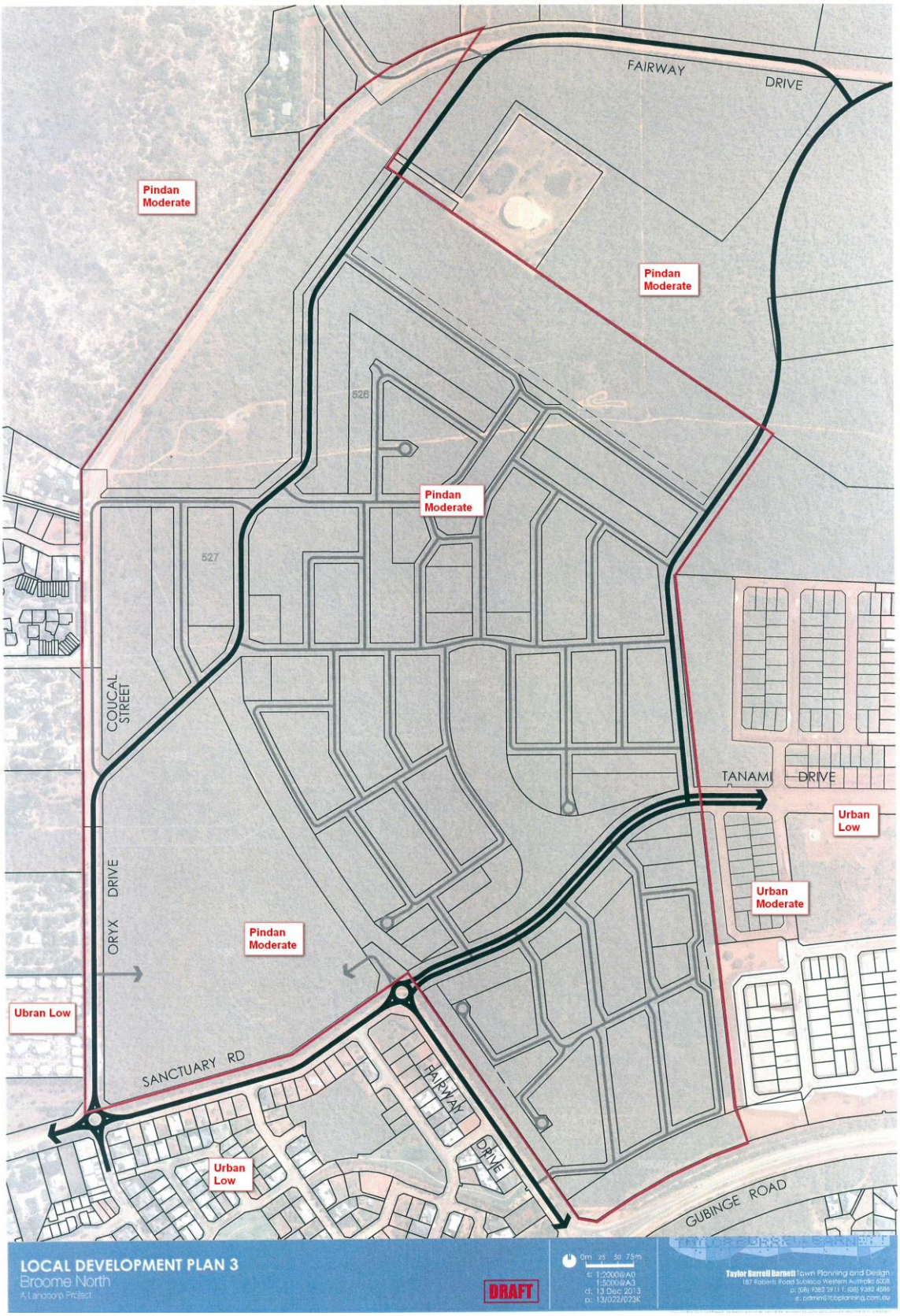
- Topography with particular reference to ground slopes and accessibility;
- Vegetation cover – both remnant and likely revegetation; and
- Relationship to surrounding development.

The Bush Fire Hazard Assessment is "Moderate" in the Pindan Woodland area" however the area within the LDP3 area will be cleared other than some POS areas, Tourism area and the Ecological Cultural Corridor.

Due to the vegetation within the site and adjoining areas having a bush fire hazard rating of "Moderate" the site is located in a *Bush Fire Prone Area*.

The minimum distance of 100 metres (from vegetation rated 'Moderate' or 'Extreme') may be reduced in compliance with AS 3959. Under AS 3959 as the distance from the vegetation is reduced, the construction standard must be increased. Table 2.4.3 AS 3959 sets out this relationship and Section 2 of AS 3959 details the methodology of determining the Bushfire Attack Level (BAL).

Figure 4 Bush Fire Hazard Assessment



5.4 BUSH FIRE THREAT

The bush fire threat within this site when developed will be greatly reduced as the residential area will have been cleared. A road reserve is located between the retained vegetation and proposed dwellings and mitigation measures implemented as detailed in Section 6. Landscape design of POS has taken into account the requirements of bush fire protection. Dwellings within 100 metres of retained vegetation will have an increased construction standard in accordance with AS 3959-2009.

5.5 SUMMARY OF BUSH FIRE POTENTIAL ISSUES

The potential bush fire issues that have been identified for this site are:-

- Bush fires occur within the general Broome area and surrounding areas.
- Management of vegetation within POS areas, ECC, undeveloped Tourism areas, undeveloped stages of land release and adjoining retained vegetation areas outside the LPD1-3 areas.
- Management of vegetation within the Neighborhood Living areas.

6.0 FIRE MITIGATION

6.1 HAZARD MANAGEMENT

Hazard Management on the lots and interface between dwellings and retained vegetation will be controlled by:-

- Installing Setbacks/Building Protection Zones to separate the interface between proposed dwellings and retained vegetation.
- All dwellings within 100 metres of retained vegetation will have an increased construction standard in accordance with AS 3959-2009.
- Weed Control will be carried out in Public Open Space areas, ECC and undeveloped Tourism area.
- All landowners complying with the Shire of Broome Firebreak Notice.
- Maintain road drainage and road reserve as a low fuel buffer complying with the Building Protection Zone Standards.
- Residents within 100 metres of retained vegetation area to manage gardens, planting of vegetation and gardens and any retained vegetation on the lots so as to comply with the Building Protection Zone standard detailed in Section 6.3
- Hazard reduction burning to be carried out in retained vegetation within and adjoining LDP3.
- Residents within Neighborhood Living Lots are to maintain fuel loads within the front portion of their lots to comply with 6-8 tonnes/ha.

6.2 BUSH FIRE RISK MANAGEMENT

6.2.1 Total Fire Ban Days

A Total Fire Ban is declared because of the extreme weather conditions or when fires are seriously stretching fire fighting resources. A Total Fire Ban is declared by DFES following consultation with Local Governments.

When a Total Fire Ban is declared it prohibits the lighting of any fires in the open air and any activities that might start a fire. The ban includes all open fires for the purpose of cooking or camping. It also includes incinerators, welding, grinding, soldering and gas cutting.

The Department of Fire and Emergency Services and the Shire of Broome are to continue to educate the public on what a Total Fire Ban means and what actions the public need to take.

6.2.2 Public Education Program

The Shire of Broome is to continue to provide the community with advice on bush fire prevention and preparedness through brochures, newspaper articles, the Firebreak Notice issued to rate payers and on their web site.

The developer is to provide a copy of the current Shire of Broome *Firebreak Notice*, *The Homeowners Bush Fire Survival Manual* and *Prepare Act Survive* brochure and this Fire Management Plan at the time of sale of a Lot effected by an increase in construction standard in

accordance with AS 3959. Copies are available at the Shire of Broome office. It is essential that the Real Estate agent handling the sale of Lots on behalf of the Developer advises potential landowners that a Fire Management Plan exist and the modification of vegetation and ongoing fuel reduction will be required within this development.

The Shire of Broome Firebreak Notice requires landowners to remove all flammable material on lots of less than 2000m².

The use of machinery such as tractors and vehicles can be controlled by the Shire of Broome as detailed in the Bush Fires Act 1954 and Regulations. Landowners within this development will need to comply with these directions.

The use of open fires for the purpose of cooking or camping, incinerators, welding, grinding, soldering and gas cutting are controlled by the Shire of Broome through its powers in the Bush Fires Act and Regulations.

Other Public Safety and Community information on Bush Fires is available on the Department of Fire and Emergency Services web site www.dfes.wa.gov.au and the Shire of Broome website www.broome.wa.gov.au.

6.3 FUTURE DEVELOPMENT

This Fire Management Plan has been prepared on the basis of the sites being developed in accordance with the subdivision plan layout detailed in Figure 2.

6.3.1 Declared Bush Fire Prone Area

Due to the Pindan Class B of vegetation being located within and adjoining the "Site" and the bush fire hazard rating for those areas is rated as "Moderate" the "Site" is considered to be a Bush Fire Prone Area and as such AS 3959 *Construction of Buildings within a Bush Fire Prone Area* will apply to all habitable buildings within 100 metres of classified vegetation as defined in the Building Code of Australia as Class 1 and 10A buildings.

6.3.2 Building Protection Zone

The aim of the Building Protection Zones (BPZ) is to reduce bush fire intensity close to buildings, and to minimise the likelihood of flame contact with buildings.

The Building Protection Zone is a low fuel area immediately surrounding a building complying with Building Protection Zone standards published on the DFES website.

A Building Protection Zone must fulfil the following conditions:

- The minimum width of the BPZ is to be 20 metres for a BAL 12.5 measured from any external wall of the building or asset to the vegetation.

- Loose flammable material within the BPZ should be removed to reduce the fuel load to less than 2 tonnes per hectare and this is to be maintained to this level.
- All dry/dead grasses within the BPZ are to be maintained to a height of a maximum 50mm.
- The crowns of trees within the BPZ should be separated where practical such that there is a clear separation distance between adjoining tree crowns.
- Prune lower branches of trees within the BPZ (up to 2 metres off the ground) to stop a surface fire spreading to the canopy of the trees.
- There are to be no tree crowns or branches overhanging the building or asset and a minimum horizontal clearance of 2 metres is required between tree branches and buildings or assets.
- Do not clump shrubs close to building. Ensure that there is a gap of at least 3 times the height (at maturity) of the shrub away from the building.
- Trees or shrubs in the BPZ are to be cleared of any dead material.
- Fences, sheds and structures within the BPZ should be constructed of non-flammable material and be clear of trees and shrubs as per building requirements.
- Gas Cylinders should be isolated from the Flame Zone and should be stored in an area that is clear of all flammable material. Gas vent valves should face away from the building and anything flammable. Gas cylinders should be securely tethered with non-flammable fastenings to prevent toppling over.
- Roof gutters should be free of leaves and other combustible material.
- Roof mounted evaporative air coolers should be fitted with ember proof screens to the filter media to reduce the possibility of bushfire embers igniting the air cooler.

It is further recommended that property owners, where possible and practical, further extend the width of the defendable space around assets by reducing fuel loads and fire hazards.

NOTE:

- The purpose of the BPZ is to reduce flammable fuel in the immediate vicinity of structures and other assets to reduce the bushfire attack level in accord with Australian Standard AS3959 section 2.
- The requirements for BPZ within Western Australia for new buildings are specified in the Guidelines and on the DFES website.
- Maintained gardens are not classed as flammable.
- Areas such as pathways, drives, lawn, vegetable gardens, pools etc. all serve to reduce fire intensity and will form an integral part of any BPZ. The effectiveness of these in reducing the risk of fire damage to a building is enhanced if these areas are close to the building.

The Building Protection Zone is to be installed by the Developer and as the BPZ will consist of road reserves and POS they will be maintained by the Shire of Broome in perpetuity.

6.3.3 Building Construction

Individual dwellings on all lots shall be designed and built to conform with:

- The Building Code of Australia; and
- AS 3959 *Construction of Buildings in a Bushfire Prone Area*;

The minimum distance of 100 metres (from vegetation rated 'Moderate' or 'Extreme') may be reduced in compliance with AS 3959. Under AS 3959 as the distance from the vegetation is reduced, the construction standard must be increased. Table 2.4.3 AS 3959 sets out this relationship and Section 2 of AS 3959 details the methodology of determining the Bushfire Attack Level (BAL).

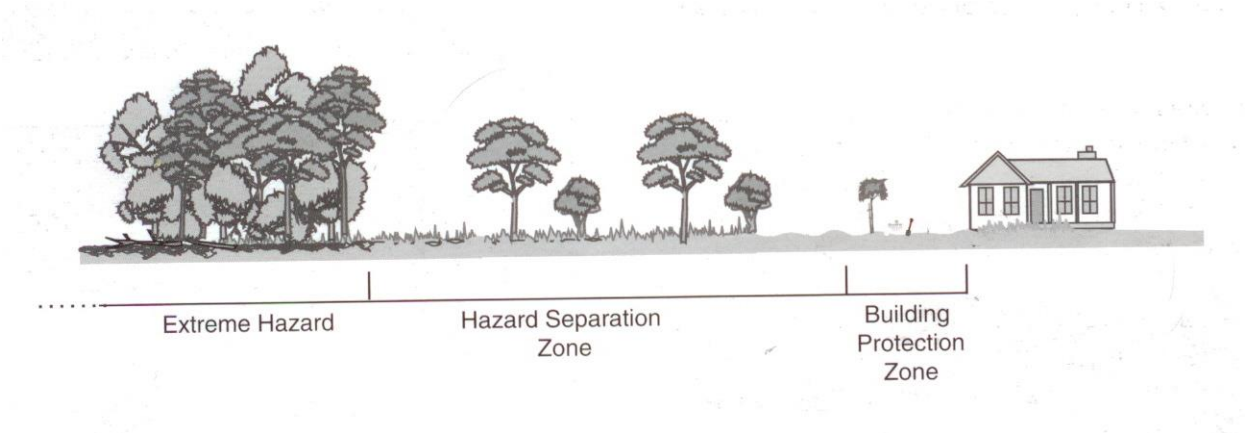
BAL (Bushfire Attack Level) Determination Using Methodology from Section 2.2.1 of current adopted AS 3959- 2009 and Table 2.4.3 which applies to the proposed Lots within 100 metres of vegetation:

Table 2 Summary of Determination of BAL using Fire Danger Index 80

Vegetation Class	Setback from Vegetation (meters)	Slope	BAL	Construction Standard AS 3959-2009	BPZ (metres)
Woodland Class B	29-100	Flat	12.5	S 3 & 5	20
Woodland Class B	20-29	Flat	19	S 3 & 6	20
Class G	14-20	Flat	29	S 3 & 7	20

The setback from the vegetation to the walls of habitable buildings is to be managed as a BPZ and may consist of a road reserve, front setback within a lot and landscaping in the vegetated area.

The indicative BAL ratings for habitable buildings is shown in Table 3 above. The Developer will provide the Shire of Broome map showing the BAL levels for each Lot of a stage of land release as part of the DAP documentation at the time of clearance of a condition of subdivision for that stage.



Neighborhood Living Lots

The Neighborhood Living Lots adjoin the ECC and are separated by a Fairway Drive with a 5 metre wide strip within the ECC which will have a footpath and street tree planting. This makes a width of 20 metres to be managed to the Building Protection Zone standard. A strip of retained vegetation not exceeding 20 metres wide, not exceeding an area of 2500m² (over several Lots) in accordance with AS 3959-2009 2.2.3.2 is considered to be low threat vegetation and does not have a bearing on the BAL rating of proposed Dwellings.

The dwellings are to be setback so that the eaves of the dwelling are a minimum of 2 metres from the vegetation at the front of the Lot. The remainder of the Lot is to be managed to the building protection Zone standard and planting of trees and vegetation must comply with that standard.

This then enable the Neighborhood dwellings to be constructed to AS 3959-2009 BAL12.5. See diagram below.

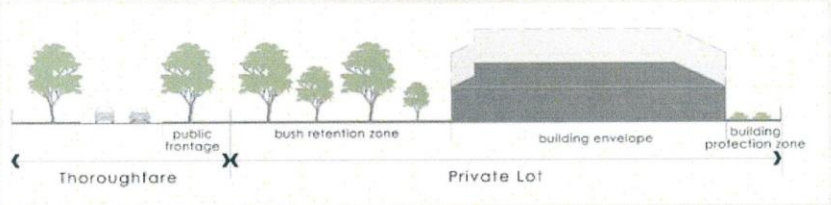
Figure 5 Neighborhood Living Lots

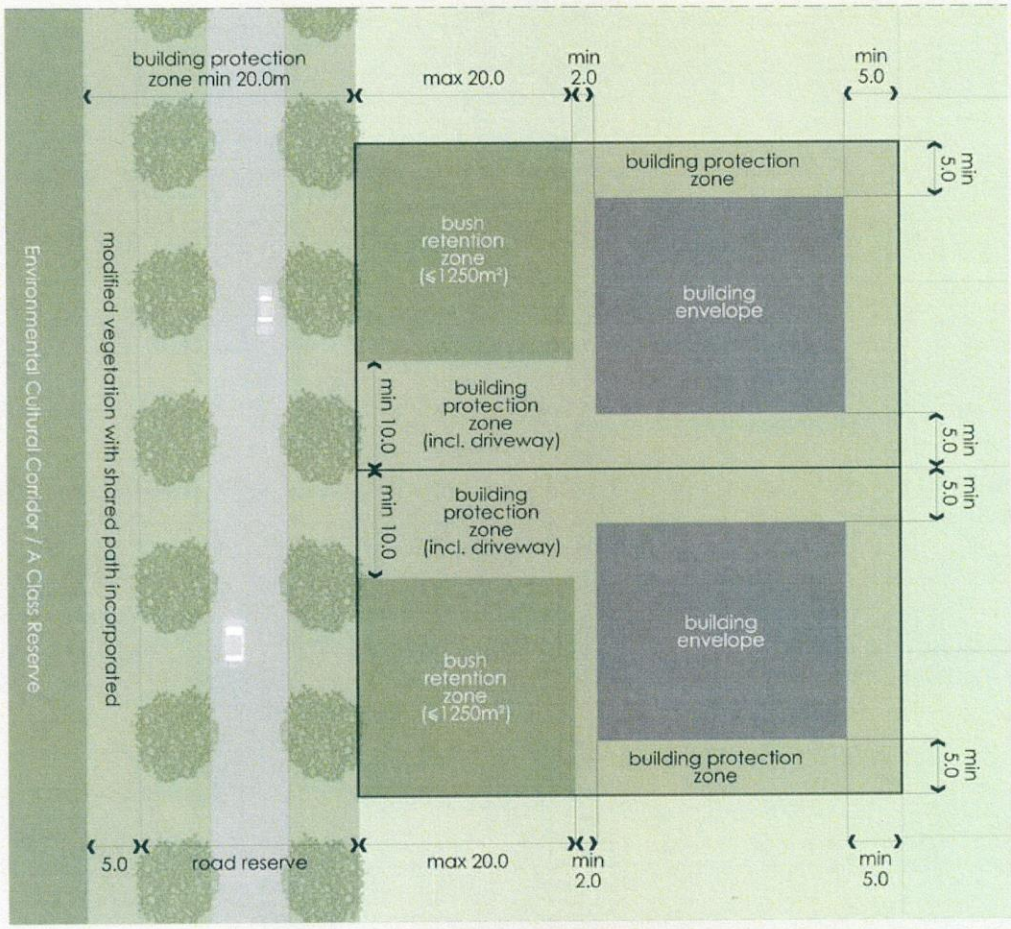
Specific Development Requirements

A Bush Retention Zone shall be included within the front setback area of all Bush Living lots. The Bush Retention Zone shall not have a depth greater than 20m (as measured from the Primary Street frontage) and shall not exceed 1,250m² in area on a single lot. A minimum dwelling setback of 2m shall be provided from the Bush Retention Zone.

[1] *The primary purpose for the proposed side and rear setbacks is to maintain breezeways for breeze access to dwellings.*

[2] *Other than Street boundaries, not as defined in the R-Codes.*





Multiple Use Corridors
In the Landscape report it is proposed that Vegetation management within the Multiple Use Corridors will comply with the Building Protection Zone. Therefore they are considered to be Low bush fire threat (AS 3595 Section 2.2.3.2) and adjoining residential areas will not require an increased construction Standard in accordance with AS 3959.

Parklands
In the Landscape Report it is proposed that parklands will be a mixture of Turfed areas and retained or planted vegetation. It is proposed that the areas of vegetation will not exceed 2500m² and each area of vegetation will be separated by a turf area of a minimum of 20 metres.

Where the Urban Living Lots adjoin retained vegetation the area of retained vegetation will comply with the Building Protection Zone Standard.

Therefore the Parkland areas managed in accordance with the above are considered being Low bush fire threat (AS 3595 Section 2.2.3.2) and adjoining residential areas will not require an increased construction Standard in accordance with AS 3959.

Examples of the setbacks/BPZ from MUC and POS are shown in the LDP3 Landscape Report February 2014

As a result of ember attack evaporative air conditioners can be the cause of a fire starting in a building. It is a requirement that the roof unit of an evaporative air conditioner is enclosed in a suitable external ember protection screen. More information is available at www.dfes.wa.gov.au and in AS 3959.

6.3.4 Stages of Land release

The main threat to each stage of development from a wildfire (bushfire) is from a fire originating in the undeveloped areas.

To provide protection to residents in the various stages, each stage is to contain the following bush fire protection requirements:-

- A fire service access route is to be constructed on the outside of the development on the alignment of the internal road in the next stage. This access is to be to the standard of a fire service access route which will comply with A2.7. It may be necessary in some places (heavy sand) to lay road base to provide access for large fire appliances.

- A 25 metre building protection zone is to be established between the last lots in each stage to be sold and the fire service access described above. The 25 metre Building Protection Zone does not remove the need for dwellings to be constructed to a higher standard in compliance with AS3959. This distance would need to be increased to 100 metres for there not to be a requirement for AS 3959 to apply. The standard of the building protection zone is detailed in this Section

- Fire hydrants are to be installed within each stage in accordance with the *Water Corporations No. 63 Water Reticulation Standard.*

6.3.5 Tourism Lots Western Boundary.

The Tourism Lots along the western boundary will be subject to a specific Development Application and Fire Protection for the development in these sites are not detailed in this Fire Management Plan.

The development of these sites will need to take into consideration the Fire Protection of the adjoining residential areas along with the Fairway Road reserve and Multiple Use Corridor provided being managed to the Building Protection Zone standard to ensure a 29 metre setback to enable dwellings to be constructed to AS 3959-2009 BAL 12.5.

Where no road separates the residential areas (area 3129) and the Tourism Lots vegetation will need to be managed for an area of 29 metres for dwellings to be constructed to AS 3959-2009 BAL 12.5
If by the time the adjoining residential is proposed to be released then all dwellings within 100 metres of the Tourism areas will be required to be constructed to AS 3959 2009 BAL 12.5.

If however the Tourism sites have been developed by the time the adjoining residential areas are to be developed an independent re assessment of BAL level in the residential area will need to be undertaken as a result of possible vegetation removed within the Tourism Lots as a result of there development.

Fuel Loads within Tourism Lots should not exceed 6-8 tonnes /ha and fuel reduction may be carried out by mechanical means of by burning.

Figure 6 AS3959-2009 BAL ratings LDP 3



6.4 ACCESS AND FIREBREAKS

6.4.1 Road System

It is proposed to have multiple access points to Fairway Drive, Sanctuary Road and eastern boundary road with an external road separating the development from the retained vegetation. Each stage of land release must have two (2) access/egress points to a public Road. As a minimum, access must comply with *Planning for Bush Fire Protection* Edition 2 2010 Acceptable Solution A2.1 & A2.2. The proposed road system complies with minimum specifications A2.2 which are detailed in Section 7.2.

6.4.2 Internal Firebreaks

Notwithstanding the provisions of this Fire Management Plan, all lots within the site must comply with the requirements of the Shire of Broome Firebreak notice, as published annually. Complies with acceptable solution A2.9

6.5 FIRE SAFER AREAS

In the event of a bush fire, the Incident Controller of Fire Fighting operation will advise if evacuation of residents is necessary and, in conjunction with the Shire of Broome, direct these residents to the Safer Refuge Areas.

6.6 ASSESSMENT OF FIRE MANAGEMENT STRATEGIES

All the actions and recommendations in this Fire Management Plan, meet the Bushfires Act 1954 and the associated Regulations and *Planning for Bush Fire Protection* Edition 2 2010 and are sound, measurable and practical having been used and proven over time. These recommendations take into account the various costs, alternatives available, benefits for protection of residents and the wider community, the environment and biodiversity protection.

It will be the responsibility of the developer to implement the provisions of this Fire Management Plan (detailed in Section 6.7.2) in order to seek clearance of those conditions of subdivision that stipulate creation of this Fire Management Plan.

Likewise it is the responsibility of the Shire of Broome to ensure that all standards required in this Fire Management Plan are met by the developer prior to clearing any conditions of subdivision relating to this Fire Management Plan.

After any major fires that may occur during or once this development has been completed, the Shire of Broome may conduct a Post Incident Analysis of the fire, which may include identifying and implementing any changes that may be needed to improve the performance of fire prevention strategies.

6.7 IMPLEMENTATION OF THE FIRE MANAGEMENT PLAN.

This Fire Management Plan becomes operational as a Condition of Subdivision.

In implementing this Fire Management Plan, the following responsibilities have been determined:

6.7.1 Property Owner/Occupier's Responsibilities

To maintain the reduced level of risk and threat of fire, the owners/occupiers of all lots created by this proposal will be responsible for undertaking, complying and implementing measures protecting their own assets from the threat and risk of bush fire:

- Maintain the property in good order to minimize potential bushfire fuels to mitigate the risk of fire on the property;
- Ensure that your lot complies with the Shire of Broome Firebreak Notice;
- Maintain the lot to the Building Protection Zone Standard in perpetuity. Refer to Section 6.3;
- Ensure that habitable buildings are constructed to AS 3959 where a lot has been identified as requiring and increased construction standard identified in Table 3 and on a map provided by the developer as part of DAP for each stage of land release. There will be a Section 70A notification on the Land Title.
- Complying with the instructions of DFES Fire Services, the Shire of Broome and/or volunteer fire services in maintaining the property or during the event of a bushfire;
- Ensure that in the event an evaporative air conditioner is installed at the property, suitable external ember screens are installed to roof mounted units and complies with AS 3959;
- Ensure that planting of a garden complies with the Building Protection Zone standard.

6.7.2 Developer's Responsibilities

Prior to the issuing of Titles the developer shall be required to carry out works described in Section 6 of this Fire Management Plan to the satisfaction of the Shire of Broome and the Western Australian Planning Commission:

- All internal roads are to comply with the design requirements of the Shire of Broome and as detailed in Sections 6.4;
- Lodging a 70A 'Notification' on each Certificate of Title of lots within the 100 metre setback to retained vegetation as identified in this Fire Management Plan. The Notification or Covenant shall alert purchasers of land and successors in Title of the existence of this Fire Management Plan and require that habitable building construction shall be in accordance with AS 3959-2009;

- Install fire hydrants as detailed in Section 4.8.2;

- Ensure that Setbacks of dwellings from retained vegetation complies with Section 6.3.

- Maintain setbacks from retained vegetation within the road reserve, POS, ECC, MUC, POS and the drainage area while these area are under the control of the developer;

- Each lot is to comply with the Shire of Broome Firebreak Notice as published annually until lots are sold;

- Provide the Shire of Broome a map for each land release depicting the AS3959 BAL ratings for dwellings located within 100 metres of retained vegetation as detailed in Section 6.3 as part of DAP documentation for each Stage of Land release;

- Supply a copy of this Fire Management Plan and *The Homeowners Bush Fire Survival Manual, Prepare Act Survive (or similar suitable documentation)* and the Shire of Broome Fire Break Notice to each property owner on sale of the allotment;

6.7.3 Shire of Broome

The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer some to the responsibilities to the Shire of Broome.

The Shire of Broome shall be responsible for:

- Ensure compliance with the current adopted AS3959, of any structure on lots that are required to have the increased construction standards, undertaken at the time of building license;
- Enforcement of the Shire of Broome Firebreak Notice;
- Monitor bush fire fuel loads in the adjoining Lots and liaise with relevant landowners to maintain safe levels;
- Provide fire prevention and preparedness advice to landowners upon request.
- Ensure Compliance with this Fire Management Plan prior to clearance of conditions of subdivision.
- Maintain setbacks between dwellings and retained vegetation in the road reserve and drainage areas to the Building Protection Zone standard as detailed in Section 6.3 to enable dwellings to retain the BAL rating identified in the building license application.
- Coordinate hazard reduction burning with Yawuru people, Fire Services, DFES and Council staff.

7.0 APPENDICES

7.1 WORKS PROGRAM

The works program required in this Fire Management Plan must be implemented by the developer as a condition of subdivision approval and each stage of land release.

Landowners will be responsible for the annual maintenance of Building Protection Zone, gardens to be planted to the building Protection Zone standards and Shire of Broome Firebreak Notice.

7.2 GUIDELINES SPECIFICATIONS AND MINIMUM STANDARDS

The following section outlines the required specifications and minimum development standards that are required under this Fire Management Plan.

7.2.1 Pubic Road Standards.

Two different vehicular access routes, both of which connect to the public road network, are available to all residents/the public at all times.

Public roads to meet the following minimum requirements:

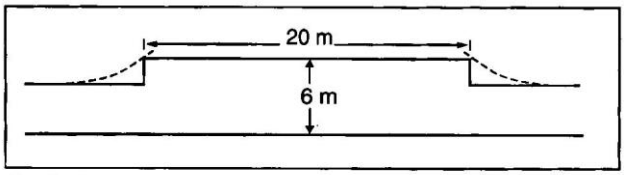
- minimum trafficable surface: 6 metres
- horizontal clearance: 6 metres
- vertical clearance: 4 metres
- maximum grades: 1 in 8
- maximum grade over <50 metres: 1 in 5
- maximum average grade: 1 in 7
- minimum weight capacity: 15 tonnes
- maximum crossfall: 1 in 33
- curves minimum inner radius: 12 metres

7.2.2 Private Driveways.

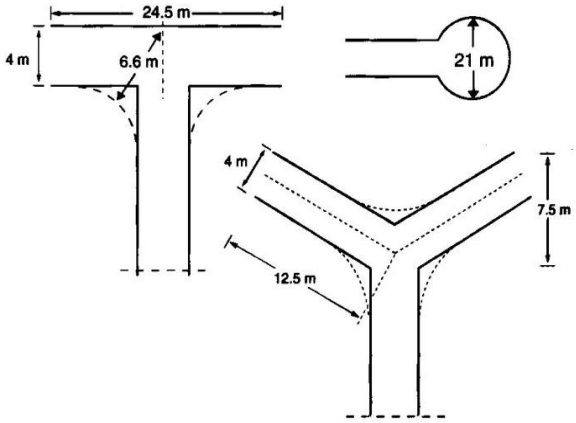
Constructed private driveways meet the following requirements:

- required where the house site is more than 50 metres from a public road;
- Minimum trafficable surface: 6 metres;
- Horizontal clearance: 6 metres;
- Vertical clearance: unlimited vertical clearance;
- Maximum grades: 1 in 8;
- Maximum grade over less than 50 metres: 1 in 5
- Maximum average grade:1 in 7;

- Minimum weight: 15 tonnes;
- Maximum crossfall: 1 in 33
- Curves minimum inner radius: 12 metres
- Turn around areas designed to accommodate 3.4 fire appliances and to enable them to turn around safely every 500 metres and within 50 metres of a house;
- Passing bays every 200 metres with a minimum length of 20 metres and minimum width of 6 metres. Total length of battle axe is less than 200 metres. Turn around area will be established just inside proposed lot 71.



Passing bay measurements.



Turn around area measurements.

7.3 GLOSSARY

Acceptable Solution
A statement describing an acceptable means of complying with the requirements of corresponding performance criteria**.**

Appliance or Fire Appliance
A fire fighting appliance (vehicle) with structural, grass and bush fire fighting capabilities, with either a 2000 litres water capacity (2.4 appliance) or a 3000 litre water capacity (3.4 appliance) and four (4) wheel drive.

BAL – (abb) Bushfire Attack Level.

Bushfire Attack Level – an assessed rating of a site's risk to a bushfire, based on vegetation type, slope of the land and its proximity to buildings.

Building Construction Standard Buffer - An area 100 metres wide Including a Building Protection Zone in which an increase in building construction standard in accordance with AS3959 will apply.

Building Protection Zone (BPZ)
Low fuel area immediately surrounding buildings. Minimum width 20 metres, increasing with slope. Maintained by the landowner.

Bush
Under the Bush Fires Act 1954 the term bush is defined to include trees, bushes, plants, stubble, scrub and undergrowth of a kind whatsoever whether dead or alive and whether standing or not standing.

Bush Fire or Wildfire
A general term used to describe fire in vegetation that is not under control.

Bush Fire Hazard.
The flammability, arrangement and quantity of vegetation, dead or alive, that can be burnt in a bush fire. Development is to be avoided in extreme bush fire hazard designated areas.

Bush fire prone area - for the purposes of this fire management plan, a bush fire prone area is an area that has been declared as such by the relevant local government responsible for an area. Once an area is declared bush fire prone, then AS 3959 applies to new residential development in it.

Bush Fire Risk
The chance of a bush fire starting that will have harmful consequences on life and property. It is measured in terms of consequences and likelihood and arises from the interaction of hazards, communities and the environment.

DFES
The Department of Fire and Emergency Services formally called the Fire and Emergency Services Authority of Western Australia.

Development Application
An application for approval to carry out a development under either a local planning scheme or regional planning scheme.

Dwelling setback – the horizontal distance between a wall of the dwelling at any point, and an adjacent lot boundary, measured at right angles (90 degrees) to the boundary.

Emergency Access Way
Road not normally open but available to the public (using two wheel drive vehicles) for evacuation during a bush fire emergency.

Fire Break or Firebreak
Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a bush fire or to provide a fire line from which to suppress a bush fire. This is an area cleared to reduce the risk of bush fire damage.

FDI- Fire Danger Index
The chance of a fire starting, its rate of spread, its intensity and the difficulty of its suppression, according to various combinations of air temperature, relative humidity, wind speed and both the long and short- term drought effects.

Fire Protection
A generic term used to describe the range of services and systems used to mitigate the impact of fire on the community. It encompasses both fire prevention and emergency response.

Fire Management Plan
Ongoing, dynamic document that sets out the medium to long term mitigation strategies for fire hazards and risks in particular developments within local government areas.

Fire Services Access Route
Accessible by heavy four wheel drive fire fighting vehicles.

Fuel Reduction also Hazard Reduction
Removal and modification of bush fire fuel, or increase in building construction standards or a combination of the two.

Hazard Separation Zone (HSZ)
The fuel reduction area between an area bush fire hazard and the buildings (and associated building protection zones) of a development.

Low Fuel Area
An area 100 metres wide of reduced bush fire fuels that is required to surround a Stage of land release and negates the need to increase the standard of dwelling construction on the edge of the Stage of land release. It complies with the Building Protection Zone standards is temporary until the next stage of land is cleared for release.

Performance Criteria.
Statement which specifies the outcomes required for the protection of life and property from bush fires.

Structural Fire
A fire in a building.

8.0 FIRE MANAGEMENT PLAN COMPLIANCE CHECKLIST FOR PERFORMANCE CRITERIA AND ACCEPTABLE SOLUTIONS

PROPERTY DETAILS: Broome North LDP 3
Local Government: Shire of Broome

Element 1: Location

Does the proposal comply with the performance criteria by applying acceptable solution A1.1? **Yes** ✓ **No**
Increased dwelling construction and appropriate BPZ.

Element 2: Vehicular Access

Does the proposal comply with the performance criteria by applying acceptable solution A2.1? **Yes** ✓ **No**

Does the proposal comply with performance criteria by applying acceptable solution A2.2? **Yes** ✓ **No**

Does the proposal comply with the performance criteria by applying acceptable solution A2.3? **Yes** **No**
Not applicable

Does the proposal comply with the performance criteria by applying acceptable solution A2.4? **Yes** **No**
Not applicable

Does the proposal comply with the performance criteria by applying acceptable solution A2.5? **Yes** ✓ **No**
Less than 50 metres long In accordance with Shire of Broome standards

Does the proposal comply with the performance criteria by applying acceptable solution A2.6? **Yes** **No**
Not applicable

Does the proposal comply with the performance criteria by applying acceptable solution A2.7? **Yes** **No**
Not applicable

Does the proposal comply with the performance criteria by applying acceptable solution A2.8? **Yes** **No**
Not applicable

Does the proposal comply with the performance criteria by applying acceptable solution A2.9? **Yes** ✓ **No**
Complying with Shire of Broome Fire Control notice.

Does the proposal comply with the performance criteria by applying acceptable solution A2.10? **Yes** **No**
Not applicable

Element 3: Water

Does the proposal comply with the performance criteria by applying acceptable solution A3.1? Fire Hydrants to be installed by developer	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A3.2? Not applicable	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A3.3? Not applicable	**Yes**		**No**	

Element 4: Siting of Development

Does the proposal comply with the performance criteria by applying acceptable solution A4.1? BPZ and increased dwelling construction	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A4.2? Not applicable	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A4.3?	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A4.4? Not applicable	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A4.5? Not applicable	**Yes**		**No**	

Element 5: Design of Development

Does the proposal comply with the performance criteria by applying acceptable solution A5.1? The development uses acceptable solutions as appropriate to meet the requirements under performance criterion P5.	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A5.2?	**Yes**		**No**	

Applicant Declaration:

I declare that the information provided is true and correct to the best of my knowledge.

Name of Person Preparing the Fire Management Plan:

Full Name: B.W. Harris *for* FirePlan WA **Date:** 6/06/2012

Developer:
Full Name: _____ **Signature:** _____ **Date:** ……

APPENDIX D
LOCAL WATER MANAGEMENT STRATEGY

09 June 2021

Kylie Coman
Tenure and Property Manager
DevelopmentWA
40 The Esplanade
Perth WA 6000

Our ref: 12516970-15037-9
Your ref:

Dear Kylie

Broome North Water Management Strategies and Plans
Broome North Local Water Management Strategy - Local Development Plan 3 Addendum 1

1 Introduction

The Broome North Local Development Plan 3 (LDP3) area is located within the western portion of the greater Broome North Development area, and comprises a mixed lot ownership of DevelopmentWA, Yawuru and Shire of Broome as well as reserve areas. The Broome North LDP3 Local Water Management Strategy (LWMS) (GHD 2015) was prepared to further develop and refine the findings from the investigations undertaken during the District Structure Planning and District Water Management Strategy, and progressive development of the Broome North Development area. This LWMS received subsequent approval by the (then) Department of Water.

This letter has been prepared to support the submission of the Broome North LDP3 Structure Plan Amendment (Attachment 1). This letter reviews the key changes in the LDP3 amendment and outlines the relevant matters relating to the approved LWMS.

2 Proposed LDP3 Structure Plan changes

The key change proposed to the LDP3 Structure Plan area comprises a change in land use over parts of the southern section of LDP3, with reduction in residential housing to accommodate a District Centre (Attachment 1). The key changes are summarised below:

- The proposed local centre located within LDP1 has been rezoned to residential and a District Centre has been identified within LDP3. This rezoning is consistent with the Shire of Broome Local Commercial Strategy for a District Centre adjacent the existing Cable Beach tourism precinct.
- The location of the District Centre reduces the extent of traditional residential housing in the southern portion of LDP3 area by approximately 60 lots.
- The configuration of the District Centre enables the best staging effectiveness for parking provision and access, site-design efficiency, and the ability for retail floorspace to be created in response to market demand. Further the configuration enables any future development to unfold eastward from Stage 1 without compromising the operation of earlier development, and may incorporate up to

approximately 5,000m^2 to 6,000m^2 of retail and office floorspace. This design includes two new carpark access points from Fairway Drive

- The configuration of the District Centre include, a stormwater drainage link between the Stage 1 and Stage 3 buildings to capture the runoff from Stage 1 into a swale along the southern boundary before it enters the Gubinge Road swale.
- The configuration of the District Centre does not impact upon the district arterial drainage corridors that occur along Gubinge Road, Fairway Drive and the eastern boundary of LDP3.

3 LWMS stormwater management

Stormwater management in the Broome North development was designed based on best practice water sensitive urban design for the Broome climate and geomorphology. Stormwater management considers the specific challenges for management of stormwater in the Kimberley in the wet season (episodic rainfall events resulting in large volumes of water and large sediment loads) and the requirement for specific infrastructure designed to handle it.

Following approval of the Broome North LDP3 LWMS (GHD 2015) various guidelines have been revised which will result in incremental change to those area of changed land use. It is proposed that the updates from *Decision Process for Stormwater Management* (DWER, 2017), *Australian Rainfall and Runoff* (Ball et. al., 2019) and the *Shire of Broome LPP 5.22 Structure Plan and Subdivision Guidelines* (Shire of Broome 2015) be considered in detail during detailed design for the development area, and outlined in subsequent Urban Water Management Plans. Preliminary modelling of the LDP3 amendment area has been completed to identify basin volume requirements to detain the 1:100 year storm event for this portion of LDP3 in accordance with revised Shire of Broome guidance (Shire of Broome 2015). The following sections provide an overview of stormwater management considerations.

3.1 Stormwater quantity management

The proposed District Centre within the southern portion of LDP3 remains within the designated DWMS catchment ‘Area 3’ as depicted in the Broome North DWMS stormwater management plan (Attachment 2). The LDP3 Amendment, including changes in road and building layout, alters the location of local drainage connection to the arterial drainage corridors, however maintenance of the earthworks concept design will largely maintain overall flow path routes and connectivity to arterial drainage corridors.

As with stormwater management across the LDP3 area stormwater runoff will follow roads until it reaches POS and/or drainage, then drain south along the eastern and western drainage corridors to the Gubinge Road drainage corridor. Stormwater management for the LDP3 amendment area is based on the following principles:

- The development is to have a detention system so that the peak runoff outflows for 5, 10, 50 and 100 year average recurrence interval events are no greater than that which would occur under pre-development conditions.
- The drainage system and all associated structures including compensating basins are to be designed to collect and convey an Average Recurrence Interval (ARI) storm event of one in 100 year storm event occurrence.

- All basins shall be designed for the 1:100 storm event.
- Finished floor levels for the buildings on all lots are to be at least 0.5 m above the crown of the road to ensure that no flooding of the residences occurs.
- A minimum of 0.4 m freeboard required between the 100 year flood level and the finished floor level of all buildings on site.
- The 50 and 100-year average recurrence interval events are to be contained within the road reserve and the 10-year average recurrence interval event is to be contained within the kerbs.

Detailed design will consider the following based on the change in land use and revised guidelines:

- The change in land use from residential to commercial results in a change in runoff coefficient from 0.7 to 0.9 within the LDP3 amendment area.
- Wider pavements or piped drainage will be considered where road lengths exceed 200 m.
- Piped drainage may need to be considered through the car park area to maintain serviceability of the District Centre.
- Increase in the freeboard between the 100 year flood level and finished floor level of buildings on site from 0.3 m to 0.4 m in accordance with LPP 5.22 (Shire of Broome 2015).
- Requirement for drainage links in the following key locations to connect to arterial drainage swales:
    - Through Stage 2 of the District Centre to connect the drainage to the Fairway Drive swale.
    - Along the boundary of Stage 1 and Stage 3 of the District Centre to connect to the Gubinge Road swale.
    - Along the northern boundary of the District Centre in road reserve to convey runoff to perimeter swales.

3.2 Stormwater quality and best management practices

The principles for managing stormwater quality remain unchanged from the LWMS with a range of best management practices (BMPs) incorporated into the development design at the lot, street and development scale to assist in the management of total suspended solids, gross pollutants and suspended or dissolved pollutants. As the majority of pollutants are transported in frequent, minor events, it is these frequent rainfall events which are targeted using at source, in-transit and end-of-catchment BMPs to improve water quality. Key street and development scale BMPs include:

- Maximising infiltration by adopting a stormwater detention system to detain the 1 yr ARI (1 EY) storm.
- Design of a linear swale detention system to reduce peak flow rates, and assist in achieving water quality objectives and to maximise the deposition of suspended sediment and promote infiltration.
- Planting and regeneration of low-lying native vegetation in swale drains for filtering of particulates and uptake of dissolved nutrients.

The vegetated drainage swales that are a key design feature throughout Broome North were designed based on extensive consultation with key stakeholders comprising the Shire of Broome, (then) Department of Water and Yawuru early in the District Structure Planning for the estate.

The Shire of Broome have raised recent concerns with regard to the bushfire risk and ongoing maintenance requirements of the linear vegetated swale drainage. These concerns will be addressed through ongoing consultation with key stakeholders during the detailed design for the development area, and outlined in subsequent Urban Water Management Plans.

3.3 Basin storage requirements

A one-dimensional DRAINS model was used for calculation of runoff. The critical 1% AEP 30 minute peak flow rates are used for the preliminary sizing of the storage requirements. Pre-development and post -development parameters are summarized in Table 1 and Table 2.

Table 1 LDP3 amendment area - pre-development catchment charcateristics

Area type – Pre dev	Runoff Coefficient (as in Shire of Broome 2015)	Area (ha)
Vegetation	0.3	18.014

Table 2 LDP3 amendment area - post-development catchment charcateristics

Area type – Post dev	Runoff Coefficient (as in Shire of Broome 2015)	Area (ha)
Residential	0.7	11.32
Commercial and Roads	0.9	6.69
Total		18.014

The basin was sized such that the total post-development flow off the site was equal to or less than the pre-development flow for the critical event. Basin parameters included:

- Nominal depth of 1.2 m
- 1V:6H side slopes
- Nominal basin volume of 8,920 m^3
- Nominal basin dimensions (top of basin) of 150 x 60 m.

4 Water Balance Modelling

The conceptual water balance was revised for the LDP3 addendum to reflect the proposed change in land use composition using the Water Corporation H2Options tool. The results of the revised water balance model are summarised in Table 3 and Attachment 3, based on the following assumptions:

- Decrease in traditional residential lots by 60 due to relocation of District Centre to southern section of LDP3.
- The District Centre comprises 6,000 sqm GFA as mixed retail (Shopping Centre).
- The balance of the District Centre comprises 30,000 sqm of road and parking area, with 500 sqm POS irrigation allowance.

Table 3 Water balance model results

Land use type	LDP3 LWMS Rev1 (2015)		LDP3 LWMS Addendum (2021)	
	Demand (kL/year)	**Required Drinking water supply (kL/year)**	**Demand (kL/year)**	**Required Drinking water supply (kL/year)**
Residential indoor	115,265	115,265	106,193	106,193
Residential outdoor	62,059	62,059	56,281	56,281
Residential total	177,324	177,324	162,474	162,474
Commercial and industrial	2,800	2,800	8,800	8,800
Public open space	8,785	8,785	9,000	9,000
Development Total (kL)		**188,909**		**180,274**

The results of the water balance model identify that LDP3 Amendment results in a decrease (8,635 kL) in the annual Drinking Water demand across the LDP3 area due to proposed change in land use from traditional residential to District Centre. The potable water and irrigation water efficiency measures proposed within the Broome North LDP3 LWMS (2015) remain unchanged.

5 Concluding comments

This addendum letter reviews the proposed changes identified in the Broome North LDP3 Structure Plan Amendment against the total water cycle management proposed in the approved Broome North LDP3 LWMS (GHD 2015). The proposed change in land use in the southern portion of the LDP3 area to accommodate a change in land use from residential to District Centre does not result in substantive changes to the management of stormwater quantity and stormwater quality within the local development area. Key considerations are outlined for stormwater flowpaths, drainage connections and revised stormwater modelling to address change in land use and revised guidelines. These will be considered further during the detailed design for the development area, and outlined in subsequent Urban Water Management Plans.

Review of water balance modelling identifies a minor decrease in Drinking Water demand associated with the change in land use.

Should you have any further questions, please do not hesitate to contact the undersigned.

Sincerely
GHD



Kelsey Hunt
Senior Environmental Scientist
+61 8 62228733

Attachment 1	Broome North LDP3 Structure Plan Amendment
Attachment 2	Broome North DWMS Development Plan – Drainage Catchment Plan
Attachment 3	Water Balance Model

Attachment 1 Broome North LDP3 Structure Plan Amendment



NOTES

(A) The Plan identifies indicative residential density ranges with the Local Development Plan 3 Area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan submitted as the time of subdivision for approval by the WAPC.

(B) The Plan depicts the indicative location of Public Open Space, which will be subject to further refinement and modification at the subdivision stage.

(C) The requirements associated with the Permanent and Temporary Bushfire Building Attack Level (BAL) 12.5 areas are outlined in Clauses 1.8.7 and 1.8.8.

(D) Appropriate land tenure arrangements are to be made for the protection and ongoing access to the Water Corporation's infrastructure contained adjacent to the Environmental and Cultural Corridor Reserve.

(E) As a condition of subdivision approval for the first stage of Subdivision, the proponent is to prepare a schedule outlining relevant items (such as roads, infrastructure and community services) arising from future development contributions. The schedule will inform the preparation of a future development contributions scheme to be prepared by the proponent and the Shire of Broome for the Broome North District Development Plan area.

(F) The District Movement Network realignments, closures and construction, including the roundabout access to the future Caravan Park on Fairway Drive and Sancturary Road is to be at the developer's cost.

(G) Broome town site experiences problems with nuisances and disease carrying mosquitoes. Strategies to minimise the breeding of mosquitoes in on-site infrastructure and constructed water bodies should be identified within the Urban Water Management Plan or a Mosquito Management Plan.

PLAN No. 1
LOCAL DEVELOPMENT PLAN 3



NOTES

(A) The Plan identifies indicative residential density ranges with the Local Development Plan 3 Area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan submitted as the time of subdivision for approval by the WAPC.

(B) The Plan depicts the indicative location of Public Open Space, which will be subject to further refinement and modification at the subdivision stage.

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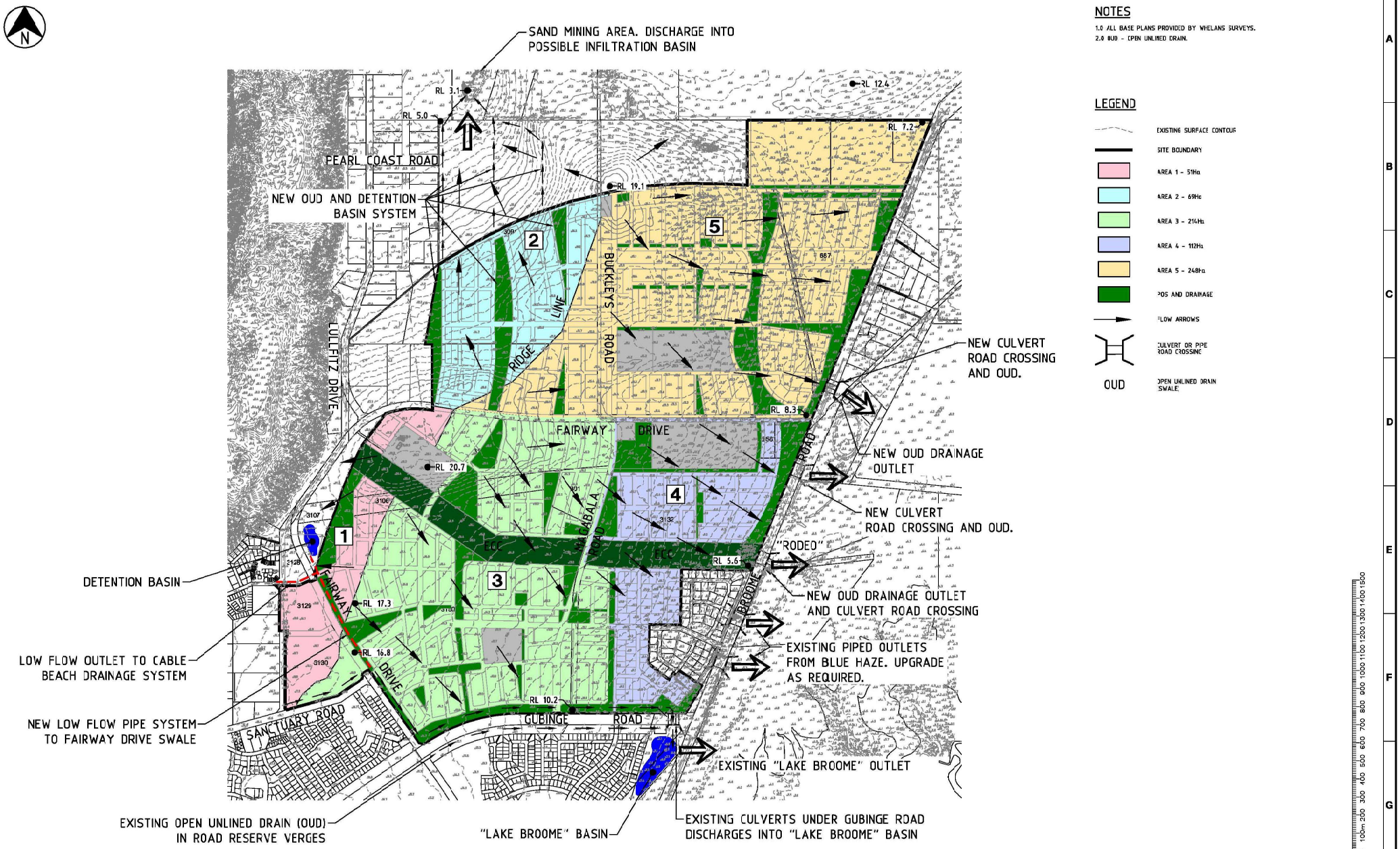
(F) The District Movement Network realignments, closures and construction, including the roundabout access to the future Caravan Park on Fairway Drive and Sancturary Road is to be at the developer's cost.

(G) Broome town site experiences problems with nuisances and disease carrying mosquitoes. Strategies to minimise the breeding of mosquitoes in on-site infrastructure and constructed water bodies should be identified within the Urban Water Management Plan or a Mosquito Management Plan.

DRAFT

PLAN No. 1 (Extract)
LOCAL DEVELOPMENT PLAN 3

Attachment 2 Broome North DWMS Development Plan – Drainage Catchment Plan



NOTES

1.0 ALL BASE PLANS PROVIDED BY WHELANS SURVEYS.
2.0 OUD - OPEN UNLINED DRAIN.

LEGEND

- EXISTING SURFACE CONTOUR
- SITE BOUNDARY
- AREA 1 - 51Ha
- AREA 2 - 69Ha
- AREA 3 - 214Ha
- AREA 4 - 112Ha
- AREA 5 - 248Ha
- POS AND DRAINAGE
- FLOW ARROWS
- CULVERT OR PIPE ROAD CROSSING
- OUD — OPEN UNLINED DRAIN SWALE

1:10000 0 100m 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
C	05.10.09					ISSUED FOR ENGINEERING REPORT
B	17.08.09					ISSUED FOR INFORMATION
A	29.07.09					INITIAL ISSUE FOR REVIEW

No	DRAWING NUMBER	REFERENCE DRAWING TITLE

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Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9469 4400 Fax (08) 9469 4488

LANDCORP

CLIENT	LANDCORP
PROJECT	BROOME NORTH
DRAFTER	C.RAYNER
DESIGNED	F.OLIVER
DRAFTING CHECK	
DESIGN REVIEW	
REVIEWED PROJECT MANAGER	
APPROVED PROJECT DIRECTOR	

TITLE: DEVELOPMENT PLAN - DRAINAGE CATCHMENT PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:10000	PB50119	C011	C

I:\PBIF\Projects\PB50119\Deliverables\Drawings\DE02736_3150 - 3011.dwg 02/10/09 18:35:46 cryner

Attachment 3 Water Balance Model

H2Options

WATER CORPORATION

Input

Please enter numeric data as numbers only, i.e. for 70% enter 70, for 1,450.5 m² enter 1450.5

Name of developer	DevelopmentWA
Name of development	Broome North LDP3
Date of entry	2 February 2021
Location of development	Broome, WA
Total development area (m²)	1,305,000

1. Residential

Household type	No. of Lots	Households per lot	Average Area per lot (m²)	Irrigated area per lot (m²)
Traditional	468	1	600	180
Terrace	0	0	0	0
Cottage	284	1	220	22
Apartment	0	0	0	0
Lifestyle/semi-rural	45	1	1,500	250

Percentage of lots with rainwater tanks (%)	0
Percentage of lots with greywater recycling systems (%)	0
Total residential area (m²)	410,780
Total irrigated area (m²)	101,738

2. Schools

	No. of Students	No. of Staff	Total Area (m²)	Irrigated area (m²)
School 1	0	0	0	0
School 2	0	0	0	0
School 3	0	0	0	0

Total school area (m²)	0
Total Irrigated area (m²)	0

3. Commercial and industrial

Industry type	Unit	No. of units	Total Area (m²)	Irrigated area (m²)
Hotel	Room	0	0	0
Shopping centre	m² GLA	6,000	6,000	0
Hospital	Bed	0	0	0
Nursing home	Bed	0	0	0
Light industrial	m² GLA	0	0	0
Commercial laundry	Entity	0	0	0
Aquatic centre	Entity	0	0	0
Municipal building	m² GLA	0	0	0
Office building	m² GLA	0	0	0

Industry type	Unit	No. of units	Total Area (m²)	Irrigated area (m²)	Total annual demand (kL/year)
Other	Tourist Park (estimate only)	50	209,471	83,788	2,800

Total commercial and industrial area (m²)	215,471
Total commercial and industrial irrigated area (m²)	83,788

4. Public Open Space (POS)

	Area (m²)	Amenities (kL/year)
Active POS	0	0
Other Irrigated POS	15,000	
Street scaping	0	
Non-irrigated POS	82,615	

Total POS area (m²)	97,615
Total irrigated POS area (m²)	15,000

5. Miscellaneous

Misc. type	Total demand (kL/year)	Comments
Environmental Cultural Corrid	0	
Roads	0	
	0	

Total other area (m²)	581,134

Area Summary

Residential (m²)	410,780
Schools (m²)	0
Commercial and industrial (m²)	215,471

Public open space (m^2)	97,615
Miscellaneous (m^2)	581,134
Total development area (m^2)	1,305,000
Area Gap - if any (m^2)	0

H2Options

WATER CORPORATION

Assumptions

1. Residential

	Value	Unit	Comments
Water use			
Indoor water use	56	kL/person/year	
Pool, spa and handwatering (outdoor except irrigation)	5	kL/person/year	
Irrigation	0.46	kL/m^2/year	
Number of residents by household type			
Traditional	2.7	No. of residents	
Terrace	1.7	No. of residents	
Cottage	1.8	No. of residents	
Apartment	1.5	No. of residents	
Lifestyle/semi-rural	2.7	No. of residents	
Demand by water type			
Indoors			
Drinking water indoors	100	%	
Non-drinking water indoors	0	%	
	Value changed		
Outdoors			
Drinking water outdoors	100	%	
Non-drinking water outdoors	0	%	
	Value changed!		
Rainwater supply			
Residential rainwater tank yield (2kL, plumbed)	55	kL/tank/year	
Greywater supply			
Greywater produced	36	kL/person/year	

2. Schools

	Value	Unit	Comments
Water consumption			
Water use indoors, drinking, outside taps	5	kL/person/year	
Water use for irrigation	0.83	kL/m²/year	
Demand by water type			
Drinking water indoors	70	%	
Non-drinking water indoors	30	%	
Drinking water irrigation	0	%	
Non-drinking water irrigation	100	%	

3. Commercial and industrial

	Value	Unit	Comments
Average total water consumption by industry type			
Hotel	150	kL/room/year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	
Shopping centre	1	kL/m² GLA /year	
Drinking water demand	100	%	
Non-drinking water demand	0	%	
	Value changed!		
Hospital	220	kL/bed/year	
Drinking water demand	90	%	
Non-drinking water demand	10	%	
Nursing home	120	kL/bed/year	
Drinking water demand	90	%	
Non-drinking water demand	10	%	
Light industrial	1	kL/m² GLA /year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	
Commercial laundry	45,000	kL/entity/year	
Drinking water demand	5	%	
Non-drinking water demand	95	%	
Aquatic centre	14,600	kL/entity/year	
Drinking water demand	80	%	
Non-drinking water demand	20	%	
Municipal building	1	kL/m² GLA/year	
Drinking water demand	50	%	
Non-drinking water demand	50	%	
Office building	1	kL/m² GLA/year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	

Other

Drinking water demand	100	%
Non-drinking water demand	0	%

Value changed!

4. Public open space (POS)

	Value	*Unit*	*Comments*
Average water consumption			
Active POS	1.3	kL/m²/year	
Other irrigated POS	0.6	kL/m²/year	
Verges / street scapes	0.65	kL/m²/year	
Demand by water type			
Drinking water	100	%	
Non-drinking water	0	%	

Value changed!

5. Miscellaneous

	Value	*Unit*	*Comments*
Demand by water type			
Drinking water	60	%	
Non-drinking water	40	%	

H2Options

WATER CORPORATION

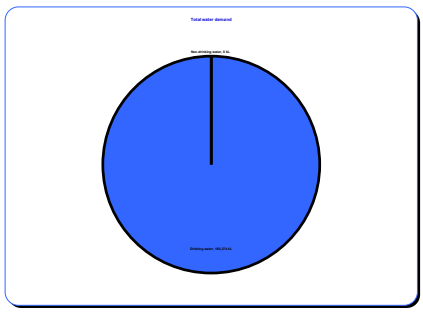
Water Balance Results

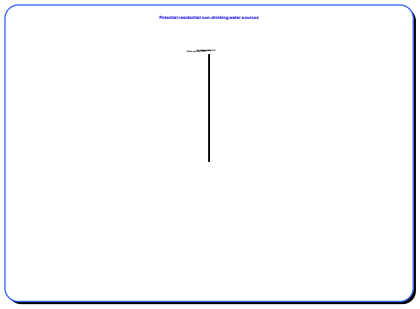
Name of developer	**DevelopmentWA**
Name of development	**Broome North LDP3**
Date of entry	**2 February 2021**
Location of development	**Broome, WA**
Total development area (m²)	**1,305,000**

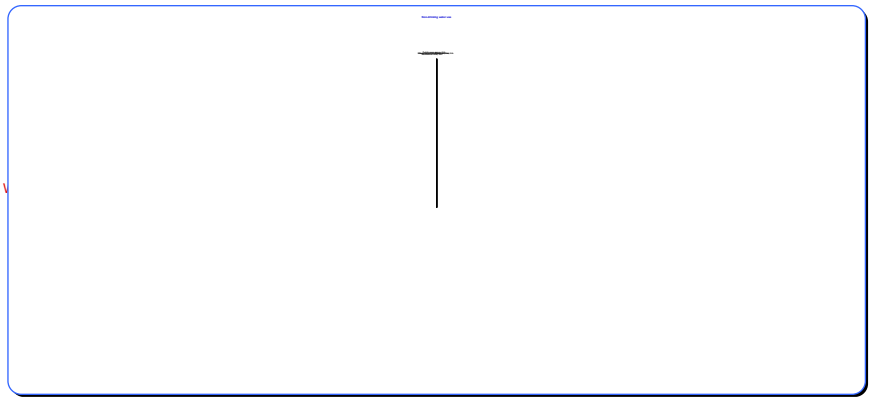
	DEMAND (kL/year)	REQUIRED SUPPLY (kL/year)	
		Drinking water	Non-drinking water
Residential indoor	106,193	106,193	0
Residential outdoor	56,281	56,281	0
Residential total	**162,474**	**162,474**	**0**
School irrigation	0	0	0
School non-irrigation	0	0	0
School total	**0**	**0**	**0**
Commercial and industrial	**8,800**	**8,800**	**0**
Public open space	**9,000**	**9,000**	**0**
Miscellaneous	**0**	**0**	**0**
Development total	**180,274 kL**	**180,274 kL**	**0 kL**
kL / person / year	**95.07**		

Potential residential non-drinking water sources (kL/year)

Rainwater	Greywater	Other sources
0	0	0









LandCorp

Broome North LDP3
Local Water Management Strategy

May 2015

Executive summary

GHD Pty Ltd was commissioned by LandCorp to prepare a Local Water Management Strategy (LWMS) for the Broome North Local Development Plan 3 (LDP3) area. The Broome North Local Development Plan 3 (LDP3) area is located within the south-west portion of the Broome North development area, and is bounded by Cable Beach estate to the west, Sunset Park residential development to the south-west, Broome North LDP1 area to the east.

The proposed Local Development Plan for Broome North LDP3 area builds on the design elements of LDP1, while acknowledging the interface of the area with the key Cable Beach tourism precinct, as well as the environmental and cultural values of the Yawuru managed land.

Residential, tourism, POS and Ecological cultural corridor land uses have been identified with Broome North LDP3 area. The following table summarises the objectives, strategy and outcomes of the LWMS.

Component	Objectives and criteria	Strategy	Outcome
Water conservation	Sustainable management of all aspects of the water cycle within the development and achieve efficient use of potable water	Install 5 Star Plus provisions for all new fittings. Best practice landscaping design and maintenance Non-potable dust suppression water	Water efficient demand of potable water supply
Stormwater quantity	Maintain discharge volume and peak flow relative to pre-development conditions.	Detention basins and swales to attenuate peak flows from impervious surfaces	Pre-development peak flow rates and volumes maintained at each outlet
Stormwater quality	Maintain and, if possible, improve the quality of water leaving the development area	Infiltration provisions in lots and public areas Erosion and sediment control during construction and post-development Water Sensitive Urban Design	Stormwater quality protected
Groundwater levels	Maintain groundwater levels	Infiltration provisions in lots and public areas	Groundwater recharge maintained
Groundwater quality	Protect groundwater quality	Capture and treat stormwater prior to infiltration	Groundwater quality protected

Checklist

The following checklist summarises the LWMS content for quick reference

Local water management strategy item	Deliverable	Ref	Comment
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Design elements & requirements for BMPs and critical control points	ES	
Introduction			
Total water cycle management – principles & objectives Planning background Previous studies		3 1.2 1.4	
Proposed development			
Structure plan, zoning and land use. Key landscape features Previous land use	Site context plan Structure plan	2, Fig 3 4.2	
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape Plan	7, Figs 7-10	Also in Appendix F
Design criteria			
Agreed design objectives and source of objective		3	
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		4	
Site Conditions - existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	4.2 Fig 4	
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	4.3 Ap. G	
Environmental - areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental Plan plus supporting data where appropriate	4.3.4 4.5, 4.6, 4.7, 4.8	
Surface Water – topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface Water Plan	4.9	
Groundwater – topography, pre development groundwater levels and water quality, test bore locations	Groundwater Plan plus details of groundwater monitoring and testing	4.10 Fig 5	
Water use sustainability initiatives			

Water efficiency measures – private and public open spaces including method of enforcement		5.4	
Water supply (fit-for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		5.2	
Wastewater management		5.1.2	
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points,100 year flow paths and 100 year detentions storage areas	100yr event Plan Long section of critical points	6.3 6.5 6.6 Ap. C	
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event Plan	6.3, 6.4, 6.5	
Protect ecology – detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1yr event plan	6.3, 6.4, 6.5	
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoils areas/exclusion zones	Groundwater/ subsoil plan	N/A	
Actions to address acid sulfate soils or contamination		N/A	
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design.		8.2	
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		8.1	
Implementation			
Developer commitments		8.3	
Roles, responsibilities, funding for implementation		8.3	
Review		8.3	

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1. Introduction

1.1 Background

The Broome North area is located approximately 4 kilometres north of the Broome town centre, within the Shire of Broome. The Broome North Local Development Plan 3 (LDP3) area is located within the south-west portion of the Broome North development area, and is bounded by Cable Beach estate to the west, Sunset Park residential development to the south-west, Broome North LDP1 area to the east, and the ecological cultural corridor (ECC) that dissects the northern and southern components of the Broome North development to the north, and an A Class Reserve to the north-west.

1.2 Planning context

The *Broome North District Water Management Strategy* (DWMS) (GHD and SKM 2009) was prepared to address total water cycle management across the 700 ha Broome North District Development Plan (DDP) area.

The Broome North LDP3 Local Water Management Strategy (LWMS) has been prepared to further develop and refine the findings from the investigations undertaken during the DSP and the DWMP, and progressive development of the Broome North development area.

This LWMS has been prepared in accordance with S*tate Planning Policy 2.9: Water Resources* (WAPC 2006) and *Better Urban Water Management* (WAPC 2008), on advice from the Department of Water (DoW) and Shire of Broome. The planning framework for land and water planning is illustrated in Figure 1.

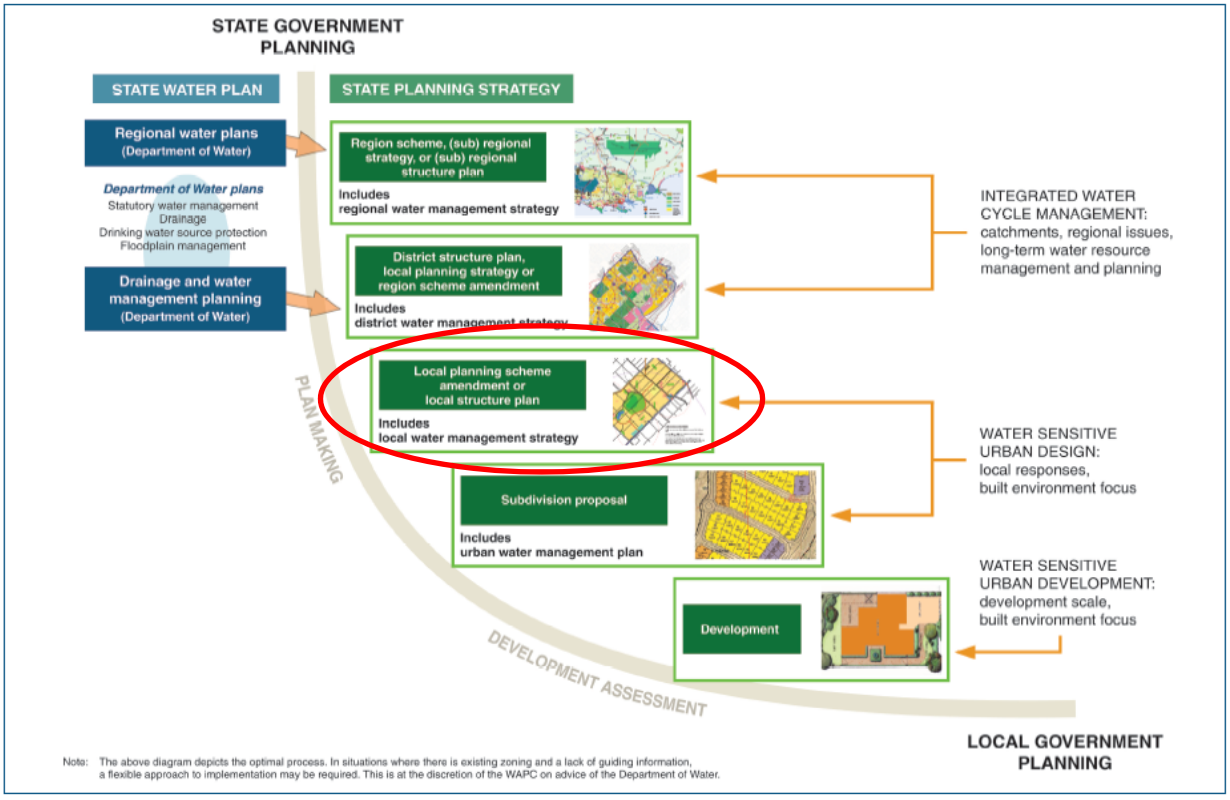


Figure 1 Framework for integrating water planning with land planning

1.3 Purpose of this report

This LWMS has been prepared to support new development and redevelopment within the Broome North LDP3 Structure Plan area. The strategy identifies characteristics of the study area, and identifies key principles, design criteria and development requirements, and additional guidance to support development in the study area.

1.4 Previous studies and relevant guidelines

In addition to the planning documents identified in Section 1.2 the following documents have been used to inform the water management principles and design criteria outlined in this LWMS.

Broome North District Water Management Strategy

The Broome North District Water Management Strategy (GHD and SKM 2009) details the key principles for water management at the district scale for the whole of the Broome North development area.

Broome North Local Development Plan No. 3 Flora and Fauna Assessment

The *Broome North Local Development Plan No. 3 Flora and Fauna Assessment* (GHD 2013) report presents the results of site specific flora and fauna survey for the LDP3 area. The vegetation and flora survey identified one vegetation association, Pindan shrubland, within the survey area consistent with previous reporting. One introduced species, listed as a Declared Pest and Weed of National Significance (Bellyache bush, *Jatropha gossypiifolia*) was identified within the northern section of the survey area. The fauna survey results identified a fauna diversity similar to that recorded in previous surveys of the broader area, with no threatened fauna species recorded. One Northern Brushtail Possum was recorded on infra-red camera. Recommendations were identified for management of the study area during development.

Broome North Local Water Management Strategy

The *Broome North Local Water Management Strategy* (GHD and SKM 2010) details the requirements for total water cycle management for the LDP1 area, the first local structure plan area developed within the Broome North area. LDP1 area lies to the east of the current LDP3 study area. The drainage system for the LDP3 area will ultimately connect with the linear drainage system constructed within the LDP1 area.

Broome North LDP2 Local Water Management Strategy

Broome North LDP2 Local Water Management Strategy (GHD 2012) report details the total water cycle management for the LDP2 Area which is located north of LDP1.

Study for Broome Groundwater Management Plan Review – Final

The *Study for Broome Groundwater Management Plan Review – Final*, (Groundwater Consulting Services 2008) report was provides an assessment of the groundwater resources in the Broome area, and was prepared for the Department of Water.

Geotechnical Investigation for Broome North – Lots 3150 and 304

The *Report on Geotechnical Investigation for Broome North – Lots 3150 and 304* (Coffey Geotechnics 2009) provides an assessment of the overall geotechnical conditions on the site and also a desktop hydrological investigation. The report also includes chemical testing of the existing soils on the site for nitrogen and phosphorus.

Broome North Acid Sulphate Soil Desktop Investigation

The *Broome North Acid Sulphate Soil Desktop Investigation* (GHD 2009) report investigates the potential for acid sulphate soils in the region and presents the findings of the desktop investigation and recommended actions. The report identified that the site has a low risk of acid sulfate soil on the basis of both desktop and site investigations.

Broome North Development Area, Targeted fauna Survey

The *Broome North Development Area, Targeted fauna Survey (*GHD 2009) report presents the results of a survey to undertaken to target conservation significant species and determine the risks to fauna from proposed development.

Preliminary Environmental Impact Assessment and Biological Survey – Southern Portion (Area A)

The *Preliminary Environmental Impact Assessment and Biological Survey – Southern Portion (Area A)* (GHD 2009) was a combined PEIA and Biological Survey completed to characterise the study area and determine and assess the potential environmental impacts of the proposed works within the project area.

Preliminary Site Investigation (PSI) – Broome North Redevelopment,

The Preliminary Site Investigation (PSI) – Broome North Redevelopment (GHD 2009) report investigates the land use history of the site to identify existing or past practises that have the potential to cause contamination of soil and/or groundwater at the site.

Broome Coastal Reserves Masterplan

The Broome Coastal Reserves Masterplan (CCS Strategic 2013) was prepared for the Shire of Broome in association with Acacia Springs Environmental and UDLA. The masterplan identifies the roles and responsibilities, and management objectives and outcomes for the coastal reserves within the Shire of Broome.

Draft Shire of Broome Environmental Management Strategy 2012-2017

The *Draft Shire of Broome Environmental Management Strategy 2012-2017* (Shire of Broome 2013) was developed by the Shire of Broome to provide strategic direction for the management of the unique Broome environment. The strategy identifies key objective including:

- Undertake and promote water sensitive urban design appropriate for North West climate conditions to better manage stormwater and its impact on natural areas.
- Improve the Shire's understanding of water quality issues and its impact on natural areas.
- Ensure the Council manages it water use appropriately through efficiency and conservation measures and the use of alternative water sources.

The management strategy identifies a number of actions relating to total water cycle management and their time frame and priority for completion.

Stormwater Management Policy

The *Stormwater Management Policy* (Shire of Broome 2003) outlines the requirements for stormwater management within the Broome area, including the requirement to demonstrate water sensitive urban design in development through the application of best management practices.

Cable Beach Development Plan - Drainage Study

The *Cable Beach Development Plan – Drainage Study* (KBR 2008) was undertaken to assess the existing drainage system, and details a drainage strategy for the Cable Beach Catchment and incorporates future development of land within the catchment. It is understood that 90% of the Option 2 pipework has been constructed to date in Millington Road.

Water Conservation and Waste Water Reuse Policy

The Water Conservation and Waste Water Reuse Policy (Shire of Broome 2006) promotes water conservation measures relevant to Broome, and applies to new development and significant additions to existing buildings.

1.5 Scope and limitations

This report has been prepared by GHD for LandCorp and may only be used and relied on by LandCorp for the purpose agreed between GHD and the LandCorp as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than LandCorp arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.6 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by LandCorp and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.6 Assumptions

GHD has prepared this LWMS relying on information provided by the client (LandCorp) and other consultants undertaking work for the Broome North LDP3 area. It has been assumed that the following sources provided correct and relevant information and that design of the site will not change:

- Taylor Burrell Barnett (Planning)
- Tabec (Stormwater design and modelling)
- UDLA (Landscape design)

2. Proposed development

Broome North LDP3 area is located within the western portion of the greater Broome North development area, and is bounded by the existing Cable Beach and Sunset Estate to the west, Gubinge Road along the southern boundary, the existing Fairway Drive alignment to the north-west, and Broome North LDP1 to the east (Figure 3). The LDP3 area comprises a mixed lot ownership of LandCorp, Yawuru and Shire of Broome as well as reserve areas.

2.1 Key elements

The Broome North development area has been progressively developed with regard to the approved District Water Management Strategy, as well as Local Water Management Strategy and Urban Water Management Plans prepared for the various stages of the LDP1 development.

The proposed Local Development Plan for Broome North LDP3 area builds on the design elements of LDP1, while acknowledging the interface of the area with the key Cable Beach tourism precinct, as well as the environmental and cultural values of the Yawuru managed land.

The following proposed land uses have been identified with Broome North LDP3 area:

- Residential – Comprising predominantly Urban Living and Neighbourhood Living, with low density Bush Living lots provided along the interface with the A Class Reserve and the Ecological Cultural Corridor.
- Tourism – Large tourism lots occur along the interface with the existing tourism precinct of Cable Beach to meet future demand.
- Public open space and drainage –Provision of linear corridors throughout the development area for both drainage and active open space functions.
- Ecological cultural corridor and A Class Reserve – Retention of existing culturally significant bushland.

The Local Development Plan for Broome North LDP3 area is displayed in Figure 3.

Since the inception of the Broome North development one of the key design elements has been the incorporation of linear swale detention drainage within the landscape with the intention of creating linear multi-use corridors for active and passive recreation, while activating the water sensitive urban design treatment train high in the catchment.

The LDP3 area continues the linear swale drainage elements, with further linkages to the ecological cultural corridor (ECC), which provides an important east west linkage across the Broome Peninsula from Cable Beach through to Dampier Creek and Roebuck Bay, and connection with the LDP1 design open space design elements. Other key elements of the proposed LDP3 area include:

- Provision of a variety of residential densities, enabling the construction of a diverse range of housing types to accommodate different housing demands.
- Integration of the surrounding existing natural environment into the development area with linear open space and green spine connection.
- Low density residential interface between areas of retained bushland and new residential areas.
- Provision of attractive, safe and convenient pedestrian and cycle connections and informal active recreation spaces throughout.

- Requirement for building setbacks that respond to the local climate (i.e. allowance for cross-breezes).

2.1.1 Ecological cultural corridor

The ecological cultural corridor (ECC) is a 150 m wide tract of naturally vegetated land that will be retained for environmental and cultural purposes. The ECC provides a naturally vegetated corridor linking the proposed A class reserve adjacent to the dunal system of Cable Beach to the mangroves of Roebuck Bay. The width and alignment of the ECC was agreed with the Traditional Owners during the development of the DDP.

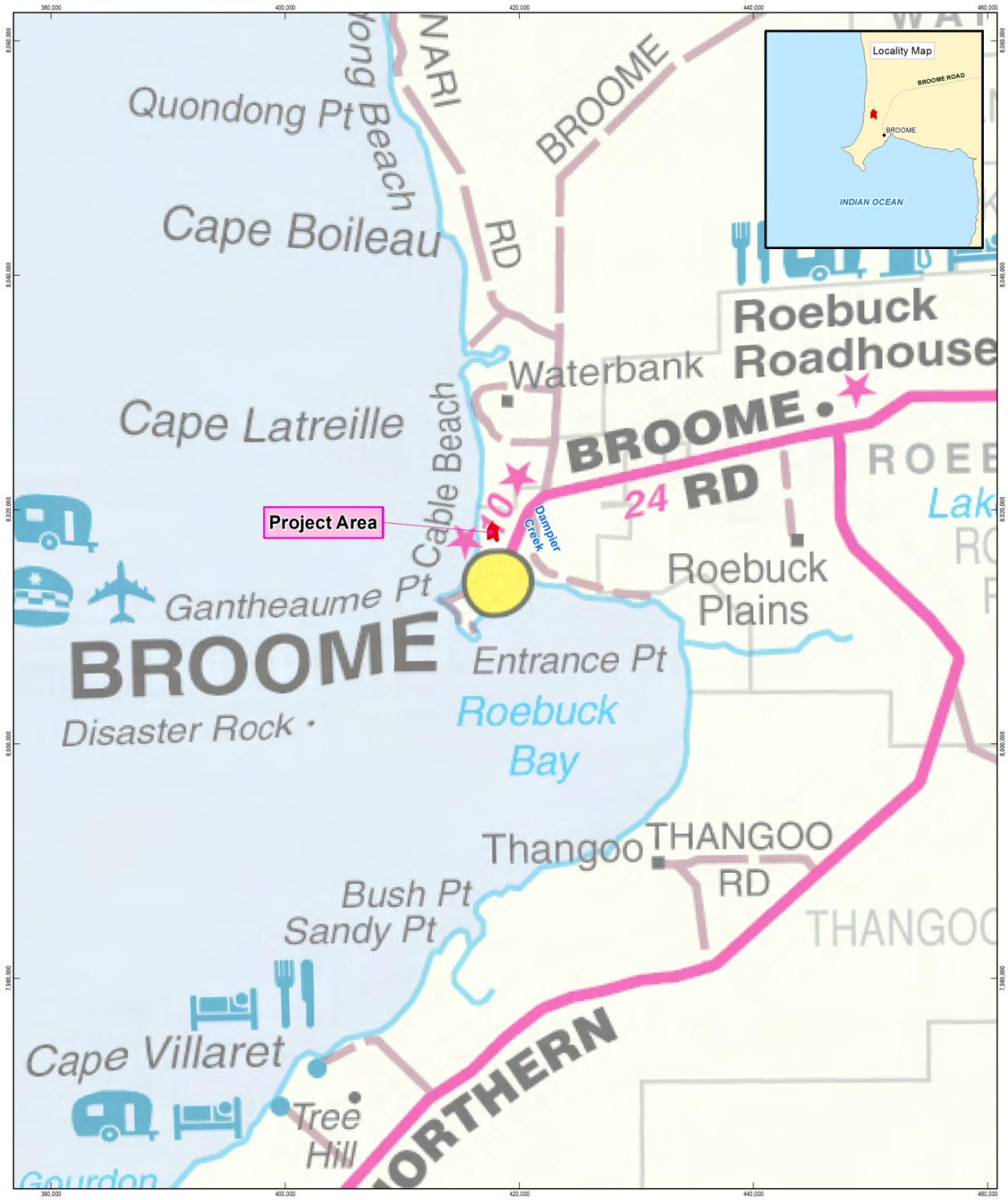
2.1.2 Landscaping and drainage

The project proposes to incorporate and retain the existing key landscape features and local landscape species and the general landform integrity within the Public Open Space (POS) areas. This landscape objective is to be achieved through the creation of landscaped lineal multi-use corridors that link urban and retained open space areas. In addition, the multi-use corridors (MUCs) are proposed to include linear drainage corridors which cater for the range of drainage events that are experienced in the region.

The landscape design uses best management practices suited to the north-west region including a soft landscape and vegetated urban drainage system to minimise runoff from hard surfaces within the development catchment area. Best management practices that are suited to the climate such as mulch, lawn or vegetated surfaces provide the opportunity for overland flows to be retarded, therefore greater percentage to be infiltrated. The use of local mulch or slashing generated during development construction has also proven to provide an immediate seed bank for revegetation, especially following the first wet season.

Specific area planning to cope with the drainage requirements will include gentle grading within the MUC areas to ensure the space is still functional for recreational uses. For example, during a large storm event the lower portion of the corridor would act as detention swales and basins, therefore, formalised dry areas and pathways are to be located on higher ground to protect equipment and built assets.

Further detail regarding the stormwater drainage system are detailed in Section 6 and landscape concept plans are detailed in Section 7.



1: 300,000 (at A3)

0 1.5 3 6 9 12 15

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

LandCorp
Broome North LDP3 LWMS

Locality Plan

Job Number	61-2969402
Revision	0
Date	15 May 2014

Figure 2

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Data source: GA: NatMap 250k Australian Topo Series 3 - 2007; Landgate: Traveller's Atlas 2004, Creek name - 20140311; LandCorp: Project Area 20140219. Created by: jcmatic


LEGEND
LOCAL DEVELOPMENT PLAN 3 AREA
LOCAL SCHEME RESERVES
ENVIRONMENTAL CULTURAL CORRIDOR
OPEN SPACE / DRAINAGE
ZONES
BUSH LIVING (R2 - R10)
NEIGHBOURHOOD LIVING (R12.5 - R25)
URBAN LIVING (R25 - R40)
TOURISM
OTHER
PERMANENT BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5
TEMPORARY BUSHFIRE BUILDING ATTACK LEVEL (BAL) 12.5
0m 50 100 150m
FAIRWAY DRIVE
FAIRWAY DRIVE TO BE CLOSED
'A' CLASS RESERVE
521
525
526
527
3128
3129
3130
504
COUCAL STREET
ORYX DRIVE
FAIRWAY DRIVE TO BE RETAINED AS MULTIPLE USE CORRIDOR
TANAMI DRIVE
SANCTUARY ROAD
FAIRWAY DRIVE
GUBINGE ROAD
R50974
NOTES
(A) The Plan identifies indicative residential density ranges with the Local Development Plan 3 Area. Lot specific residential densities are to be assigned in accordance with a Residential Density Code Plan submitted as the time of subdivision for approval by the WAPC.
(B) The Plan depicts the indicative location of Public Open Space, which will be subject to further refinement and modification at the subdivision stage.
(C) The requirements associated with the Permanent and Temporary Bushfire Building Attack Level (BAL) 12.5 areas are outlined in Clauses 1.8.7 and 1.8.8.
(D) Appropriate land tenure arangements are to be made for the protection and ongoing access to the Water Corporations's infrastructure contained adjacent to the Environmental Cultural Corridor.
PLAN No. 1 | LOCAL DEVELOPMENT PLAN 3

3. Design principles and objectives

Water management for the Broome North development is based on best practice water sensitive urban design that is suitable for the Broome climate and geomorphology. The design criteria adopted for this local water management strategy have been based on the design objectives outlined in *Better Urban Water Management* (WAPC 2008) with consideration of the specific challenges for water management presented by urban development in the Kimberley region.

In recognising the specific challenges for stormwater management in the Kimberley during the wet season (episodic rainfall events resulting in large volumes of water, large sediment loads), and the requirement for specific infrastructure designed to handle it, the *Kimberley Regional Water Plan* (DoW 2010) recommended a review of the *Stormwater management manual for Western Australia* (DoW 2004-2007).

In the absence of this review the stormwater management principles presented within this LWMS are built on the water management principles initially presented within the *Broome North DWMS* (GHD and SKM 2009), that have been progressively refined to local conditions during development and planning for the Broome North LDP1 area and LDP2 areas, in consultation with the Department of Water and the Shire of Broome.

The criteria for water conservation, stormwater management and groundwater management are summarised in the following sections. Further details of the strategies to achieve the design objectives are outlined in Section 5 for water conservation, Section 6 for water quantity and Section 6.7 for water quality.

3.1 Water conservation

The overall intention of this LWMS is to achieve the sustainable management of all aspects of the water cycle within the development and achieve efficient use of potable water. Specifically the objectives for integrated urban water management for the development are:

- Potable water use outside of buildings should be limited and as efficient as possible.
- Encourage the installation of 5 Star Plus provisions for all new fittings.
- Encourage the planting of native gardens.
- Use of endemic species within the development that require a local climate based low water-use and nutrient use regime.
- Minimising water use in public open space through use of low water use landscaping treatments and retention of native vegetation where possible.

3.2 Water quantity management

The principle for water quantity management is the maintenance of discharge volume and peak flow relative to pre-development conditions.

To achieve this principle the following criteria have been incorporated:

- *Ecological Protection* – The stormwater drainage system begins high in the catchment to retain flows near source. In particular, for the critical one year average recurrence interval event, the design of the stormwater drainage system has aimed to maintain post development discharge volume and peak flow rates relative to pre-development conditions in all parts of the catchment.

- *Flood management* – The stormwater drainage system has been designed to manage the catchment runoff for up to the 1 in 100 year ARI event in the development area to pre-development peak flows.
- *Protect infrastructure and assets from inundation and flooding* – The stormwater drainage system has been designed to ensure the system conveys flows and ensures protection of infrastructure and assets during flooding events.

3.3 Water quality management

The principle for water quality management is to maintain and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub catchment in which the development is located. To achieve this principle the following criteria have been incorporated:

- The stormwater drainage system has been designed to treat flows in bio-retention swales near the source of flows.
- Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual (Department of Water, 2004-2007).
- Development of a monitoring program to measure the water quality of the development, with comparison to ambient conditions, where achievable, and relevant water quality guidelines. Protect groundwater as a resource.



Plate 1: Multi-use corridor located in Broome North Stage 7

4. Pre-development environment

4.1 Climate

Broome has a tropical climate characterised by two distinct seasons; 'the wet season' and 'the dry season'. The wet season usually extends from December to March and the dry season for the remainder of the year. The closest weather station to the proposed development area is Broome Airport. The mean annual minimum temperature range varies between 13.7 ^{o}C in July and 26.5 ^{o}C in December, and mean annual maximum temperature range varies between 28.8 ^{o}C in July and 34.3 ^{o}C in April (Bureau of Meteorology 2014).

Mean annual rainfall in Broome is 606.3 mm with 35.4 mean rain days. Average monthly rainfall is shown in Table 1.

Table 1 Mean monthly rainfall Broome Airport (1941-2013)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	181.6	179.8	101.7	26.2	27.3	19.9	7.1	1.7	1.4	1.5	9.2	57.7

4.2 Site conditions and topography

The study area has not been developed and comprises remnant bushland within a sandplain characterised by red loamy soils. During a recent flora and fauna survey (GHD 2013) it was noted that a number of unauthorised internal tracks traverse the study area, and rubbish (including cars, commercial and household waste) was observed throughout the site.

A ridge line traverses the study area in a south-west to north-east direction, with the western side grading to the base of the dunal system to the west and the eastern side grading toward Dampier Creek. The elevation of the ridge line is generally 17 mAHD, increasing to 18 MAHD along the northern extent of the study area. Within the ECC, along the northern boundary, the elevation reaches 20 mAHD along the ridge line.

The lowest natural surface west of the ridgeline (approximately 14 mAHD) occurs in the vicinity of the drainage basin located between the Yawuru conservation reserve and Fairway Drive. East of the ridgeline the lowest natural surface (13.8 mAHD) occurs in the south-east corner of the site along Gubinge Road.

The topography of the Broome North development area is shown in Figure 4 and Appendix A.

4.3 Geotechnical conditions

4.3.1 Geology and soils

The proposed development is situated on a flat to gently undulating plain of the Dampier Peninsula, which is underlain by the ancient (Pre-Cambrian) rocks of the Canning Basin. The Geological Survey of Western Australia (1982) indicates that the geology comprises "red sand, fine to medium, minor silt: Aeolian".

The principle soil type of the Dampier Peninsula is the Pindan identified as red earthy sands which are of windblown origin (Kenneally *et al*. 1996). Within the Broome area the Pindan is often overlain by a layer of more recent, coarser and unconsolidated sand, which assists in water penetration, plant establishment and growth (Kenneally *et al*. 1996).



LEGEND

Hydrology

Contour

Project Area

Acid Sulfate Risk Map

High to moderate ASS disturbance risk (<3m from surface)

1: 20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

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LandCorp
Broome North LDP3 LWMS

Topography
and acid sulfate risk map

Job Number	61-2969402
Revision	0
Date	15 May 2014

Figure 4

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Data source: GA: NatMap 250k Australian Topo Series 3 - 2007; Landgate: Broome Townsite Sep 2012 Mosaic - 20130726, Hydrology - 20140311, 1m Contour - 20140311; LandCorp: Project Area 20140219: DEC; Acid Sulfate Risk - 20140305. Created by: jcmatic

4.3.2 Geotechnics

The site has a general subsurface strata summarised as silty clayey SAND, fine to medium coarse, dense, red to brown, weakly cemented (Coffey, 2009).

The Pindan sand was encountered to the test pit termination depth of 2.5m BGL. Little variation laterally or over depth was encountered (Coffey, 2009). On this basis, perched groundwater is unlikely to occur.

Soil permeability testing was undertaken by Coffey (2009) using the in-situ falling head methodology, resulting in a recommended permeability of 0.1 m/day.

Further information is provided in Appendix G.

4.3.3 Acid sulfate soils

Mapping of acid sulfate soils by the Western Australian Planning Commission in the Shire of Broome is very limited with no mapping for the proposed study area.

An acid sulfate soil investigation of the Broome North area, comprising a desktop investigation as well as targeted sampling, concluded that the risk of ASS occurrence in the Broome North area is inherently low (GHD 2009a). Given the findings of the investigation, it is considered that no further ASS investigations or management is likely to be required prior to development of the Broome North area assuming that excavation works are limited to Pindan Soils and dewatering is not required.

4.3.4 Contaminated sites

The Department of Environment Regulation (DER) Contaminated Sites Database presents information on known or suspected contaminated sites that have been classified by the DER within the following categories:

- Contaminated - remediation required.
- Contaminated - restricted use.
- Remediated for restricted use.

The DEC Contaminated Sites Database does not provide details of sites that are listed as ‘Possibly contaminated – investigation required’.

A search of the DEC Contaminated Sites Database shows that the Site and surrounds have not been reported as known contaminated sites at the time of the search (22 January 2014).

Broome North Preliminary Site Investigation

The *Broome North Preliminary Site Investigation* (PSI) (GHD 2009b) investigated the historical and current land uses within the study area in order to determine if there is any potential soil or groundwater contamination present.

The *Broome North PSI* also observed many areas of illegal dumping along unsealed tracks across the study area. Dumped wastes included white goods, cans, bottle, drums and other household wastes, generally limited to unsealed tracks across the study area.

Except for the minor and localised dumping of waste materials, the *Broome North PSI* concluded that no significant contamination issues were observed within the study area. However, this conclusion is subject to the timeframes for the development and whether dumping of waste continues to occur and potentially cause contamination in the future.

4.4 Aboriginal heritage

The Aboriginal site register is held under Section 38 of the State Aboriginal Heritage Act 1972. It protects places and objects customarily used by, or traditional to, the original inhabitants of Australia. A search of the Department of Aboriginal Affairs database identified one registered Aboriginal site within the proposed development. The details of the site is summarised in Table 2.

Table 2 Registered Aboriginal Heritage sites within the study area

Site ID	Site name	Type	Additional information
12839	Billingurru	Ceremonial, Mythological	Camp

Figure 5 identifies the location of the registered Aboriginal heritage sites within the vicinity of the study area. A Search of the Department of Aboriginal Affairs database does not comprise of a full assessment under the Aboriginal Heritage Act (1972). This would require consultation with Aboriginal people with knowledge of the area, and an archaeological survey to ascertain whether any previously unrecorded archaeological sites are within the proposed works area.

Under the Aboriginal Heritage Act (1972), it is an offence to disturb an Aboriginal heritage site whether it is registered or not. Where an activity disturbs an Aboriginal site or object an application for permission to disturb those sites will need to be submitted under Section 18 of the Aboriginal Heritage Act (1972). Where an area of previously unknown Aboriginal heritage is to be disturbed, it is advised that a detailed anthropological and archaeological survey is undertaken to find if there are any sites of objects of significance in that area.

4.5 Environmentally sensitive areas

The Department of Environment Regulation's online native vegetation viewer was searched to determine the location of any environmentally sensitive areas (ESAs) within the study area, as declared by a notice under Section 51B of the Environmental Protection Act (1986). The study area, the surrounding Broome Peninsula and a substantial portion of the coastline to the north and south occurs within an Environmentally Sensitive Area. This is mapped in Figure 5.

4.6 Reserves and conservation areas

The closest DPaW-managed reserve is a Wildlife Veterinary Clinic that undertakes care and rehabilitation of wildlife. The reserve is vested with the Conservation Commission of Western Australia and is located approximately 500 m north of the Project area.

Yawuru Indigenous Land Use Agreement (ILUA) Conservation Estate occurs immediately west of the north-western part of the LDP3 area and adjacent to Yawuru land parcel continuing west of Fairway Drive (the proposed Fairway Drive closure) and linking north along the coast.

The Yawuru conservation estate is classified as an ILUA in-Town reserve, and is classified as A-class reserve to protect cultural and natural heritage. Any effort to amend an A-class reserves purpose, or to alter its boundary, requires approval from Parliament (CCS Strategic, 2013).

The *Broome Coastal Reserves Master Plan* (CCS Strategic, 2013), includes outcomes proposed for ILUA reserves, and applicable to the Yawuru conservation estate:

- To restore, protect and sustainably manage the cultural and natural values for the enjoyment and benefit of present and future generations;
- To provide recreational facilities and activities consistent with the reserve's A-class status;

- To preserve and promote Aboriginal cultural and heritage values, archaeological values and natural environmental values including indigenous flora and fauna;
- To facilitate public utilisation of the spaces and promote the concept that the public's wise usage is an important part of the management matrix;
- To facilitate Yawuru access for purposes consistent with Yawuru Culture and tradition and to preserve and sustain recognised native title rights and interests;
- To make available employment, service provision and training opportunities for the Yawuru People for planning and management;
- To facilitate commercial and economic opportunities for the Yawuru Community and the Yawuru RNTBC, subject to such activities being consistent with the management of the Conservation Estate; and
- To monitor and report on the effectiveness of implementing the Management Plan.

4.7 Vegetation and flora

The Project area is situated in the Northern Botanical Province of Western Australia (Beard 1990), within the Dampierland bioregion and the Pindanland sub-region as described by the Interim Biogeographic Regionalisation of Australia (IBRA) (DSEWPaC 2013b).

The vegetation of the Dampier Peninsular has been described by Kenneally *et al.* (1996) who recognise 11 (ten terrestrial and one marine) plant communities on or around the Dampier Peninsular. Kenneally *et al*. (1996) note that the vegetation is predominantly Pindan 'a grassland wooded by scattered trees, generally eucalypts, with a variably dense middle layer of wattles'. Fire is the controlling agent of the Pindan with the variety in the vegetation, particularly wattles, relating directly to a fire-regeneration cycle (Kenneally *et al.* 1996).

GHD conducted a Level 1 vegetation and flora survey of the study area from 17-19 July 2013. The vegetation of the study area was largely uniform and comprised one vegetation association (Pindan shrubland) consistent with the Keneally et al (1996) and the findings of GHD (2009).

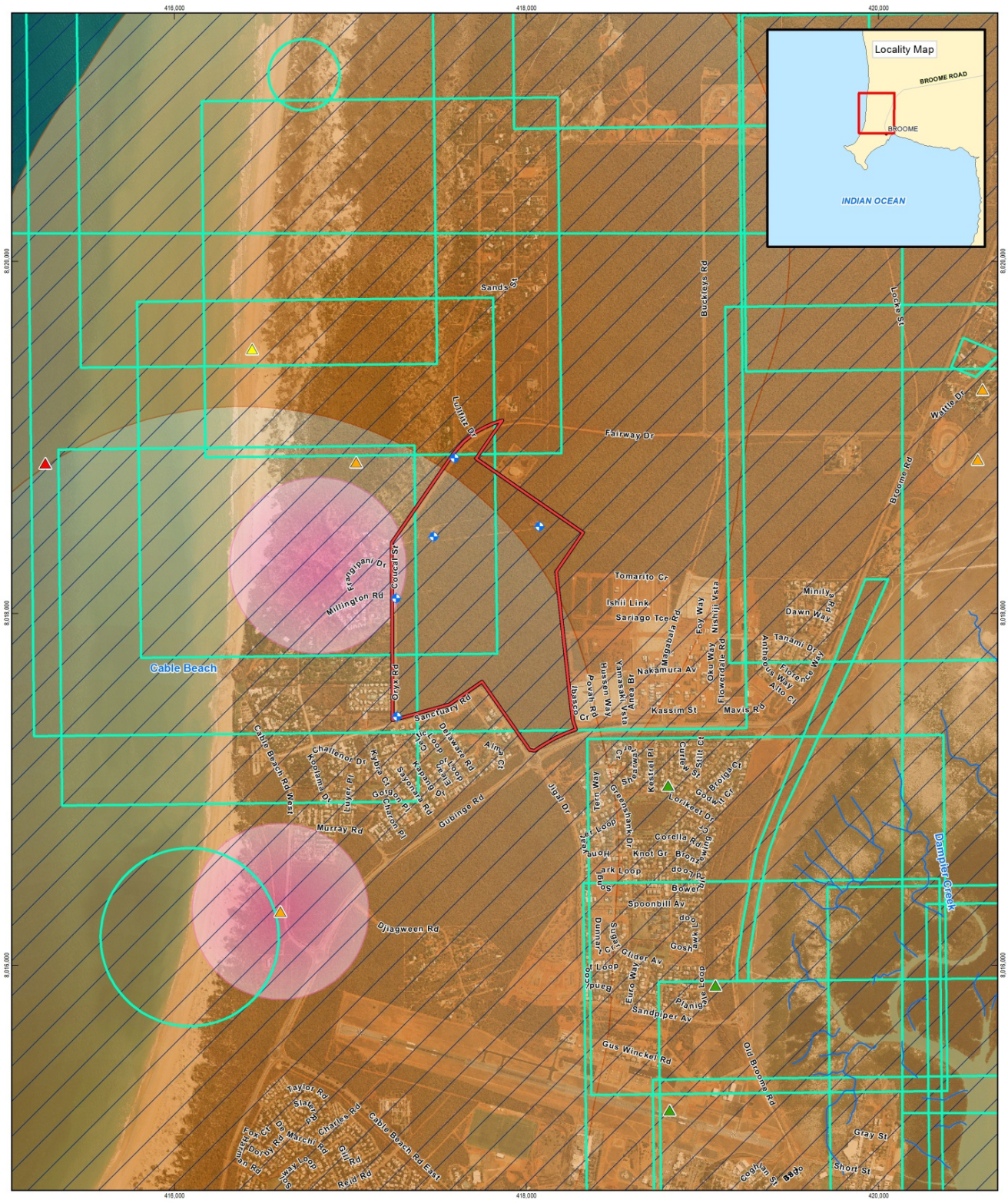
The study area did not contain any coastal or vine thicket vegetation associations, and no Federal or State listed Threatened Ecological Communities or Priority Ecological Communities were identified during the survey (GHD 2013).

4.8 Fauna

GHD conducted a Level 1 fauna assessment (reconnaissance survey) of the study area concurrently with the vegetation and flora survey as a follow-up of the *Preliminary Environmental Impact Assessment and Biological Survey* (GHD 2009c).

No Threatened fauna species were recorded within the study area during the survey, nor are any expected to occur in the area (GHD 2013). One migratory species was recorded on site, the Rainbow Bee-eater, however, this species is wide spread across Australia and would not be impacted by this development. Eleven migratory or priority fauna species may visit the Project area opportunistically, however, it is not considered core habitat for these species.

A Northern Brushtail Possum was recorded on camera trap in the study area which is considered by DPaW to be a locally significant species. During phase 1 of the Broome North project, DPaW requested that a relocation program be undertaken of Northern Brushtail Possums in the project site prior to clearing.



LEGEND

WIN Sites
- Ground

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa
- Project Area
- Aboriginal Heritage Sites
- Environmentally Sensitive Areas
- Priority Ecological Community
- Threatened Ecological Community

1: 586,538 (at A3)
0 100 200 400 600 800 1,000
Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

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Environmental Constraints

Figure 5

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Data source: GA: NatMap 250k Australian Topo Series 3 - 2007; Landgate: Broome Townsite Sep 2012 Mosaic - 20130726; LandCorp: Project Area 20140219; DEC: Threatened (Declared Rare) & Priority Flora - 20130802, Priority Ecological Community (DEC, 2011a and 2011b) - 20130812, Threatened Ecological Community (DEC, 2011a and 2011b) - 20130812; DIA: Aboriginal Heritage Sites - 20140305; Dow; Win Sites - 20140305. Created by: erice, jcmatic

4.9 Surface water

The Department of Water's Geographic data atlas identifies that the proposed development is located in the Cape Leveque Coast drainage basin. The study area is not located in a proclaimed surface water management area (Department of Water 2009).

Surface drainage is poorly developed over much of the Dampier Peninsula, with surface flow predominantly occurring as sheet flow. In response to the surface drainage there are no wetlands or watercourses located within the study area boundary.

4.9.1 Surface water quality

Due to the sheet flow nature of natural surface drainage there is limited opportunity to collect baseline surface water samples from the site. An opportunistic grab sample was collected from surface runoff alongside the road reserve at the corner of Fairway Drive, near to intersection with Coucal Street on 29 December 2013. Rainfall for the event was recorded as 31.2 mm at Broome Airport.

Sample field observations note that the sample was very turbid with pindan washouts evident within the road reserve area. Water quality data is summarised in Table 3, with samples exceeding ANZECC guidelines in bold. Note that metals are total metals and are compared to guidelines for dissolved species.

Table 3 Surface water quality

Parameter	ANZECC Guideline - Tropical lowland river (ANZECC 2000)	LDP3 value
pH (Lab)	6-8	7.86
TSS (mg/L)		685
Total nitrogen (mg/L)	0.3	<0.5
Ammonia-N (mg/L)	0.01	0.03
Nitrite+Nitrate-N (mg/L)	0.01	0.06
Total phosphorus (mg/L)	0.01	0.22
Filterable reactive P (mg/L)	0.004	0.02
Arsenic (mg/L)	0.013	0.001
Cadmium (mg/L)	0.0002	0.0001
Chromium (mg/L)	0.001	0.006
Copper (mg/L)	0.0014	0.002
Nickel (mg/L)	0.011	0.002
Lead (mg/L)	0.0034	0.016
Zinc (mg/L)	0.008	0.014
Mercury (mg/L)	0.00006	<0.0001

4.9.2 Wetlands

The Department of the Environment, Water, Heritage and the Arts (2012) identifies Roebuck Bay, an internationally significant wetland (RAMSAR listed site), within 5 km of the study area.

Surface water from proposed development is not expected to impact on the water quality or quantity in the Ramsar wetland area due to the distance to it and the drainage management that is proposed in this LWMS and further refinements to the drainage design in the subsequent UWMPs to support subdivision for this area. The treatment processes will be designed to detain the majority of water on site in suitably sized swale detention basins within the site.

4.9.3 Water dependent ecosystems

Water dependent ecosystems have been identified along the western coastline of the Dampier Peninsula (DoW 2012), with wetlands classified using the geomorphic approach of Semeniuk and Semeniuk (1995). Within the Cable Beach area these are mapped as intermittent wetlands by Boggs (2011). The mapping was completed using Landsat imagery and has not been ground truthed.

The mapping corresponds with the description of freshwater discharge along the edge of the pindan, forming a wetland in the swale or depression between the red sand and the coastal dunes (Mathews *et al.* 2011). These freshwater sources are of great cultural value to the Yawaru and are of regional significance as they represent freshwater occurrences in a regional setting of tropical semi-aridity (Mathews et al. 2011). In some instances vine thickets have developed in the freshwater discharge locations, representing the most southern occurrence of vine thicket in Western Australia (Mathews *et al.* 2011).

An area identified as a freshwater discharge location of cultural significance to the Yawuru is located west of the ‘A’ Class Reserve and proposed Fairway Drive closure, in a natural depression at the foot of the Cable Beach dune system.

Surface water runoff from the proposed development area is not expected to impact on the water quality or quantity of the freshwater discharge water dependent ecosystem as no direct flows will be directed towards the area. In order to maintain the water dependent ecosystem it is important to maintain pre-development flows, as sheet flow, towards the site.

Any proposed stormwater management and treatment processes within the catchment of the freshwater discharge zone will be designed to deliver water as sheet flow at pre-development flow rates.

4.9.4 Public drinking water source areas

The Department of Water’s Geographic Data Atlas indicates that there are no public drinking water source areas within the vicinity of the study area. The nearest public drinking water source is approximately 8 km north east of the site.

4.10 Groundwater

4.10.1 Regional groundwater

The study area falls within the Cable Beach Groundwater sub area.

The regional groundwater resources of the Broome area (1:250,000 map sheet SE516, GSWA 1982) comprise both confined and unconfined aquifers of significant extent. The hydrogeology

of the Broome area is documented by Laws (1991). The most utilised aquifer is the Broome sandstone that comprises fine to coarse grained sandstone with minor beds of pebble conglomerate, grey siltstone and claystone. The Broome sandstone is unconfined and is separated from the underlying (confined) aquifers, Alexander formation and the Wallal sandstone, by an aquiclude, the Jarlemai siltstone.

4.10.2 Local groundwater

Groundwater in the Broome area moves under the influence of gravity down the hydraulic gradient west toward the ocean and south toward Roebuck Bay (WRC 2001).The Broome Groundwater Management Plan Review (Groundwater Consulting Services 2008), prepared for the Department of Water, presented groundwater levels for the Broome region, with levels for the Broome North area less than 3 mAHD. The geotechnical investigation over the study area (Coffey Geotechnics 2009) reported that groundwater was not encountered during test pitting over the study area to 2.5 m below ground level, and estimated an average annual maximum groundwater level based on DoW WIN bores within 2 km of the site 2.5 mAHD.

A search of the Department of Water WIN database identifies two bores along the western edge of the study area that have groundwater level data for the period 1986 to 2013, with a third bore located adjacent to the A Class reserve and Fairway Drive with groundwater level data for the period 1986 to 2001 (Figure 5). The range of groundwater levels for these bores is reported in Table 4. Based on site contours the clearance to groundwater is approximately 12 to 14 m from maximum groundwater levels.

Table 4 Groundwater levels for bores within LDP3 area

Groundwater parameter	WIN bore 8054	WIN bore 8055	WIN bore 8056
Period of record	1986-2011	1986-2013	1986-2013
Minimum (mAHD)	1.171	0.206	0.828
Median (mAHD)	2.191	2.201	2.008
Maximum (mAHD)	3.491	2.706	3.456
Count	27	36	48

5. Water use and conservation strategy

5.1 Existing servicing

5.1.1 Potable water

The existing town of Broome is currently supplied by groundwater from the local Water Corporation production bore field in Reserve 25716 located to the north east of the Broome Township. A Safe Yield of 10.6GL/annum was determined in 1994 within the *Broome Groundwater Management Plan* (WAWA 1994).

5.1.2 Wastewater

In Broome, wastewater is collected via a traditional gravity sewer and transferred to the wastewater treatment plant owned and operated by the Water Corporation. Expansion of the existing gravity system to include the Broome North LDP3 Area will be required.

Collected wastewater will be transferred to the new Water Corporation wastewater treatment plant (WWTP) constructed to the north east of the town at Crab Creek. The wastewater will be treated at this WWTP and treated wastewater will be managed by irrigating Rhodes Grass adjacent to the new WWTP. Water Corporation plans to undertake a review of wastewater management options for the longer term prior to the implementation of Stage 2 of the WWTP (in approximately 2021).

5.2 Water sources

5.2.1 Groundwater supply scheme

Review of the *Broome Groundwater Management Plan* supported the expansion of the town water supply borefield in a northerly direction to meet future potable water demand for Broome townsite (Groundwater Consulting Services, 2008). The review also identified that future growth projections for Broome would result in a total water demand of about 9.5 GL/annum by 2030, with increased demand if horticultural expansion occurred (Groundwater Consulting Services 2008).

This is the preferred water source for Broome North LDP3 Area since there is sufficient sustainable yield to provide for the development with substantial existing infrastructure in place. Groundwater supply is recognised as the most economically viable water supply option for towns within the Kimberley (DoW 2010).

Appendix H presents correspondence with Water Corporation for securing this supply. The Water Corporation identify that if only scheme water available a target figure for Broome will need to be established. Water Corporation also note that potable water supply for POS irrigation is possible in the short term however a significant lead time is required to assess supply in the long term for reasons relating to pumping and water distribution rather than limitations of the borefield or aquifer.

5.2.2 Wastewater reuse

Wastewater reuse is viable when the flows into the wastewater treatment plant:

- Reach a level that is sufficient to justify the capital investment in infrastructure.
- Produce sufficient flows to supply the required non-potable demand.

In order to reuse wastewater for non-drinking purposes, treatment, storage and distribution infrastructure will be required. The advantage of treated wastewater is that it will be a

continuous and reliable source and is independent of the future climate. To implement treated wastewater as a non-drinking water source, additional distribution and treatment infrastructure will be required.

Wastewater reuse will not be endorsed on a site scale due to the constraints for space at the site (which may be necessary for odour buffers). Wastewater reuse may be more appropriately considered on a larger scale for the Broome townsite as an option to be considered in future Regional water planning. Small scale treatment systems may be considered suitable to provide a non-drinking water source (i.e. for irrigation purposes) for the tourism development lots due to their larger scale.

5.2.3 Rainwater

Due to the seasonal nature of rainfall within Broome rainwater is not a reliable year round water source.

Individual lot owners may choose to install rainwater tanks for private use, however this is considered a decision made at the discretion of the individual landowner and is not considered further in this document.

5.2.4 Water source recommendations

Whilst it is desirable to reduce scheme water demands for the development it is unlikely that a third pipe wastewater reuse option is feasible for the supply of POS irrigation water for the development due to the space constraints discussed above.

It is recommended that the options for long term sustainable POS irrigation continue to be investigated by the Broome Water Issues Meetings Group comprising the Department of Water, Water Corporation, Shire of Broome and LandCorp.

A feasibility study for the POS irrigation water supply, including the above options and alternative water supply options (ie. potential to shandy saline local groundwater with scheme water) will be included in the Urban Water Management Plan for the development, confirming the POS irrigation supply source.

5.3 Water balance modelling

A conceptual water balance was developed for the study area using the Water Corporation H_2Options tool. The water balance has been based on potable water supply for both residential indoor and outdoor use, and POS irrigation supply from the Broome town water supply borefield.

The required potable water supply for the Broome North LDP3 development area is summarised in Table 5 and the water balance is included as Appendix I.

Table 5 Broome North LDP3 water balance

Land use type	Demand (kL/year)	Required Drinking water supply (kL/year)
Residential indoor	115,265	115,265
Residential outdoor	62,059	62,059
Residential total	177,324	177,324
Commercial and industrial (Tourist Park)	2,800	2,800
Public open space	8,785	8,785

5.4 Water efficiency measures

5.4.1 Potable water

Water efficiency is enabled through the use of technology and by changing behaviour to use less water. The Western Australian Government has introduced a range of measures to ensure that new houses built in Western Australia meet minimum standards for energy and water efficiency including:

- All tap fittings must be minimum 4 stars WELS rated;
- All showerheads must be minimum 3 stars WELS rated;
- All sanitary flushing systems must be a minimum 4 stars WELS rated dual flush;
- Water using appliances installed (such as washing machines and dish washers) are 4 stars WELS rated or better.

The Shire of Broome through their *Water Conservation and Waste Water Reuse Policy* (Shire of Broome 2006) also supports the use of water efficient devices and appliances.

The Broome North LDP3 development area is committed to the above water conservation measures and new development areas will have water efficient fittings and appliances installed as identified by the Building Code of Australia and WA's "5-Star Plus Stage 1 supplement" provided as Appendix B.

5.4.2 Irrigation and landscaping

The Shire of Broome *Water Conservation and Waste Water Reuse* Policy (Shire of Broome 2006) supports the use of efficient irrigation technology, planting of native species to reduce water demand and mulching to reduce evaporation and therefore increase water efficiency. This is particularly important given that irrigation will be provided through the potable water supply.

The Shire of Broome Coastal Reserve Masterplan (CCS 2013) also identifies water efficiency measures including:

• Optimising irrigation systems for maximum water-use efficiency.

• Hydro-zoning of park turf surfaces.

• Eco-zoning of vegetated areas in parks surrounding turfed surfaces as well as road verges and medians.

Commitment to water conservation is a key element in the design and management of streetscapes and POS areas across the Broome North development area, with further refinement within LDP3. The water management strategies for landscaped and POS areas in LDP3 include:

- Investigate opportunities to optimise the frequency and timing of irrigation so that peak irrigation demands do not correspond to peak potable demands.
- Use of endemic species within the development that require a local climate based low water-use and nutrient use regime.
- 80% of planting is mostly revegetation with drip irrigation turned off once planting is established (2 years).
- Lawn areas are minimised. The lawn species is indigenous to the Broome Peninsula (Roebuck Bay Couch) and has low water and nutrient use requirements.
- Irrigation of public open space to occur only at night, to reduce evaporation losses.

- The irrigation schedule for most planting is daily during a 13 week establishment period and then reduced to irrigating twice a week, or less, as required.
- During the maintenance period the water needs of the plants will be assessed and irrigation will be reduced accordingly.
- The irrigation systems will be designed in accordance with Shire of Broome requirements and specification.
- Establishment of street trees to be negotiated between the Shire of Broome and the developer.

5.4.3 Construction

The Shire of Broome *Water Conservation and Waste Water Reuse* Policy (Shire of Broome 2006) supports the use of water from non-potable sources to wet roads during construction.

5.5 Tourism development

The proposed tourism development areas are required to adhere to the water efficiency measures for potable water, irrigation and landscaping and construction identified in Section 5.3.

If the proposed tourism development areas have a projected water use of more than 20,000 kL of scheme water per year they will be required, under the Water Agencies (Water Use) By-laws 2010, to participate in the Water Corporation Water Efficiency Management Plan (WEMP) program. The program involves developing a WEMP detailing the water saving actions and initiatives implemented by the business; and providing annual progress reports on these actions and initiatives.

6. Stormwater management strategy

The modelling of the stormwater drainage system was completed by TABEC Civil Engineering Consultants using the surface water modelling package XP-SWMM 2013. The following sections outline the assumptions made and results calculated from TABEC's drainage modelling.

6.1 Existing conditions

The Broome North LDP3 Area is located on the sandplains of the Dampier Peninsula. The study area is located in the higher areas of the overall catchment, in between Sunset Estate to the west, and Broome North Development LDP1 to the east. Surface runoff at the site during episodic rainfall events primarily occurs as sheet flow towards the upper reaches of Dampier Creek (Figure 5).

As noted in Section 4.2 a natural ridgeline dissects the study area south-west to north-east direction. Under pre-development conditions the western portion of the study area grades to the base of the Cable Beach dunal system, with the majority of the study area draining east along the Gubinge Road drainage conveyance system, discharging to Dampier Creek.

6.2 District Water Management Strategy

The *Broome North DWMS* (GHD and SKM 2009) designates the western portion of the study area within a small elongated catchment that drains west of the ridgeline to the coastal dune system (Area 1, Appendix C).

East of the ridgeline the study area forms the part of the upper catchment (Area 3, Appendix C) that drains east along Gubinge Road to the upper reaches of Dampier Creek.

Descriptions of the catchment areas from the DWMS include:

- Area 1 – This area grades directly to the west, and the Shire of Broome have advised that any discharge from this area cannot be accommodated in the existing Cable Beach drainage system, apart from a DN 300 pipe, which can be used as a low flow drain. This area will require a detention basin with a low flow pipe into the Cable Beach drainage system as well as a low flow pipe to discharge into the open unlined drain along Sanctuary Road (GHD and SKM 2009).
- Area 3 – This area grades to the east and south towards Magabala and Gubinge Roads. The outlet for the southern section of this catchment is along the northern side of Gubinge Road and then east to the existing detention basin on the corner of Gubinge and Broome Roads. This is currently under investigation to look at ways to improve the water quality effectiveness of the detention basin. The "Lake Broome" basin discharges into the upper reaches of Dampier Creek. The northern section of the catchment will discharge into a swale/detention system on the southern edge of the environmental cultural corridor which outlets into the upper reaches of Dampier Creek via a culvert crossing under Broome Highway (GHD and SKM 2009).

6.3 Proposed stormwater management strategy

In accordance with the principals and objectives of the DWMS (GHD and SKM 2009) the proposed development will maintain the pre-development stormwater discharge rates for the critical duration 1 yr ARI, and be protected from flooding in the 100 yr ARI event. The stormwater management strategy has also been developed with consideration of the key principles of the Shire of Broome *Stormwater Management Policy* (Shire of Broome 2003) in

particular the design of the linear swale drainage system that acts as a treatment train to detain and retain and treat flows close to source. The concept details of the drainage swale detention system are provided in Section 6.5.

A key design principle for stormwater management in Broome uses the roads to carry the majority of flow for all events. Overland flow through roads connected to vegetated swales is used in preference to a piped system to slow flows, enable some infiltration and some treatment of stormwater through vegetative uptake and contact with sediment. Runoff is discharged from lots into the road system, from where it is discharged into the unlined vegetated swale/detention drainage system as high as possible within the catchment in order to manage flood events and improve water quality.

Roads are kerbed adjacent to residential lots to contain the 10 yr ARI event, with flush kerbing used on roads adjacent to public open space (POS), multiple use corridors (MUC), the ECC and the A Class Reserve. The intention of flush kerbing is to reduce flow velocity, compared to kerbed roads which efficiently transport stormwater runoff into the drainage system. Critical road reserves at the end of the catchment will be kerbed, with kerb openings to direct discharge into the swale drainage system (Plate 2). At these locations the swales will require rock protection to reduce flow velocities and manage scour.

Gullies and pipes are only used to manage the 10 yr ARI flow where it cannot be carried in the road between the kerbs. Where appropriate, pipes are also used for low flow drains from detention basins.

Stormwater conveyed within the road reserve discharges into an open unlined swale/detention drainage system as high as possible in the catchments. This is to ensure that the road system is not overtopped and the water quality treatment train is activated as soon as possible. Through the use of weirs within the unlined swale/detention drainage system and culverts at road crossings the post development flow rates will be reduced to pre-development rates. The weirs incorporate a v-notch or low flow pipe in order to ensure water is conveyed downstream even under low flow conditions.

The surface water management for the study area will be based on the following principles:

- The primary function of the detention system is to maintain the 1yr 1hr flow regime and keep flow velocities below 0.5 m/s to assist in achieving water quality objectives.
- The development will have a detention system so that peak flow from 50 yr ARI and 100 yr ARI events are not greater than that which would occur under pre-development conditions.
- All events up to the 100 yr ARI events are to be contained within the road reserve and the 10 yr ARI event is to be contained within the kerbs.
- Finished floor levels for the buildings on all lots are to be at least 0.5 m above the crown of the road to ensure that no flooding of the residences occurs.
- A minimum of 0.3 m freeboard is required between the flood level of a 100 yr ARI design event and the finished floor level of all buildings on the site.

A summary of the stormwater strategy for the different stormwater events is identified below.

1 year ARI event

- Impervious areas within lots to be detained before draining to roads.
- Roads and POS will drain into the swale detention system.
- Weirs will detain flows within the swale to pre-development peak discharge.

10 year ARI

- Lots, roads and POS will drain to the swale detention system.
- Weirs with low flow outlets, and culverts at road crossings will detain flows within the swale system.

100 year ARI

- Lots, roads and POS will drain to the swale detention system.
- Lot levels set higher than peak flood levels.
- A minimum of 0.3 m freeboard required between the flood level and the finished floor level of all buildings on site.



Plate 2: Typical kerb opening detail to drainage swale, and weir with low flow outlet

6.4 Stormwater management design

Preliminary surface water modelling of the drainage system was undertaken using the surface water modelling software XP-SWMM 2013 to provide details of the required detention volumes for the catchments. The stormwater model considers the development proposed within the Broome North LDP3 (TBB plan sheet 13/022/027A, dated 13 December 2013) and also considers existing catchment of Sunset Estate and Broome North LDP1.

Detailed modelling, using XP-SWMM, will be undertaken during the detailed design phase of the project which will provide further details of water levels, detention volumes and velocities for the critical storms once the subdivision design has progressed. This information will be detailed in the UWMPs submitted at the time of subdivision applications.

There is uncertainty as to the existing drainage provision provided within Sunset Estate and following clarification of the as constructed drawings for the estate further investigation will be completed during detailed stormwater design to ensure that LDP1 is not adversely affected. The modelling of the Broome North LDP3 area has accounted for the Sunset Estate drainage system based on the assumptions in the *Broome North Local Water Management Strategy* (GHD and SKM 2010) for LDP1 area, and as identified in the following sections.

6.4.1 Catchment areas

Pre-development catchment areas

As noted in Section 6.1 there is a natural ridgeline that results in two catchments within the study area, one draining west to the existing excavated basin near the intersection of Coucal Street and Frangipani Drive and a larger catchment in the eastern part of the study area that drains south-east towards Dampier Creek, via the Gubinge Road drainage swale.

The catchment areas are relatively flat and heavily vegetated with localised depressions. There are no natural streams or channels apparent from the contours of the area suggesting that overland flow is characterised by wide sheet flow. A number of informal roads and paths within the study area have interrupted the natural flow path. The existing alignment of Fairway Drive along the north-west boundary of the study area, acts as a barrier to drainage.

Sunset Estate contributes to flows to the eastern catchment at the south-west corner of the LDP3 area at Gubinge Road.

The pre-development catchment plans are shown in Figure C.2 Appendix C (Drawing 2287-LDP3-SK01B_A).

Post development catchment areas

The post development catchment of the study area is shown in Figure C.3 Appendix C (Drawing 2287-LDP3-SK01A_A). The majority of the study area will discharge to the drainage swale in Gubinge Road. The Bush Living, and small parts of the Neighbourhood Living and Urban Living residential areas, and part of the Tourism node will discharge west or north-west into the existing basin, and/or indirectly connecting to the existing Cable Beach drainage system, in accordance with the Cable Beach Development Plan – Drainage Study, prepared for Shire of Broome by KBR consulting engineers (2008).

6.4.2 Pre development flows

Pre-development flows for the study area were determined using XP-SWMM 2013 to determine the storage required within the study area. The critical 1 yr 1 hr and 50 yr 30 min ARI peak flow rates are used for the preliminary sizing of the storage requirements.

The Laurenson runoff routing method was used in XP-SWMM to determine the peak flow rates from the entire study area. A Manning's roughness of 0.1 was used for the pre-development catchment areas and the coefficient of runoff for pre-development vegetation and bushland is 0.4, as per the Shire of Broome design guidelines. A Uniform Loss model was applied to the catchment, with Initial Loss of 20 mm and a Continuing Loss of 4 mm/hr. The Continuing Loss assumption is in accordance with Coffey Geotechnics findings, this area subsurface soil is predominately Pindan Soil with low permeability of approximately 0.1m/day (Coffey 2009).

The existing topography of the site suggests that the eastern catchment of the study area (73.3 ha) will discharge at the south east corner, connecting to existing LDP1 Gubinge Road drainage system via overland flow and roadside swales. The western catchment of the study area (59.4 ha) drains west, towards an existing basin (a local depression point) near the intersection of Coucal Street and Frangipani Drive, and will connect with the existing Cable Beach drainage system (Refer to Appendix D- KBR Plan PEV216 for more information).

As discussed in Section 6.4.1, Sunset Estate discharges along the south of the study area through the Gubinge Road drainage system, as such the pre-development flow from Sunset Estate has also been considered in the drainage model.

The estimated peak pre-development flows using XP-SWMM are as shown in Table 6.

Table 6 Peak pre-development flow rates using XP-SMM

Location	1 yr 1 hr (m^3/s)	50 yr 30 min (m^3/s)
LDP3 Western Portion	1.04	6.41
LDP3 Eastern Portion	1.26	8.65
Sunset Estate	0.87	3.74

Table 7 Peak pre-development flow rates using Rational Method

Location	1 yr 1 hr (m^3/s)	50 yr 30 min (m^3/s)
LDP3 Western Portion	2.20	9.27
LDP3 Eastern Portion	2.80	11.79
Sunset Estate	1.51	6.38

It is commonly accepted that Rational Method peak flow calculation is more conservative than the actual peak flow. As suggested by Main Roads WA, for pindan areas in the West Kimberly, the Rational Method peak flow calculation should apply a reduction factor of 3.

TABEC's modelled results show an average reduction factor of 2 and 1.5 for the 1 year 1 hour and the 50 year 30 minutes ARI storm events, respectively (Table 7). Therefore, and can be concluded that the pre-development XP-SWMM model for the study area is an acceptable representation of the onsite stormwater runoff.

The peak pre-development flow rate for the Western Portion of LDP3 is 6.41 m^3/s during the 50 yr 30 min ARI event. The Cable Beach Development Plan – Drainage Study by KBR consulting engineers (2008) Option 2 allows for a peak post development flow of 2.95 m3/s. Therefore, this area will require a detention basin prior to discharging into the existing Cable Beach drainage system.

6.5 Detention system

The stormwater drainage system for Broome North LDP3 area builds on the drainage designed and constructed for the LDP1 area, with the incorporation of linear swale detention throughout the development with the intention of activating the water sensitive urban design treatment train high in the catchment.

The linear swale detention system is designed to retard flows high in the catchment, and are vegetated to stabilise the swale system, increase roughness, slow velocities and encourage sedimentation. Swales and retarding structures will be used to control the ultimate flow rate at the culverts at Broome Road.

The Manning's roughness coefficients use in the modelling within swales was set at 0.03, and a value of 0.016 was used for roads.

Key elements of the drainage system include:

- Detention areas are to be shallow and wide with 1:6 side slopes generally but up to 1:8 where achievable. The maximum water depth will be 1.2 m.

- Swales and detention areas are to be integrated with the POS and ECC areas and be designed as part of the overall landscape planning.
- The swales and detention areas will be designed to integrate into the existing landscape and POS area and form natural creeks and streams within the green spaces. The 1yr 1 hr flows will generally be off-line to the POS areas due to the recent Shire of Broome requirement of a 2% grade across areas that have turf to prevent sedimentation on the turf.
- Drop structures will be used to minimise the longitudinal grade of swales and reduce the flow velocity to minimise the transportation of silt.
- The use of v-notch weirs and flow width restrictions to control flow and create detention areas upstream, while ensuring water is conveyed downstream even under low flow conditions.
- 100 yr ARI flood width to include adjacent roads, but not overtop kerbs on the opposite side of the road from the POS.

6.5.1 Multiple use corridors

The linear swale system has been incorporated into the MUCs, with a primary north-south corridor following the existing natural contours of the study area enabling natural drainage patterns to be more closely mimicked post-development. Typical MUC cross-sections are displayed in Chapter 7.

6.5.2 Ecological cultural corridor

The ECC is a 150m wide corridor running east-west along the northern boundary of the site that provides a buffer between development and significant cultural areas, while also maintaining important habitat and cultural and community connection to 'country'. The traditional owners of the land, the Yawaru people, have provided permission for the design of 'creek-style' drainage swales along the boundaries of the ECC to a maximum width of 30 m. Where a creek style drainage swale is proposed within the ECC the swale will be vegetated and will have a typical cross-section as shown in Figure below.

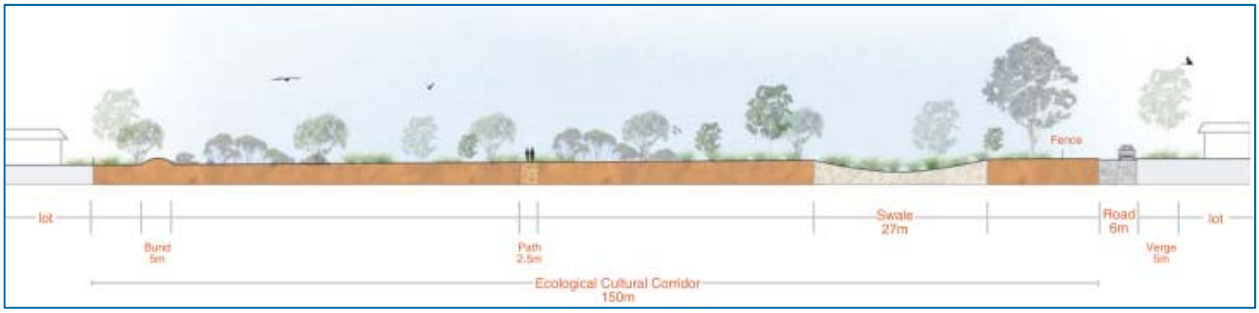


Figure 6 Typical ECC corridor (UDLA 2012)

6.6 Storage

The preliminary storage area required for the study area was calculated using Taylor Burrell Barnett's LDP3 Planning Layout (13/022/027A, dated 13 Dec 2013), and TABEC's conceptual drainage and earthworks design.

Total storage required for LDP3:

- 1yr 1hr: 36,707 m^3
- 50yr Critical: 127,404 m^3

Based on the Broome North LWMS for LDP1 area and assumptions, the storage in Sunset Estate is 50,280 m^3 for the critical 50 yr event to ensure that Broome North LDP3 and LDP1 are not adversely affected.

6.6.1 Post development flows

During the preliminary modelling of the proposed development the post-development flows were determined by applying parameters shown in Table 8, to the Hydrology module of XP-SWMM using the Laurenson runoff routing method. The ECC is included in the post-development flow at the outlet using the same parameters as the pre-development model (Table 9).

Preliminary post-development flow rates at specific locations are shown in Table 10 based on the concept stormwater drainage design presented in Figure C.3 (Appendix C).

Detailed design of the stormwater drainage system will be undertaken to support subdivision application, and provided in the urban water management plan.

Table 8 Post development coefficient of runoff as per the Shire of Broome Design Guidelines

Land Use	Coefficient of Runoff
Residential Lots	0.7
Road Reserves	0.9
POS	0.4 (assumed)
Tourism	0.4 (assumed)
ECC	0.4

Table 9 Post development loss model

Land Use	Manning's Coefficient of Roughness 'n'	Initial Loss (mm)	Continuing Loss (mm/h)
Impervious	0.03	1.5	4
Pervious	0.016	20	5

Table 10 Indicative peak post development flow rate contributing to Gubinge Road swale

Location	1 yr 1 hr (m^3/s)	50 yr Critical (m^3/s)
LDP3 Gubinge Road swale	0.63	5.4
Cable Beach Drainage System	NIL	1.43

6.6.2 Discharge outlets

Existing pre-development outlets from the Broome North LDP3 area occur at 2 low points. The western catchment drain to the existing excavated basin near the intersection of Coucal Street

and Frangipani Drive and a larger catchment in the eastern part of the study area that drains south-east towards Dampier Creek, via the Gubinge Road drainage swale. These locations were identified within the *Broome North DWMS* (GHD and SKM 2009) (Figure C.1, Appendix C).

Under the post-development conditions the western catchment will drain towards the existing excavated basin via a roadside swale system.

Breakouts in the roadside swale system are proposed to enable low flow discharge into the A Class Reserve area as overland flow. Liaison with Yawuru and the Department of Parks and Wildlife has indicated that the controlled discharge of flows into the A Class Reserve is supported provided adequate controls are in place to manage erosion. The concept plan for the roadside swale adjacent to the A Class Reserve is provided in Appendix E.

Final approval of the discharge outlet design into conservation estate will be sought from Yawuru, the Department of Parks and Wildlife and the Shire of Broome during detailed design.

The basin will discharge through an extension of the existing Cable Beach drainage system.

Post development, the catchment will discharge to the existing LDP1 Gubinge Road drainage system via an open swale/detention drainage system maintaining the pre-development flow rates at the Broome Road culvert outlet.

6.7 Stormwater quality

Stormwater quality issues which may require management within the Broome North LDP3 Area include:

- Sediment load: Erosion caused by high flow velocity can result in loss of soil and increased sediment load to the receiving water body.
- Nutrient load: Over application of fertilisers to landscaped areas may result in increased nutrient loading to the receiving water body.
- Gross, suspended and dissolved pollutants: Including rubbish, hydrocarbons and dissolved metals.

Best management practices (BMPs) are strategies incorporated into design to assist in the management of total suspended solids, gross pollutants and suspended or dissolved pollutants. As the majority of pollutants are transported in frequent, minor events, it is these frequent rainfall events which are targeted using at source, in-transit and end-of-catchment BMPs to improve water quality.

Table 11 Recommended stormwater management BMPs

Development scale	Best management practice
Residential construction	Mulching of lot and road verges and drainage swales to prevent silt runoff from sites under construction onto the roads and into the drainage system. Promotion of the use of temporary bunds and silt fences by builders to prevent Pindan silt runoff from sites under construction into the drainage system. Promotion of the use of litter and waste storage bins to prevent litter to be blown by wind or washed away by rainfall. Promotion of the establishment of wash-down areas behind the bund or silt fence by builders. Builders to provide a stabilised entry and exit point to prevent vehicle

Development scale	Best management practice
	tracking of soil from the building site onto roads. Builders to position sand and soil stockpiles to prevent material being tracked, washed, or blown into roads, and then into the stormwater systems.
Lot scale	Promotion of on-lot infiltration for events up to the 1-year ARI storm. Use of low water soluble fertiliser. Water-wise and nutrient-wise landscaping, including minimising lawns.
Street scale	Construction of channels and dry/ephemeral detention swales using weirs and low flow drain system, to reduce flow velocity, thus reducing erosion and sediment mobilisation, allowing sedimentation, reduce total flow discharged from site, and allowing infiltration to groundwater. Planting and regeneration of low-lying native vegetation in swale drains for filtering of particulates and uptake of dissolved nutrients.
Development scale	Maximising infiltration by adopting a stormwater detention system to detain the 1 yr ARI storm. The linear swale detention system is designed to reduce peak flow rates, to assist in achieving water quality objectives and to maximise the deposition of suspended sediment and promote infiltration. Sediment traps are located immediately upstream of weirs to promote sedimentation. Maintenance of the stormwater drainage system, including street sweeping and removal of silt build up.

6.8 Disease vector and nuisance insect management

The Shire of Broome does not accept permanent water bodies within the drainage system. All detention basins are required to grade out and discharge over a period of time not exceeding 72 hours

7. Landscaping concepts

The landscaping concepts for the Broome North LDP3 Area have been developed by UDLA, and continue the design elements from the adjacent LDP1 Area to the east of the site.

The primary landscape typologies include neighbourhood parks and multi-use corridors, a key feature of which is the north-south central parkland. The design intent of the LDP3 Area is to provide a cultivated artistic bushland aesthetic comprising formal active spaces, informal spaces and bushland areas, including retained vegetation.

Major bushland tracts define the greater Broome North development area, including a 150m wide Environmental Cultural Corridor (ECC) that runs east-west, connecting Roebuk Bay to Cable Beach.

The interface of the development area with the ECC to the north, A class reserve to the west and the nearby coastal landscape has also been considered.

7.1 Central parkland

The central parkland incorporates open space design concepts for recreational purposes, and also serves a drainage function during the wet season. The function of the central parkland is the provision of both active and informal recreational areas, with open lawn areas, local planting and shade amenity and formal and informal pathways and corridors. The drainage features of the neighbourhood parks occur in the form of a grassed drainage swale.

7.1.1 Active recreation

Within the designated active recreation areas open lawn is provided on higher ground above the drainage swale (Figure 7). The drainage function of the active recreation areas occurs in the form of a vegetated drainage swale and dry creek beds, located adjacent to the open lawn area.

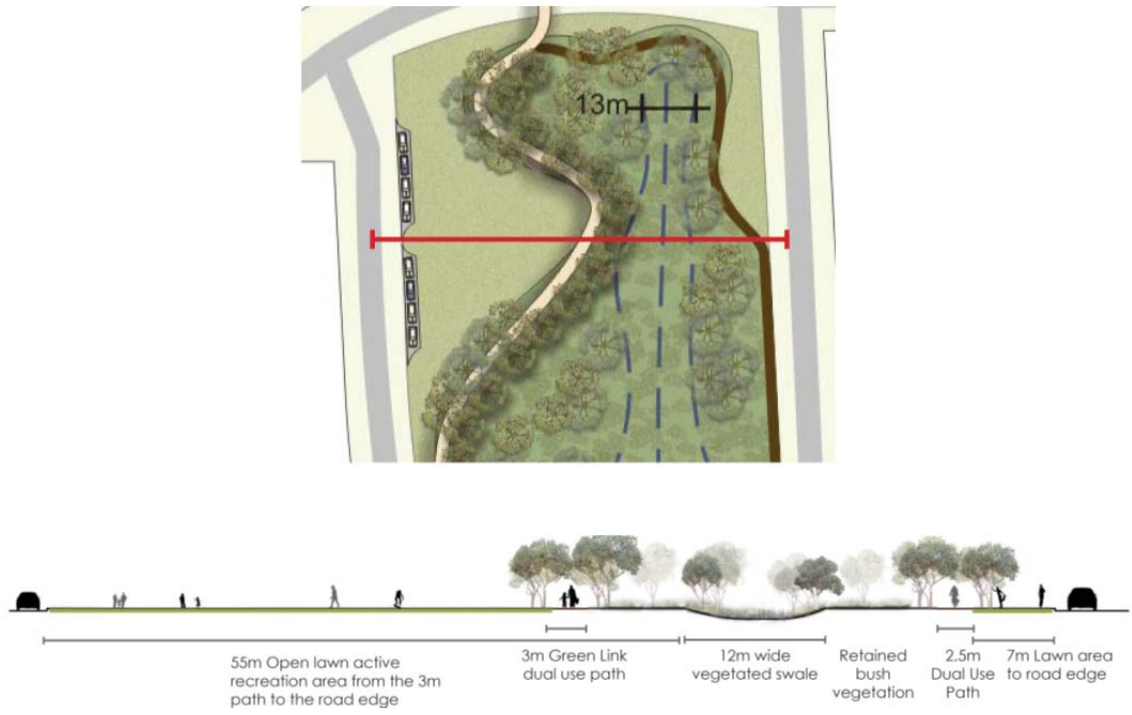


Figure 7 Lawn public open space – active recreation

7.1.2 Informal recreation

Within the informal recreation areas lawn provides connectivity through the public open space area, while providing additional recreational space for the majority of the year (Figure 8).

The drainage function of the informal recreation area occurs in the form of a grassed drainage swale at a shallow grade.

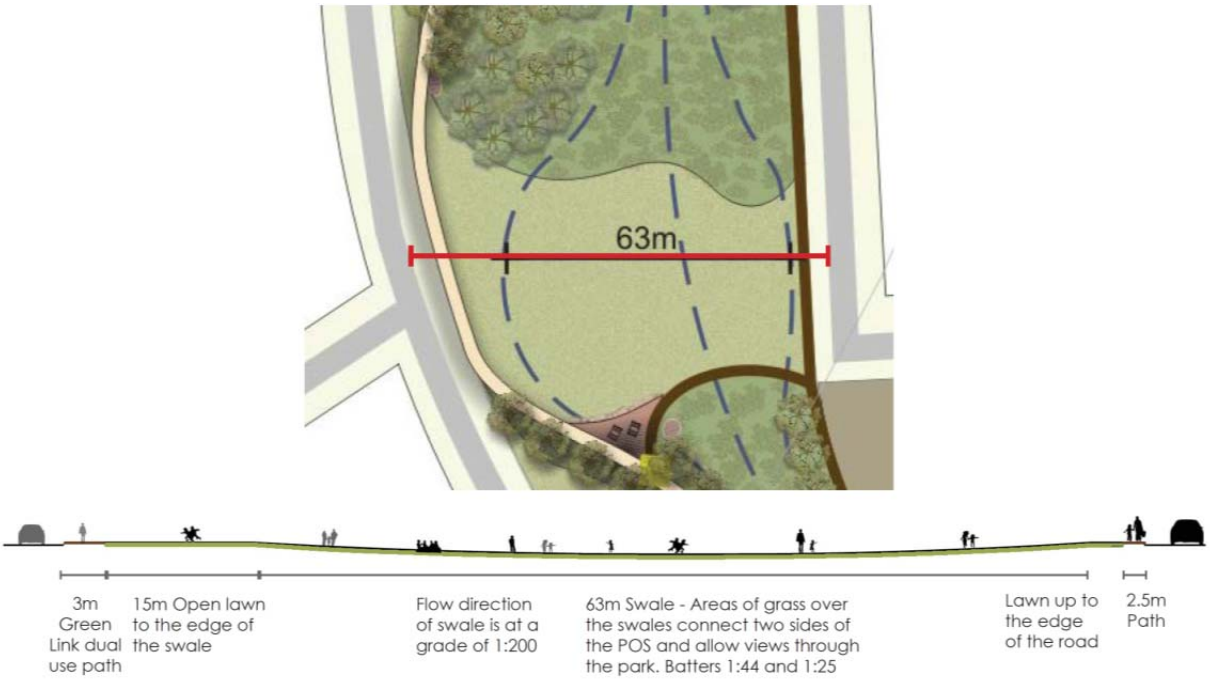


Figure 8 Lawn public open space – informal recreation

7.1 Multi-use corridor

The multi-use corridors act as local park areas while also providing a primary drainage function throughout the LDP3 area. An example of the multi-use corridor typology along the western boundary of the site is shown in Figure 9.

The local park function is in the form of both active and passive recreational areas, through provision of local play and resting spaces and pedestrian connectivity. The drainage function of the multi-use corridor occurs in the form of a vegetated drainage swale and dry creek beds.



Figure 9 Western Parkland - multi-use corridor concept

7.2 Swale vegetation

Planting to the floor of the drainage swales is a critical design feature for the Broome North development. The swale vegetation provides both an aesthetic and recreational function within the linear POS areas, while also helping to stabilise the sediment within the swale and improve stormwater quality by helping to slow flows and promote sedimentation in runoff.

UDLA, the landscape consultant for LDP3 has identified from previous experience with the drainage swales within the LDP1 area and other sites throughout Broome, that the key issues of planting of the floor of the swales include species tolerance to consistent inundation and submergence during the wet season and baking pindan and extreme temperatures during the dry season. Swale planting concepts for LD3 area have been refined based on this experience and knowledge of local conditions.

Tree spacings have also been determined with consideration of the Bushfire Management Plan which requires tree spacings to be 10 m apart so that mature tree canopies do not touch. Trees may be interplanted with low growing species.

7.2.1 Swale floor establishment

Initial tubestock establishment is preferable for the swale floor as the plants have already successfully germinated and established, resulting in a higher plant establishment success rate for the first season. The floor swale planting technique is proposed to be in the form of ‘finger planting’ layout.

Established plants (a combination of tubestock and 200 mm tree pots) will seed within the area over a couple of seasons, with substantial coverage of the swale floor within 5-7 years.

Designated areas of the drainage swales will be planted with stolons of the native grass *Cynodon dactylon* (Roebuck Bay Couch) to ensure rapid vegetation coverage of the swale floor in designated areas. These areas are also intended to create a bushfore low growth zone between planted and bush areas, and will create an adaptive space which provides both recreational and visual and pedestrian access through the site.

7.2.2 Swale batters

The seed store within the local site mulch that is spread over the first 5m of the swale batter is considered successful in generating considerable regrowth to the batters and lower batters.

7.2.3 Swale planting layout

The typical swale planting layout proposed the swales within LDP3 area is identified in Figure 10. Proposed native species for the swale planting (floor and batters) are provided in Appendix F.

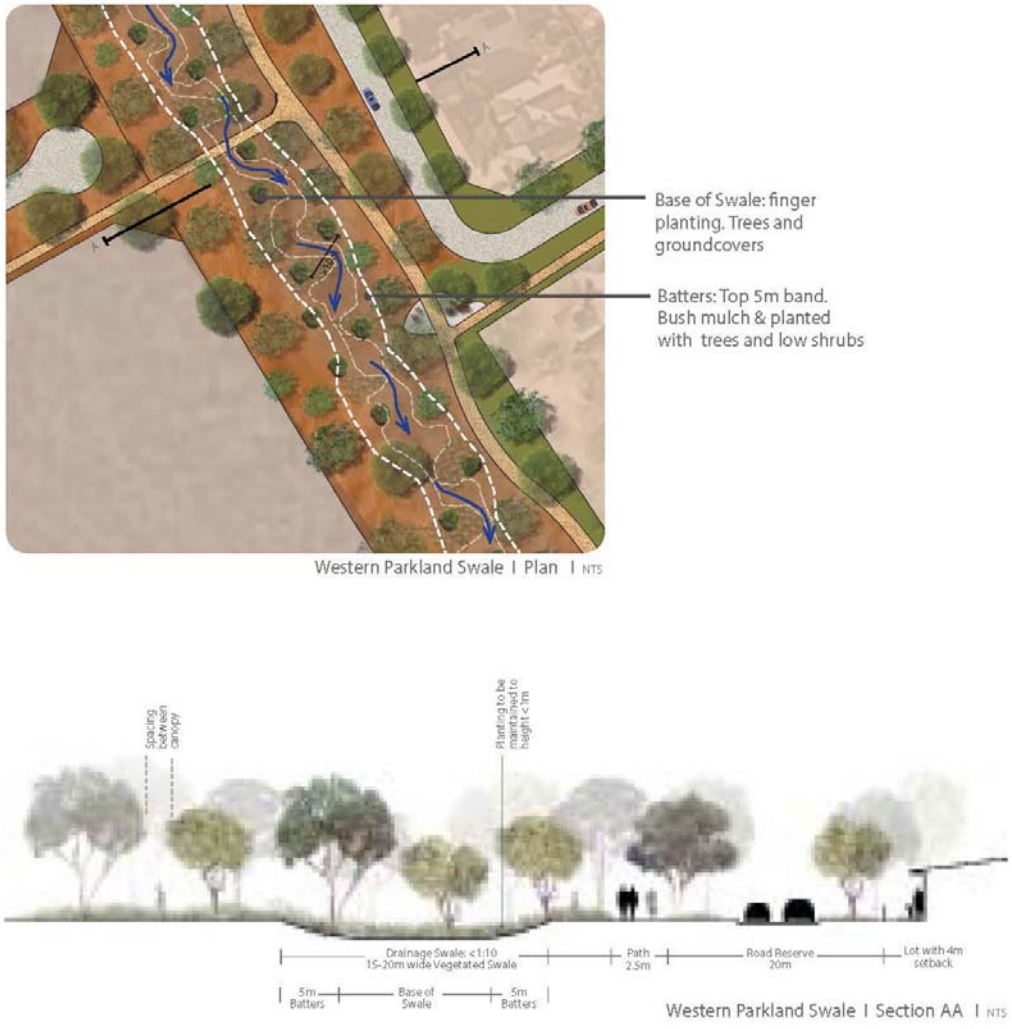


Figure 10 Typical swale planting layout

8. Implementation plan

8.1 Monitoring plan

8.1.1 Groundwater

As there will be minimal impact on groundwater no groundwater monitoring is proposed.

8.1.2 Surface water

As there are no defined surface water drainage features within the LDP3 Area, no predevelopment surface water monitoring is proposed.

Surface water monitoring will commence following construction of the drainage swales. Due to the ephemeral nature of surface runoff in the Kimberley surface water monitoring will be undertaken opportunistically during or following rainfall events where conditions are considered safe to sample.

Monitoring locations

Monitoring locations within the drainage features will comprise the inflow (start of swale), mid-swale and outlet structures of the drainage swales within the LDP3 Area in order to capture variation in water quality along the swale extent.

- Inflow (start of swale): Collected from a suitable location where overland flow paths converge to enable sample collection. Should aim to be representative of upstream, undeveloped runoff where possible.
- Mid-swale: Collected from mid-way along the swale system to capture variation in water quality along the linear extent of the swale.
- Outlet: Collected at the outlet of the swale system from the LDP2 area.

Due to the episodic nature of surface flow events in the Kimberley a number of health and safety issues need to be considered when undertaking monitoring near open channel flows, including sampling at night. Where occupational health and safety allow the monitoring program will make all reasonable attempts to:

- Capture the first flush event, which is considered to be an event that generates surface flow within the drainage system.
- Undertake consecutive sampling (3 samples from each sample location) during the event to demonstrate the effectiveness of the swale system at different stages of an event.

Monitoring frequency and parameters

Monitoring should be undertaken at least three times per wet season (typically November-March). The water quality samples should be collected for analysis of the following parameters:

- Physiochemical parameters (ph, total suspended solids, electrical conductivity).
- Nutrients (total nitrogen, total kjeldahl-N, nitrate-N, nitrite-N, ammonia-N, dissolved organic-N, total phosphorous, filterable reactive phosphorous).
- Heavy metals (As, Cd, Cr, Cu, Pb, Ni, Zn, Hg).

The monitoring will be undertaken for a period of three years, with initial monitoring commencing following construction of the linear drainage swale system.

8.2 The next stage – Urban Water Management Plan

The next stage of subdivision planning will require the development of an urban water management plan. This will include progressing conceptual designs to detailed designs. Specifically, the following issues will need to be addressed within the urban water management plan:

- Determining the infrastructure requirements and land required to fit the infrastructure for the detailed design, including drainage and development requirements for stormwater management.
- Flow rates and water levels at critical locations for the 1-, 5- and 100-year ARI events.
- Location, level and dimensions of the drainage structures such as open channels and weirs.
- Management of subdivision works.
- Implementation plan, including roles and responsibilities.
- Identification of monitoring locations and reporting timeframes.

8.3 Responsibilities

Table 12 sets out the roles and responsibilities for the actions outlined for the future planning for the development area. This strategy is based on the Broome North LDP3 Framework Plan prepared by Taylor Burrell Barnett in February 2014. Should the Framework Plan be altered the LWMS will be reviewed.

Table 12 Roles and responsibilities

Role	Responsibility	Requirement and Period
Prepare an urban water management plan	Developer	Prior to commencement of subdivision works
Design and construction of surface drainage system demonstrating compliance with this LWMS	Developer	Prior to commencement of subdivision works Constructed drainage infrastructure to be handed over to Shire of Broome at practical completion
Obtain approvals from Shire for connection to the Cable Beach drainage system	Developer	Prior to commencement of subdivision works of future development within western catchment
Obtain approvals from Yawaru Park Council for design of overflow into A Class Reserve	Developer	Prior to commencement of subdivision works of future development within western catchment as part of UWMP approval
Maintenance of culvert outlets	Developer	Maintenance of culvert outlets will be undertaken by the developer for a period of two years from practical completion
Implementation of post-	Developer	Commencing for a period of three years

Role	Responsibility	Requirement and Period
development monitoring program		following construction of the linear drainage swale system
Non-structural controls Land use and management	Developer	Sediment and erosion control during construction
Non-Structural Controls: Street Sweeping and waste management	Developer Shire of Broome	Street sweeping to be undertaken as required following rainfall events, with frequency agreed to within the UWMP As needed following the maintenance period

9. References

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Appendices

Appendix A - – Survey

Whelans (2009)

APPENDIX E
ENGINEERING INFRASTRUCTURE REPORT

TABEC
Civil Engineering Consultants

DevelopmentWA
40 The Esplanade
Perth WA 6000

8 February 2021
2287-LDP3-REP-002

Attention: Ms Sariska Neale

RE: BROOME NORTH LDP3 AMENDMENT
ENGINEERING SERVICING ADDENDA

The following addenda has been prepared by TABEC Pty Ltd for the proposed Broome North Local Development Plan No. 3 (LDP3) amendment. It summarises the results of a review of the civil engineering aspects which inform and support the delivery of the development plan and the impact of the proposed plan amendment on the civil engineering servicing capability and requirements for the proposed development.

The Broome North LDP3 provides the planning framework to guide the development of the landholding. An amendment to the approved LDP3 is proposed, with the approved structure plan to be modified to include a district commercial centre, and consequently the removal of a local centre in the Broome North Local Development Plan No. 1 (LDP1), in accordance with the Broome Local Commercial Strategy. The Broome North District Structure Plan and LDP1 are also currently being amended to reflect the proposed modification.

The approximately 131.5ha site is bounded by Fairway Drive and the Water Corporation Tank site to the north; the existing Broome North LDP1 area to the east; Fairway Drive, Sanctuary Road, Lulfitz Drive (Oryx Drive) and Coucal Street to the west and Gubinge Road to the south.

The primary road access to LDP3 remains via an extension of Tanami Drive from LDP1 to an intersection with Fairway Drive and Sanctuary Road.

The landholding is relatively flat with a small ridge running northeast - southwest dividing the site and a steeper ridge along the northern portion of LDP3. The western side of the ridge line grades to Fairway Drive, Lullfitz Drive (Oryx Drive) and Coucal Street and the eastern side of the ridge grades towards Gubinge Road and the existing LDP1 swale system. The earthwork and drainage strategies, catchments, and general location of the outfalls from the site are not affected by the proposed LDP3 change.

The majority will still outfall to the existing LDP1 swale system adjacent to Gubinge Road before ultimately discharging via culvert under Gubinge Road to the Gubinge Road Retention Area. Whilst part of the northern and western catchments will still discharge into the existing Cable Beach drainage system. Drainage links may be required through the District Commercial Centre to connect the drainage system to the Fairway Drive and Gubinge Road swales.

The sewerage, water supply, power supply and telecommunications planning, servicing strategies and site requirements are also unaffected by the LDP3 modification.

The Water Corporation wastewater and water planning and servicing strategy for the LDP3 area is not impacted by the proposed amendment.

To facilitate development of the southern wastewater catchment and majority of LDP3, including the proposed District Commercial Centre, an extension of the existing DN225 sewer mains that terminate at the LDP1 western boundary in Tanami Drive and Ibasco Crescent is required. The smaller northern wastewater catchment that is part of the greater Cable Beach wastewater catchment will be served by a DN150 sewer extension of the existing DN225 sewer in Millington Road.

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TABEC PTY LTD ABN 64 090 796 204
14 Wickham Street, East Perth Western Australia 6004
PO Box 6762, East Perth Western Australia 6892

The location of the connections to the existing water networks remains as per the approved LDP3. The one change has been the completion of the DN600 distribution main along Fairway Drive, Sanctuary Road and Coucal Street by the Water Corporation that reinforces the existing water network. The DN600 distribution main was in the scoping phase when the original LDP3 report was prepared.

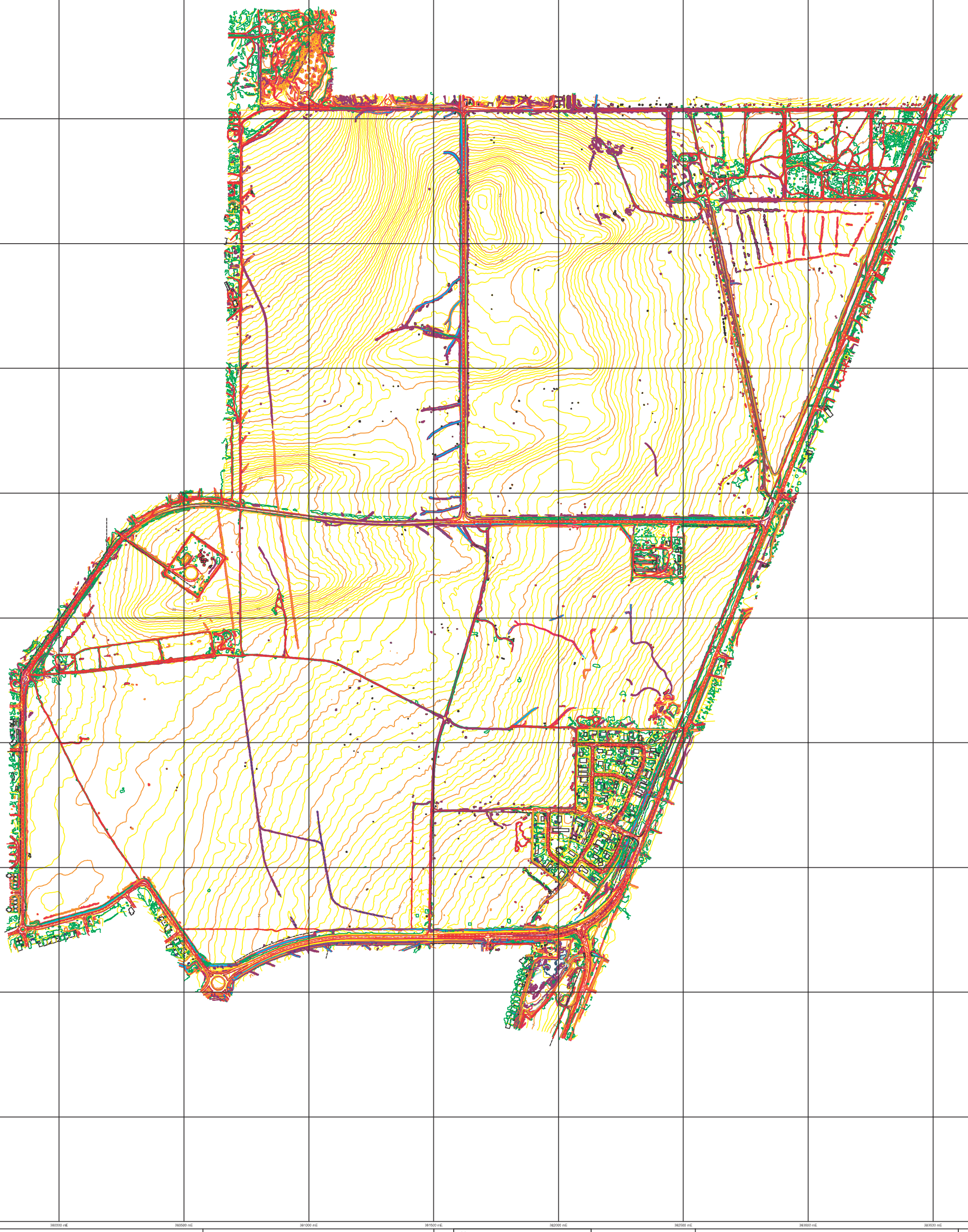
The Horizon Power Bilingurr zone substation site, at the intersection of the future Magabala Road extension and Fairway Drive, has also been established along with the 33kV feeder cable. Power supply for LDP3 will emanate from this substation. As per the existing LDP3 report, connection to the high voltage underground cables in Tanami Drive and Fairway Drive/Sanctuary Road can initially serve LDP3. Ultimately high voltage interconnection to the existing cables in Fairway Drive north of LDP3 and the aerials in Lulfitz Drive (Oryx Drive) and Coucal Street will be necessary to complete a high voltage ring.

The telecommunication servicing strategy is not affected by the LDP3 amendment. The LDP3 telecommunication network will still be an extension of the existing NBN infrastructure in LDP1 that terminates at the western boundary of Tanami Drive.

The investigation has found that the proposed Local Development Plan 3 modifications do not impact the servicing strategies and site requirements for the proposed Broome North development. Consistent with the TABEC Engineering Report included as part of the approved LDP3, the land is capable of supporting development in accordance with the proposed development plan with a logical progressive extension of infrastructure and base capacity. There are no engineering impediments to the development, though coordination and cooperation with the relevant service authorities will be required as the development progresses.

380000 mE 380500 mE 381000 mE 381500 mE 382000 mE 382500 mE 383000 mE 383500 mE

221000 mN 220500 mN 220000 mN 219500 mN 219000 mN 218500 mN 218000 mN 217500 mN 217000 mN 216500 mN 216000 mN



SCALE: 1:5000 @ A1 SHEET SIZE	all distances are in metres
DATE: 17 Dec 2009	HORIZONTAL DATUM: GRO '94
JOB No: 13367	VERTICAL DATUM: AHD
WORK DIR: s:\projects\13367\cnthn\	PHOTOGRAPHY DATE: n/a
CAD REF: 13367-016.dgn	DRAWN: NDW
	PLAN No: 13367-016

whelans
133 Scarborough Beach Road, Mount Hawthorn WA 6016
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Broome North Mapping

PLAN 16

All Dimensions & areas are subject to survey. This plan must not be reproduced without the permission of WHELANS.

Appendix B – 5 Star Plus – Water Use in House Codes

Building Code Australia – WA Supplement

Department of Housing and Works
Government of Western Australia

5 Star Plus

Energy Use in Houses Code
Water Use in Houses Code



Playing our part in building better communities for Western Australia

Introduction

In May 2006, Western Australia adopted the minimum 5 Star energy efficiency provisions of the Building Code of Australia for all new homes. Now the Government has gone further and introduced 5 Star Plus – that builds on the energy efficiencies from 5 Star with the added benefits of water reduction measures for all homes right across the State.

5 Star Plus is based around two new Codes:

The Energy Use in Houses Code - confirms the existing 5 Star provisions for house design and construction and adds requirements for energy efficient water heating.

The Water Use in Houses Code - aims to reduce the consumption of water in residential homes by requiring water efficient fittings, minimising the wastage of water and facilitating the appropriate use of alternative sources of water such as grey water and rain water.

5 Star Plus will be applicable to new homes approved for construction after 1 September 2007, however, existing home owners can also use these Codes to improve energy and water efficiency in their homes. During 2008, the Government will investigate measures to apply the 5 Star Plus provisions to existing homes.

The Energy Use in Houses Code and Water Use in Houses Code are written to supplement the Building Code of Australia (BCA) and adopt BCA definitions and format for consistency. The Codes are published together for the convenience of builders, plumbers and certifiers who may need a convenient reference on site.

The Codes are available online at **www.5starplus.wa.gov.au**

Energy Use in Houses Code

Application

This Code applies to all new buildings classified as Class 1 and 10 buildings by the Building Code of Australia.

Interpretation

"The Building Code of Australia" means the latest edition of the Building Code of Australia published from time to time by, or on behalf of, the Australian Building Codes Board, but not including explanatory information published with that Code.

Objective

The objective of this Code is to reduce greenhouse gas emissions.

Functional Statement

In order to reduce greenhouse gas emissions, a building, including its services, is to be capable of efficiently using appropriate sources of energy.

Compliance With This Code

A building will comply with this Code if its construction satisfies all the Performance Requirements. Compliance with the Performance Requirements can be shown by:

(a) Complying with the Deemed-to-Satisfy provisions as listed in the Acceptable Construction Practice; or

(b) Formulating an alternative solution that is shown to be equivalent to the Deemed-to-Satisfy provisions; or

(c) Formulating an alternative solution that is verified using an acceptable verification method; or

(d) Formulating an alternative solution that is based on expert judgement or supported by suitable evidence in accordance with clause 1.2.2 of the Building Code of Australia; or

(e) Any combination of the above.

Energy Use in Houses Code

Performance Requirements

PR1 – Building

A building must comply with the Building Code of Australia Performance Requirement P2.6.1.

PR2 – Services

A building's domestic services including any associated distribution system and components must have features that comply with the Building Code of Australia, Performance Requirement P2.6.2.

PR3 – Hot Water Systems

A building's hot water systems including any associated components must have features that produce low levels of greenhouse gases when heating water.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS1 satisfy the Performance Requirement PR1 for a building.

(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS2 satisfy the Performance Requirement PR2 for a building.

(c) Compliance with all of the Deemed-to-Satisfy provisions of DTS3 satisfy the Performance Requirement PR3 for a building.

Deemed to Satisfy Provisions

DTS 1 – Thermal Comfort

The building must comply with the provisions of Part 3.12 of the Building Code of Australia for Building Fabric, External Glazing, Building Sealing and Air Movement.

DTS 2 – Services

The building must comply with the provisions of Part 3.12 of the Building Code of Australia for Services.

DTS 3 – Hot Water Systems

A hot water system must be either:

(i) a solar hot water system, complying with AS 2712-2002, that has been tested in accordance with AS 4234-1994, and achieves a minimum energy saving of 60% for a hot water demand level of 38MJ per day for climate zone 3; or

(ii) a gas hot water system, complying with AS 4552-2005 that achieves a minimum energy rating of "5 stars"; or

(iii) a heat pump hot water system, complying with AS 2712-2002 that has been tested in accordance with AS 4234-1994, and achieves a minimum energy saving of 60% for a hot water demand level of 38MJ per day for climate zone 3.

Explanatory Notes:

1. **BCA Performance Requirement P2.6.1**

   A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

   (a) the function and use of the building; and
   (b) the internal environment; and
   (c) the geographic location of the building; and
   (d) the effects of nearby permanent features such as topography, structures and buildings; and
   (e) solar radiation being—
      (i) utilised for heating; and
      (ii) controlled to minimise energy for cooling; and
   (f) the sealing of the building envelope against air leakage; and
   (g) the utilisation of air movement to assist cooling.

2. **BCA Performance Requirement P2.6.2 – Services**

   A building's domestic services including any associated distribution system and components must have features that, to the degree necessary, facilitate the efficient use of energy appropriate to –

   (a) the domestic services and its usage; and
   (b) the geographic location of the building; and
   (c) the location of the domestic services; and
   (d) the energy source.

3. **AS 2712-2002** details the design and construction of solar and heat pump water heaters.

4. **AS 4234-1994** sets out the method of testing and calculation of energy consumption for domestic solar water heaters and heat pumps.

5. **AS 4552-2005** details the design of gas forced water heaters for hot water supply and/or central heating.

Water Use in Houses Code

Application

This Code applies to all new buildings classified as Class 1 and 10 buildings by the Building Code of Australia.

Interpretation

"The Building Code of Australia" means the latest edition of the Building Code of Australia published from time to time by, or on behalf of, the Australian Building Codes Board, but not including explanatory information published with that Code.

"Alternative Internal Water Supply" refers to a water supply such as collection of rainwater on site, external third pipe non-potable water source, on-site bores or the like, other than potable water supplied by a licensed water service provider, and approved for use inside a dwelling.

"Alternative External Water Supply" refers to a water supply such as collection of rainwater on site, external third pipe non-potable water source, re-cycled grey water, on-site bores or the like, other than potable water supplied by a licensed water service provider, and approved for use outside a dwelling.

"Potable Water" refers to water intended for human consumption supplied by a licensed water service provider.

Objective

The objective of this Code is to reduce water demand by efficiently using water, and minimising the wasting of water, and facilitating the appropriate use of alternative sources of water.

Functional Statement

To reduce potable water demand a building must:

(a) enable the efficient use of potable water; and
(b) prevent excessive loss of potable water; and
(c) have the capacity to connect to alternative sources of water supply; and
(d) use alternative sources in situations of high water demand or restricted availability of potable water.

Compliance With This Code

A building will comply with this Code if its construction satisfies all the Performance Requirements. Compliance with the Performance Requirements can be shown by:

(a) complying with the Deemed-to-Satisfy provisions as listed in the Acceptable Construction Practice; or
(b) formulating an alternative solution that is shown to be equivalent to the Deemed-to-Satisfy provisions; or
(c) formulating an alternative solution that is verified using an acceptable verification method; or
(d) formulating an alternative solution that is based on expert judgement or supported by suitable evidence in accordance with clause 1.2.2 of the Building Code of Australia; or
(e) any combination of the above.

Explanatory Notes:

Stage 1 of the Code will be prescribed in the Building Regulations to apply from 1 September 2007.

Stage 2 of the Code will be prescribed in the Building Regulations to apply from date to be determined.

Implementation of Stage 2 of the Code is dependent on further consultation and research to determine areas of application and on amendments to plumbing regulations and processes as well as ensuring compliance with health regulations and policies.

Stage 1 - To apply from 1 September 2007

Performance Requirements

PR1 – Water Use Efficiency

A building must have features that, to the degree necessary, facilitate the efficient use of potable water appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building.

PR2 – Water Loss Prevention

A building, including any water holding structures, must have features that, to the degree necessary, prevent the excessive loss of potable water appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building; and
(d) the effects of permanent features such as topography, structures and buildings.

PR3 – Hot Water Use Efficiency

A building must have features that, to the degree necessary, facilitate the efficient use of hot water appropriate to:

(a) the geographic location of the building; and
(b) the available hot water supply for the building; and
(c) the function and use of the building.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS1 satisfies the Performance Requirement PR1 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS2 satisfies the Performance Requirement PR2 for a building.
(c) Compliance with all of the Deemed-to-Satisfy provisions of DTS3 satisfies the Performance Requirement PR3 for a building.

Deemed to Satisfy Provisions

DTS 1 – Water Use Efficiency

(a) all tap fittings other than bath outlets and garden taps must be minimum 4 stars WELS rated.
(b) all showerheads must be minimum 3 stars WELS rated.
(c) all sanitary flushing systems must be a minimum 4 stars WELS rated dual flush.

DTS 2 – Swimming Pool Covers and Blankets

An outdoor private swimming pool or spa associated with a Class 1 building must be supplied with a cover, blanket or the like that:

(a) is designed to reduce water evaporation; and
(b) is listed on the Smart Approved Watermark Scheme.

DTS 3 – Hot Water Use Efficiency

All internal hot water outlets (taps, showers, washing machine water supplies) must be connected to a hot water system or a recirculating hot water system with pipes installed and insulated in accordance with AS/NZS 3500:2003. Plumbing and Drainage, Part 4 Heated Water Services. The pipe from the hot water system or recirculating hot water system to the furthest hot water outlet must not exceed 20 metres in length or 2 litres of internal volume.

Explanatory Notes:

The Smart Approved Watermark Scheme is implemented through the National Water Commission as a simple identification label about water efficient products. Further information can be obtained from www.nwc.gov.au

Stage 2 - To apply from (date to be determined)

Performance Requirements

PR4 – Alternative Water Supply Use Capacity

A building, including any associated plumbing, must have features that, to the degree necessary, facilitate the future use of alternative water supplies appropriate to:

(a) the geographic location of the building; and
(b) the function and use of the building; and
(c) the soil type and ground condition; and
(d) the available alternative sources of water; and
(e) the size and type of external landscaping.

PR5 – Grey Water Use Capacity

A building including any associated plumbing, located on a lot of a size and in a location suitable for recycling of grey water, must have features that, to the degree necessary, facilitate the future use of grey water recycling appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for landscaping; and
(c) the function and use of the building; and
(d) the soil type and ground condition; and
(e) the available alternative sources of water; and
(f) the size and type of external landscaping.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS4 satisfies the Performance Requirement PR4 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS5 satisfies the Performance Requirement PR5 for a building.

Deemed to Satisfy Provisions

DTS 4 – Alternative Water Supply Use Capacity

All sanitary flushing systems and washing machines must be able to be connected at a later date, to an appropriate alternative water supply without the need to break, or cut into the fabric of the building to run new pipes.

DTS 5 – Grey Water Use Capacity

All shower, bath, laundry trough and washing machine drains must be able to be connected at a later date to an appropriate grey water diversion system without the need to break, or cut into the fabric of the building to run new pipes.

Explanatory Notes:

1. Health regulations apply to the use of alternative water supplies and will, amongst other things, limit the alternative water sources suitable for various uses.
2. The DTS 4 provisions do not require rainwater tanks. They require buildings to be able to be connected to such alternative water supplies relatively easily at a later date (i.e. the buildings are to be alternative supply 'ready'). Subject to health regulations and policies, alternative water supplies could also include bore water, third pipes, and the like.
3. All plumbing work associated with these requirements must be carried out by licensed plumbers and in accordance with all relevant plumbing regulations.

Water Use in Houses Code

Performance Requirements

PR6 – Alternative Internal Water Supply

A building with more than two showers or two WC facilities must use alternative internal water supplies for internal uses appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building; and
(d) the available alternative sources of water.

PR7 – Alternative External Water Supply

A building located on a lot of a size and in a location likely to use significant potable water for landscaping use must use alternative internal or external water supplies appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building; and
(d) the soil type and ground condition; and
(e) the available alternative sources of water; and
(f) the size and type of external landscaping.

Deemed to Satisfy Provisions

DTS 6 – Alternative Internal Water Supply

All sanitary flushing systems and clothes washing facilities must be connected to an alternative internal cold water supply.

DTS 7 – Alternative External Water Supply

(a) All external garden taps and irrigation systems must be connected to an alternative external water supply; or
(b) all shower, bath, laundry trough and washing machine drains must be connected to an approved grey water diversion and recycling system.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS6 satisfies the Performance Requirement PR6 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS6 or DTS7 satisfies the Performance Requirement PR7 for a building.

Explanatory Notes:

1. Houses required to be "grey water ready" under PR5 are those on large enough lots to allow drains carrying appropriate water to be run outside the house before connection to other waste pipes, and where there is likely to be enough landscaped area to adequately dilute the grey water.
2. Lots where houses are required to comply with PR7 will be identified through regulations. Further research is needed with relevant stakeholders to resolve which lots will be subject to this requirement.
3. Health regulations apply to the use of alternative water supplies and will, amongst other things, limit the alternative water sources suitable for internal or external use in different localities. For example most private bore water, whilst it may be suitable for garden use, may be inappropriate for use internally.
4. Alternative water supplies can include but is not limited to, rainwater tanks, bore water, third pipes, and the like.
5. Subject to health regulations an acceptable alternative internal water supply is an appropriately sized rainwater tank harvesting the rainwater runoff from the roof.
6. Subject to health regulations an acceptable alternative external water supply is a domestic bore.
7. All plumbing work associated with alternative water supplies must be carried out by licensed plumbers and in accordance with all relevant plumbing regulations.
8. The Water Use in Houses Code is implemented in two stages to allow amendment of plumbing regulations and training of licensed plumbers to ensure alternative water supplies are appropriate and safe, and that there is no risk of cross contamination with potable water supplies.

Further information

These Codes are intended to supplement the Building Code of Australia and will be called up by the Building Regulations 1989

For further information about 5 Star Plus please visit our website at www.5starplus.wa.gov.au

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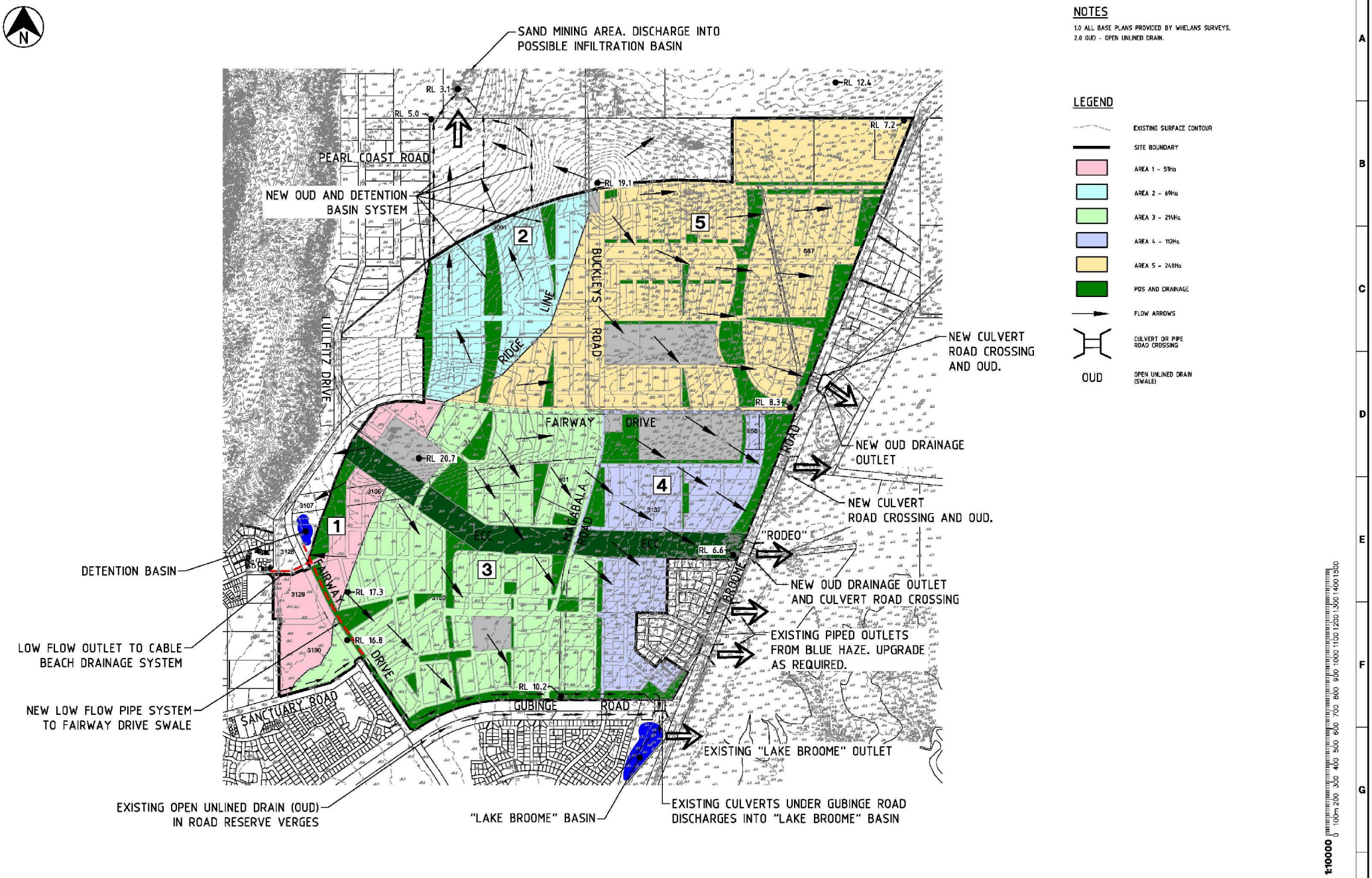
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Appendix C – Catchment plans

Figure C.1	DWMS Catchment Plan (GHD and SKM 2009)
Figure C.2 (Tabec (2014)	LDP3 Area Pre-development Catchment Plan (Drawing 2287-LDP3-SK01B)
Figure C.3 (Tabec 2014)	LDP3 Area Post-development Catchment Plan (Drawing 2287-LDP3-SK01A)



NOTES

1.0 ALL BASE PLANS PROVIDED BY WHELANS SURVEYS.
2.0 OUD - OPEN UNLINED DRAIN.

LEGEND

- EXISTING SURFACE CONTOUR
- SITE BOUNDARY
- AREA 1 - 51Ha
- AREA 2 - 69Ha
- AREA 3 - 214Ha
- AREA 4 - 112Ha
- AREA 5 - 248Ha
- POS AND DRAINAGE
- FLOW ARROWS
- CULVERT OR PIPE ROAD CROSSING
- OUD — OPEN UNLINED DRAIN (SWALE)

1:10000

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
C	05.10.09					ISSUED FOR ENGINEERING REPORT
B	17.08.09					ISSUED FOR INFORMATION
A	29.07.09					INITIAL ISSUE FOR REVIEW

No	DRAWING NUMBER	REFERENCE DRAWING TITLE

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PROJECT	BROOME NORTH
DRAFTER	C.RAYNER
DRAFTING CHECK	
REVIEWED PROJECT MANAGER	
APPROVED PROJECT DIRECTOR	
DESIGNED	P.OLIVER
DESIGN REVIEW	

TITLE: DEVELOPMENT PLAN - DRAINAGE CATCHMENT PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:10000	PB50119	C011	C

LEGEND

SUBJECT LAND

16 EXISTING SURFACE CONTOUR (1.0m INTERVAL)

EXISTING SURFACE CONTOUR (0.20m INTERVAL)

CATCHMENT BOUNDARY

DIRECTION OF FLOW

CATCHMENT AREA
59.4ha

CATCHMENT AREA
73.3ha

COUCAL STREET

ORYX DRIVE

SANCTUARY ROAD

FAIRWAY DRIVE

GUBINGE ROAD

TANAMI DRIVE

SCALE A1

No.	DATE	DRAWN	APPROVED	AMENDMENT
A	07.02.14	KS	BF	ISSUED FOR INFORMATION

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CLIENT LANDCORP

DESIGNED	CHECKED	APPROVED
KS	.....	.....
DRAWN KS	CHECKED	.....

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Telephone 9225 4100, Fax 9225 4188
Email info@tabec.com.au

PROJECT BROOME NORTH - LDP3

TITLE PRE DEVELOPEMENT CATCHMENT PLAN

DRAWING NUMBER 2287-LDP3-SK01B ISSUE A

LEGEND

- OPEN SPACE/DRAINAGE
- DIRECTION OF FLOW
- SUBJECT LAND
- FINISHED SURFACE CONTOUR (0.25m INTERVAL)
- EXISTING SURFACE CONTOUR (0.20m INTERVAL)
- CATCHMENT BOUNDARY
- PROPOSED PIPE
- EXISTING PIPE
- CONCEPTUAL ONSITE RETENTION FOR TOURISM SITES

ARI	LDP3 TOTAL STORAGE REQUIRED	SUNSET TOTAL STORAGE REQUIRED	TOTAL STORAGE REQUIRED
1 Yr	36,707m³	-	36,707m³
50 Yr	127,404m³	50,280m³	177,684m³

ECOLOGICAL CULTURAL CORRIDOR

'A' CLASS RESERVE

EVENT	VOLUME	DEPTH
1yr 1hr	2,344m³	
50yr 72hr	25,230m³	0.7m
100yr 72hr	32,696m³	0.9m

EXISTING BASIN

PROPOSED OVERFLOW

PROPOSED DRAINAGE PIPE

EVENT	VOLUME	DEPTH
1yr 1hr	1,870m³	0.53m
50yr 1hr	5,800m³	1.2m
100yr 1hr	6,810m³	1.4m

EVENT	VOLUME	DEPTH
1yr 1hr	740m³	0.5m
50yr 1hr	3,400m³	1.2m
100yr 6hr	11,555m³	1.56m
WITH OVERFLOW TO ECC 1,300m³ SPREAD AT 70mm		

EVENT	VOLUME
1yr 1hr	480m³

OVERFLOW	
LDP3 MODEL	KBR
Q_1 = NIL	Q_1 = NIL
Q_5 = NIL	Q_5 = N/A
Q_{50} = 0.48m³/s	Q_{50} = 1.72m³/s
Q_{100} = 1.3m³/s	

PROPOSED DRAINAGE PIPE

EVENT	VOLUME	DEPTH
1yr 1hr	4,825m³	0.25m
50yr 6hr	24,555m³	1.0m
100yr 6hr	29,350m³	1.28m

EVENT	VOLUME	DEPTH
1yr 1hr	6,320m³	0.6m
50yr 6hr	16,280m³	1.2m
100yr 6hr	22,690m³	1.33m
*INCLUSIVE OF LDP1 STORMWATER CONTRIBUTION		

PIPED FLOW	
LDP3 MODEL	KBR
Q_1 = NIL	Q_1 = NIL
Q_5 = 0.56m³/s	Q_5 = N/A
Q_{50} = 0.95m³/s	Q_{50} = 2.3m³/s
Q_{100} = 0.98m³/s	

PROPOSED EXTENSION OF EXISTING Ø750 PIPE

EVENT	VOLUME
1yr 1hr	335m³

PROPOSED DRAINAGE PIPE

COUCAL STREET

EVENT	VOLUME	DEPTH
1yr 1hr	3,440m³	0.7m
50yr 6hr	9,400m³	1.4m
100yr 6hr	9,720m³	1.45m

EVENT	VOLUME
1yr 1hr	1,120m³

EVENT	VOLUME	DEPTH
1yr 1hr	170m³	0.12m
50yr 6hr	10,630m³	1.3m
100yr 6hr	12,930m³	1.5m

TANAMI DRIVE

EVENT	VOLUME	DEPTH
1yr 1hr	1,057m³	0.7m
50yr 6hr	2,440m³	1.2m
100yr 6hr	2,574m³	1.22m
*INCLUSIVE OF LDP1 STORMWATER CONTRIBUTION		

EVENT	VOLUME
1yr 1hr	2,375m³

ORYX DRIVE

EVENT	VOLUME
1yr 1hr	1,084m³

CRITICAL EVENT	VOLUME	DEPTH
1yr 1hr	1,112m³	0.6m
50yr 6hr	4,760m³	1.3m
100yr 24hr	4,868m³	1.36m

THE EXISTING OPEN DRAIN ALONG FAIRWAY DRIVE FROM SANCTUARY ROAD TO GUBINGE ROAD TO BE FILLED IN AND INCORPORATED INTO THE NEW ADJACENT DRAINAGE SYSTEM.

SANCTUARY ROAD

FAIRWAY DRIVE

EVENT	VOLUME	DEPTH
1yr 1hr	635m³	0.6m
50yr 6hr	2,820m³	1.4m
100yr 6hr	3,290m³	1.5m

EVENT	VOLUME	DEPTH
1yr 1hr	1,440m³	0.96m
50yr 6hr	2,435m³	1.3m
100yr 6hr	2,540m³	1.3m
*INCLUSIVE OF LDP1 STORMWATER CONTRIBUTION		

Q_1 = 0.63m³/s
Q_5 = 2.3m³/s
Q_{50} = 5.4m³/s
Q_{100} = 6.4m³/s

EVENT	VOLUME	DEPTH
1yr 1hr	3,580m³	0.8m
50yr 6hr	7,010m³	1.3m
100yr 24hr	7,125m³	1.4m

GUBINGE ROAD

THE EXISTING OPEN DRAIN ALONG GUBINGE ROAD FROM FAIRWAY DRIVE TO LDP1 TO BE FILLED IN AND INCORPORATED INTO THE NEW ADJACENT DRAINAGE SYSTEM.

SUNSET MAXIMUM STORAGE REQUIREMENT

EVENT	VOLUME
50yr 12hr	50,280m³
100yr 12hr	60,540m³

EVENT	VOLUME	DEPTH
1yr 1hr	3,780m³	0.8m
50yr 6hr	7,250m³	1.4m
100yr 6hr	7,400m³	1.4m

SCALE 1:2500 (0, 40, 80, 120, 160)

A1

No.	DATE	DRAWN	APPROVED	AMENDMENT
E	10.09.14	KS	BF	100 YEAR EVENT INFORMATION ADDED
D	16.06.14	DP	BF	MINOR AMENDMENTS TO TOURISM SITE.
C	06.06.14	KS	BF	CATCHMENT INFORMATION ADDED
B	08.05.14	KS	BF	CATCHMENT REVISED
A	07.02.14	KS	BF	ISSUED FOR INFORMATION

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CLIENT: LANDCORP; WARANYJARRI ESTATE; BROOME NORTH

DESIGNED	CHECKED	APPROVED
KS		
DRAWN	CHECKED	
KS		

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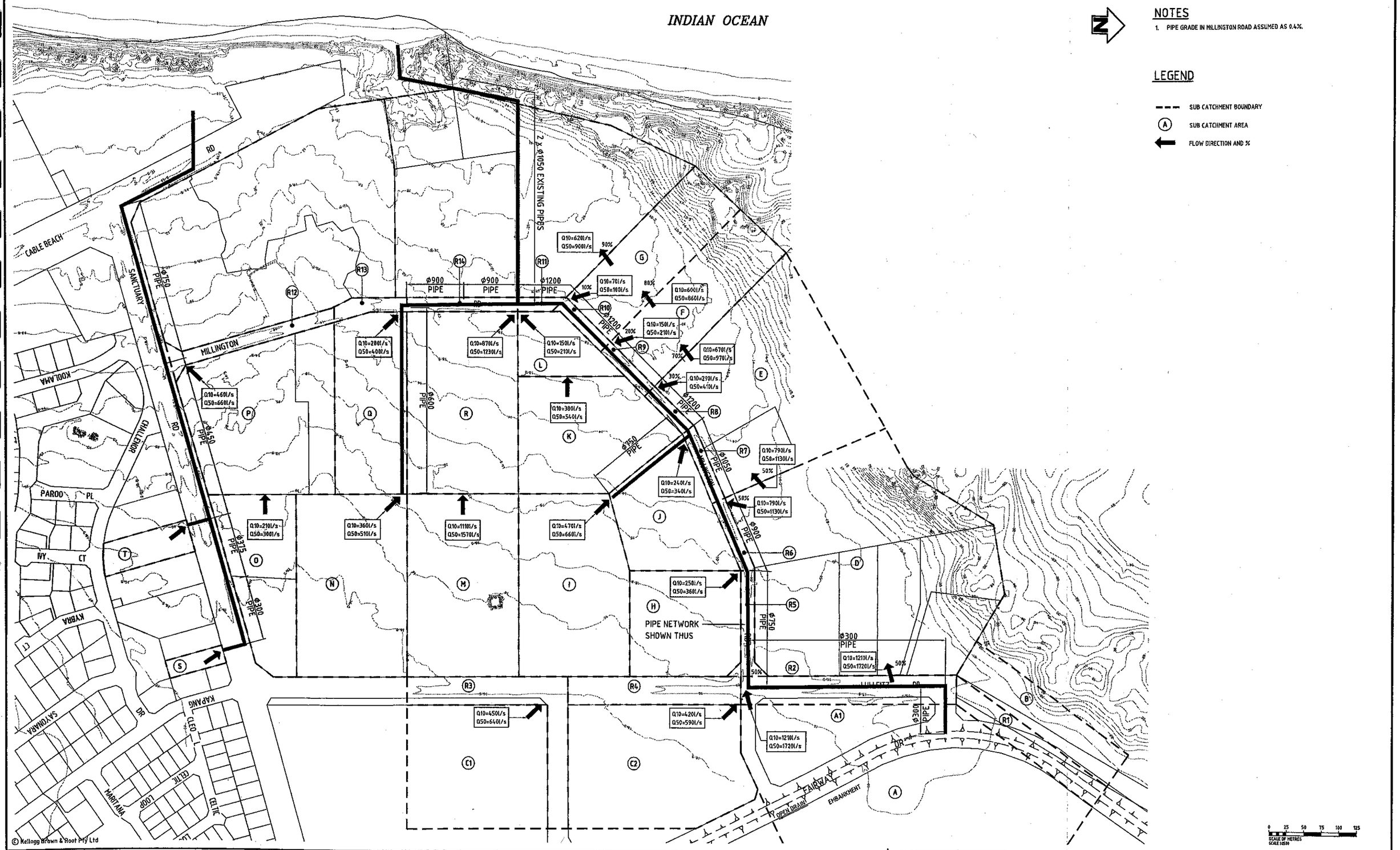
PROJECT: BROOME NORTH - LDP3

TITLE: POST DEVELOPEMENT CATCHMENT PLAN

DRAWING NUMBER: 2287-LDP3-SK01A

ISSUE: E

Appendix D – Cable Beach Development Plan Pipe Network



© Kellogg Brown & Root Pty Ltd

NOTES

1. PIPE GRADE IN MILLINGTON ROAD ASSUMED AS 0.4%.

LEGEND

- SUB CATCHMENT BOUNDARY
- (A) SUB CATCHMENT AREA
- FLOW DIRECTION AND %

DRAWING No.	DESCRIPTION
REFERENCE DRAWINGS	

100mm ON ORIGINAL DRAWING

NOTES

REV	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	02.04.04
B	AREAS S AND T ADDED	20.03.08

REVISIONS

	NAME	SIGNATURE
DRAFTING APPROVAL		
DESIGN APPROVAL		
DESIGN VERIFICATION		
PROJECT APPROVAL		
CLIENT APPROVAL		

APPROVALS

Kellogg Brown & Root Pty Ltd
KBR
Kellogg Brown & Root Pty Ltd ABN 91 007 660 317
Level 2, Capital Centre, 256 St George's Terrace
Perth, Western Australia 6000

TITLE
CABLE BEACH DEVELOPMENT PLAN
PIPE NETWORK
OPTION 2

DRAWING SCALE	ORIG. SIZE	PROJECT No.
1:2500	A1	PEV216

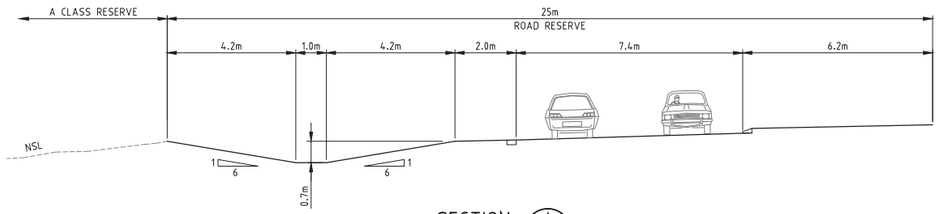
DRAFTER: G.McLEAN
CAD FILE: OPTION 2.dwg

DRAWING No.
OPTION 2 - PIPE NETWORK

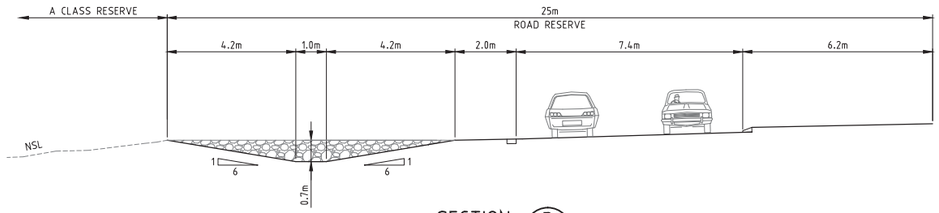
REVISION
B

Plot Date: 19 Mar, 2008 - 9:30am User Name: hbf5776

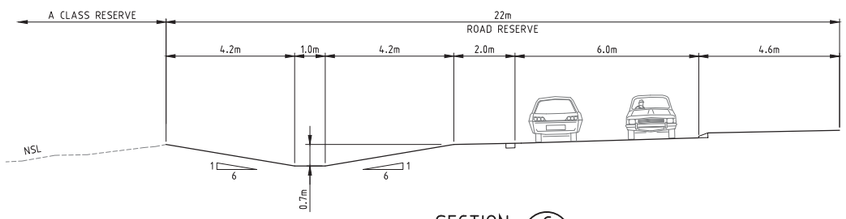
Appendix E - Roadside swale concept



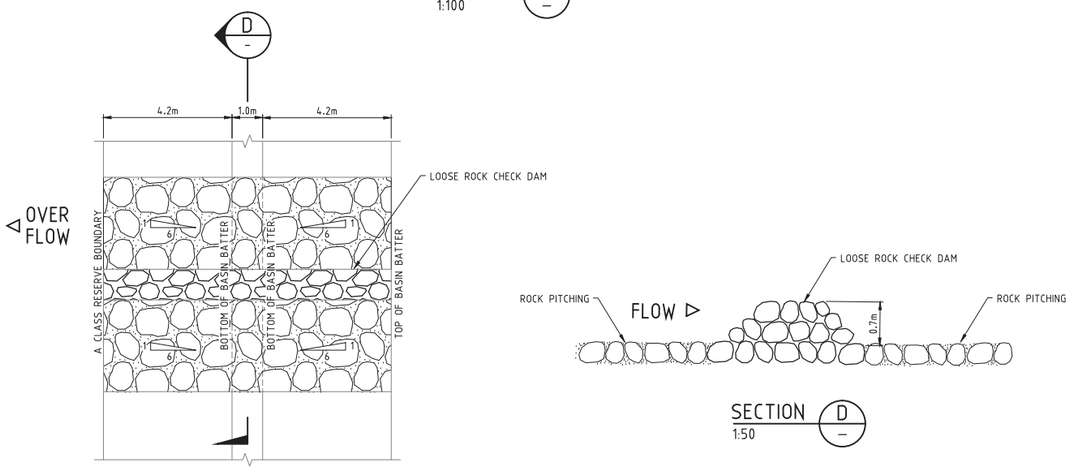
SECTION A
1:100



SECTION B
1:100



SECTION C
1:100



DETAIL 1
1:100

SECTION D
1:50



PLAN
1:2000

SCALE
1:100
1:2000
A1

No.	DATE	DRAWN	APPROVED	AMENDMENT
A	07.02.14	KS	*BBF	ISSUED FOR COMMENTS

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DESIGNED	CHECKED	APPROVED
KS		
DRAWN	CHECKED	DATE
KS		

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PROJECT: BROOME NORTH

TITLE: A CLASS RESERVE ROAD CROSS SECTION

DRAWING NUMBER: 2287-LDP3-SK004

ISSUE: A

T:\Projects\2287\Design\CAD\LDP3\2287-LDP3-SK004.dwg 17/02/14 8:35:02 katharland

Appendix F - Landscape concepts

UDLA (2013) Draft Broome North LDP3 Estate Vision

UDLA (2014) Planting to the swale areas in BRONB LDP3 - Typical Swale Vegetation

BROOME NORTH LOCAL DEVELOPMENT PLAN 3

Landscape Report REV D May 2014







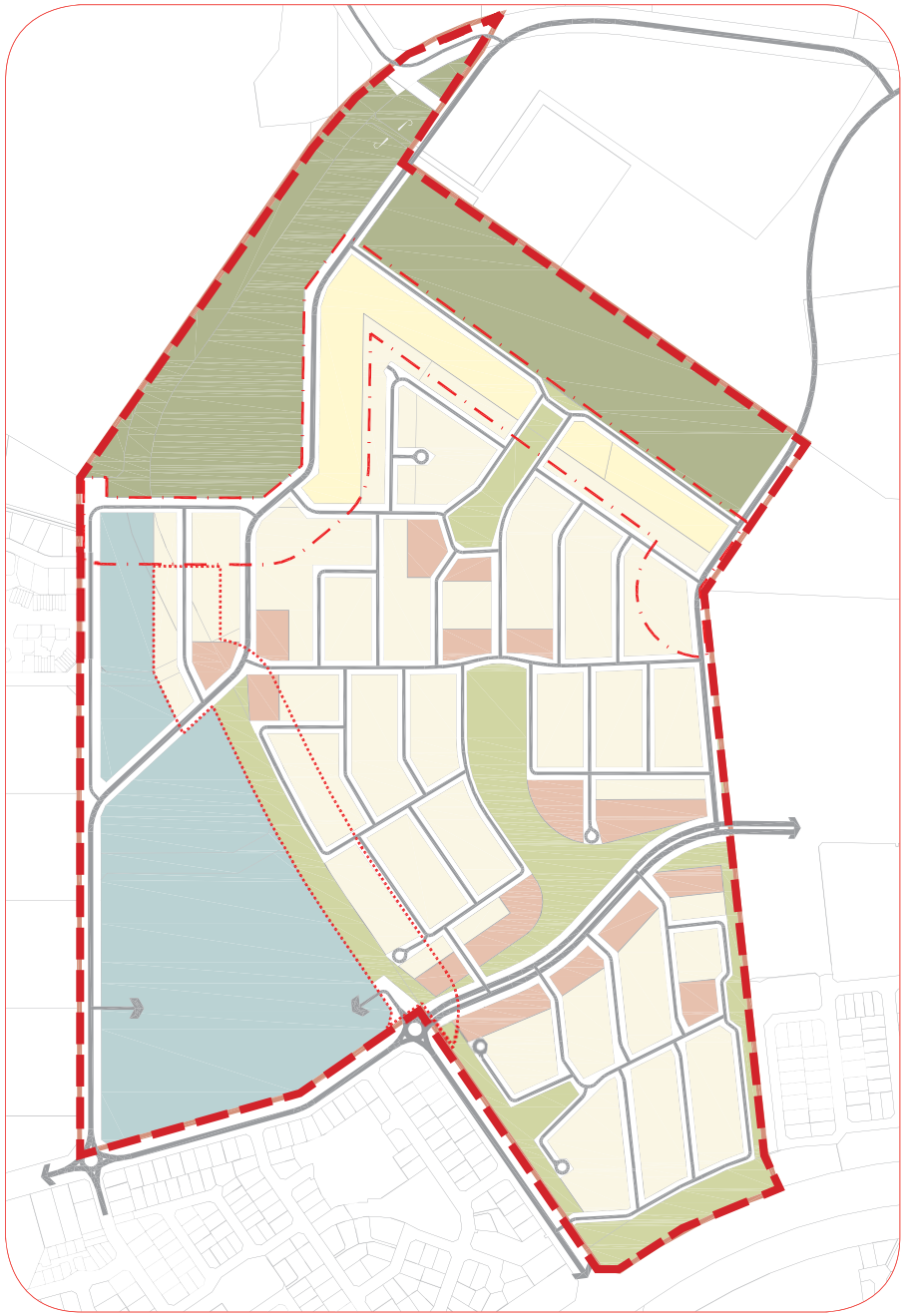
Level 1A 1-3 Josephson Street, Fremantle WA 6160 t +61 (08) 9336 7577 w udla.com.au





CONTENTS

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2	CULTURAL ASPECTS	7
3	URBAN WATER MANAGEMENT	7
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11	CENTRAL BOULEVARD, GREEN LINK & STREETSCAPES	17
12	PLANT PALETTE	18
13	CONCLUSION	21



LANDSCAPE

- ECC- Environmental Cultural Corridor
- POS- Public Open Space & Drainage
- Extent of LDP 3

LAND USE

- Bush Living
- Neighbourhood Living
- Urban Living
- Tourism
- Temporary Bush fire Building Attack Level (BAL) 12.5
- Permenant Bush fire Building Attack Level (BAL) 12.5

1 INTRODUCTION

LDP3, the latest LandCorp Estate in Broome North takes full advantage of its idyllic Cable Beach location, nestled into the red soils and rich culture of the stunning Kimberley landscape. Developed in a collaboration with the Traditional Custodians- the Yawuru, the estate aims to form a coastal community seamlessly connected to culture and country. Major bushland tracts define the estate including a 150m wide Environmental Cultural Corridor that runs directly east - west, across the Broome Peninsula.

The landscape intent of the LDP3 area is to provide a local, cultivated landscape aesthetic, using lawn, existing trees, local earthy materials and public art features. While this aesthetic draws from the more formalised gardens of the nearby resorts, the parklands maintain a strong local theme through the use of the local vernacular. Lawn will be minimised and used to connect and contrast the bushland settings of trees and low planted understory.

A Central Park filled with a myriad of recreational possibilities, including adventure play, cycle and pedestrian networks is situated at the heart of the Estate and a series of Open Spaces are linked to this. All parkland provides prime access to the Kimberley bushland, and experience of living in this rich coastal country Open Space design will use white trunked Cable Beach Ghost Gums, architectural Pandanus and earthy sandstone boulders as a common aesthetic thread/ striking natural element throughout the Estate. Recreational paths will circumnavigate and meander through the estate providing shaded 'Green Links' throughout and beyond the Estate.

This Landscape Report specifically focuses on the provision of new public open space within Local Development Plan 3 (LDP3) through developing unique streetscapes, parklands and multiple-use corridors that sensitively deal with the local drainage condition. The report focuses on retention and supplementation of existing vegetation for cultural, fauna and water quality purposes, and fire management strategies.

Key aspects guiding the landscape design report include:

- Maintaining connections and linkages through the site via multiple-use and ECC corridors for cultural, community and habitat purposes;
- Protecting and repairing natural systems so traditional practices and a continued 'lifestyle' can occur alongside urban development;
- Design to experience the coastal bushland location and the rich culture of the stunning Kimberley landscape;
- Bushfire Management Design Implementation;
- Minimal existing landform reshaping;
- Maximum existing vegetation retention and supplementation on site;
- Combining recreation, preservation, education/ interpretation and linking urban/ natural drainage systems through multiple-use corridors;
- The inclusion of interpretation and art opportunities within public open space as part of an overall open space strategy,and;
- Incorporating site specific solutions (such as the provision of shade amenity through consistent street tree planting in medians and alongside roads and pedestrian connections).



2 CULTURAL ASPECTS

The Yawuru people are the Native Title Holders of 530,000Ha of land within the Broome region and for thousands of years their ancestors have lived and travelled along the foreshores of Roebuck Bay, across the pindan plains and along the fringes of the Great Sandy Desert. It is understood that the Broome North development including the LDP3 is an important part of a broader cultural landscape which needs to be cared for and respected.

Respecting and retaining the Yawuru's strong connection and relationship to 'country' is therefore an essential consideration of the streetscape and public open space design. Through ongoing dialogue with local Yawuru people initiatives to maintain an unbroken traditional 'lifestyle' with continual access to the land will be established.

Sensitive cultural design may include initiatives such as:

- The creation of an Environmental Cultural Corridor (ECC) for continual connection and movement east west across the Broome Peninsular connects the significant Cable Beach dunes with Dampier Creek and Roebuck Bay;
- Empowering local Yawuru artists and cultural/environment custodians to inform open space design outcomes and the use of local materials;
- Engaging local Traditional Custodians to instruct on retention and supplementation of vegetation including species selection; and,
- Instruct on maintaining existing drainage systems within and downstream of the development.

The non-indigenous community identify with a specific character for Broome which involves climate, an outdoor lifestyle, multiculturalism and tourism. Responding to these characteristics involves 'open plan' designs which allow for breezeways, multi-purpose active and passive open spaces, shaded, dual-use walkways to encourage community interaction, and activated streetscapes. All of these features capitalise on the outdoor lifestyle and coupled with adopting sustainable engineering practices, promotes the local environment and visual experience of Broome.

The streetscape and public open space design has been informed through consultation and engagement with key members of the community. This not only ensures the views and requirements of the community are addressed but also helps to foster local pride and ownership, with the public open spaces less likely to fall victim to vandalism and neglect as a result.

3 URBAN WATER MANAGEMENT

The streetscape and public open spaces of LDP3 form an integral part of the water management strategy of the Broome North development.

In broad terms, the excess urban water run-off is directed from housing lot frontages directly onto the pavement where it is then transferred via kerbing and outlet devices into endemically vegetated swales within multiple-use open space drainage corridors.

The specialised Northwest designed swale system's main purpose is to transport water across the site and deliver downstream run-off water at a similar quality, velocity and volume as per pre-development. A vegetated retarding swale system reduces the amount of nutrient binding sedimentation leaving the site and the transportation of contaminates such as invasive weeds.

Built structures are utilised to retard and slow water volumes within these swales and include concrete or stone gabion weirs that feature low flow devices such as V notches and low flow apertures (average 300mm dia.). These weirs are constructed to contain up to 1:10 events with 1:100 events allowed to overflow the structures and prevent upstream flooding. In addition, drop structures are located along the swale floor thus reducing water velocity.

Re-vegetation of the swale systems is a critical factor for Northwest drainage conveyance. Planting plans will be designed with Bushfire Management design principles. Vegetation of swales:

- Stabilises swale bases and batters;
- Filters nutrient captive silts such as Broome's Pindan soils, which can starve downstream marine ecologies;
- Filters fine silts which if otherwise transported can clog up downstream drainage conveyances and waterways;
- Aids in providing natural drainage 'roughness' which reduces the velocity of overland flows; and
- Reduces the distribution of potential contaminates and exotic weeds.

Also vital to water quality, revegetation and protection of the drainage swale system is the use of the local site mulch and topsoil collected prior to site bulk earthworks. Use of local site mulch and topsoil includes an endemic seed bank. This, along with appropriate supplemental planting, is fundamental to maintaining local biodiversity within the development area.







4 WATER CONSERVATION STRATEGIES

Commitment to water conservation is inherent in the design and management of the streetscapes and public open spaces of LDP3 area. Landscape Water Management strategies Include the following:

- Use of endemic species within the development that require a local climate based low water-use and nutrient use regime;
- 80% percent of planting is mostly re-vegetation with drip irrigation turned off once planting is established (2 years);
- Lawn areas are minimised. The lawn species is indigenous to the Broome Peninsula (Roebuck Bay Couch) and has low water and nutrient use requirements;
- The irrigation schedule for most planting is daily during a 13 week establishment period and then reduced to irrigating twice a week or less, as required;
- During the maintenance period the assessment of water needs of the plants will be amended on a regular basis and the watering adjusted accordingly;
- Should a residential rebate package be provided, the irrigation to residential street trees shall be established as part of the rebate package and it would be the responsibility of the residence for watering and establishment; and,
- The irrigation systems will be designed in accordance with Shire of Broome Requirements and Specification.

5 VEGETATION RETENTION

The LDP3 site area features existing vegetation typical of a low and open Pindan Woodland plant ecology with scattered trees and dominate *Spinifex* species grassland. Some *Corymbia paractia* have been identified on site. Retaining as much of this vegetation as possible while adhering to the Bushfire Management Design Guidelines, has many benefits such as:

- Reduced erosion and a reduction in soil run-off into adjacent sites, waterways and the downstream marine ecology;
- Weed control;
- Maintaining flora and fauna biodiversity, including the critical specialised Broome Peninsula habitat;
- Immediate site maturity and a local sense of place;
- Shade and visual amenity;
- Cost savings on clearing;
- Respect of Traditional Owners (Yawuru) ethno-biological connection to 'country' and continuing 'lifestyle'; and
- Allowing for the fast creation of multiple-use open space areas for recreation, drainage, flood control, dual use pathways & linkages etc.

In order to realise these benefits, significant individual trees and low vegetation areas within the LDP3 site area will be identified, surveyed and where possible, integrated into the design of the public open space areas.

6 WEED CONTROL

Any introduced weed species that are identified across the LDP3 site area will be managed under a weed control program. The weed control program is to be developed as part of the landscape management plan. The existence of weeds reflect the extent of disturbance throughout Broome as a result of land clearing, vehicle access, rubbish dumping and surrounding exotic gardens. To reduce the increase and spread of weed species, the following management and control actions should be adopted:

- Minimising clearing where possible (during the construction period);
- Where possible, using existing tracks and roads, preventing uncontrolled access to the site and minimising the number of new tracks required;
- Ensuring cleared vegetation and topsoil (if contaminated with weed seed) is removed and disposed of at Shire approved dumpsites;
- Ensuring all vehicles and machinery are cleaned of plant material and soil before and after entering the site (in particular when working along the perimeter of the site or in areas noted to have an invasive weed presence);
- Imported soils and materials should be certified weed free; and;
- All litter and waste materials should be contained and removed off-site regularly.

General vegetation mitigation for the area would include the following:

- Manual/ physical selective removal of weeds;
- Weed spraying using the industry's best practice and appropriate regimes (e.g. use non-residual glysophate based herbicide sprays, limit herbicide overspray, herbicide only applied by a by qualified technician, use of an appropriate herbicide near waterways etc.);
- Regular verge slashing of invasive grasses/low shrubs before seeding occurs, and;
- Controlling declared plants under the Agriculture and Related Resources Protection Act, 1976, using recommended methods .

7 ENVIRONMENTAL CULTURAL CORRIDOR

The 150m wide Environmental Cultural Corridor (ECC) running east-west across the site is an initiative used previously within developments in Broome and was born out of extensive consultation with the Yawuru people. Essentially it is a tract of naturally vegetated land set aside to be retained without development.

The Broome North ECC is intended to provide:

- A buffer between the development and existing infrastructure, or significant cultural areas;
- A habitat for flora and fauna and an opportunity to support biodiversity and natural drainage networks;
- An important cultural and community connection to 'country'. The retention of a substantial portion of local bushland that traverses west to east across the Broome Peninsula provides a mostly unhindered bush connection from the culturally significant Cable Beach dunes to the equally significant Dampier Creek marine wetlands and Roebuck Bay. This link provides Traditional Owners (Yawuru) with the opportunity to continue a 'lifestyle' passing on cultural education and traditional practices as historically and presently practiced on this land; and
- A strong sense of place for the development by maintaining this important open space bushland.

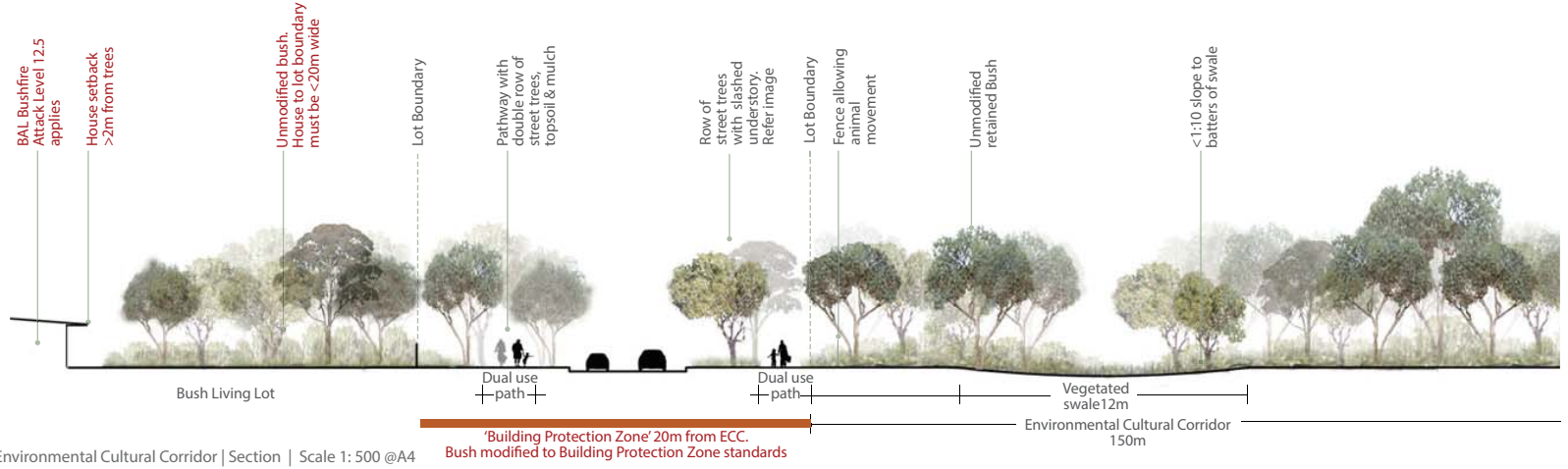
The ECC area will comprise a simple network of low maintenance cleared pindan tracks to enable appropriate and managed access only. A rural style perimeter fence around the ECC will also discourage trail bikes and vehicles from entering. Areas that have been degraded through earlier land uses and weed infestation shall be monitored and managed.

This low-key approach also allows for the design of 'creek style' drainage swales within the ECC. The Yawuru have provided permission for drainage to be contained within the ECC but only along the boundaries and to a maximum width of 20m within either side of the ECC boundaries.

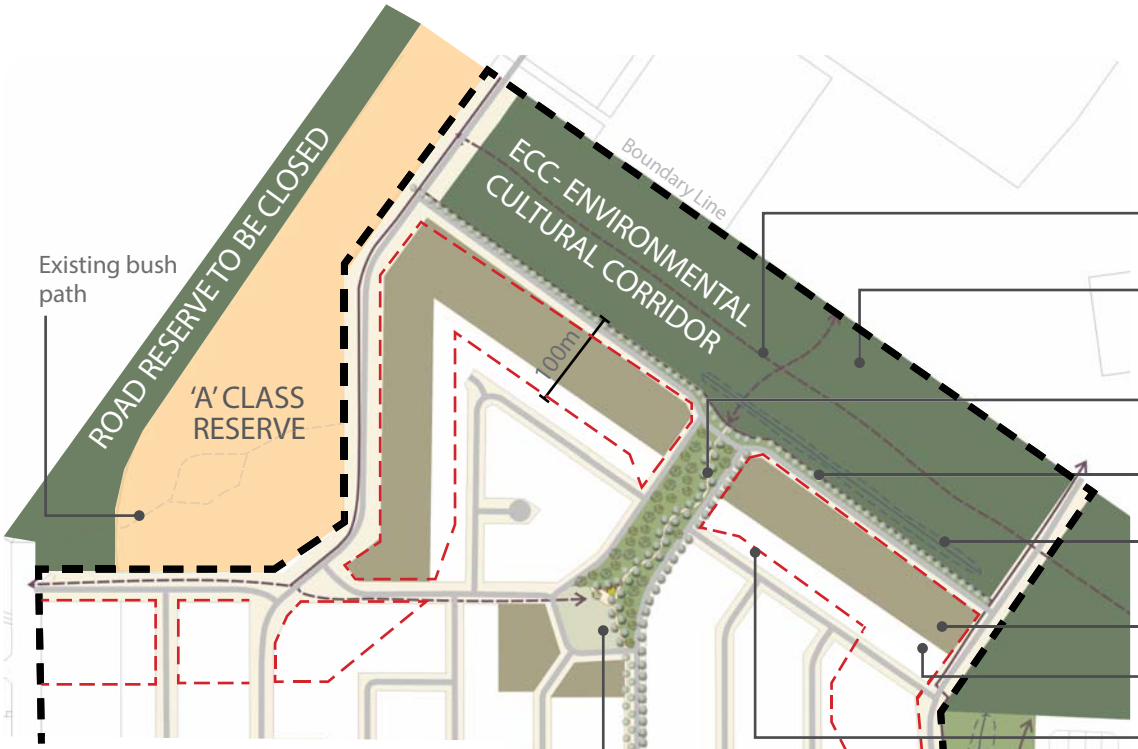
8 BUSHFIRE MANAGEMENT DESIGN IMPLEMENTATION

Current bushfire policy and guidelines state that BAL Bushfire Attack Level 12.5 must be applied to all buildings wihin 100m of unmodified bushland and vegetation is to be modified to create a Building Protection Zone between the ECC and Residential Lots. The dual use pathway running along the ECC lot boundary marks the Building Protection Zone boundary, 20m the from the residential lot boundary. All vegetation(existing and proposed) not in the ECC or in the front of Bush Living Lots must be designed according to Building Protection Zone standards: Trees to be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers. Alternatively, groundcover/ shrubs are not to exceed total fuel load of 2 tonnes per ha (this allows for larger shrubs to be included in planting design). The bush at the front of the Bush Living Lots may remain unmodified if the width of the retained bush does not exceed a maximum of 20m. If this maxiumum is exceeded, Building Protection Zone Standards must be applied.





Environmental Cultural Corridor | Section | Scale 1: 500 @A4
* Concept only. subject to detail design



* Concept only. subject to detail design

The central bush path to the ECC is a cultural requirement of Yawuru. The exact location of the path will be confirmed during Design Development.

Unmodified bushland

Dual use pathway with double row of trees- continuous walkway/ cycling circuit

Dual use path with row of street trees for continuous shade

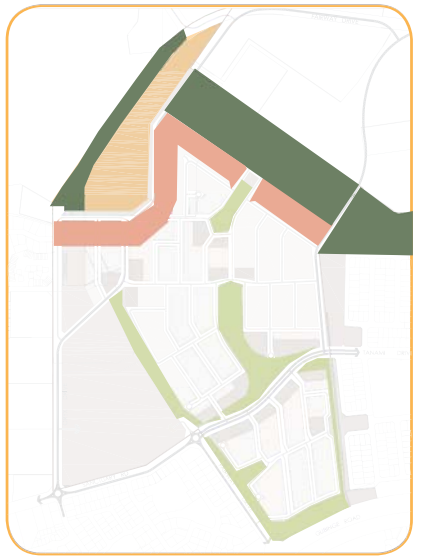
Vegetated swale 15-20m wide with 1:10 grade on batters

Bush Living Lots with large frontage of unmodified bush (front must be <20m width)

Neighbourhood Living Lots

BAL Level12.5 Fire Rating applies to all Lots within 100m from unmodified bushland (ECC & A Class Reserve). Refer Bushfire Management Plan (BMP)

Northern Park landscaping to be designed according to Building Protection Zone standards

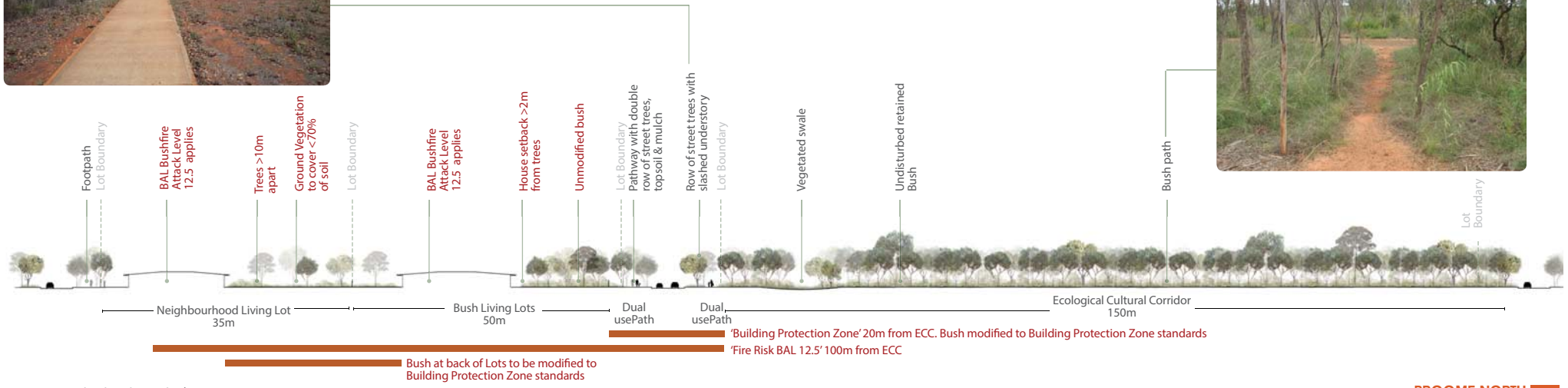


* Concept only. subject to detail design

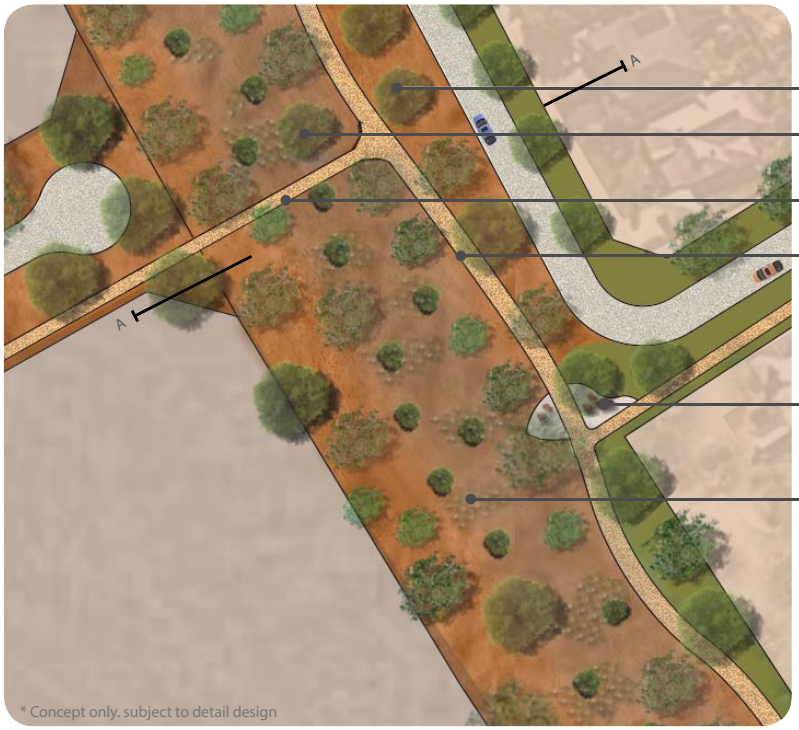
- Environmental Cultural Corridor
- 'A' Class Reserve
- Lots to have BAL12.5 Fire Rating. Refer Bushfire Management Plan. Vegetation at back of lots is to to be designed according to Building Protection Zone principles
- POS Areas- All to be treated as a 'Building Protection Zone'- All trees (existing and proposed) must be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers. Or groundcover/ shrubs are not to exceed total fuel load of 2 tonnes per ha







Environmental Cultural Corridor | Section NTS
* Concept only. subject to detail design



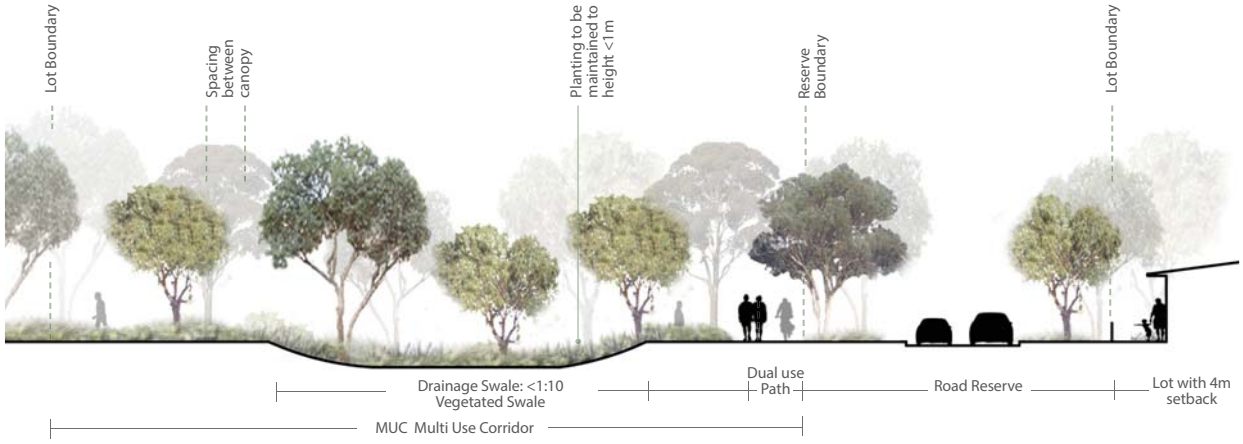
Western Parkland Multiple Use Corridors | Plan

Not to Scale

9 MULTIPLE USE CORRIDORS

These areas comprise a combination of retained existing vegetation, drainage swales, vegetated buffers and parks. They provide a number of functions including:

- An informal connection to 'country' (through the use of local planting, materials and linkages to the ECC);
- Urban drainage and flood management including holistic management of upstream and downstream conveyance;
- Flora and fauna habitat and linkages;
- Passive and active open space with informal (grassed kick-about) areas and formally programmed, built play areas;
- Dual use paths suitable for walking, jogging, cycling etc. with rest areas and water fountains,
- Opportunities for cultural and environmental interpretation including intergenerational education and community art projects, and;
- Building Protection Zone to mimimize the risk of fires spreading along the MUCs. All trees must be >10m apart, no canopies are to be touching, and all undergrowth is to be either slashed or low shrubs/ groundcovers.
- Bushfire Management by Design



Western Parkland Multiple Use Corridors | Section AA | Scale 1: 500 @A4

* Concept only. subject to detail design





Multiple Use Corridors | Location Plan

10 LDP3 PARKLANDS

CENTRAL PARK, NORTHERN PARK AND PEARLER'S ROW PARK

Central Park is the primary 'spine' of LDP3, centrally located within the development area. To the north, the park links to the Northern Park and ECC via the Green Link path network, to the south the park borders Tanami Drive which runs East- West, where there is opportunity for a dual use Art Path connecting Central Park to the future school and civic centre.

Pearler's Row Park has a latitudinal connection to LDP1 Stage 8 Park connected by a dual use shaded pathway. This connection allows residents to access the amenity of the neighbouring parks in Stage 8 and 10 (LDP1). Pearler's Row Park has a path that curves through a grove of trees and into an open playground area.

The collection of Parks feature the following amenity:

- Formal play areas with play equipment, shade structures, seating and picnic facilities, resting places;
- Nature Play Areas;
- Grassed open space areas for active and passive recreation;
- Areas of retained mature existing vegetation (providing existing shade and visual amenity);
- Interesting topographical changes that form part of the larger drainage swale network and the landscaped areas;
- Landscapes incorporating local sandstone boulders and boulder formations;
- Strong path networks that link to the immediate community and beyond via the connected multiple-use corridors and ECC;
- Exercise, walking, dog walking, running and cycling networks;
- Connecting pindan path that connect to grasses areas and the larger path network;
- Hard-stand areas which use local concrete and aggregates, with further rest areas consisting of local gravels and/or compacted, stabilised pindan;
- Bushtucker planting;
- Local species planting and
- Opportunities for lawn irrigation hydro-zoning according to active and passive uses, and:
- Interpretation and art opportunities as developed with the Traditional Owners's, community and within the proposed art and strategy.







Shadad dual use path meanders through the POS

Active play and lawn areas are on higher ground above the swale

Parallel on road parking

Areas of grass over the swales connect two sides of the POS and allow views through the park. Batters 1:44 and 1:25

Play elements meander through areas of retained bush

Interactive play includes a lookout to the bush and public art work as an entry feature and play element

Picnic area set on the top of the swale batter edged with a low, dry stone wall. From the slightly higher levels of the picnic area pad, views over the open, turfed swale area are accentuated

Dual use path

Opportunity to install Art Work to create points of interest along the entry road; Tanami Drive



Garden bed with low shrubs/ ground covers, trees and existing trees

Path network links spaces within the estate and intersects with the Green Link

Shade Shelter and Picnic Area

Urban Living Lots

Turf kick-about area

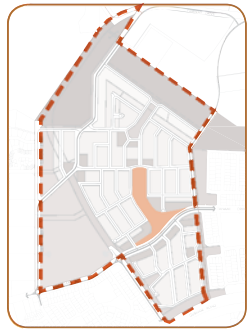
Grass over swale. Batters 1:40 Allows views through park

Shadad dual use path meanders through the POS

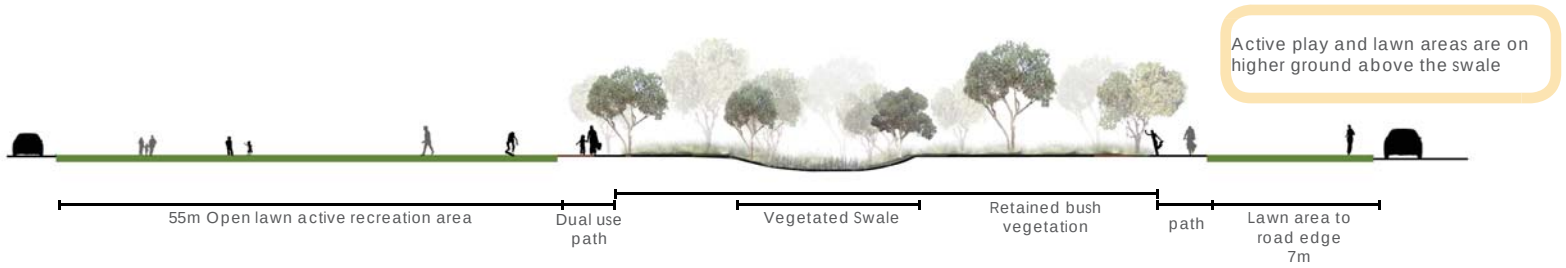
Lawn extends to edge

Double row trees to dual use path provides a continuous walking and cycling circuit

Central Park | Plan I Scale 1:1000 @ A1

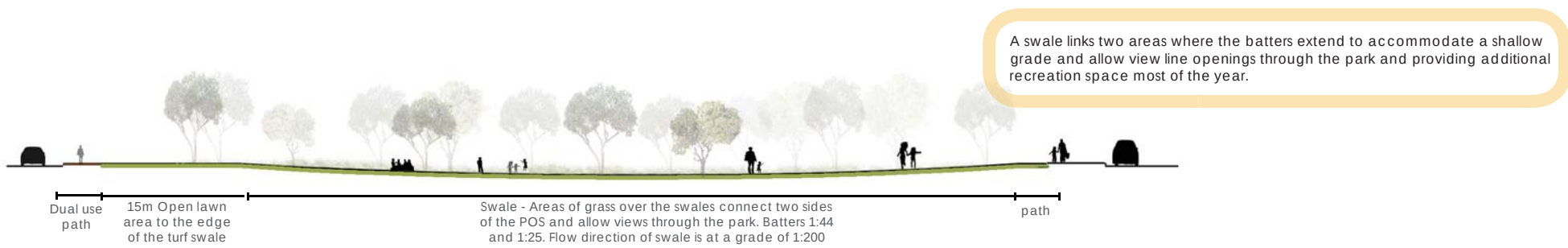


Central Park | Location Plan



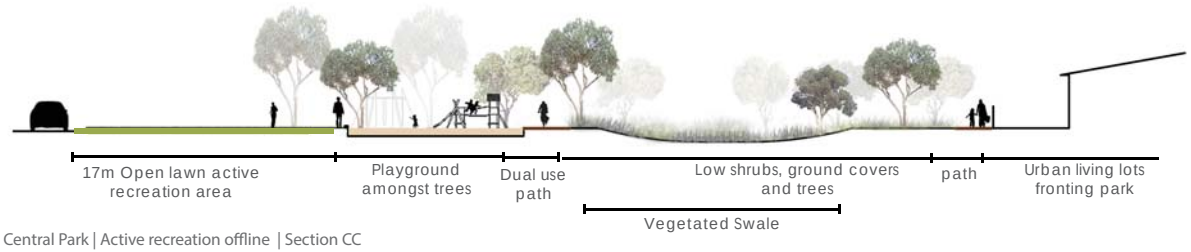
Central Park | Lawn public open space, active recreation | Section AA

Scale 1: 500 @A4 * Concept only. subject to detail design



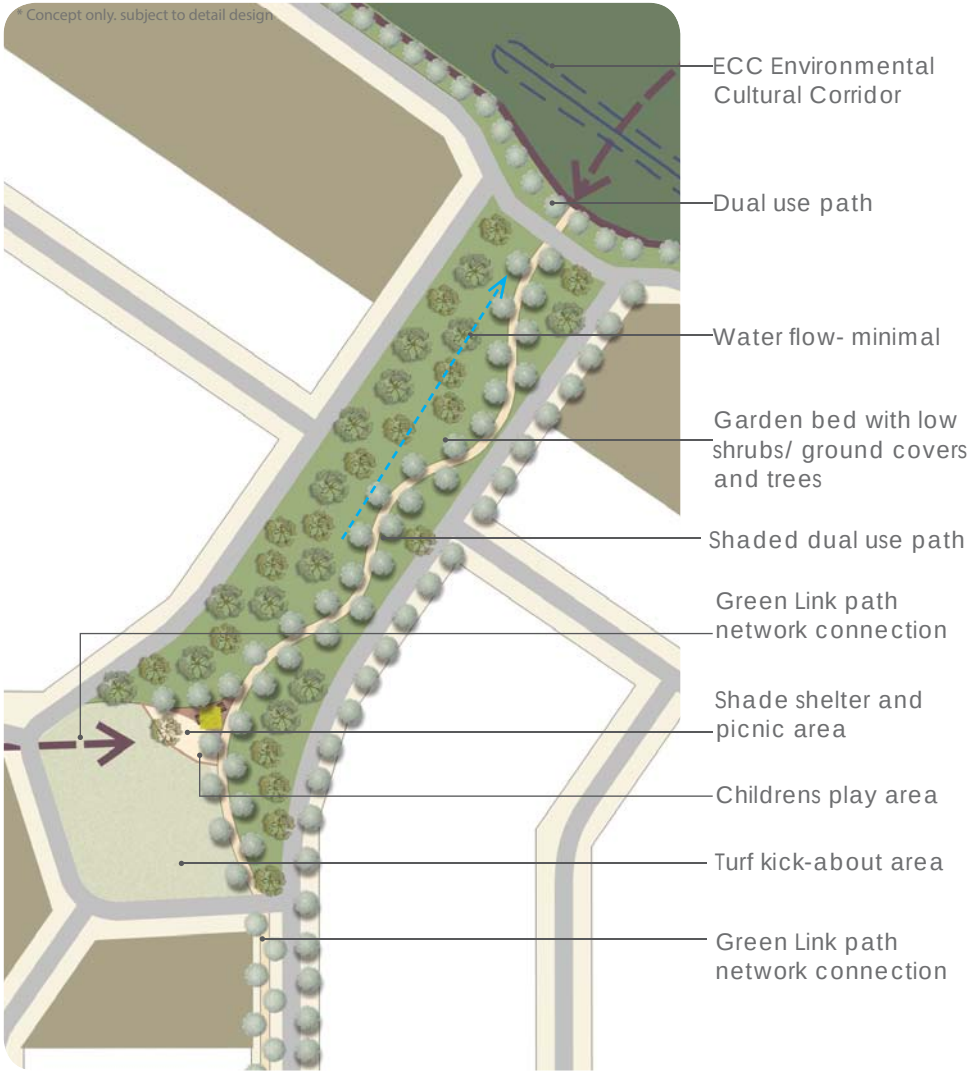
Central Park | Connecting lawn inline, informal recreation | Section BB

Scale 1: 500 @A4 * Concept only. subject to detail design

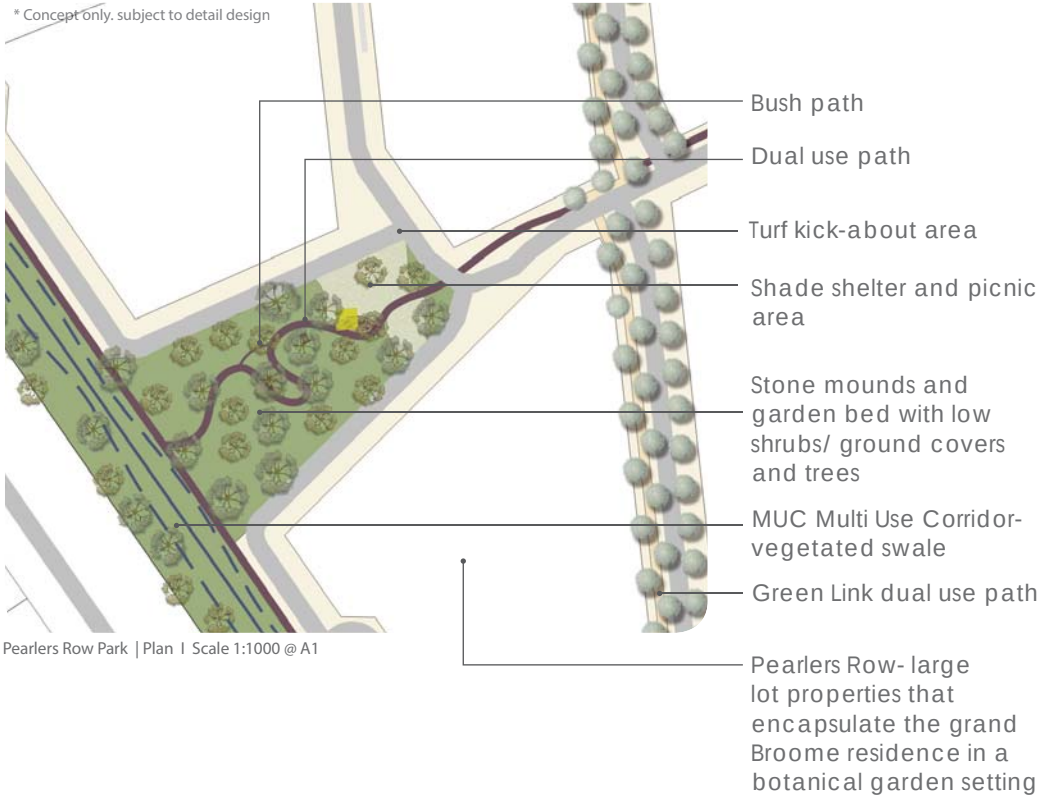


Central Park | Active recreation offline | Section CC

Scale 1: 500 @A4 * Concept only. subject to detail design



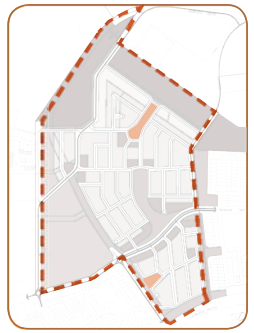
Northern Park | Plan I Scale 1:1000 @ A1



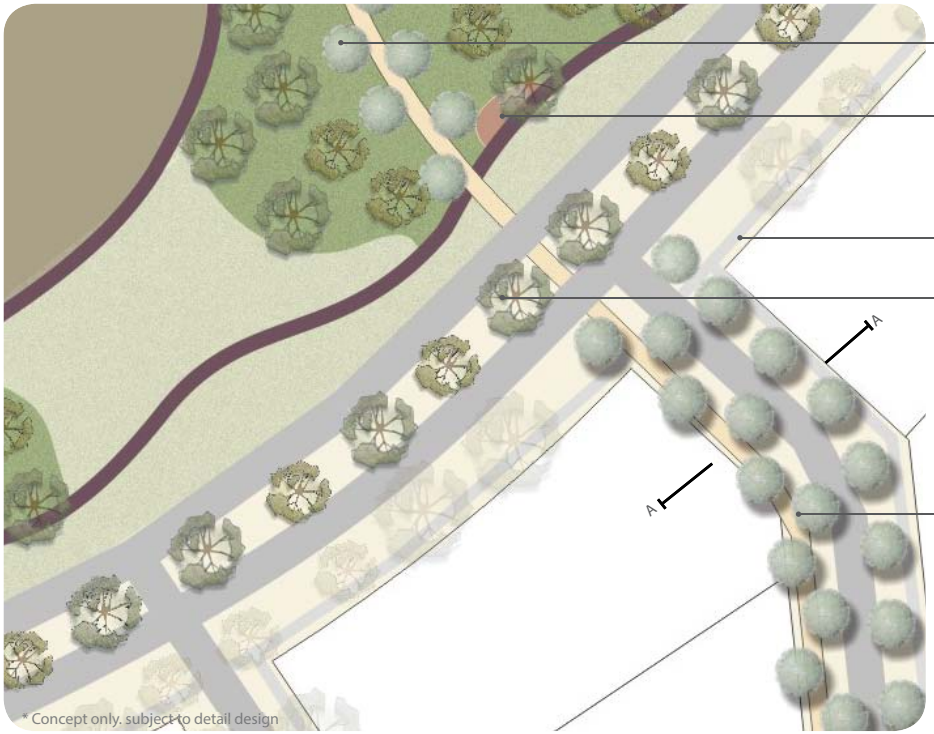
Pearlers Row Park | Plan I Scale 1:1000 @ A1



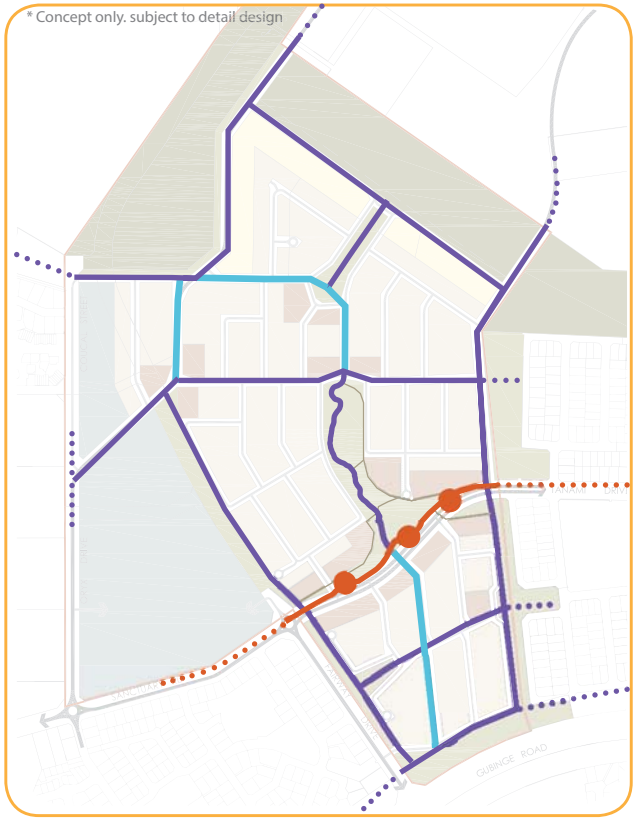




Northern Park & Pearlers Row Park | Location Plan



Path Typologies | Plan | NTS



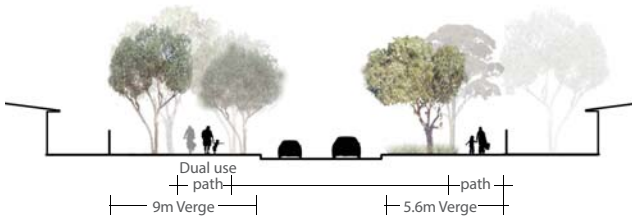
Path Network | Plan | NTS

Dual use path and Art Strategy along Tanami Drive (road suitable for buses)

Green Link- dual use pathway with double row of trees- continuous walkway/ cycling

Dual use pathway

Possible future connections



Green Link | Section AA | Scale 1: 500 @A4

* Concept only. subject to detail design

11 CENTRAL BOULEVARD, GREEN LINK & STREETSCAPES

Within LDP3 there is an opportunity to create shaded central boulevards. While not spatially designed to be used as parkland, the shaded boulevards will provide adjacent lot owners, pedestrians and visitors with shade and natural amenity. Within these central medians, a row of trees will be formally planted to provide this amenity with mulch and lawn ground cover. Robust bollards/guards within the medians are proposed as a means of increasing the perceived value of the trees and protecting them from vandalism and damage from large vehicles (particularly during residential construction). Endemic tree species, Corymbia paractia is proposed to edge these boulevards and reinforce local characteristics and provide shade. Integrator Arterial B and Neighborhood Connector Streets will have street trees as part of the landscape works and should be part of the Minimum Design Requirements. Should a residential rebate package be provided; it will be the responsibility of the lot owner for the planting, irrigation and establishment of the street trees to lots on Major Access Streets and Access Links. These trees will be the species nominated in the Street Tree Masterplan (Refer Pg.20). The lawn is proposed to be a local Roebuck Couch variety, again using the balanced nutrient and water qualities found in this environment.





12 PLANT PALETTE

A plant palette consisting of local, endemic species has been largelly adopted for the LDP2 development area. Endemic species are adapted to Broome's environmental conditions, require less ongoing maintenance and provide habitat for fauna. The requirements of a local plant palette will also support the growing Northwest landscape industry, by further establishing local plant awareness and stocks.

Local vegetation within the multiple-use corridors and parkland is environmentally crucial for maintaining local habitat and biodiversity. Retaining and supplementing local endemic vegetation supports Traditional Owners cultural practices and the opportunity to maintain a Broome 'sense of place' and 'lifestyle'.

The following is a locally proven street tree species list considered appropriate for use within the LDP2 area:

- *Bauhinia cunninghamii* - Jigal
- *Brachychiton diversifolius* - Northern Kurrajong
- *Corymbia ptychocarpa* - Swamp Bloodwood
- *Eucalyptus microtheca* - Coolibah
- *Eucalyptus miniata* - Woollybutt
- *Eucalyptus tectifica* - Darwin Box
- *Terminalia petiolaris x Terminalia ferdinandiana* - Red Gubinge

Endemic species which have performed well in Broome in establishing multiple-use corridors, open space parks and swale vegetation modules will include the following:

TREES

- *Bauhinia cunninghamii* - Jigal
- *Corymbia flavescens* - Cabbage Ghost Gum
- *Corymbia polycarpa* - Bloodwood
- *Eucalyptus jensenii* - Wandi Ironbark
- *Eucalyptus microtheca* - Coolibah
- *Eucalyptus tectifica* - Darwin Box
- *Ficus opposita* - Sandpaper Fig
- *Gyrocarpus americanus* - Coolamon
- *Santalum lanceolatum* - Tropical Sandalwood
- *Terminalia petiolaris x Terminalia ferdinandiana* - Red Gubinge

LARGE SHRUBS/ SMALL TREES

- *Acacia eriopoda* - Broome Pindan Wattle
- *Acacia monticola* - Scratchy Wattle
- *Acacia platycarpa* - Pindan Wattle
- *Dolichandrone heterophylla* - Lemonwood
- *Ehretia saligna* - Native Willow
- *Hakea aborescens* - Yellow Hakea
- *Hakea macrocarpa* - Boomerang Tree

MEDIUM SHRUBS

- *Acacia bivenosa* - Dune Wattle
- *Acacia translucens* - Poverty Bush
- *Caesalpina major* - Yellow Nicker
- *Carissa lanceolata* - Conkerberry
- *Crotalaria cunninghamii* - Green Birdflower
- *Dodonaea platyptera* - Hopbush
- *Flueggea virosa* - Snowball Bush

SMALL SHRUBS

- *Acacia adoxa* - Prostrate Acacia
- *Canavalia rosea* - Beach Bean
- *Dodonaea lanceolata* - Broad-winged Hopbush







- *Hybanthus aurantiacus* - Orange Spade Flower
- *Sida hackettiana* - Spiked Sida

GROUNDCOVERS/ GRASSES

- *Acacia hilliana* - Hills Tabletop Acacia
- *Enchylaena tomontosa* - Barrier Salt Bush
- *Ipomea pes-caprae* - Beach Morning Glory
- *Ptilotus exaltatus* - Tall Mulla Mulla
- *Triodia pungens* - Soft Spinifex





Hybanthus aurantiacus - Orange Spade Flower



Dodonaea lanceolata - Broad Winged Hopbush



Acacia bivenosa - Dune Wattle



Hakea arborescens - Yellow Hakea



Crotalaria cunninghamii - Green Birdflower



Acacia hilliana - Hills Tabletop Acacia



Ipomea pes-caprae - Beach Morning Glory

* Concept only. subject to detail design



STREET TREE MASTERPLAN

The overall Street Tree Masterplan allocates trees to different street typologies. This masterplan will be amended after consultation with and approval from Traditional Owners. Choosing local species as street trees is another opportunity to create a unified bush aesthetic with local character and meaning specific to the site.



Terminalia cunninghamii- Inland Gubinge



Eucalyptus miniata - Woollybutt



Bauhinia cunninghamii - Jigal



Brachychiton diversifolius - Northern Kurrajong



Peltophorum pterocarpum - Yellow Flame Tree



Corymbia pychocarpa - Swamp Bloodwood



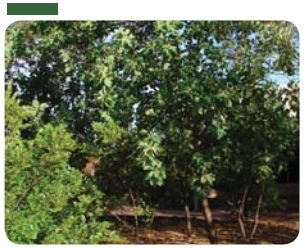
Eucalyptus microtheca - Coolibah



Corymbia paractia- Cable Beach Ghost Gum



Eucalyptus tectifica - Darwin Box



Terminalia petiolaris x Terminalia ferdinandiana - Red Gubinge

13 CONCLUSION

The LDP3 Landscape Report demonstrates that a sustainable and site specific landscape amenity for the future Broome North community can be achieved through understanding the Broome Peninsula's unique ecological condition. The report acknowledges the existing Broome 'lifestyle' and the Traditional Owners (Yawuru's) cultural relationship to the site and associated lands.





Swale Planting Species List

The species in the lists below represent species which have been successful in swale revegetation in earlier stages of Broome North. Planting to the floor of the swales must be able to survive consistent inundation and submergence during the wet season and baking pindan and extreme temperatures during the dry season. By choosing tubestock the plants have already successfully germinated and established. There is good seed bank in the local site mulch which covers the first 5m band of the swale batter. This has proven to generate a lot of regrowth to the batters and lower batters.

Swale Batters

Planting spacing will be determined by the Bushfire Management Design requirements. Tree centres will be 10m apart. Where a 'light green' zone is required tree centres will set so the mature canopy does not touch. Ground cover and low shrubs or grass can be planted beneath the trees. Refer Bushfire Management Design Response Plan included in the Landscape Report.

Trees
Acacia dunnii
Acacia platycarpa
Acacia tumidia
Bauhinia cunninghamii
Brachychiton diversifolia
Corymbia dampieri
Corymbia flavescens
Corymbia paractia
Corymbia ptchocarpa
Corymbia zygophylla
Eucalyptus jensenii
Eucalyptus microtheca
Eucalyptus miniata
Eucalyptus tectifica
Ficus opposite
Gyrocarpus americanus
Hakea marrocarpa
Melaleuca dealbata
Melaleuca nervosa
Melaleuca leucadendron
Melaleuca argenta
Persoonia falcata
Sesbania formosa
Santalum lanceolatum
Terminalia ferdinandiana
Terminalia petiolaris x Terminalia ferdinandiana
Terminalia petiolaris

Ground Cover and Low Shrubs to the Swale Batters **(Size to fit Bushfire Design Guidelines)**
Acacia adoxa
Acacia hilliana
Acacia hippuroides
Canavalia rosea
Cymbopogon procerus

Gomphrena flaccida
Ptilotus exaltatus
Sesuvium portulacastrum
Solanum beaugleholei

Lower Batters and into the Floor of the Swale

It is proposed that bands of planting be established in the floor of the swales.
This will consist of a combination of tubestock of tree and groundcover species. There will be planted at about 10m intervals and irrigated for the first two dry seasons. The trees will be planted close to the lower edge of the batters.

Melaleuca dealbata
Melaleuca nervosa
Melaleuca leucadendron
Melaleuca argenta
Sesbania formosa

Floor of Swale Tubestock Planting List
Cymbopogon procerus
Cleome cleomoides
Sesbania cannabina
Sesuvium portulacastrum
Spinifex Sp

Local species, *Frimbristylis dichotoma*, is a common regrowth following the construction of the swale.

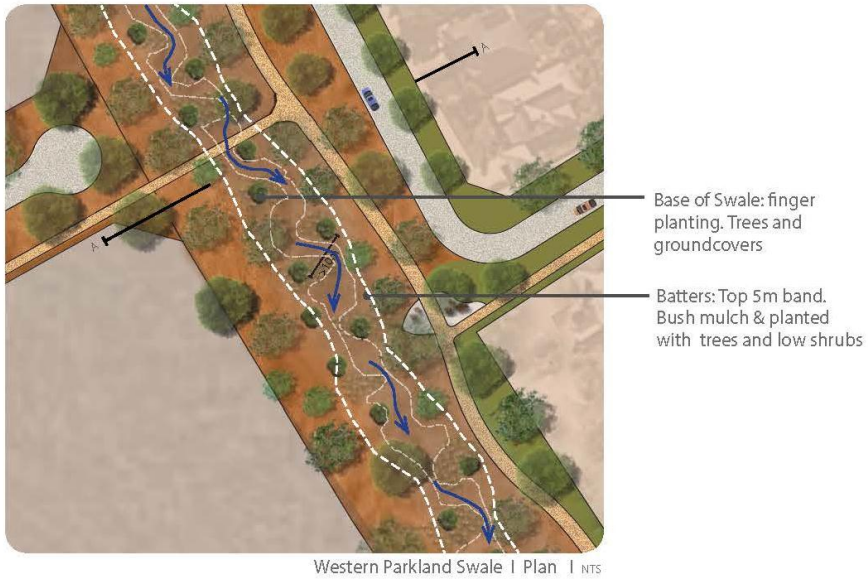
Grass as Cover to portions of the Floor of the Swale
Designated areas will be planted with the local grass stolons, ***Cynodon dactylon*** *(Common Couch- Roebuck Bay Couch). These areas will create a bushfire 'low growth zone' between planted and bush areas. This will create an adaptive space which can be a recreational area during the dry season and allow visual and pedestrian access through the site. The use of the hardy Cynodon dactylon will ensure vegetation coverage to the floor of the swale where it is planted.*

Seed Bank in Local site Mulch
This list is based on observed regrowth of local species form site bush mulch. This list is a representation of plants that may occur as a result of using site bush mulch to stabilise batters. This range of species cannot be guaranteed.

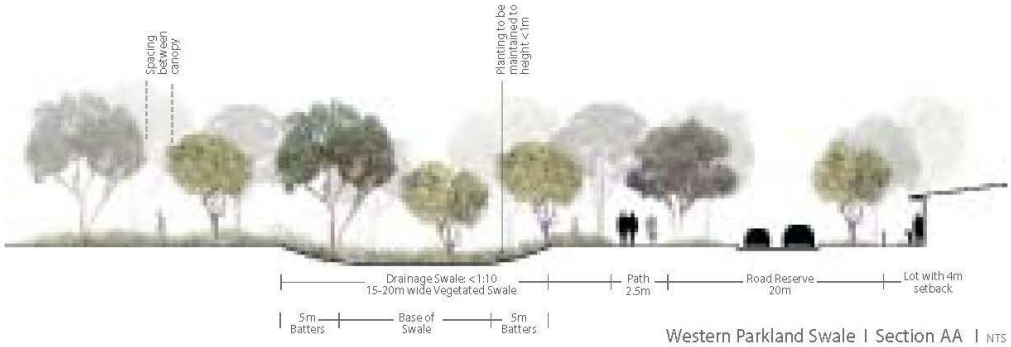
Acacia ecolei
Acacia bivenosa
Acacia dunnii
Acacia hilliana
Bauhinia cunninghamii
Calytrix exstipulata
Canavalia rosea
Cymbopogon procerus
Eucalystus. Sp
Grevilea pteridifolia
Grevillea pyramidalis

Grevillea refracta
Goodenia scaevolina
Ptilotus exaltatus
Senna notabilis
Sesbania cannabina
Sesbania formosa
Solanum cunninghamii
Trichodesma zeylanicum

Figure 1 Typical Swale Planting Layout



Western Parkland Swale I Plan I NTS



Western Parkland Swale I Section AA I NTS

Appendix G – Geotechnical Report

Coffey Geotechnics (2009) Lots 3150 and 304

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

REPORT ON GEOTECHNICAL INVESTIGATION

BROOME NORTH - LOTS 3150 AND 304
Landcorp

GEOTPERT08647AB-AB
28 August 2009

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
89-91 Burswood Road Burswood WA 6100 Australia

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

27 August 2009

LANDCORP
Level 3, 40 The Esplanade
PERTH WA 6000

Attention: Ms Margriet Van Tuyll

Dear Madam

RE: BROOME NORTH - LOTS 3150 AND 304

This letter presents our report on a geotechnical investigation carried out at the above.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact Mr Neil Farquharson or the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd

Hamish Nelson

Associate Geotechnical Engineer

Distribution:	Original held by	Coffey Geotechnics Pty Ltd
	1 copy	Coffey Geotechnics Pty Ltd Library
	2 copies	Landcorp
	1 copy	Sinclair Knight Merz (Attention of Peter Oliver)

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Table 4: Summary of Fall Head Permeability tests carried out in Pindan Sands across Lot 3150 7

Table 5: Summary of Fall Head Permeability tests carried out in Pindan Sands across Lot 304 7

Table 6: Summary of Fall Head Permeability tests carried out in Dune Sands across Sand Mining Area 8

Figure

1 Test Location Plan – Lot 3150

2 Test Location Plan – Lot 304, Lot 2605 and Sand Mining Area

Appendices

A Results of Field Investigation (32 pages)

B Results of Geotechnical Laboratory Testing (30 pages)

C Results of Geoenvironmental Laboratory Testing (19 pages)

D A Technical Note on The Effects of Compaction Plant on Adjacent Structures (Tynan 1973).

1 INTRODUCTION

This report presents the results of geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for Landcorp in North Broome.

The investigation comprised geotechnical and geoenvironmental investigation and testing across Lots 3150 and 304 and geoenvironmental testing across Lot 2605 (which at the time of the fieldwork comprised a disused chicken shed) (see Figures 1 and 2).

On request from Peter Oliver of SKM, additional site permeability testing was carried out in an existing Sand Mining Area 1.5kms north of Lot 304 (see Figure 2).

This work was commissioned on 29 July 2009 by Landcorp Consultant's Contract (contract number 90395).

This report is prepared and is to be read subject to the terms and conditions contained in our proposal dated 17 July 2009 (Ref. GEOTPERT08647AB-P-AA-Rev3). Our advice is based on the information stated and on the assumptions expressed herein. Should that information or the assumptions be incorrect then Coffey Geotechnics Pty Ltd shall accept no liability in respect of the advice whether under law of contract, tort or otherwise.

2 PROPOSED DEVELOPMENT

It is understood that the project comprises the development of approximately 700Ha of land for residential development. The land is spread over 3 sites Lot 3150, Lot 304 and Lot 2605 (disused chicken shed area) (see Figure 1).

3 OBJECTIVES

The objectives of the geotechnical investigation were to assess the following;

Soil, rock and groundwater conditions within the significant foundation support zone and at the number of investigation stations specified;

Indicative site classification in accordance with AS 2870-1996;

Assessment of in-situ soil permeability and potential for disposal by soakage;

Assessment of the rippability of in situ materials encountered in excavations;

Assessment of the groundwater at the time of fieldwork and comments on its likely seasonal fluctuations over yearly intervals.

Provide soil parameters for pavement design by others.

Provide construction considerations pertinent to the proposed development, including site preparation, excavation conditions, protection of footing excavations, compaction control, groundwater control during construction and the need for subsoil drainage.

4 INFORMATION SUPPLIED BY OTHERS

Landcorp provided us with the following information:

A site locality plan in pdf format;

A letter dated 10 June 2009 detailing the proposed development and surface characteristics at present;

L04 PBO CG Geotech Brief #2 Lot 3150 & 304.pdf;

Site Plan with Geotech markup 17 June 09.pdf; and

13367-broome-image-extent.pdf.

Coffey have also been provided with a copy of the Department of Water "Study for Broome Groundwater Management Plan Review" dated November 2008.

5 FIELDWORK

5.1 General

Fieldwork was carried out between 30 July 2009 and 2 August 2009 in the full time presence of personnel from Coffey. All test pits locations were measured by differential Global Positioning System with an advised accuracy of $\pm$1m by Coffey personnel. Investigation locations are shown in Figure 1.

Groundwater was not observed in the test pits during the site work. It must be noted that seasonal fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors.

Access to Lot 3150, Lot 304 and Sand Mining Area was gained via existing unmade tracks off Gubinge Road and Fairway Drive. Access to Lot 2605 was gained via a private driveway, south off Fairway Drive near the junction with Broome Road.

Please note that, due to clearing restrictions, access was limited to existing roads and tracks in and around the Lots. Therefore the majority of the test pits are located around the perimeter of the Lots.

Trafficability at the time of fieldwork was suitable for 4 x 4 vehicles. Frequent ares of loose surface sand were present on existing tacks.

Weather conditions at the time of fieldwork were fine and mild.

5.2 Test pitsting

A total of 27 Test pits were excavated by backhoe to approximately 2.5m depth below the existing ground surface.

Test pits excavated across Lot 3150 are numbered TP1 though TP15. Test pits excavated across Lot 304 are numbered TP1b through TP12b. Test pits were not excavated in the Sand Mining Area.

Disturbed samples were taken from 10 locations of representative soil types for laboratory testing.

The records of the test pits logs showing the major strata that were intersected, the depths at which the samples were taken together with Explanation Sheets defining the terms used are presented in Appendix B.

5.3 Perth Sand Penetrometer Testing

Perth Sand Penetrometer tests were carried out at 29 locations adjacent to the test pits locations to depths varying from nominally 0.2m to 0.6m below the existing ground surface. This test is described in AS 1289-1996.6.3.3.

The results of these tests are presented in Appendix B.

5.4 Hand Augered Boreholes and Falling Head Permeability Tests

Ten hand augered boreholes were undertaken adjacent to selected Test pits locations across Lot 3150 and Lot 304 and two additional hand auger boreholes were carried out in the Sand Mining area. The boreholes were augered to a depth of between 0.5m and 1.0m below existing ground level. The hard ground conditions encountered on site during the fieldwork restricted the depth achievable with a hand auger.

Falling head permeability tests were carried out in each hand augered borehole in general accordance with BS 5930: 1981. The results of these can be found in Appendix B and summarised in Section 7.4.

6 DESCRIPTION OF LABORATORY TESTING

6.1 Geotechnical Testing

Geotechnical laboratory testing was carried out in accordance with the general requirements of AS 1289 by Kimberley Soils Laboratory, a NATA registered soils laboratory located at Broome Airport.

All samples were collected during the fieldwork by Coffey Personnel. The samples were collected in bulk bags, labelled and sealed with a cable tie.

The extent of testing carried out is presented in Table 1 and summarised in Table 2.

Table 1 - Extent of Geotechnical Laboratory Testing

Type of Test	Number
Particle Size Distribution tests	10
Atterberg Limits tests	10
Modified Compaction (MMDD) tests	5
Soaked CBR tests	5

Table 2 - Summary of Geotechnical Laboratory Testing

		Particle Size Distribution (% Passing size)			Atterberg Limits (%)			Modified Compaction (MMDD) Tests		Soaked CBR (%) (to 98% compactive effort)
Sample ID	Depth (m)	Fines <0.075mm	Sand 0.0075 to 2.36mm	Gravel 2.36mm +	LL	PI	LS	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	
TP1	1.0-1.5	26	95	100	22.0	8.5	1.0	2.010	6.4	11
TP6	2.0 – 2.5	19	97	100	22.3	10.0	1.0	2.114	7.4	12
TP8	0.5 – 1.0	23	95	100	20.5	4.8	1.2	Not Tested		
TP10	1.0 – 1.5	16	95	100	26.0	13.9	1.4	2.122	7.0	4
TP1b	0.5 – 1.0	25	94	100	21.5	4.5	0.8	1.928	6.4	30
TP3b	0.5 – 0.6	22	96	100	21.7	6.5	1.0	Not Tested		
TP6b	1.0 – 1.2	21	96	100	23.8	8.9	1.2	Not Tested		
TP9b	1.0 – 1.5	20	93	100	23.3	9.1	1.0	2.039	6.4	20
TP10b	0.5 -1.0	22	92	100	20.3	6.1	1.0	Not Tested		
TP11b	0.5 – 0.6	17	92	100	23.0	7.7	1.2	Not Tested		

Note: LL = Liquid Limit

PI = Plastic Index

LS = Linear Shrinkage

6.2 Geoenvironmental Testing

Geoenvironmental laboratory testing was carried out by MPL Laboratories a NATA registered environmental laboratory located in Perth.

The geoenvironmental sampling at Lot 2606 was carried out by Coffey personnel under direct supervision of Miss Ashton Betti of GHD. GHD were responsible for identifying sampling locations and depths on site, and the required testing on each sample.

Additional Geoenvironmental samples were also taken by Coffey at three locations across Lot 3150 and Lot 304.

Interpretation of analysis results are to be carried out by GHD. For the purpose of this report the results have been reported factually and are attached in full in Appendix C.

Geoenvironmental sampling was carried in accordance with Development of Sampling and Analysis Programs Guidelines (DEP, 2001) and Australian Standard AS 4482.1 - 2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil (Standards Australia, 2005).

Samples were collected using clean nitrile gloves and placed into laboratory prepared containers provided by MPL Laboratories. Each sample was identified by means of a label, detailing the sample location, date, job number and depth. The samples were frozen over night and air couriered to MPL the next day.

To ensure that soil samples were are collected without the potential presence of cross contamination, sampling equipment (hand auger/shovel) was decontaminated between sampling locations in accordance with the procedure and methods described in the above referenced Australian Standard.

Table 3 - Extent of Geoenvironmental Laboratory Testing

Type of Test	Number
PAHs	13
TPHs	13
Metals (As, Cd, Cr, Co, Cu, Pb, Zn)	13
Phosphorus & Nitrogen	13

Test results for the test listed in Table 3 tests are attached in Appendix C.

7 SITE CONDITIONS

7.1 Surface Conditions

Lot 3150 occupies an area of 125 ha of undeveloped land, situated in well vegetated, relatively flat topography. The site is well drained with no groundwater observed during the site investigation. No services were present across the Lot, although a gas main pipe runs in a north south direction along an unsealed gravel track off Gubinge Road which marks the eastern boundary of Lot 3150. Buried electrical cables run in an east west direction along the northern side of Gubinge Road which marks the southern boundary of Lot 3150. The site was accessed via track roads leading off Lullfitz Drive in the west and Gubinge Road in the south. Trafficability at the time of fieldwork was good, although high clearance 4 x 4 is required for access. Access within the Lot was restricted due to the lack of tracks and restriction of vegetation clearance.

Lot 304 occupies an area of 27 ha of undeveloped land, situated in well vegetated relatively flat topography. The site is well drained with no groundwater observed during the site investigation. No services were present across the Lot, although a gas main pipe runs in a north south direction along a track off Fairway Drive which marks the eastern boundary of Lot 304. The site was accessed via various track roads leading off Fairway Drive to the south. Trafficability at the time of fieldwork was good, although as across Lot 3150 high clearance 4 x 4 is required for access. Access within the Lot was restricted due to the lack of tracks and restriction of vegetation clearance.

Lot 2605 occupies an area of 3.2 ha. A large disused chicken shed complex spanning three, 100m long sheds, with separate single storey housing on a 300m^2 plot. The chicken sheds are constructed out of sheet corrugated steel on a steel frame sitting on concrete footings. The Lot is relatively flat and sparsely vegetated and has a 2m high perimeter fence. Access is gained via the main gate south off Fairway Drive.

The Sand Mining Area is located 1.5km north of Lot 304 and occupies approximately 4 ha. The site comprises a number of shallow excavations (1m to 2m bgl and up to 100m wide) to mine fine white dune sand. The site is accessed via the northern extent of Lullfitz Drive east of Pearl Coast Road.

7.2 Subsurface Conditions

Available geological and topographical data from the Broome 1:50,000 Environmental Geology Series map describes the subsurface profile as medium to coarse grained coastal dune sands (locally known as Pindan Sands) overlying fine to medium grained sands with a variable silt content and possible cementation.

Based on the field investigation the site has a generalised subsurface strata summarised as;

Silty Clayey SAND, fine to medium coarse, dense, red to brown, weakly cemented. Occasional yellow specks (Pindan Sand).

Laboratory testing results for all samples tested reported fines content of between 16% and 26%, these fines are likely to be a combination of silt and clay material. The fines are of low plasticity.

The Pindan Sand was encountered to the test pit termination depth of 2.5m bgl. Little variation laterally or over depth was encountered.

7.3 Groundwater Levels

Groundwater was not encountered during test pitting which took place from 30 July 2009 to 2 August 2009. Discussion following a search of publicly available information is contained in Section 8.3.

It should be noted that groundwater levels are subject to variation due to the influence of rainfall, temperature, local drainage and the seasons. There is potential for development of perched groundwater tables following periods of rainfall.

7.4 Soil Permeability Tests

Falling head permeability tests were carried out in 12 hand augered boreholes during the fieldwork. Five tests were carried out across Lots 3150 and 304 and two tests carried out in the Sand Mining Area, the results of these tests are detailed in Tables 4 to 6.

Table 4: Summary of Fall Head Permeability tests carried out in Pindan Sands across Lot 3150

Location	Test Depth (m) bgl	m/sec	m/day
TP1	0.5	8.75E-06	0.76
TP4	0.5	1.65E-05	1.43
TP6	0.5	3.36E-05	2.90
TP8	1.0	3.60E-05	3.11
TP11	0.5	4.11E-05	3.55

(Testing carried out on the 31 July 2009)

Table 5: Summary of Fall Head Permeability tests carried out in Pindan Sands across Lot 304

Location	Test Depth (m) bgl	m/sec	m/day
TP1b	0.5	1.51E-05	1.30
TP4b	1.0	1.22E-05	1.06
TP7b	0.5	4.32E-05	3.73
TP9b	0.5	3.14E-05	2.71
TP12b	0.5	3.60E-05	3.11

(Testing carried out on the 1 August 2009)

Considering the values from the insitu field tests in the Pindan Sands and previous Coffey projects carried out within 2km of Lot 3150 and Lot 304, a design value of permeability of k = 10^{-06} m/s (approximately 0.1 m/day) can be adopted.

On request from Peter Oliver (SKM) additional falling head permeability tests were carried out in an existing Sand Mining area found 1.5kms north of Lot 304. Both tests were carried out in Dune Sands, which were described in the field as 'SAND, medium coarse, grey to white'. Clay was found at 1.5m depth in HA2, this reduced the permeability to 0.07 m/day.

Table 6: Summary of Fall Head Permeability tests carried out in Dune Sands across Sand Mining Area

Location	Test Depth (m) bgl	m/sec	m/day
HA1	0.5	3.71E-05	3.20
HA2	1.5	8.10E-07	0.07

(Testing carried out on the 2 August 2009)

8 RECOMMENDATIONS

8.1 General

It should be noted that the ground encountered by the hand augered boreholes and test pits represents the ground conditions at the location where the tests have been undertaken and as such are an extremely small proportion of the site to be developed. Accordingly, variations to the ground conditions are likely and allowance should be made for variability in the design and construction budgets.

Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, ground conditions including groundwater levels can change in a limited time or due to seasonal fluctuations. For example fill could be added to a site or surface materials removed from a site that will change the thickness of surface materials and depth to the underlying materials. The potential for change in ground conditions should be recognised particularly if this report is used after a protracted delay.

It is also recommended that any plans and/or specifications prepared which relate to the content of this report or amendments to original plans and specifications be reviewed by Coffey to verify that the intent of the recommendations contained in this report are properly reflected in the design.

8.2 Site Classification

It is understood that the Lots are to be developed for residential use and therefore the structures will comprise one and two storey buildings on strip and pad footings.

The investigated ground conditions are suitable to support conventional shallow foundation systems comprising pad and strip footings.

Australian Standard AS2870-1996 provides a system of site classification for residential slabs and footing design.

From the assessment of ground conditions Lot 3150 and Lot 304 can be classified as Class 'S' in accordance with AS2870 – 1996. The classification as Class 'S' is considered appropriate due to the proportion of fines within the Pindan Sand. Particle Size Distribution (PSD) tests indicate a fines fraction of between 16% and 26% across Lot 3150 and Lot 304.

Pindan Sand is recognised as soil with collapse potential (Davenport F, 2007), ground preparation procedures designed to limit this settlement are detailed in Section 8.5 and 8.6.

8.3 Groundwater

8.3.1 General

Prior to discussing conditions at Lot 3150, Lot 304 and Lot 2605 (Chicken Shed), it is relevant to have an understanding of the factors which influence groundwater levels. Groundwater levels on a particular site are influenced by regional groundwater levels, local Geology, rainfall, local and regional drainage, changes in land use and groundwater extraction (by the local horticultural industry).

Local differences in soil permeability and in the depth of the aquifer will influence hydraulic gradients.

The process of urbanisation can also affect groundwater levels. Trees are effective pumps removing groundwater. Clearing has the effect of raising groundwater levels. Similarly road paving and house construction removes a portion of the soil surface from which evaporation can take place. Whether or not roof runoff is piped off site or returned to the soil via soakwells will also have an effect.

In addition to the above, the process of estimating AAMGL is made more difficult by the lack of a precise definition of the term. While an environmentally based criterion of a minimum development level 1.2m above AAMGL, has been set by the relevant government authorities, it has not been made clear whether the AAMGL is:

- A long term (say 100 years), historic value before the influences of lower rainfall, regional drainage and groundwater extraction;
- A short term (say 10 years), historic value which takes into consideration the effects of lower rainfall over the last 20 years, the installation of regional drainage and extraction from local aquifers;
- The future level taking into consideration influences such as filling of the site and urbanisation and the possibility of a return to heavier rainfall.

The uncertainty in AAMGL estimates is probably $\pm$0.5m.

8.3.2 Desktop Study on Groundwater Levels

For the purpose of this desktop study, groundwater level data and extracts from the following documents have been used;

- Coffey Report on Broome Pumping Station No. 6 (Coffey report Ref: GEOTPERT08083BZ-AA) which included data from Water Information (WIN) database – discrete sample data (30 June 2009) Department of Water, Water Information Provision Section, Perth Western Australia.
- Department of Water "Study for Broome Groundwater Management Plan Review" dated November 2008.

Please note that the assessment of the groundwater boreholes is only relevant to the Lots within the Pindan Sands (Lots 3150, 304 and 2605), the sand mining area described in Section 7 is situated within white dune sands and is therefore likely to have some variation in groundwater regime.

Coffey have performed a review of publicly available information on groundwater boreholes within a 2km radius of the sites (Lots 3150, 304 and 2605). Based on these records the annual groundwater level fluctuation is in the order of ±1m, with a peak level in April. Therefore the Average Annual Maximum Groundwater Level (AAMGL) is estimated to be approximately 2.5m AHD. Coffey have assumed a reoccurrence interval of 2 years for the AAMGL.

Following a monsoonal low in January 1997, 476mm of rain fell in Broome in one day. Records of the monitoring boreholes showed the groundwater peaked approximately 1.5m above the "normal" end of wet season peak. Other peaks in groundwater elevations are noted in the record, however, climate records are not easily available to correlate these occurrences. The Maximum Probable Groundwater Level (MPGL) is therefore estimated to be 2.0m higher than the AAMGL or 4.5m AHD.

8.4 Subsoil Drains & Soak Wells

The short term historic AAMGL value, while relevant to setting levels for subsoil drains, does not allow for the effects on groundwater levels of urbanisation or the possibility of a return to heavier rainfall. If the levels described in Section 8.3 of this report are adopted, then subsoil drains must be provided along both sides of all roads and Lot connections must be provided for roof runoff.

Soak wells should not be used within 6m of footings due to the collapse potential of Pindan Sands when inundated with water.

8.5 Flexible Pavement Design

The subgrade to support the flexible pavement comprises Pindan Sand. A subgrade CBR of 4% is recommended provided the subgrade is prepared in strict compliance with site preparation recommendations given in Section 8.6. For rigid pavements (if proposed), edge confinement of the granular subgrade is essential to maintain design shear strength.

8.5.1 Pavement Design (Public Roads)

For lightly trafficked public roads, pavement thickness design should be based on the Austroads (2006) Supplement to Austroads Pavement Design Guide and prepared in accordance with principals set out in Section 8.6.3.

The mechanistic procedure set out in Main Roads WA Engineering Road Note 9 (March 2008) can lead to unrealistic pavement designs and anomalous results. The Main Roads WA (March 2008) mechanistic procedure must only be used on Main Roads WA projects.

The recommended pavement composition is:

Surface — 30mm thickness of dense graded asphalt/ 40mm thickness of (polymer modified binder) dense graded intersection mix;

tack coat;

2 coat primer seal;

prime;

Base Course	200mm Bitumen Stabilised Limestone/Crushed Rock Base/ Lateritic Gravel
Sub Base	150mm Crushed limestone/ Lateritic Gravel/Calcrete/ Crushed Rock

8.5.2 Pavement Materials

Pavement materials for public roads should conform to the "Guide to the Selection and Use of Naturally Occurring Materials as Base and Sub Base" jointly published by Main Roads Western Australia and Australian Geomechanics Society (2002).

It must be understood that some cracking is normal if self stabilising materials (lateritic gravel, ferricrete, calcrete), cement stabilised material or material with a significant linear shrinkage is used. Cracking is more visually apparent when asphalt surfacing is used compared to a sprayed seal. Cracking (which may originate in the base course) is more apparent when asphalt manufactured using laterite or ferricrete (ie red asphalt) is used as the surfacing.

Coffey does not support the use of HCTCRB.

8.6 Earthworks

8.6.1 General

Earthworks should be carried out in accordance with the principles set out in AS3798-1996.

A characteristic of high silt content sands is they can be very weakly cemented and prone to collapse settlement when inundated with water and subjected to load. An associated feature of these soils (and an indication that they may be subject to collapse) is that when wet, they may provide little support for vehicular traffic (they may rut deeply).

An accepted procedure to confirm whether the silty soils at this site are subject to collapse, is to undertake plate bearing tests firstly in the dry, and then with inundation of the plate area. It is recommended such testing be undertaken either prior to or at the commencement of, site preparation works.

8.6.2 Removal of Topsoil and Uncontrolled Fill

Limited organic material was encountered in the test pits. Organic material encountered was recorded to a depth of 0.4m bgl. It is important to note that this only relates to the material encountered in the test pits excavated, variations of organic material may be present across the Lots.

Uncontrolled fill was not encountered in the test pits.

Any organic materials and uncontrolled fill encountered during site clearance should be stripped and stockpiled.

Organic material is not suitable for use as structural filling but maybe suitable for landscaping purposes.

It should be noted that ground conditions and particularly groundwater levels may vary with the seasons. As such, site preparation procedures may differ from the above if development proceeds during the summer months when monsoonal rains are expected.

8.6.3 Proof Compaction

After the site has been stripped to the satisfaction of the Supervising Engineer, the site should be proof compacted using a heavy, self-propelled, smooth drum vibrating roller, capable of operating in variable frequency modes. A Dynapac CA 251D, or equivalent, is recommended (subject to the protection of adjacent buildings from damaging ground vibrations).

The following proof compaction procedure is recommended:

- The entire site should be given a minimum of 4 passes with the roller operating in the low frequency/high amplitude mode. A pass should include a minimum overlap of 20%.
- The site should then be given an additional minimum of 4 passes with the roller operating in the high frequency/low amplitude mode.
- All weak areas that deform excessively under rolling should be removed and replaced with clean sand/crushed rock.
- On completion of vibratory rolling, 2 passes of the site should be made with the roller operating in a static mode. This will compact the sands in the upper 300mm that were disturbed by cyclic mobility.

Due to the collapse potential of the Pindan Sand and the vibration caused by trafficked pavements, the following recommendations should be undertaken prior to preparing road pavement subgrade;

- Over excavate by up to 0.5m for an area extending at least 0.5m beyond the width of the road;
- Flood the soils and allow to drain;
- Proof compact with 4 overlapping passes of a 10 tonne smooth drum vibratory compactor in each direction, prior to back filling with the excavated material at a dry density ration of 95% of Maximum Dry Density (Modified Compactive Effort).

It is recommended that the proof compaction be monitored by an Engineer experienced in earthworks.

8.6.4 Excavation Characteristics

Excavation characteristics have been assessed based on site observations during Test pits excavation. A bobcat backhoe excavator was able to achieve the required Test pits excavation depth with relative ease.

8.6.5 Suitability of Excavated Materials for Use as Fill

Sand excavated from site may be used as structural fill, if the following criteria is satisfied;

a) Having a maximum particle size of nominally 2.36mm.

b) Containing between 20% and 30% by weight of soil fractions finer than 0.075mm

c) Having a liquid limit <25%

d) Is non-plastic

Topsoil may be used as fill in landscape areas but should not be used as structural fill.

8.6.6 Compaction Requirements

The structural fill shall be compacted to achieve a dry density ratio not less than 95% of the Modified Maximum Dry Density (MMDD), as determined from AS 1289.5.2.1.

The Contractor shall determine his loose lift thickness appropriate to the compaction plant to achieve the above compaction requirements.

It is recommended that the Contractor submits, in writing with his tender, details of his compaction plan including methods of compaction to achieve the specified level of compaction and his experience with simular materials.

Compliance with compaction requirements should be checked by carrying out field density sand replacement, AS 1289.5.3.1 and/or nuclear density meter tests AS 1289.5.8.1 and comparing the field results with the results of laboratory modified compaction tests AS 1289.5.2.1.

8.7 Construction Considerations

8.7.1 General

There are a number of activities that must be undertaken during construction to ensure compliance with design and to ensure the smooth running of the project. The following activities should be carried out during the contract.

8.7.2 Protection of Adjacent Structures

Care must be exercised when compacting in the vicinity of existing structures, particularly if vibratory compaction is being carried out.

A Technical Note is attached to assist with the selection of compaction equipment when operating near existing structures. The minimum operating distances for the different compaction plant given in this note were suggested by Tynan (1975) from work carried out by the Australian Road Research Board.

8.7.3 Site Drainage and Erosion Control

Runoff from upslope of the site should be collected and diverted away from the structures. The finished surface level of the site should be graded with falls away from the structures and their foundations. This will limit the incidence of water ponding around the footings.

A minimum fall of 2% is recommended

10 field falling head permeability tests carried out during fieldwork (detailed in Section 7.4) provided a range of permeability values from 10^{-05} to 10^{-06} m/s. For the purpose of this assessment a design value of 10^{-06} m/s (approximately 0.1 m/day) has been adopted for the Pindan Sands.

Due to this low permeability and the well documented collapse potential of the Pindan Sands when the ground is saturated and loaded (Davenport (2007) and the Water Authority of Western Australia (1990) it is recommended that soak wells are not used.

Subsoil drainage should be designed to safely dispose of storm water off site.

8.7.4 Preparation of Footing Bases in Sands

Proof compaction is recommended across the building envelopes for lightly loaded surface structures across Lots 3150 and 304

Proof compaction will require 4 overlapping passes of a 10 tonne smooth drum vibratory compactor in each direction, prior to back filling with the excavated material at a dry density ratio of 95% of Maximum Dry Density (Modified Compactive Effort).

Any uncontrolled fill must be excavated and replaced.

The bases of all footings excavations in Pindan sands should be compacted to achieve 95% of Maximum Modified Dry Density (MMDD).

A minimum of 3 MMDD tests should be carried out in the base of each footing excavation.

To facilitate compaction, the groundwater should not be any closer than 1m to the base of the footing excavation.

8.8 Construction Monitoring

8.8.1 General

Variations in ground conditions may occur between test locations. If conditions other than those described are encountered, further advice should be sought without delay.

Earthworks control testing should be undertaken in accordance with the guidelines set out in AS3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".

8.8.2 Settlement Monitoring

Settlement monitoring is recommended.

Settlement monitoring is common for major structures and can provide additional assurances to third party interests (i.e. financiers) that the performance of the structure is within the design limits.

Coffey would be pleased to advise you on a suitable settlement monitoring plan on request.

9 IMPORTANT INFORMATION ABOUT YOUR COFFEY REPORT

The reader's attention is drawn to the important information about this report which follows the main text.

10 REFERENCES

The following standards and references were used in the preparation of this report.

AS 1726-1993 SAA Geotechnical Site Investigations.

AS 1289 Method of Testing Soils For Engineering Purposes.

AS 2870-1996 Residential Slabs and Footings.

AS 3798-2007 Guidelines on Earthworks for Commercial and Residential Developments

Bowles, J.E. (1988) "Foundation Analysis and Design".

Cocks G C "Disposal of Stormwater runoff by soakage in Perth Western Australia". Australian Geomechanics Vol 42 No 3

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Institute of Public Works Engineering Australia : Western Australia Division (2006). "Policy Note: Pavement Profiles in Residential Streets".

Main Roads Western Australia and Australian Geomechanics Society (2002) " A Guide to the Selection and Use of Naturally Occurring Materials as Base and Sub Base in Roads in Western Australia"

Tynan, A.E. (1973) "Ground Vibration, Damaging Effects to Buildings". ARRB Special Report 11.

Davenport, F.(2007) Problem Soils – A West Australian Perspective. Australian Geomechanics Vol 42 No 3.

Water Authority of Western Australia (1990) Collapsible Soils: Identification and Design Considerations.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

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Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

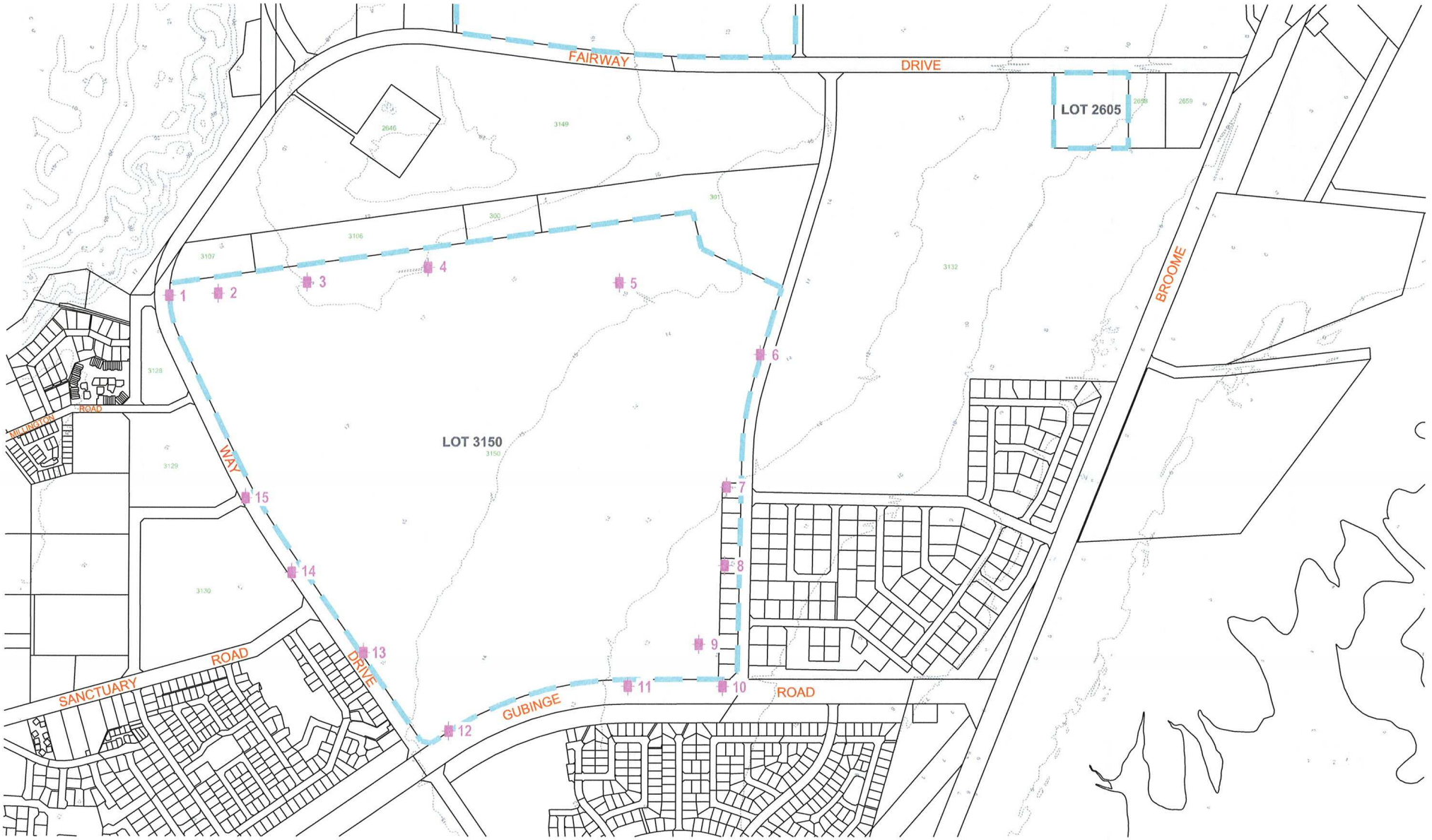
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures



LEGEND

EXISITING SURFACE CONTOUR

SITE BOUNDARY

TESTPIT LOCATION

0 100 200 300 400

Scale (metres)

drawn	HE
approved	
date	13/08/09
scale	1:10000
original size	A3

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SPECIALISTS MANAGING THE EARTH

client:	LANDCORP
project:	BROOME NORTH
title:	TEST LOCATION PLAN - LOT 3150
project no:	GEOTPERT08647AB
fig no:	FIGURE 1
rev:	

REF:
DWG: F:\GEOTPERT\00000\08647AB Broome North- Lot 3150 & 304\DWG\TP LOCATIONS.dwg



LEGEND

EXISITING SURFACE CONTOUR

SITE BOUNDARY

TESTPIT LOCATION

0 100 200 300 400

Scale (metres)

drawn	HE
approved	
date	13/08/09
scale	1:10000
original size	A3

coffey geotechnics

SPECIALISTS MANAGING THE EARTH

client: LANDCORP

project: BROOME NORTH

title: TEST LOCATION PLAN - LOT 304, LOT 2605 AND SAND MINING AREA

project no: GEOTPERT08647AB | fig no: FIGURE 2 | rev:

REF:
DWG: F:\GEOTPERT\00000\08647AB Broome North- Lot 3150 & 304\DWG\TP LOCATIONS.dwg

Appendix A

Results of Field Investigation

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Engineering Log - Excavation

Excavation No	TP1
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Client : Landcorp

Principal : Landcorp

Project : Broome North

Location : Lot 3150

Position : E: 417329.946, N: 8018401.274 (50 MGA94) Surface Elevation : 16.01m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	16.0	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					15.5	0.5							
					15.0	1.0							
					14.5	1.5							
					14.0	2.0							
					13.5	2.5			EXCAVATION TP1 TERMINATED AT 2.50 m				
					13.0	3.0							
					12.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP2
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	31/7/09
Principal :	Landcorp
Date completed	31/7/09
Project :	Broome North
Logged by :	NF
Location :	Lot 3150
Checked by :	

Position : E: 417459.897, N: 8018406.81 (50 MGA94) Surface Elevation : 18.77m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H VH)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed		18.77	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					18.5	0.5							
					18.0	1.0							
					17.5	1.5							
					17.0	2.0			....becoming well cemented		VD		
					16.5	2.5			EXCAVATION TP2 TERMINATED AT 2.50 m				
					16.0	3.0							
					15.5	3.5							
					15.0								

COFFEY_03 GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration (VE E F H VH)

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP3
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 417686.822, N: 8018434.42 (50 MGA94) Surface Elevation : 17.67m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N	Not Observed		17.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					17.0	0.5							
					16.5	1.0							
					16.0	1.5							
					15.5	2.0			....becoming well cemented		VD		
					15.0	2.5			EXCAVATION TP3 TERMINATED AT 2.50 m				
					14.5	3.0							
					14.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS.GPJ DWG 6230-4 GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H VH

water
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP4
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	31/7/09
Principal :	Landcorp
Date completed	31/7/09
Project :	Broome North
Logged by :	NF
Location :	Lot 3150
Checked by :	

Position : E: 418018.945, N: 8018476.292 (50 MGA94) Surface Elevation : 18.05m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed		18.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					17.5	0.5							
											VD		
					17.0	1.0							
					16.5	1.5							
					16.0	2.0			....becoming well cemented				
					15.5	2.5			EXCAVATION TP4 TERMINATED AT 2.50 m				
					15.0	3.0							
					14.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS GPJ DWG 2304.GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E W F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP5
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 418528.399, N: 8018435.941 (50 MGA94) Surface Elevation : 16.37m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed		16.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		Roots encountered down to 0.4m
					15.5	0.5							
					15.0	1.0							
					14.5	1.5							
					14.0	2.0			....becoming well cemented		VD		
					13.5	2.5			EXCAVATION TP5 TERMINATED AT 2.50 m				
					13.0	3.0							
					12.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:10

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration (VE E F H VH)

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP6
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	31/7/09
Principal :	Landcorp
Date completed	31/7/09
Project :	Broome North
Logged by :	NF
Location :	Lot 3150
Checked by :	

Position : E: 418905.502, N: 8018246.24 (50 MGA94) Surface Elevation : 14.32m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	14.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					13.5	0.5							
					13.0	1.0							
					12.5	1.5							
					12.0	2.0							
					11.5	2.5			EXCAVATION TP6 TERMINATED AT 2.50 m				
					11.0	3.0							
					10.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:10

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE E F H

water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP7
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Date excavated	31/7/09
Date completed	31/7/09
Logged by	NF
Checked by	

Client : Landcorp

Principal : Landcorp

Project : Broome North

Location : Lot 3150

Position : E: 418816.912, N: 8017895.267 (50 MGA94) Surface Elevation : 11.97m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F S H	N	Not Observed		11.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	Roots encountered down to 0.5m
					11.0	0.5							
					10.5	1.0							
					10.0	1.5					VD		
					9.5	2.0			....becoming well cemented				
					9.0	2.5			EXCAVATION TP7 TERMINATED AT 2.50 m				
					8.5	3.0							
					8.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LCQS.GPJ DWG 2304.GDW 31/08/2009 15:10

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F S H

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

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Engineering Log - Excavation

Excavation No	TP8
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 418812.226, N: 8017686.908 (50 MGA94) Surface Elevation : 10.81m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	10.5 / 10.0 / 9.5 / 9.0 / 8.5 / 8.0 / 7.5 / 7.0	0.0 / 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
									EXCAVATION TP8 TERMINATED AT 2.50 m				

COFFEY_03 GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS GPJ DWG 8/2/2008 15:10

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP9
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 418743.247, N: 8017478.099 (50 MGA94) Surface Elevation : 13.03m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed		13.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					12.5	0.5							
					12.0	1.0							
					11.5	1.5							
					11.0	2.0							
					10.5	2.5			EXCAVATION TP9 TERMINATED AT 2.50 m				
					10.0	3.0							
					9.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG92304.GDW 31/08/2009 15:10

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE VL L M H VH

water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_l - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP10
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 418808.076, N: 8017366.477 (50 MGA94) Surface Elevation : 11.59m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	11.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					11.0	0.5							
					10.5	1.0							
					10.0	1.5							
					9.5	2.0							
					9.0	2.5			EXCAVATION TP10 TERMINATED AT 2.50 m				
					8.5	3.0							
					8.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE VL L MD D VD

water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP11
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	31/7/09
Principal :	Landcorp
Date completed	31/7/09
Project :	Broome North
Logged by :	NF
Location :	Lot 3150
Checked by :	

Position : E: 418555.029, N: 8017366.828 (50 MGA94) Surface Elevation : 12.67m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed		12.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					12.0	0.5							
					11.5	1.0							
					11.0	1.5							
					10.5	2.0							
					10.0	2.5			EXCAVATION TP11 TERMINATED AT 2.50 m				
					9.5	3.0							
					9.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT08647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP12***
Sheet No.	1 of 1
Project No.	***GEOTPERT08647AB***
Client :	***Landcorp***
Date excavated	***31/7/09***
Principal :	***Landcorp***
Date completed	***31/7/09***
Project :	***Broome North***
Logged by :	***NF***
Location :	***Lot 3150***
Checked by :	

Position : E: 418078.315, N: 8017247.584 (50 MGA94) Surface Elevation : 14.72m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	VE E F H penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	Not Observed		14.5	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					14.0	0.5							
					13.5	1.0							
					13.0	1.5							
					12.5	2.0			....becoming well cemented		VD		
					12.0	2.5			EXCAVATION TP12 TERMINATED AT 2.50 m				
					11.5	3.0							
					11.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:09

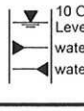
method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration



water



10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP13
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 3150
Date excavated	31/7/09
Date completed	31/7/09
Logged by :	NF
Checked by :	

Position : E: 417848.18, N: 8017455.4 (50 MGA94) Surface Elevation : 16.94m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	VE E F H penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	Not Observed		16.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0			....becoming well cemented		VD		
					14.0	2.5			EXCAVATION TP13 TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG52304.GDV 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear, P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP14
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	31/7/09
Principal :	Landcorp
Date completed	31/7/09
Project :	Broome North
Logged by :	NF
Location :	Lot 3150
Checked by :	

Position : E: 417660.214, N: 8017667.917 (50 MGA94) Surface Elevation : 16.55m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed		16.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0							
					14.0	2.5			EXCAVATION TP14 TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS GPJ SWG62304 GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_l - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP15***
Sheet No.	1 of 1
Project No.	***GEOTPERT08647AB***
Client :	***Landcorp***
Date excavated	***31/7/09***
Principal :	***Landcorp***
Date completed	***31/7/09***
Project :	***Broome North***
Logged by :	***NF***
Location :	***Lot 3150***
Checked by :	

Position : E: 417535.529, N: 8017865.205 (50 MGA94) Surface Elevation : 16.62m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed		16.5	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0							
					14.0	2.5			EXCAVATION TP15 TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 3150 LOGS.GPJ DWG62304.GDW 31/08/2009 15:09

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration (VE E F H VH)

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP1b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418662.344, N: 8019753.494 (50 MGA94) Surface Elevation : 16.35m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E S F H	N	Not Observed	B	16.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					15.5	0.5							
					15.0	1.0							
					14.5	1.5							
					14.0	2.0							
					13.5	2.5			EXCAVATION TP1b TERMINATED AT 2.50 m				
					13.0	3.0							
					12.5	3.5							

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E S F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

COFFEY_03.GLB Log EXCAVATION GEOTPERT08647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP2b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418739.356, N: 8019785.602 (50 MGA94) Surface Elevation : 16.23m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F St VSt H	N	Not Observed		16.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	Roots in top 0.5m
					15.5	0.5							
					15.0	1.0							
					14.5	1.5							
					14.0	2.0							
					13.5	2.5			EXCAVATION TP2b TERMINATED AT 2.50 m				
					13.0	3.0							
					12.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE E F St VSt H

water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP3b***
Sheet No.	1 of 1
Project No.	***GEOTPERT08647AB***
Client :	***Landcorp***
Date excavated	***1/8/09***
Principal :	***Landcorp***
Date completed	***1/8/09***
Project :	***Broome North***
Logged by :	***NF***
Location :	***Lot 304***
Checked by :	

Position : E: 418816.125, N: 8019865.802 (50 MGA94) Surface Elevation : 16.75m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	VE E F H penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	Not Observed	B	16.5	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		Roots to 0.5m
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0							
					14.0	2.5			EXCAVATION TP3b TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

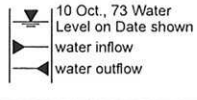
method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration



water



samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP4b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418913.852, N: 8019774.635 (50 MGA94) Surface Elevation : 16.64m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed		16.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0							
					14.0	2.5			EXCAVATION TP4b TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT08647AB LOT 304 LOGS GPJ <<DrawingFile>> 31/08/2009 16:44

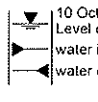
method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration



water



samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear, P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_l - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP5b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	1/8/09
Principal :	Landcorp
Date completed	1/8/09
Project :	Broome North
Logged by :	NF
Location :	Lot 304
Checked by :	

Position : E: 418970.556, N: 8019489.67 (50 MGA94) Surface Elevation : 16.88m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E P H	N	Not Observed		16.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	Excavation carried out in drainage channel
					16.0	0.5							
					15.5	1.0							
					15.0	1.5							
					14.5	2.0			....becoming well cemented		VD		
					14.0	2.5			EXCAVATION TP5b TERMINATED AT 2.50 m				
					13.5	3.0							
					13.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS GPJ <<Drawingfile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE E P H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP6b***
Sheet No.	1 of 1
Project No.	***GEOTPERT08647AB***
Client :	***Landcorp***
Principal :	***Landcorp***
Project :	***Broome North***
Location :	***Lot 304***
Date excavated	***1/8/09***
Date completed	***1/8/09***
Logged by :	***NF***
Checked by :	

Position : E: 418964.695, N: 8019074.951 (50 MGA94) Surface Elevation : 14.66m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed	B	14.5	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					14.0	0.5							
					13.5	1.0							
					13.0	1.5							
					12.5	2.0							
					12.0	2.5			EXCAVATION TP6b TERMINATED AT 2.50 m				
					11.5	3.0							
					11.0	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration (VE E F H VH)

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP7b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418719.921, N: 8019014.453 (50 MGA94) Surface Elevation : 15.99m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed		15.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					15.0	0.5							
					14.5	1.0							
					14.0	1.5							
					13.5	2.0							
					13.0	2.5			EXCAVATION TP7b TERMINATED AT 2.50 m				
					12.5	3.0							
						3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT8647AB LOT 304.GCS GPJ <<DrawingFile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP8b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	1/8/09
Principal :	Landcorp
Date completed	1/8/09
Project :	Broome North
Logged by :	NF
Location :	Lot 304
Checked by :	

Position : E: 418433.25, N: 8019032.147 (50 MGA94) Surface Elevation : 18.03m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration (VE E F H VH)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	Not Observed		18.0	0.0		SC-SM	**SILTY CLAYEY SAND** fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					17.5	0.5							
					17.0	1.0							
					16.5	1.5							
					16.0	2.0							
					15.5	2.5			EXCAVATION TP8b TERMINATED AT 2.50 m				
					15.0	3.0							
					14.5	3.5							

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration (VE E F H VH)

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

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Engineering Log - Excavation

Excavation No	TP9b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Date excavated	1/8/09
Principal :	Landcorp
Date completed	1/8/09
Project :	Broome North
Logged by :	NF
Location :	Lot 304
Checked by :	

Position : E: 418120.335, N: 8019121.711 (50 MGA94) Surface Elevation : 19.58m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E P H	N	Not Observed		19.5	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					19.0	0.5							
					18.5	1.0							
					18.0	1.5							
					17.5	2.0			....becoming well cemented		VD		
					17.0	2.5			EXCAVATION TP9b TERMINATED AT 2.50 m				
					16.5	3.0							
					16.0	3.5							

COFFEY_03 GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS GPJ <<DrawingFile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E P H

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_l - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP10b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Date excavated	1/8/09
Date completed	1/8/09
Logged by	NF
Checked by	

Client : Landcorp

Principal : Landcorp

Project : Broome North

Location : Lot 304

Position : E: 418120.236, N: 8019252.693 (50 MGA94) Surface Elevation : 17.73m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	17.5 / 17.0 / 16.5 / 16.0 / 15.5 / 15.0 / 14.5 / 14.0	0.0 / 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
									EXCAVATION TP10b TERMINATED AT 2.50 m				

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 15:43

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F H VH

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear, P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_l - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP11b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418119.802, N: 8019424.815 (50 MGA94) Surface Elevation : 15.35m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N	Not Observed	B	15.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D		
					14.5	0.5							
					14.0	1.0							
					13.5	1.5							
					13.0	2.0			....becoming well cemented		VD		
					12.5	2.5			EXCAVATION TP11b TERMINATED AT 2.50 m				
					12.0	3.0							
					11.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT8647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 15:43

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration

VE E F H

water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

Engineering Log - Excavation

Excavation No	TP12b
Sheet No.	1 of 1
Project No.	GEOTPERT08647AB
Client :	Landcorp
Principal :	Landcorp
Project :	Broome North
Location :	Lot 304
Date excavated	1/8/09
Date completed	1/8/09
Logged by :	NF
Checked by :	

Position : E: 418108.498, N: 8019535.005 (50 MGA94) Surface Elevation : 15.36m (AHD)

Equipment type : Backhoe Method : Bucket Excavation dimensions : 3.00m long 1.00m wide

excavation information | **material substance**

method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components)	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F P R	N	Not Observed	B	15.0	0.0		SC-SM	SILTY CLAYEY SAND fine grained, red to brown; fines are of low plasticity, weakly cemented	D	D	100 200 300 400	
					14.5	0.5							
					14.0	1.0							
					13.5	1.5							
					13.0	2.0			....becoming well cemented		VD		
					12.5	2.5			EXCAVATION TP12b TERMINATED AT 2.50 m				
					12.0	3.0							
					11.5	3.5							

COFFEY_03.GLB Log EXCAVATION GEOTPERT08647AB LOT 304 LOGS.GPJ <<DrawingFile>> 31/08/2009 16:44

method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration
VE E F P R

water
- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests
- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
- PBT - Plate Bearing Test

classification symbols & soil description
Based on Unified Classification System

moisture
- D - Dry
- M - Moist
- W - Wet
- W_P - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

coffey geotechnics

PERTH SAND PENETROMETER ✓
AS1289.6.3.3 - 1997
SCALA PENETROMETER TEST
AS1289.6.3.2 - 1997

Test Report No. 1
Job No: GEOTPERT08647AB
Office: Perth

Client: LANDCORP Principal: LANCORP Project: BROOME NORTH Location: BROOME 3150 Soil type: PINDAN SAND Soil moisture: DRY Depth to water: NOT ENCOUNTERED	date: 31/07/2009 tested by: NF hammer mass: 6KG hammer drop: 6000MM penetrometer used: Coffey 1

Test Location	TP1	TP2	TP3	TP4	TP5	TP6
Ground Level m AHD	16.01	18.77	17.67	18.05	16.37	14.32

Test Depth mm	Blows/150mm					
0-150	SET	SET	SET	SET	SET	SET
150-300	8	10	11	15	10	10
300-450	15R	15R	15R	15R	15R	10
450-600						15R
600-750						
750-900						
900-1050						
1050-1200						
1200-1350						
1350-1500						
1500-1650						
1650-1800						
1800-1950						
1950-2100						
2100-2250						
2250-2400						
2400-2550						
2550-2700						
2700-2850						
2850-3000						
3000-3150						
3150-3300						
3300-3450						

Note: Testing was continuous without augering to target depth except where shown.

Signatory

coffey geotechnics

PERTH SAND PENETROMETER ✓
AS1289.6.3.3 - 1997
SCALA PENETROMETER TEST
AS1289.6.3.2 - 1997

Test Report No. 1
Job No: GEOTPERT08647AB
Office: Perth

Client: LANDCORP Principal: LANCORP Project: BROOME NORTH Location: BROOME 3150 Soil type: PINDAN SAND Soil moisture: DRY Depth to water: NOT ENCOUNTERED	date: 31/07/2009 tested by: NF hammer mass: 6KG hammer drop: 6000MM penetrometer used: Coffey 1

Test Location	TP7	TP8	TP9	TP10	TP11	TP12
Ground Level m AHD	11.97	10.81	13.03	11.60	12.67	14.72

Test Depth mm	Blows/150mm					
0-150	SET	SET	SET	SET	SET	SET
150-300	10	10	9	10	10	7
300-450	15R	10	15	9	10	8
450-600		15R	15R	15R	15R	10
600-750						15
750-900						15R
900-1050						
1050-1200						
1200-1350						
1350-1500						
1500-1650						
1650-1800						
1800-1950						
1950-2100						
2100-2250						
2250-2400						
2400-2550						
2550-2700						
2700-2850						
2850-3000						
3000-3150						
3150-3300						
3300-3450						

Note: Testing was continuous without augering to target depth except where shown.

Signatory

coffey geotechnics

PERTH SAND PENETROMETER ✓
AS1289.6.3.3 - 1997
SCALA PENETROMETER TEST
AS1289.6.3.2 - 1997

Test Report No. 1
Job No: GEOTPERT08647AB
Office: Perth

Client: LANDCORP Principal: LANCORP Project: BROOME NORTH Location: BROOME 3150 Soil type: PINDAN SAND Soil moisture: DRY Depth to water: NOT ENCOUNTERED	date: 31/07/2009 tested by: NF hammer mass: 6KG hammer drop: 6000MM penetrometer used: Coffey 1

Test Location	TP13	TP14	TP15			
Ground Level m AHD	16.94	16.55	16.62			

Test Depth mm	Blows/150mm					
0-150	SET	SET	SET	SET	SET	SET
150-300	9	10	9			
300-450	10	15R	15R			
450-600	15R					
600-750						
750-900						
900-1050						
1050-1200						
1200-1350						
1350-1500						
1500-1650						
1650-1800						
1800-1950						
1950-2100						
2100-2250						
2250-2400						
2400-2550						
2550-2700						
2700-2850						
2850-3000						
3000-3150						
3150-3300						
3300-3450						

Note: Testing was continuous without augering to target depth except where shown.

Signatory

coffey geotechnics

PERTH SAND PENETROMETER ✓
AS1289.6.3.3 - 1997
SCALA PENETROMETER TEST
AS1289.6.3.2 - 1997

Test Report No. 1
Job No: GEOTPERT08647AB
Office: Perth

Client: LANDCORP Principal: LANCORP Project: BROOME NORTH Location: BROOME 304 Soil type: PINDAN SAND Soil moisture: DRY Depth to water: NOT ENCOUNTERED	date: 1/08/2009 tested by: NF hammer mass: 6KG hammer drop: 6000MM penetrometer used: Coffey 1

Test Location	TP1b	TP2b	TP3b	TP4b	TP5b	TP6b
Ground Level m AHD	16.36	16.23	16.75	16.64	16.88	14.66

Test Depth mm	Blows/150mm					
0-150	SET	SET	SET	SET	SET	SET
150-300	10	10	11	9	15	10
300-450	15R	10	15R	15R	15R	15R
450-600		15R				
600-750						
750-900						
900-1050						
1050-1200						
1200-1350						
1350-1500						
1500-1650						
1650-1800						
1800-1950						
1950-2100						
2100-2250						
2250-2400						
2400-2550						
2550-2700						
2700-2850						
2850-3000						
3000-3150						
3150-3300						
3300-3450						

Note: Testing was continuous without augering to target depth except where shown.

Signatory

coffey geotechnics

PERTH SAND PENETROMETER ✓
AS1289.6.3.3 - 1997
SCALA PENETROMETER TEST
AS1289.6.3.2 - 1997

Test Report No. 1
Job No: GEOTPERT08647AB
Office: Perth

Client: LANDCORP Principal: LANCORP Project: BROOME NORTH Location: BROOME 304 Soil type: PINDAN SAND Soil moisture: DRY Depth to water: NOT ENCOUNTERED	date: 1/08/2009 tested by: NF hammer mass: 6KG hammer drop: 6000MM penetrometer used: Coffey 1

Test Location	TP7b	TP8b	TP9b	TP10b	TP11b	TP12b
Ground Level m AHD	15.99	18.03	19.58	17.74	15.35	15.36

Test Depth mm	Blows/150mm					
0-150	SET	SET	SET	SET	SET	SET
150-300	10	10	10	10	10	9
300-450	10	9	15R	10	10	15R
450-600	15R	10		15R	15R	
600-750		15R				
750-900						
900-1050						
1050-1200						
1200-1350						
1350-1500						
1500-1650						
1650-1800						
1800-1950						
1950-2100						
2100-2250						
2250-2400						
2400-2550						
2550-2700						
2700-2850						
2850-3000						
3000-3150						
3150-3300						
3300-3450						

Note: Testing was continuous without augering to target depth except where shown.

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Appendix B

Results of Geotechnical Laboratory Testing

KIMBERLEY SOILS LABORATORY

Surfmet Pty Ltd trading as Kimberley Soils Laboratory ABN 40 109 682 493
Gus Winckel Road, Broome, Australia

Tel: 0410 341 636
Phone: (08) 9192 3126
Fax: (08) 9192 3012

PO Box 1897, Broome, WA 6725
E-mail: kimberleysoils@westnet.com.au

TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	1.0-1.5
SAMPLE No:	09KSL 935	**PROPOSED USE:**	--
PROJECT:	Supplied Sample	**RECEIVED DATE:**	31/07/2009
LOCATION:	3150-TP1	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

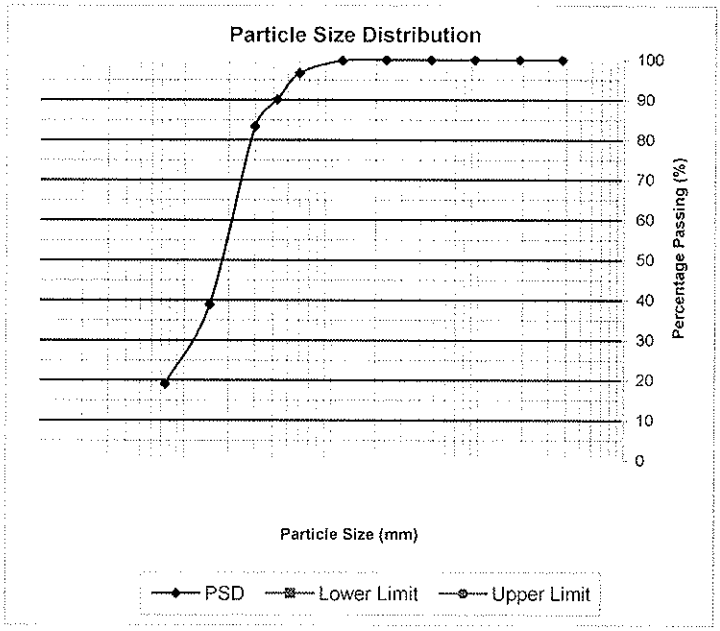
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	97
0.425	90
0.300	83
0.150	39
0.075	19

DUST RATIO

0.21



Notes

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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	2.0-2.5m
SAMPLE No:	09KSL 937	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	31/07/2009
LOCATION:	3150-TP6	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

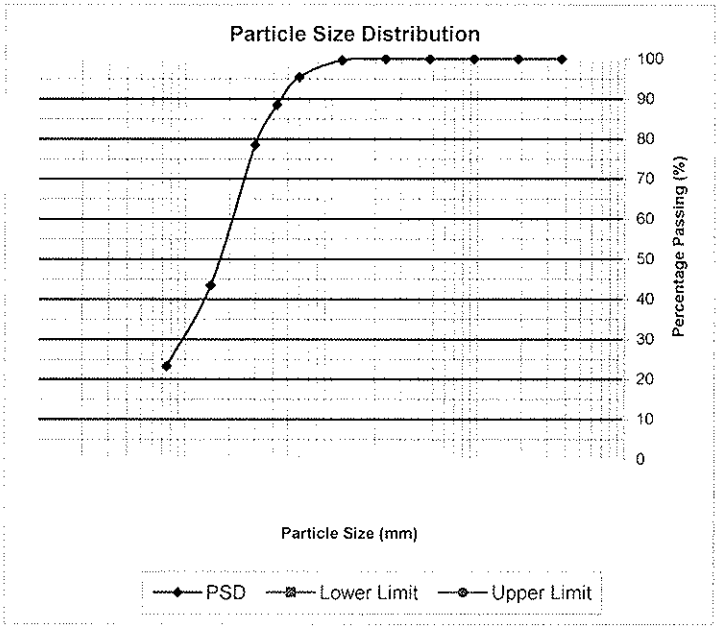
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	**100**
37.5	**100**
19.0	**100**
9.5	**100**
4.75	**100**
2.36	**100**
1.18	**100**
0.600	**95**
0.425	**89**
0.300	**79**
0.150	**44**
0.075	**23**

DUST RATIO

0.26



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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	0.5-1.0m
SAMPLE No:	09KSL 938	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	31/07/2009
LOCATION:	3150-TP8	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

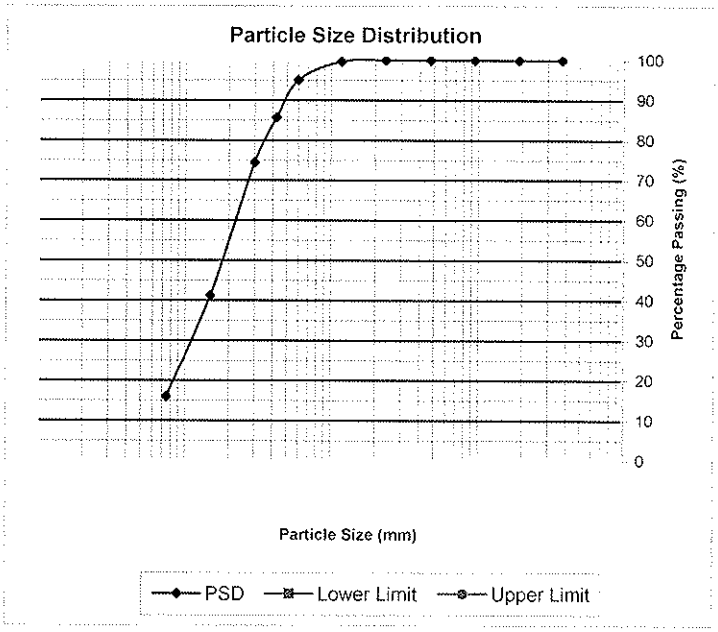
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	95
0.425	86
0.300	74
0.150	41
0.075	16

DUST RATIO

0.19



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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	1.0-1.5
SAMPLE No:	09KSL 934	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	31/07/2009
LOCATION:	3150-TP10	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

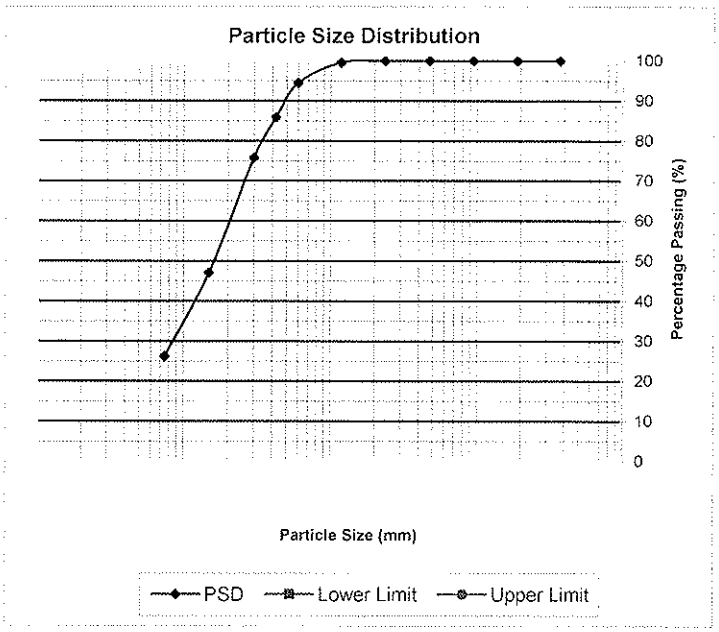
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	95
0.425	86
0.300	76
0.150	47
0.075	26

DUST RATIO

0.31



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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	0.5-1.0m
SAMPLE No:	09KSL 936	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP1B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

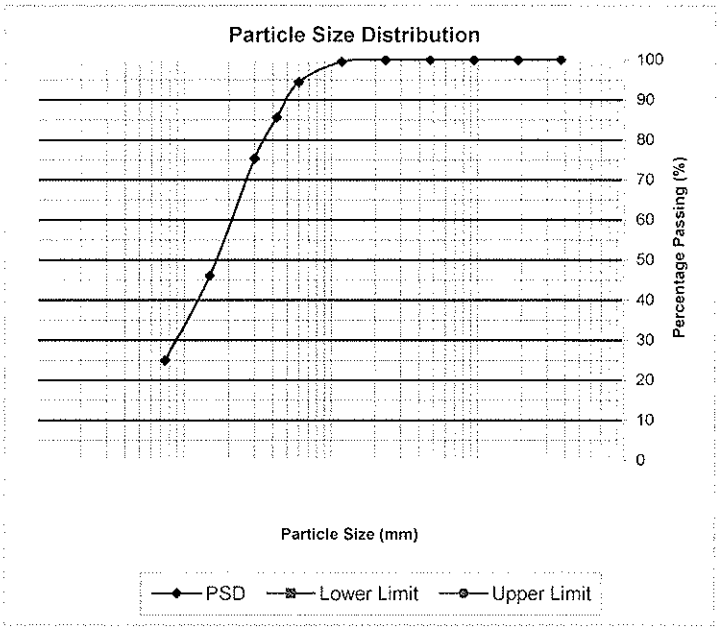
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	94
0.425	86
0.300	75
0.150	46
0.075	25

DUST RATIO

0.29



Notes

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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	0.5-0.6m
SAMPLE No:	09KSL 940	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP3B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

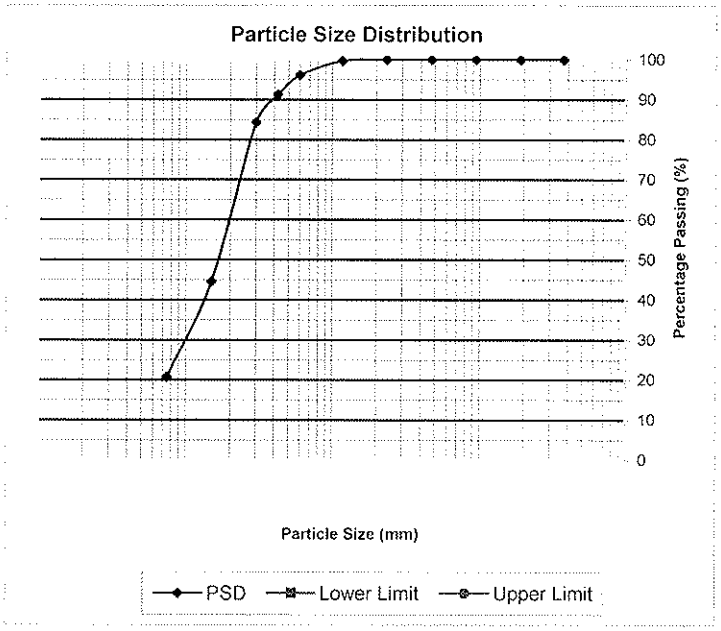
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	96
0.425	91
0.300	84
0.150	45
0.075	21

DUST RATIO

0.23



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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	1.0-1.2m
SAMPLE No:	09KSL 939	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP6B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

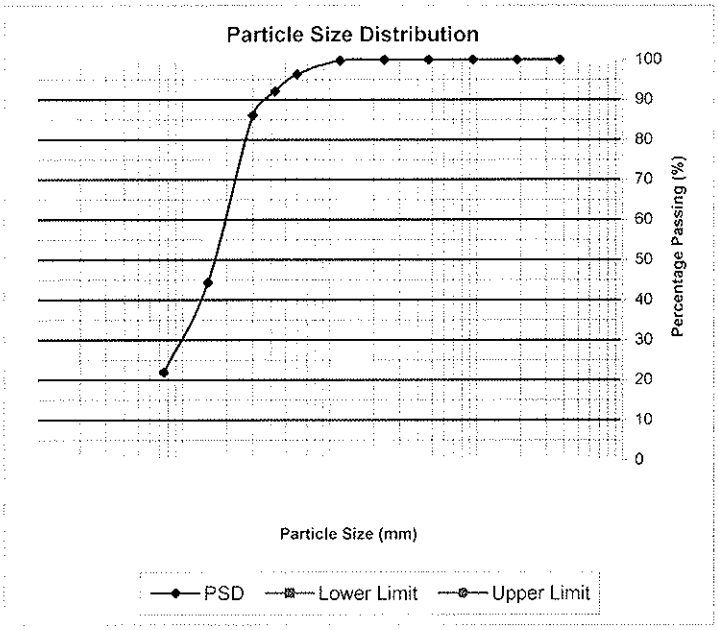
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	96
0.425	92
0.300	86
0.150	44
0.075	22

DUST RATIO

0.24



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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	1.0-1.5m
SAMPLE No:	09KSL 943	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP9B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

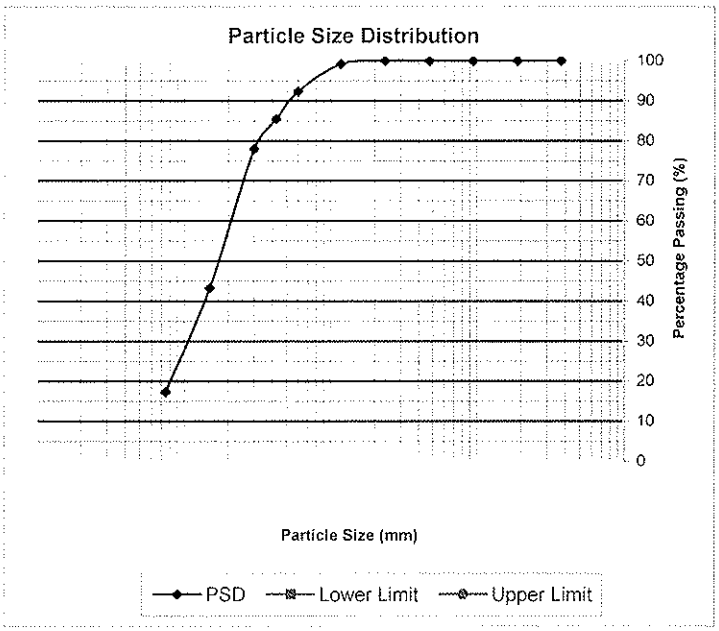
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	99
0.600	92
0.425	85
0.300	78
0.150	43
0.075	17

DUST RATIO

0.20



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TABEC
Civil Engineering Consultants



LandCorp

Local Development Plan 3
BROOME NORTH

Engineering Infrastructure Report

CLIENT: LANDCORP

PROJECT: 2287 – BROOME NORTH LDP3

TITLE: BROOME NORTH LDP3 ENGINEERING INFRASTRUCTURE REPORT

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
REV 1 (DRAFT)	27 JANUARY 2014	BBF	BJP	BBF
REV 2	25 MARCH 2014	BJP	BBF	BBF
REV 3	8 MAY 2014	BBF	CCB	BBF
REV 4	13 MAY 2014	BJP	BBF	BBF

Note:

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1 INTRODUCTION AND SUMMARY

1.1 Introduction

TABEC Pty Ltd has prepared this report for the Broome North Local Development Plan 3 (LDP3). A team of consultants on behalf of LandCorp has carried out the preparation of LDP3. The LDP3 area forms part of the Broome North District Structure Plan.

The report provides civil engineering advice on the capability and future requirements of the development plan area to support the proposed development and the civil engineering influences on the development plan form.

This report has been based on the civil engineering aspects of urban residential and related land uses. In particular we have considered earthworks, roads, drainage, wastewater and utility services with a particular emphasis on stormwater management and major servicing requirement to support urban development.

The investigation and preparation of the report are mainly based on preliminary advice from the various service authorities. The information is current as of February 2014 and is subject to change as the development proceeds around the proposed development site.



Figure 1 – Broome North LDP3 Aerial

2 THE STUDY AREA

The proposed LDP3 Framework Plan prepared by Taylor Burrell Barnett (TBB) is shown in Figure 2.



Figure 2 – Broome North LDP3 Framework Plan (TBB)

The LDP3 development site is approximately 131.5Ha and is bounded by Fairway Drive and Water Corporation Tank site to the north; the existing Broome North Local Development Plan 1 (LDP1) area to the east; Fairway Drive, Sanctuary Road, Lulfitz Drive (Oryx Drive) and Coucal Street to the west and Gubinge Road to the south.

The Local Development Plan identifies indicative zonings and locations of roads and public open space (POS) within the Plan area. The plan area comprises of urban, neighbourhood and bush living ranging in densities from R5 to R40 and tourism sites. In addition the plan includes the extension of the 150m wide Ecological Cultural Corridor (ECC) from LDP1, running east-west along the northern boundary of the development and the creation of linear POS that traverse the centre and boundaries of LDP3 residential areas connecting with existing POS. These multiple use corridors (MUC) will provide the main drainage function for the development site, linking with the existing LDP1 drainage before discharging via a culvert under Gubinge Road.

The current estimated lot yield for the development area is approximately 590 lots which can potentially provide approximately 857 dwellings. The proposed development yield and elements will be subject to further refinement and modification at the subdivision design stage.

2.1 Landform / Topography

The LDP3 area features existing vegetation consisting of scattered trees and low grassland species typical of a low and open Pindan woodland.

The topography is relatively flat with a small ridge running northeast – southwest dividing the site and a steeper ridge along the northern portion of LDP3. The majority of the site has a grade between 0% and 0.8%, though there is a small section of the northern portion where the grade is up to 2%. The site predominantly falls from an approximate level of RL 17.2m on the dividing ridge to RL 13.8m in the southeast and to a lesser degree to RL 15.4m in the northwest. There is also a high point of approximately RL 20.0m located in the proposed ECC along the northern boundary of the site.

Figure 3 shows the existing terrain within LDP3.

2.2 Ground Conditions

Douglas Partners have undertaken an initial desktop investigation over the LDP3 area, which is included in Appendix A.

The Broome-Roebuck Plains 1:50,000 Environmental Geology Series Map indicates red-brown silty sand generally underlie the LDP3 site. The geological unit is the same as in the LDP1 and Broome North Local Development Plan 2 (LDP2) areas. Review of the soil conditions encountered within previous Broome North geotechnical investigations, which occurred within the same geological unit as the LDP3 site indicate the following shallow soils;

- Topsoil – generally to a depth of 0.1m.
- Sand – medium dense, light brown sand encountered below the topsoil to a maximum depth of 0.5m in limited locations.
- Silty Sand – very loose to medium dense, red-brown silty sand with a trace of clay up to 5.0m depth across LDP1 and LDP2.
- Sandy Silty Clay – clay content may increase below 5.0m to red-brown sandy silty clay.

The soil unit described above is locally identified as 'Pindan Sand'. Pindan Sand is recognised as a soil with collapsing potential. Collapsing soil is a weakly cemented material that is potentially subject to large settlement upon wetting under load.

Moderate to high fines content of Pindan Sand results in low infiltration values and generally precludes methods for onsite stormwater disposal. Based on typical in situ test values measured in the area, a presumptive permeability value of between 1×10^{-6} m/s and 1×10^{-7} m/s is anticipated for the soils beneath the site. Therefore, it is expected that stormwater disposal will utilise detention basins and swales as per LDP1.

Due to the occurrence of Pindan sands, based on the recommendations of AS2870 a class "P" classification is associated to the site. An improved classification can be targeted and achieved with suitable soil preparation.

Further geotechnical investigation will be required at the subdivision stage to confirm assumptions.

2.3 Groundwater

A number of factors including regional groundwater levels, local geology, rainfall and urbanisation influence groundwater levels.

A desktop study of the groundwater levels undertaken by Coffey Geotechnics for the Broome North District Development Plan indicated the average annual maximum groundwater level (AAMGL) is approximately RL 2.5m AHD and an estimated maximum probably groundwater level (MPGL) 2.0m higher at RL 4.5m AHD.

Groundwater levels are not expected to impact adversely on the development of LDP3.

2.4 Unexploded Ordnance Assessment

Milsearch in December 2009 conducted an Unexploded Ordnance (UXO) Assessment over the Broome North District Development Plan area, including the LDP3 area. The conclusions from the report indicated that no UXO residue or solid-shot projectiles were situated in the area assessed. Milsearch state that future planned development within those areas assessed and recorded by their report, can now proceed without further concern for potential UXO hazards.



Figure 3 – Broome North LDP3 Existing Contours

3 SITEWORKS

Siteworks for urban development generally comprises the clearing of existing vegetation and the earthworking of existing ground surfaces to facilitate a required form of development.

Notwithstanding the above, there is a growing appreciation of the importance to retain significant existing vegetation and topography to provide a sense of place within development areas and to meet sustainability objectives.



Picture 1 – Clearing works undertaken in LDP1

Prior to siteworks, significant vegetation can be identified for potential retention and typically vegetation within ±150mm earthwork band and outside the service trenching requirements can be retained. In addition POS areas that don't have a drainage function can also generally provide opportunities for the retention or incorporation of significant vegetation into their design.

Earthworking of the site, particularly lot areas and road reserves will be required to ensure the positive drainage of the lots to the road reserves for disposal. Finished development levels within LDP3 will need to account for the existing road levels of Tanami Drive, Gubinge Road, Fairway Drive, Sanctuary Road, Lulfitz Drive (Oryx Drive) and Coucal Street as well as existing ground levels for the MUC along the eastern boundary and A Class Reserve on the northern boundary.



Picture 2 – Typical earthworks undertaken in LDP1

It is anticipated that siteworks within the LDP3 area will be undertaken such that foundations for residential development on the created lots within the proposed development can be designed for the desired Australian Standard Classification, as set out in AS2870-1996.

Figure 4 shows a concept earthworks design for LDP3.



Figure 4 – Broome North LDP3 Earthworks Concept Design

4 ROADS AND TRAFFIC

Riley Consulting, on behalf of LandCorp, has prepared a Structure Plan Traffic Report to consider the traffic and transport impacts of the Broome North LDP3. Their traffic report has been provided separate to this report.

The primary road access to the LDP3 area is planned to be via an extension of Tanami Drive from LDP1 to an intersection with Fairway Drive and Sanctuary Road. Main accesses will also be provided through the creation of a new Neighbourhood Connector linking Tanami Drive to Fairway Drive along the eastern boundary and the realignment of Fairway Drive/Lulfitz Drive (noted as Oryx Drive on LDP3) along the western boundary of LDP3.

The internal street network within LDP3 has been planned in regard to the requirements of Department of Planning and Infrastructure Liveable Neighbourhoods and will consist of major and local access streets to provide local access. The high level objective for LDP3 is to provide a well-connected street network for access and to develop safe, attractive streets for living.



Picture 3 – Tanami Drive in LDP1



Picture 4 – Typical road in LDP1

The engineering design of the streets will be based on the Shire of Broome subdivisional guidelines, Liveable Neighbourhoods recommendations and stormwater drainage requirements. Street cross-sections will be designed to consider utility services, street trees, parking and paths.

A network of paths will be provided throughout the development in accordance with the Riley Consulting Structure Plan Traffic Report and Shire of Broome subdivisional guidelines.

5 STORMWATER DRAINAGE

5.1 Urban Water Management Strategy

Total water cycle management, also referred to as integrated water cycle management, 'recognises that water supply, stormwater and sewerage services are interrelated components of catchment systems and therefore must be dealt with using a holistic water management approach that reflects the principles of ecological sustainability' (Department of Water, 2004 – 2007, Stormwater Management Manual for Western Australia).

GHD, on behalf of LandCorp, has prepared a Local Water Management Strategy in accordance with the Broome North District Water Management Strategy (DWMS) (GHD and SKM 2009) and Better Urban Water Management (WAPC, October 2008) to support the proposed development of the Broome North LDP3 area. The key principles of integrated urban water management are:

- Minimise total water use in the development area;
- Protect infrastructure and assets from inundation and flooding;
- Manage groundwater levels to protect infrastructure and assets; and
- Protect environmental values of receiving water bodies.

The design principle for stormwater management in Broome uses the roads to carry the majority of flow for all events. Overland flow is preferred to a piped system to slow flows, potentially enable some infiltration and treatment of stormwater through vegetative uptake and contact with sediment. Runoff discharges from the lots into the road system, from there it discharges into and is stored in the open unlined swale/detention system as high as possible in the catchments in order to manage flood events and to improve water quality.

Due to high intensity rainfall events in Broome, sediment or silt control and velocity management are key considerations for both water quantity and quality management. The stormwater management strategy follows the principle of Water Sensitive Urban Design (WSUD) and uses a combination of swales and sediment detention basins.

Figure 5 shows the pre-development stormwater catchments within LDP3.

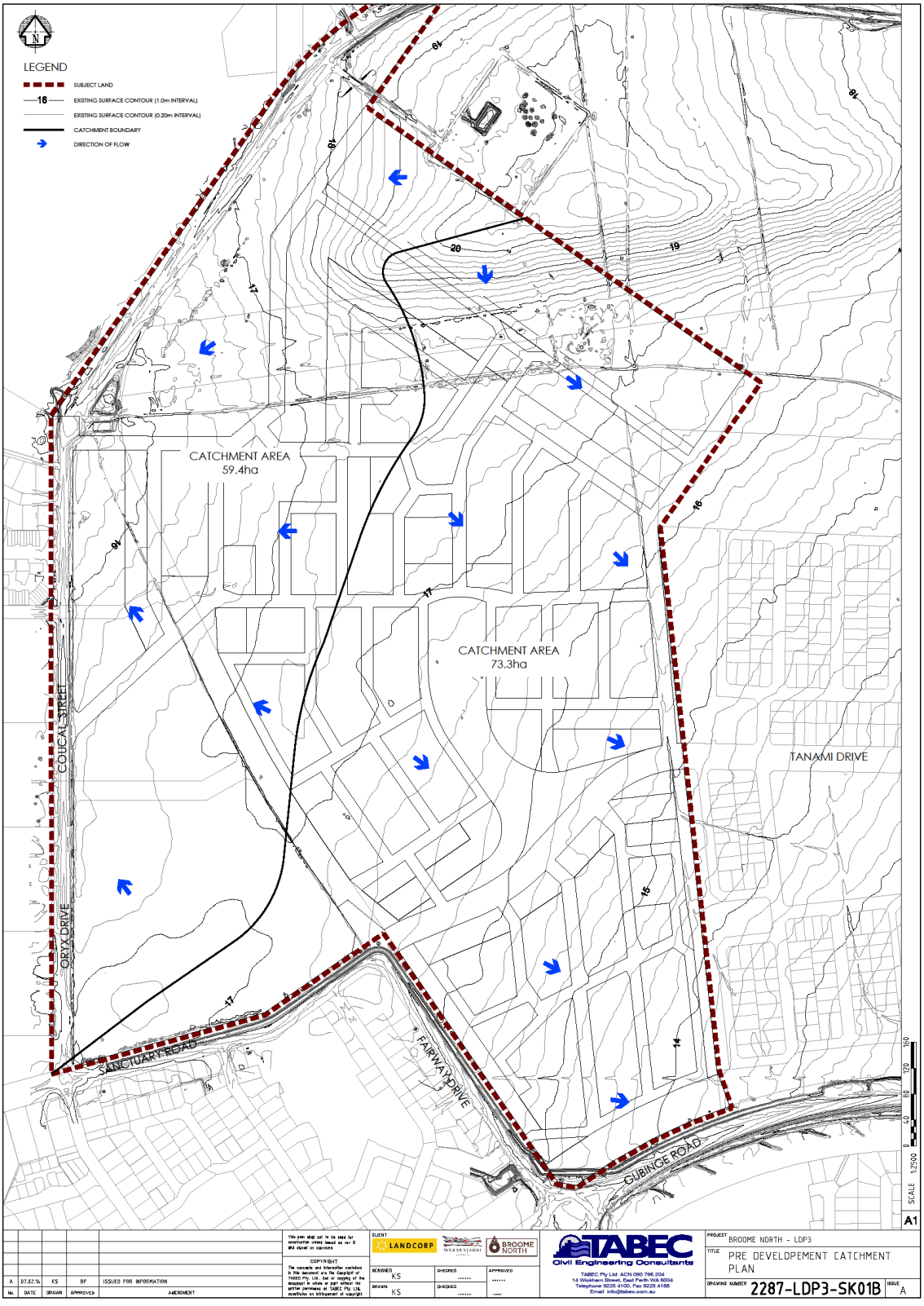


Figure 5 – Broome North LDP3 Pre-Development Stormwater Catchments

5.2 Stormwater Quantity Management

In LDP3, stormwater runoff will be conveyed via the roads where it discharges to open swales and ephemeral detention basins located through the centre and along the edges of LDP3. The majority will outfall to the existing LDP1 swale system adjacent to Gubinge Road before ultimately discharging via a culvert under Gubinge Road to the Gubinge Road Retention Area (GRRA). Whilst part of the northern and western catchments will discharge into the existing Cable Beach drainage system.

The stormwater drainage system will be designed to cater for the runoff from storms with up to Q10 year ARI event below the top of kerb level. Gullies and pipes are only used to manage the Q10 year flow where it cannot be carried in the road pavement between the kerbs and for low flow drains from detention basins. Finished lot levels are set 300mm above the crown of the road and the finished floor levels for the buildings on all lots are to be at least 500mm above the crown of the road.

Flows associated with a major Q100 year ARI event will be accommodated such that the floor level of all buildings shall be a minimum of 300mm above the Q100 year ARI flood level and the event retained within the road reserve.



Picture 5 – Typical swale and basin with weir structure in LDP1

A linear swale and ephemeral detention basin system will be used, similar to that in the development of LDP1. The linear swale detention system is designed to retard flows high in the catchment and will feature weir structures and drop structures to attenuate stormwater runoff. Native planting will also be provided to slow and treat stormwater. Attenuating and spreading stormwater provides an opportunity for pollutant carrying sediments to settle, reducing nutrient and other pollutants leaving the site. The system will also feature stone pitching at inlets to disperse flow and minimise erosion.

Detention basins are to be shallow and wide with typically 1:6 side slopes and a maximum water depth of 1.2m. Open swales and ephemeral detention basins are to be integrated with the MUC and ECC areas and designed in conjunction with the overall landscape planning.

The weirs and levels set at the spillways within the swales and basins control water levels within the drainage system. The top of the weir wall controls the 50-year ARI event flood level with the extra capacity for larger events provided by the road reserve adjacent to the swales and basins. Low flow pipes within the weir structures convey the critical 1yr 1hr event without overtopping the spillway.



Picture 6 – Typical swale and basin with weir structure in LDP1

Post-development flows from LDP3 will be compensated to rates similar to pre-development levels before discharging to the existing LDP1 swale system adjacent to Gubinge Road.

Detailed modelling, using the industry-standard surface water modelling software package XP-SWMM will be undertaken during the detailed subdivision design phase of the development which will provide full details of water levels, basin volumes and velocities for the critical storm events. This information will be detailed in the Urban Water Management Plan (UWMP), which will be a Western Australian Planning Commission (WAPC) condition of subdivision as stages are developed.

Figure 6 shows a preliminary drainage catchment plan for LDP3.

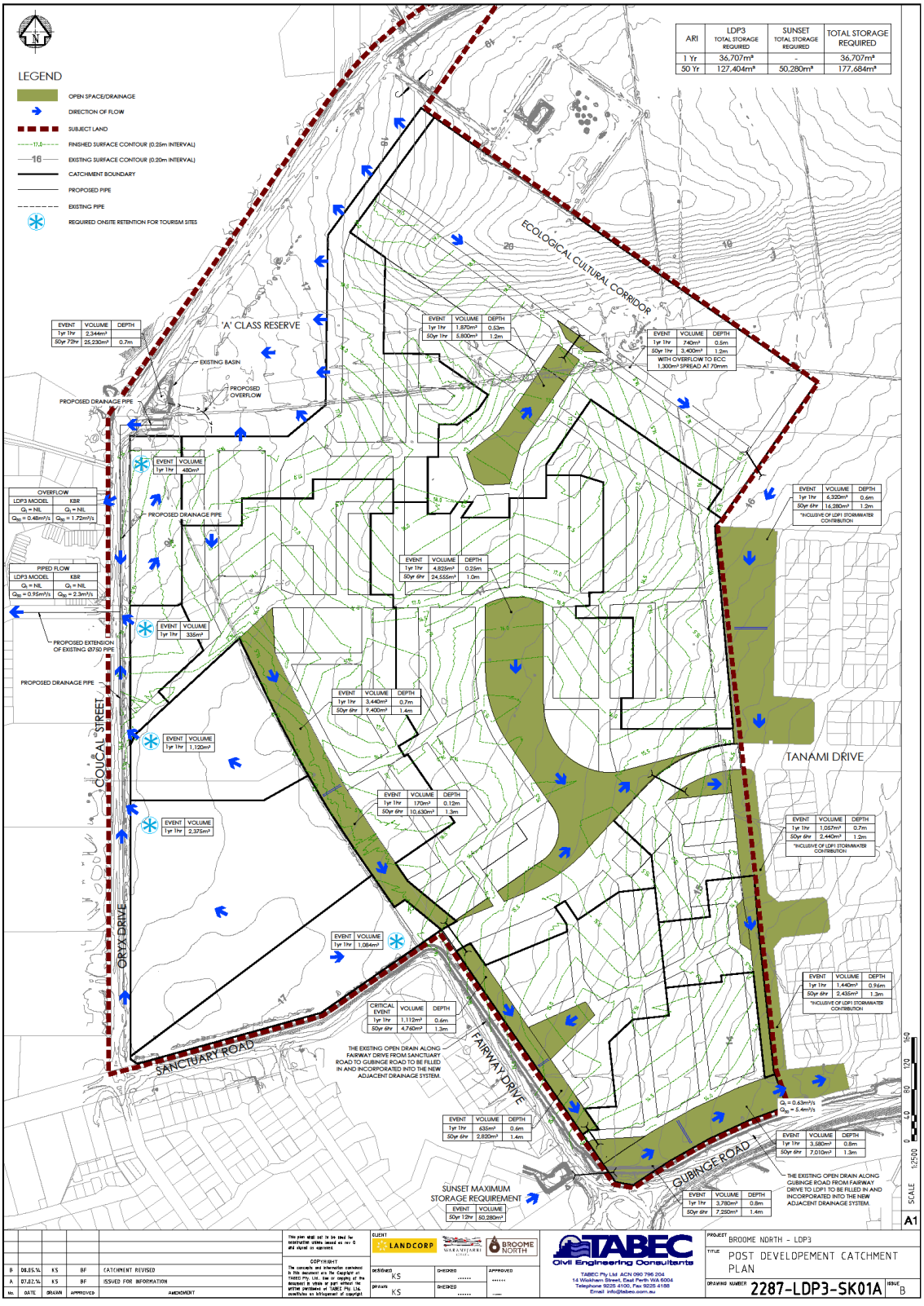


Figure 6 – Broome North LDP3 Stormwater Catchment Concept Design

5.3 Stormwater Quality Management

The key objectives for water quality management are to maintain surface and groundwater quality at pre-development levels and if possible, improve the quality of water leaving the development area.

The development of a catchment affects stormwater quality by increasing the nutrient generation above existing levels. The water quality of stormwater originating from LDP3 will be managed by the following methods:

- Reduce and minimise stormwater flow velocities to aid sedimentation, reduce erosion and reduce the carriage of seeds into the natural landscape.
- Vegetated swales and ephemeral detention basins using weirs and low flow drain systems to reduce water velocity to allow settling out of the silt load and the removal of gross pollutants.
- Use grassed POS area and multi-use parks in the swale/detention systems to improve water quality through the take up of nutrients.
- Sediment traps in detention basins to maximise the deposition of silt within the basin.
- Filtering of sediments and nutrient removal through natural vegetation re-growth by using topsoil generated from LDP3 and additional planting of low-lying native vegetation on the sides of the swales and the bases of the detention basins.
- Promote maintenance and education programs in the community.

6 WASTEWATER

6.1 Existing Wastewater Services

Water Corporation has existing planning that covers the LDP3 area and hence advises that it can be serviced pending augmentation and upgrades to Water Corporation headworks components and reticulation mains. Subject to orderly planning, staging and scheduling of LDP3, the Corporation will fund headworks and the Developer will be responsible for funding reticulation works.

Water Corporation has advised that the LDP3 area is located within two existing wastewater catchment areas that gravitate to the Sanderling Drive Pumping Station (PS No. 6b) and Broome Pumping Station No.4 (Cable Beach Road West).

The existing Broome North LDP1 to the east of the LDP3 area is serviced by a reticulated gravity sewer which also outfalls to the Sanderling Drive Pumping Station (PS No. 6b).

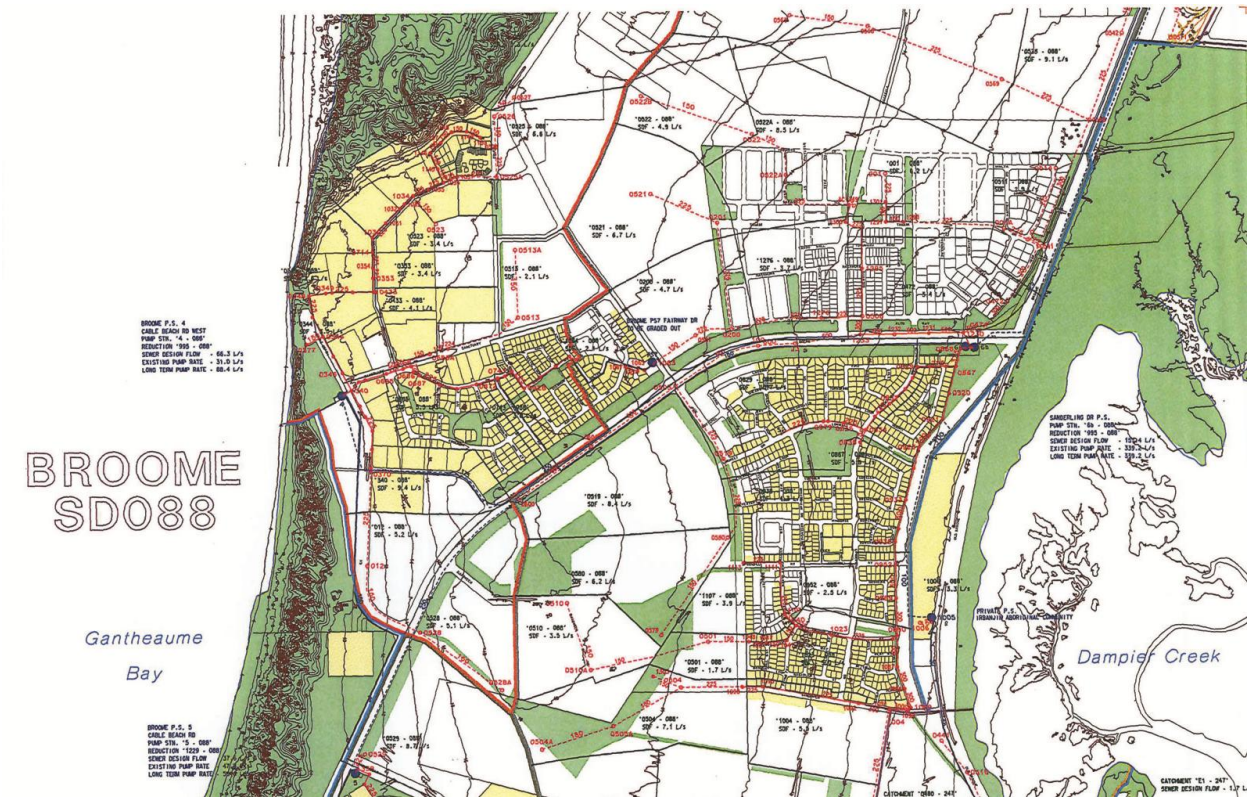


Figure 7 – Current Water Corporation Wastewater Planning for LDP3

6.2 Proposed Wastewater Services

To facilitate development of the southern wastewater catchment and majority of LDP3, current Water Corporation planning indicates an extension of the existing DN225 sewer mains that terminate at the LDP1 western boundary in Tanami Drive and Ibasco Crescent is required. The smaller northern wastewater catchment that is part of the greater Cable Beach wastewater catchment will be served by a DN150 sewer reticulation extension of the existing DN225 sewer reticulation in Millington Road.

A conventional reticulated gravity sewer system will provide connections to individual lots throughout LDP3. Standard Water Corporation headworks contributions are expected to apply to LDP3. Water Corporation planning would be reviewed when the staging and timing of the development progresses further.

Figure 8 shows a concept wastewater design for LDP3.



Figure 8 – Broome North LDP3 Wastewater Concept Design

7 WATER SUPPLY

7.1 Existing Water Services

Water Corporation has existing planning that covers the LDP3 area and hence advises that it can be serviced pending augmentation and upgrades to Water Corporation headworks components and reticulation mains.

LDP3 is within the Cable Beach zone that is serviced by the Cable Beach Tank located on Fairway Drive to the north of LDP3. Existing potable water services are located to the west of LDP3 in Fairway Drive, Lulfitz Drive and Sanctuary Road and to the east in the existing Broome North LDP1 development.

7.2 Proposed Water Services

Water Corporation are currently in the early stages of scoping for the provision of an additional DN600 distribution main along Fairway Drive, Sanctuary Road and Coucal Street that will connect existing DN450 and DN500 distribution mains. The project known as CW02432 Cable Beach Fairway Drive DM is considered a fast track project by the Corporation. Planning for the expansion of the Cable Beach Tank site is also expected to commence in 2015. Further upgrading of services is proposed as development and demand in Broome proceeds.

LDP3 will include a standard water reticulation network in accordance with Water Corporation requirements. Initially, connection to the existing DN450/DN300 mains to the west and/or an extension of the existing DN250 main in Tanami Drive to the east are likely to service the development of LDP3. At subdivision stage, Water Corporation will provide further advice on the required reticulation main sizes throughout the LDP3 area.

Standard Water Corporation headworks contributions are expected to apply to LDP3. Subject to orderly planning, staging and scheduling of LDP3, the Corporation will fund headworks and the Developer will be responsible for funding reticulation works.

Figure 9 shows the proposed water infrastructure requirements for LDP3.

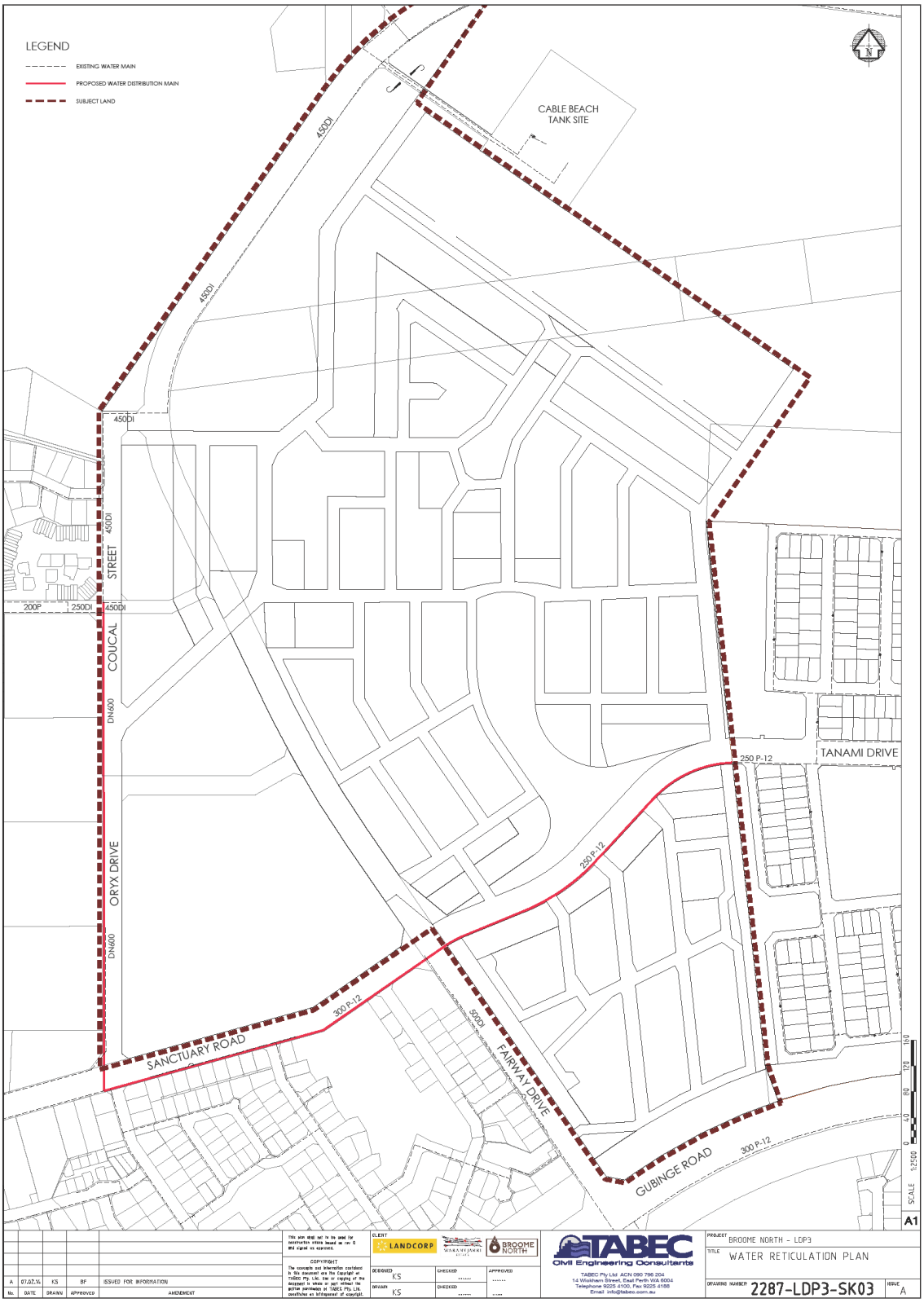


Figure 9 – Broome North LDP3 Proposed Potable Water Infrastructure

8 POWER SUPPLY

8.1 Existing Power Infrastructure

Underground Power Development (UPD), Electrical Engineers have advised that currently there is existing underground high voltage infrastructure located in Tanami Drive, Sanctuary Road, Fairway Drive and overhead 11Kv aerial transmission lines which run along the western side of Lulfitz Drive (Oryx Drive) and Coucal Street.

There are some power constraints on the current high voltage network configuration. The existing high voltage network cannot support the LDP3 development, hence the requirement for a new zone substation. The new zone substation is to be located on the existing Fairway Drive site at the northern intersection with Magabala Road in the northwest corner of LDP2. The zone substation is planned for possible construction in 5 years, once constructed the power supply for LDP3 will emanate from this substation.

Initially, Horizon Power has proposed to transfer loads between zone substation feeders to balance the load to LDP3, thus allowing the development to connect to the high voltage network.

8.2 Proposed Power Infrastructure Requirements

From preliminary discussions with Horizon Power, supply by the existing network of the estimated 9MVA load required for LDP3 should occur through Horizon Power upgrades over the next few years.

Connection to the existing high voltage underground cables in Tanami Drive and Fairway Drive/Sanctuary Road can initially serve LDP3. An internal underground electrical distribution system will be provided in accordance with the requirements of Horizon Power to supply allotments within the LDP3 area. This will include both high and low voltage cables and the necessary transformers and switchgear to be installed throughout the development. A high voltage concept plan is shown in Figure 10.

Ultimately high voltage interconnection to the existing cables in Fairway Drive north of LDP3 and the aerials in Lulfitz Drive (Oryx Drive) and Coucal Street will be necessary to complete a high voltage ring as required by Horizon Power. Staging of the LDP3 development will influence the timeframes for the construction of the high voltage ring.

According to the Horizon Power Network Asset Policy, aerial power lines that abut a development may have to be undergrounded as part of the development. Current indications are that the aerials along Lulfitz Drive (Oryx Drive) and Coucal Street that abut the development will require undergrounding as part of the adjacent stage of development.

Street lighting in accordance with Horizon Power and Shire of Broome guidelines will also be required as part of the development.

To confirm requirements, a Horizon Power network study would be undertaken with Stage 1 of the LDP3 subdivision.

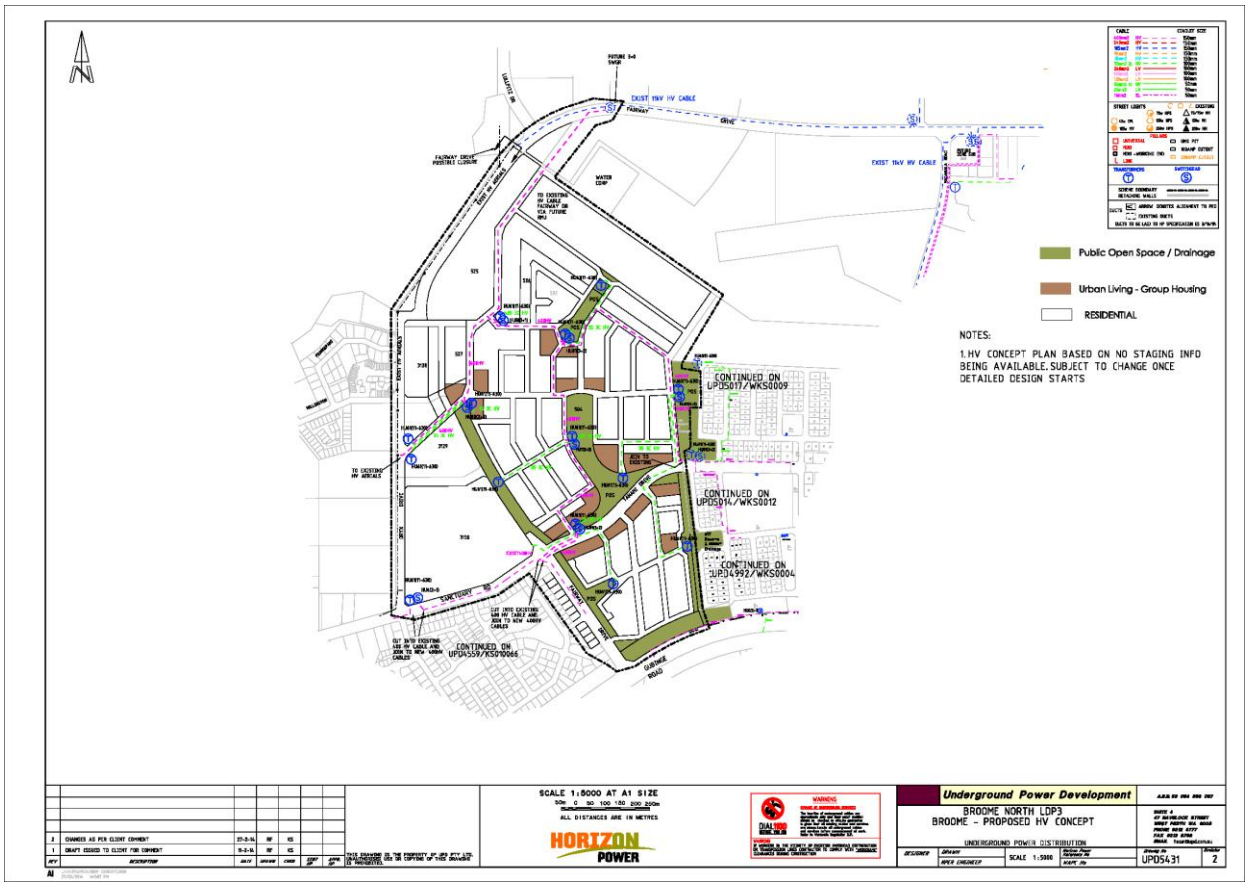


Figure 10 – Broome North LDP3 HV Concept Plan

9 TELECOMMUNICATIONS

9.1 Existing Telecommunication Assets

Existing NBN Co fibre optic infrastructure is currently located in the Broome North LDP1 development to the east of LDP3. The Broome North development has been accepted as part of the NBN Co Fibre footprint. As such, the subsequent stages of the Broome North development, including LDP3 are eligible to receive high-speed fibre optic telecommunication services from NBN Co.

Figure 11 indicates the current NBN Co fibre rollout plan for the existing Broome North development.



Figure 11 – Broome North NBN Co Fibre Rollout Plan

9.2 Proposed Telecommunication Requirements

The LDP3 telecommunication network would be an extension of the existing NBN Co infrastructure in Broome North LDP1. A telecommunication pit and pipe network would be installed, including a service conduit to each lot to facilitate the fibre connection to each premise, in LDP3 in accordance with the NBN Co guidelines and specifications.

The telecommunication network will require a number of strategically placed Fibre Distribution Hubs (FDH). FDH are a street-side cabinet that provide an optical connection point between the distribution and local networks. An FDH provides connectivity for a maximum of 172 premises, due to the expected lot yield within LDP3 a number of FDH will be required. The placing and positioning will be determined at the subdivision stage in conjunction with the pit and pipe design.

Developers are required to provide the pit and pipe infrastructure at their cost, and once the infrastructure is deemed fit for purpose by NBN Co the ownership is relinquished to NBN Co. NBN Co will then connect the infrastructure to the existing NBN Co network.

10 GAS SUPPLY

LDP3 will not be serviced by gas, as reticulation to lots is not currently provided in Broome nor is there any current intention to implement this service.

11 REFERENCES

- Cover and Aerial Image sourced from Nearmap, Image dated 17 September 2013.
- Douglas Partners, February 2014, Desktop Geotechnical Study Broome North Local Development Plan 3, WA, Ref 76353.01/46659, Prepared for TABEC.
- GHD and SKM, 2009, Broome North District Water Management Strategy, Prepared for LandCorp.
- Milsearch Pty Ltd, 1 December 2009, Post Activity Report: 5% Unexploded Ordnance Contamination Assessment (Field Validation Survey), Broome North Site, Broome, WA - Contract A63468.
- Riley Consulting, January 2014, Broome North LDP3 Structure Plan Traffic Report, Prepared for LandCorp.
- SKM, January 2010, Broome North Development Engineering Report – Final, Rev 5. Prepared for LandCorp.

APPENDIX 1 DESKTOP GEOTECHNICAL STUDY (DOUGLAS PARTNERS)

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Project 76353.01/46659
26 February 2014
JL

TABEC PTY LTD
14 Wickham Street
EAST PERTH WA 6004

Attention: Mr Brian Farrell

Dear Sirs

Desktop Geotechnical Study
Broome North Local Development Plan 3, WA

1. Introduction

This letter presents the results of a desktop geotechnical study undertaken by Douglas Partners Pty Ltd (DP) for a proposed development of Broome North Local Development Plan (LDP) 3. This report was commissioned by TABEC Pty Ltd in an email dated 22 January 2014.

The purpose of this work is to review available geotechnical information to provide preliminary comments on:

- The likely subsurface soil and groundwater conditions;
- The suitability of the site for development;
- Possible geotechnical constraints and hazards to site development;
- The likely site classification in accordance with the requirements of AS 2870-2011;
- Typical site preparation and earthworks requirements for the anticipated ground conditions;
- An indicative California bearing ratio (CBR) for the design of new pavements; and
- The permeability of the shallow ground and site drainage.

A plan provided by TABEC indicates that the subject area comprises approximately 131.5 ha which is to generally be developed to form residential subdivisions (refer to Drawing 1 Rev B, attached).

2. Available Information

The following information was reviewed during this study:

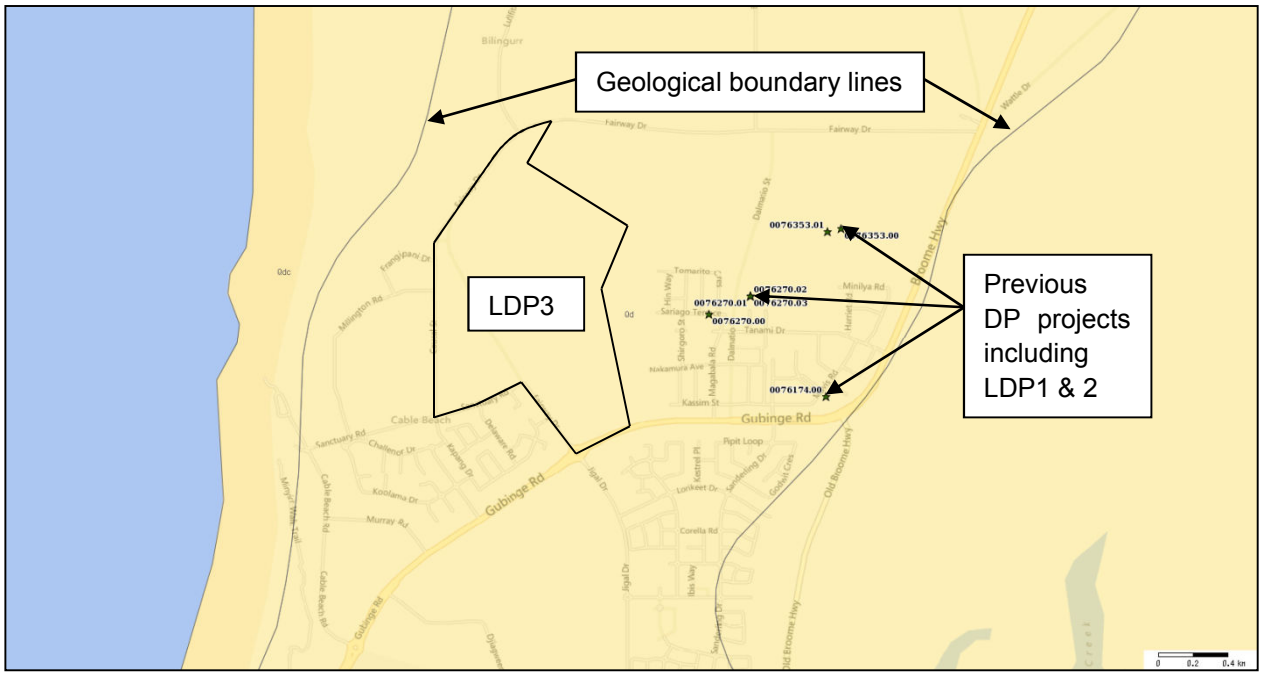
- Broome – Roebuck Plains 1:50 000 Environmental Geology Series Map;
- Aerial Photograph from Landgate, July 2013;

- Technical Paper: 'Sand-Clay Pindan Material in Pavements as a Structural Layer', Emery, Masterson and Caplehorn;
- Geotechnical investigations undertaken by DP within the local area and within the same geological unit; and
- Observations of earthworks across LDP1.

3. Review of Available Information

The Broome – Roebuck Plains 1:50 000 Environmental Geology Series Map indicates that the site is generally underlain by red-brown silty sand. As shown on Figure 1 below the geological unit is the same as in the LDP1, and 2 area.

Figure 1: Geology



Review of the soil conditions encountered within DP's previous geotechnical investigations, which are shown as occurring within the same geological unit as the site, indicate the following shallow soils:

- Topsoil – generally to a depth of 0.1 m.
- Sand – medium dense, light brown sand encountered below the topsoil to a maximum depth of 0.5 m in limited locations.
- Silty Sand – very loose to medium dense, red-brown silty sand with a trace of clay up to 5.0 m depth across LDP1 and LDP2.

- Sandy Silty Clay – clay content may increase below 5.0 m to red brown sandy silty clay.

This soil unit described above is locally identified as 'Pindan Sand'. Pindan Sand is known to sometimes exhibit collapsing potential. Collapsing soil is a weakly cemented material that is potentially subject to large settlement upon wetting under load, and this could possibly have an impact on the proposed structures at the site.

Specific testing has been carried out across LDP1 and LDP2.

Aerial photos indicate a coverage of shrubs and small trees across LDP2 and LDP3 with occasional red brown tracks.

4. Preliminary Engineering Comments

It is emphasised that the comments included in this section are based on the review of published documents, aerial photography and DP's experience on other projects in the vicinity of the site. Further geotechnical investigation including in situ sampling and testing will be required to confirm the comments presented in this section.

4.1 Geotechnical Issues

Loose soil – Identified to depths in excess of 2.0 m across the majority of LDP2. Investigation is required to assess the full depth impact and on the proposed development of loose materials. Standard compaction techniques are normally effective for the top 0.5 m after this there impact declines. Generally a residential development would require at least 2.0 m of medium dense material below design levels.

The density of the underlying soils may be the overriding factor for design of standard earthwork techniques and foundation options for residential development. Alternative solutions could be considered following the geotechnical investigation.

Collapsible soil – The results of the assessment indicate that the shallow soils are classified as 'moderate trouble' when assessed for soil collapse potential using the method suggested by J.E. Jennings and K. Knight, (1975). As an example, a total settlement of 7% under 200 kPa would indicate a settlement of 70 mm per metre depth of collapsible soil under 200 kPa. Earthworks across LDP1 included conditioning (by inducing the collapse) in the near surface material.

4.2 Site Classification and Foundation Design

If collapsing soils are identified at the site, the strict site classification in accordance with AS 2870-2011 should be 'P'. In DP's experience, this classification can be readily improved to a less restrictive class following suitable site preparation. The following site classification where considered suitable in LDP1 following site preparation:

- Equivalent to class 'M' – where less than 250 mm of conditioned soil lies below the foundations; or
- Equivalent to class 'S' – where at least 250 mm of conditioned soil lies below the foundations.

If buildings where to settle due to collapsing soils this would likely occur during the wet season. Areas of LDP1 have been developed for well over one year. DP are not aware of any large settlement resulting collapsing soils.

4.3 Site Preparation

The minimum site preparation requirements prior to construction of buildings or placement of filling are likely to include:

- Stripping of all vegetation, topsoil and deleterious materials beneath development areas;
- Compaction the site using a medium to heavy (minimum of 14 tonne) vibrating roller.

In the event that collapsing soils are indentified beneath the site, additional specific ground improvement measures may be recommended dependent on the severity of the collapse potential.

It is understood that some of the lots are to remain as bush until development. The use of vibrating equipment should be limited close to existing buildings and buried services. Earthworks and thus, foundation options may be limited where loose ground conditions are encountered.

4.4 Pavement

Based on the available literature a typical soaked California bearing ratio (CBR) of 3% to 7% can be anticipated for Pindan Sand subgrade, following suitable site preparation. However, our experience at investigated areas within this site and its vicinity, indicate that higher CBR values are routinely achieved on laboratory tested samples.

A design CBR value of 10% is anticipated for the near surface sand and silty sands likely to occur at this site. Laboratory testing will be required to confirm this value at a later stage in the progression of the development.

4.5 Soil Permeability and Drainage

A presumptive permeability value of between 1 x 10^{-6} m/s and 1 x 10^{-7} m/s is anticipated for the pindan soils beneath the site. The above estimate is based on typical in situ test values measured by DP in the area, although it should be refined by in situ testing.

The moderate to high fines content of Pindan Sand results in low infiltration values and generally precludes the use of onsite stormwater disposal methods such as soakwells. It is anticipated that stormwater disposal will use swales, drainage channels, retention basins as used in LDP1.

The implementation of a suitable drainage strategy is suggested to control water collecting on the site surface during the large rain events which seasonally occur in the Kimberley region. The typical approach for ensuring amenity of sites such as this in regional areas includes grading of the lots to allow surface water to flow into roadside drains, and on towards a subsequent suitable outflow.

The long term performance of pavement will require suitable drainage to be implemented to avoid saturation of the pavement layers. Saturation of pavements would result in a decrease in the basecourse strength and could result in pavement failure.

5. References

1. Australian Standard AS 2870-2011, Residential Slabs and Footings.
2. Emery S, Masterson S and Caplehorn M (2003), Sand Clay Pindan Material in Pavements as Structural Layer.
3. Broome – Roebuck Plains 1:50 000 Environmental Geology Series Map Geological Survey of Western Australia.

6. Limitations

Douglas Partners Pty Ltd has prepared this desktop geotechnical study for the Broome North LDP3 project in accordance with DP's fee proposal dated 20 January 2014 and commissioned by TABEC Pty Ltd on 22 January 2014. This report is provided for the exclusive use of TABEC Pty Ltd for this project only and for the purposes described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

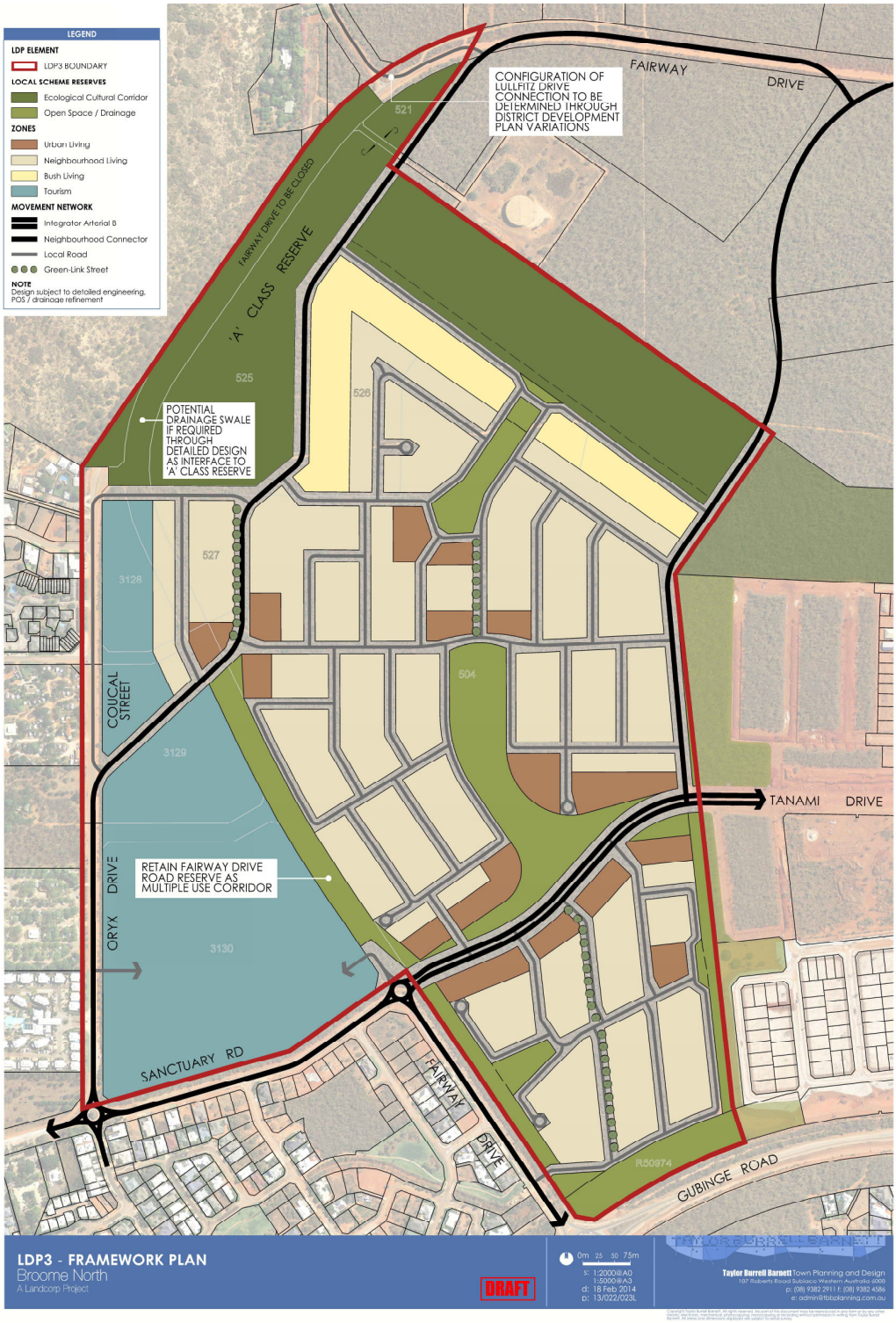


p.p. 

Matt Williams
Geotechnical Engineer

Michael J Thom
Principal

Attachments: About this Report
Drawing 1 Rev B – Proposed Site Layout



Douglas Partners *Geotechnics / Environment / Groundwater*	**Development Areas** **Broome North LDP 3**	PROJECT: 76353.01 DWG No: 1 REV: B
	CLIENT: TABEC Pty Ltd	DATE: 25-Feb-14

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

KIMBERLEY SOILS LABORATORY

Surfmet Pty Ltd trading as Kimberley Soils Laboratory ABN 40 109 682 493
Gus Winckel Road, Broome, Australia

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Phone: (08) 9192 3126
Fax: (08) 9192 3012

PO Box 1897, Broome, WA 6725
E-mail: kimberleysoils@westnet.com.au

TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	0.5-1.0m
SAMPLE No:	09KSL 941	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP10B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

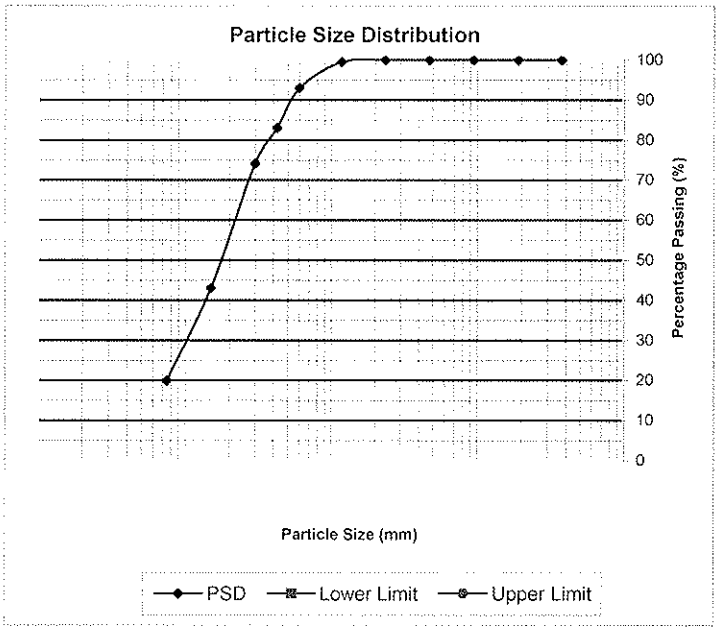
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	93
0.425	83
0.300	74
0.150	43
0.075	20

DUST RATIO

0.24



Notes

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G. Barten

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TEST CERTIFICATE
AS1289 3.6.1 SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	0.5-0.7m
SAMPLE No:	09KSL 942	**PROPOSED USE:**	–
PROJECT:	Supplied Sample	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP11B	**TEST DATE:**	2/08/2009
DESCRIPTION:	Pindan		

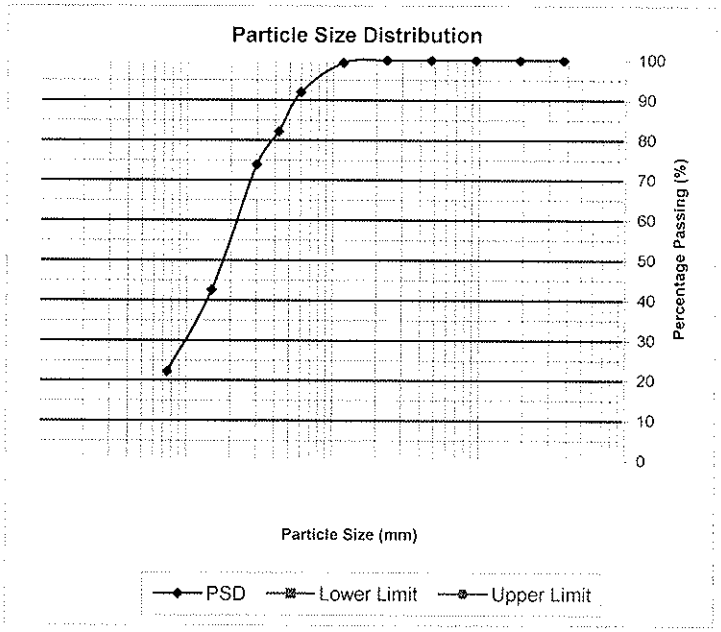
TEST METHODS USED

SAMPLING AND PREPERATION	AS1289 .1
PARTICLE SIZE DISTRIBUTION	AS1289 3.6.1

SIEVE SIZE (mm)	% PASSING
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	99
0.600	92
0.425	82
0.300	74
0.150	43
0.075	22

DUST RATIO

0.27



Notes

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	3150-TP1- 1.0-1.5	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**22.0** %
PLASTIC LIMIT WA 121.1	**13.5** %
PLASTICITY INDEX WA 122.1	**8.5** %
LINEAR SHRINKAGE WA 123.1	**1.0** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	3150-TP6- 2.0-2.5	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**22.3** %
PLASTIC LIMIT WA 121.1	**12.3** %
PLASTICITY INDEX WA 122.1	**10.0** %
LINEAR SHRINKAGE WA 123.1	**1.0** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	3150-TP8- 0.5-1.0	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**20.5 %**
PLASTIC LIMIT WA 121.1	**15.7 %**
PLASTICITY INDEX WA 122.1	**4.8 %**
LINEAR SHRINKAGE WA 123.1	**1.2 %**

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	3150-TP10- 1.0-1.5	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**26.0** %
PLASTIC LIMIT WA 121.1	**12.1** %
PLASTICITY INDEX WA 122.1	**13.9** %
LINEAR SHRINKAGE WA 123.1	**1.4** %

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP1B- 0.5-1.0	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**21.5** %
PLASTIC LIMIT WA 121.1	**17.0** %
PLASTICITY INDEX WA 122.1	**4.5** %
LINEAR SHRINKAGE WA 123.1	**0.8** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP3B- 0.5-0.6	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**21.7 %**
PLASTIC LIMIT WA 121.1	**15.2 %**
PLASTICITY INDEX WA 122.1	**6.5 %**
LINEAR SHRINKAGE WA 123.1	**1.0 %**

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP6B- 1.0-1.2	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**23.8** %
PLASTIC LIMIT WA 121.1	**14.8** %
PLASTICITY INDEX WA 122.1	**8.9** %
LINEAR SHRINKAGE WA 123.1	**1.2** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP9B- 1.0-1.5	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**23.3** %
PLASTIC LIMIT WA 121.1	**14.3** %
PLASTICITY INDEX WA 122.1	**9.1** %
LINEAR SHRINKAGE WA 123.1	**1.0** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP10B- 0.5-1.0	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**20.3** %
PLASTIC LIMIT WA 121.1	**14.2** %
PLASTICITY INDEX WA 122.1	**6.1** %
LINEAR SHRINKAGE WA 123.1	**1.0** %

NOTES:

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TEST CERTIFICATE
WA SOIL CLASSIFICATION TEST

CLIENT:	Coffey	**TEST DEPTH:**	–
SAMPLE No:	09 KSL	**PROPOSED USE:**	–
PROJECT:	Broome Testing	**RECEIVED DATE:**	1/08/2009
LOCATION:	304-TP11B- 0.5-0.7	**TEST DATE:**	4/08/2009
DESCRIPTION:	Pindan		

TEST METHODS USED
SAMPLED WA 100.1
PREPARATION WA 105.1
MOISTURE CONTENT (oven drying) WA 110.1

CONE LIQUID LIMIT WA 120.2	**23.0** %
PLASTIC LIMIT WA 121.1	**15.3** %
PLASTICITY INDEX WA 122.1	**7.7** %
LINEAR SHRINKAGE WA 123.1	**1.2** %

NOTES:

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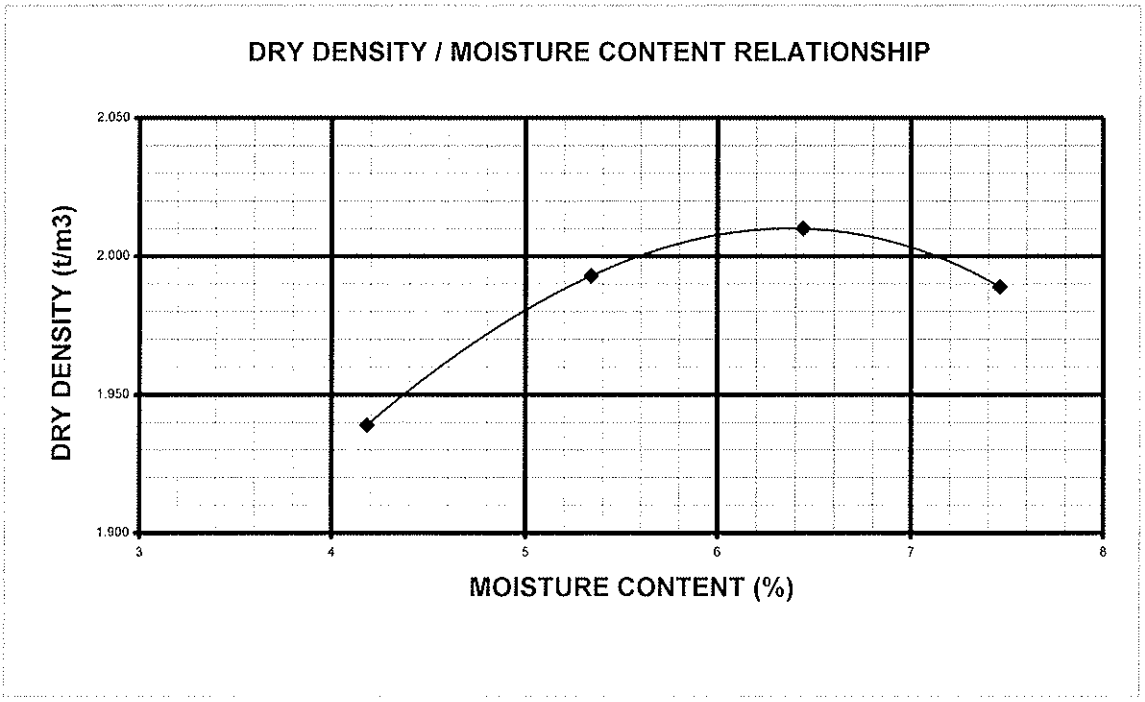
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TEST CERTIFICATE
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT
TEST METHOD AS1289 5.2.1 - MODIFIED COMPACTION

CLIENT:	Coffey	**Sample No:**	09KSL 932
PROJECT:	Supplied Sample		
LOCATION:	Broome	**Date Tested:**	2/08/2009
Sample Details:	3150-TP1-1.0-1.5		
Material Description:	Pindan		



Maximum Dry Density:	**2.010 t/m³**
Optimum Moisture Content:	**6.5 %**
Adjusted Maximum Dry Density:	**– %**
Adjusted Optimum Moisture Content:	**– %**
Oversized Material (+19.0mm):	**0.0 %**
Oversized Material (+37.5mm):	**– %**
Field Moisture Content:	**– %**

Notes: Sampled by client

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Number: 14582

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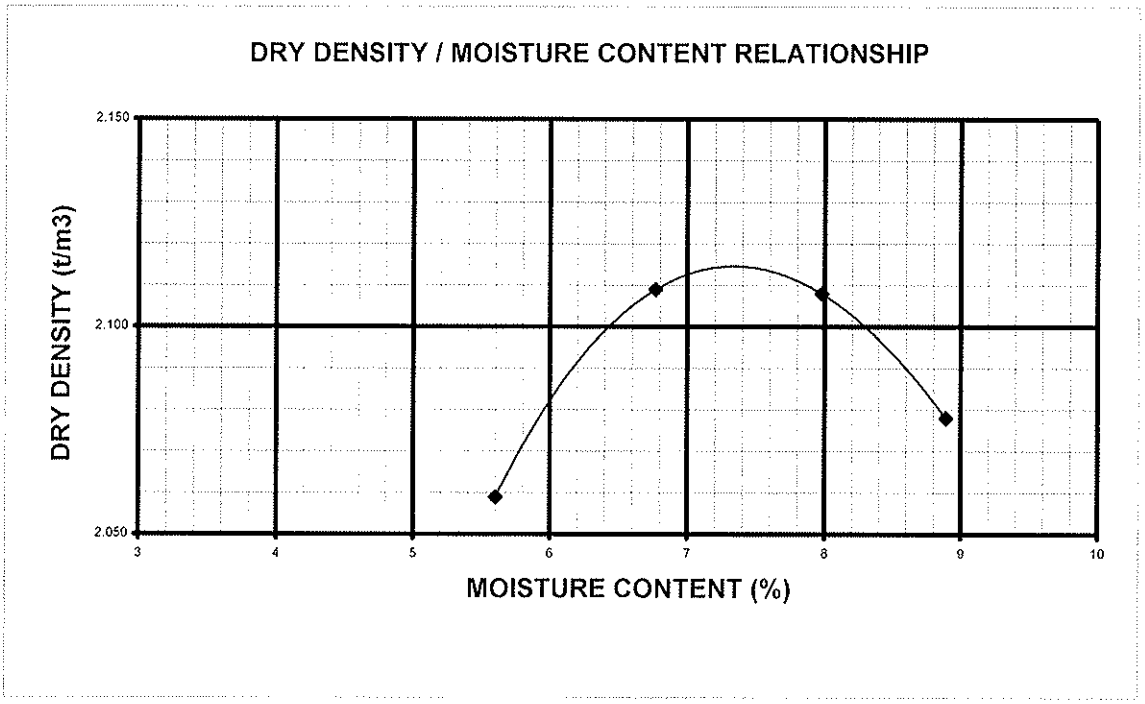
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TEST CERTIFICATE
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT
TEST METHOD AS1289 5.2.1 - MODIFIED COMPACTION

CLIENT:	Coffey	**Sample No:**	09KSL 931
PROJECT:	Supplied Sample		
LOCATION:	Broome	**Date Tested:**	2/08/2009
Sample Details:	3150-TP6-2.0-2.5		
Material Description:	Pindan		



Maximum Dry Density:	**2.114 t/m³**
Optimum Moisture Content:	**7.4 %**
Adjusted Maximum Dry Density:	**– %**
Adjusted Optimum Moisture Content:	**– %**
Oversized Material (+19.0mm):	**0.0 %**
Oversized Material (+37.5mm):	**– %**
Field Moisture Content:	**– %**

Notes: Sampled by client

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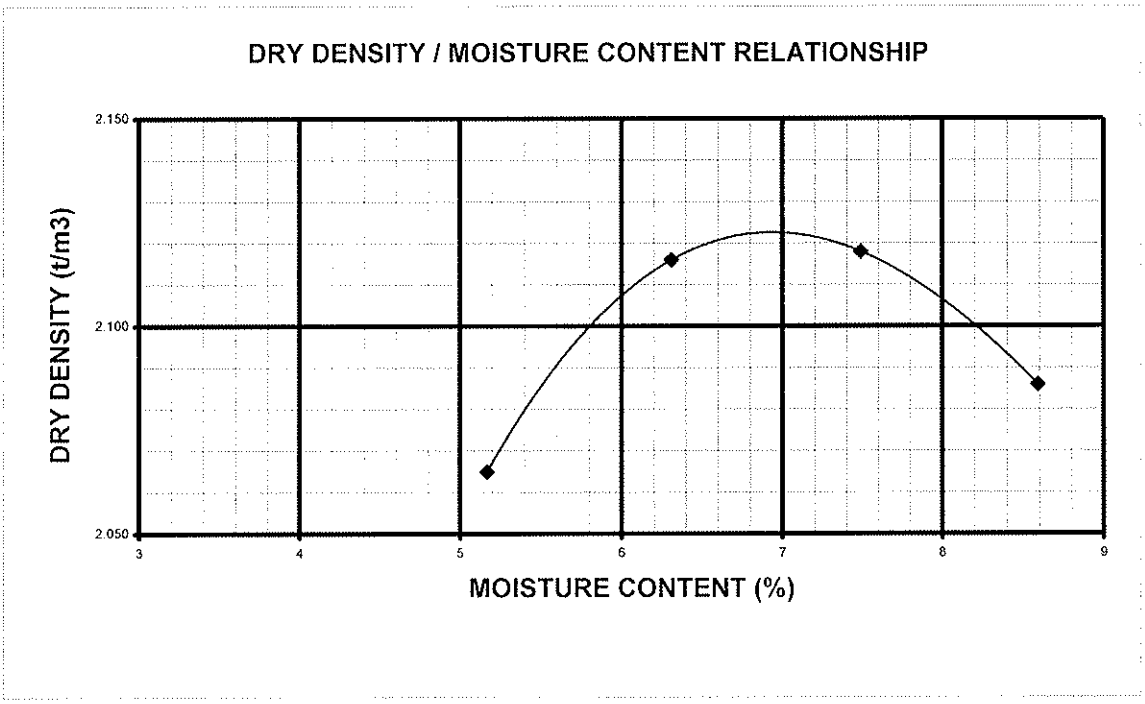
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Fax: (08) 9192 3012

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TEST CERTIFICATE
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT
TEST METHOD AS1289 5.2.1 - MODIFIED COMPACTION

CLIENT:	Coffey	**Sample No:**	09KSL 933
PROJECT:	Supplied Sample		
LOCATION:	Broome	**Date Tested:**	2/08/2009
Sample Details:	3150-TP10-1.0-1.5		
Material Description:	Pindan		



Maximum Dry Density:	**2.122 t/m³**
Optimum Moisture Content:	**7.0 %**
Adjusted Maximum Dry Density:	**– %**
Adjusted Optimum Moisture Content:	**– %**
Oversized Material (+19.0mm):	**0.0 %**
Oversized Material (+37.5mm):	**– %**
Field Moisture Content:	**– %**

Notes: Sampled by client

NATA Accredited Laboratory Number: 14582

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KIMBERLEY SOILS LABORATORY

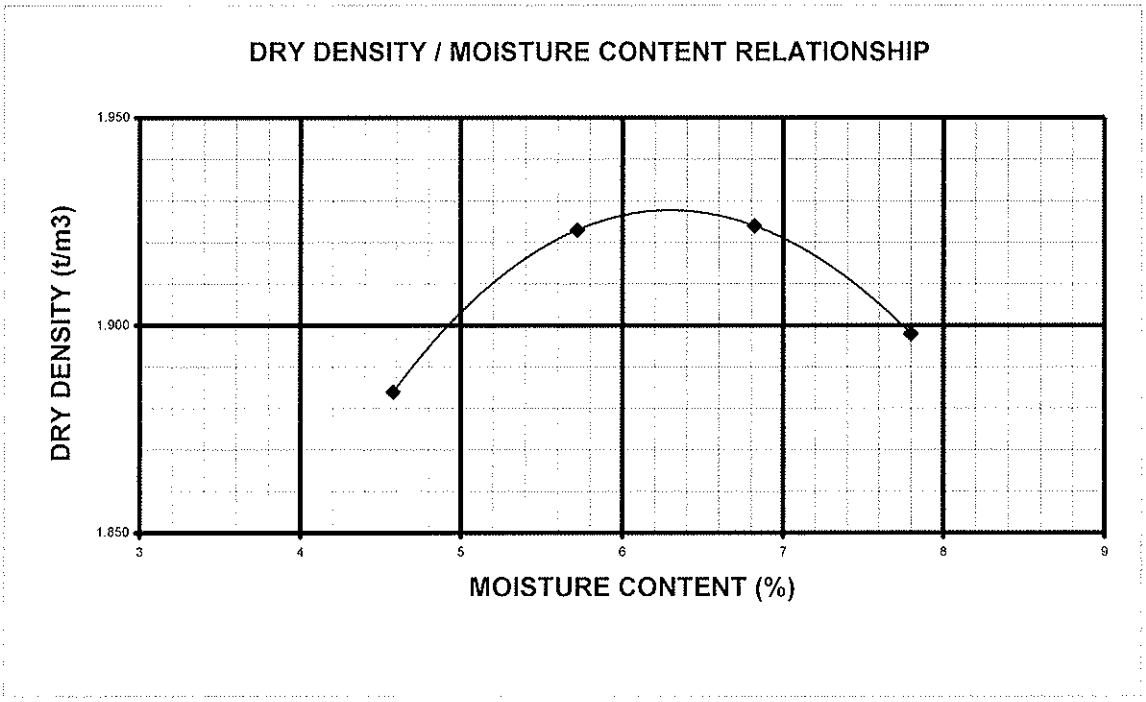
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TEST CERTIFICATE
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT
TEST METHOD AS1289 5.2.1 - MODIFIED COMPACTION

CLIENT:	Coffey	**Sample No:**	09KSL 930
PROJECT:	Supplied Sample		
LOCATION:	Broome	**Date Tested:**	2/08/2009
Sample Details:	304-TP1B-0.5-1.0		
Material Description:	Pindan		



Maximum Dry Density:	**1.928 t/m³**
Optimum Moisture Content:	**6.4 %**
Adjusted Maximum Dry Density:	**– %**
Adjusted Optimum Moisture Content:	**– %**
Oversized Material (+19.0mm):	**0.0 %**
Oversized Material (+37.5mm):	**– %**
Field Moisture Content:	**– %**

Notes: Sampled by client

NATA Accredited Laboratory Number: 14282

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Approved Signatory: G. Barten

KIMBERLEY SOILS LABORATORY

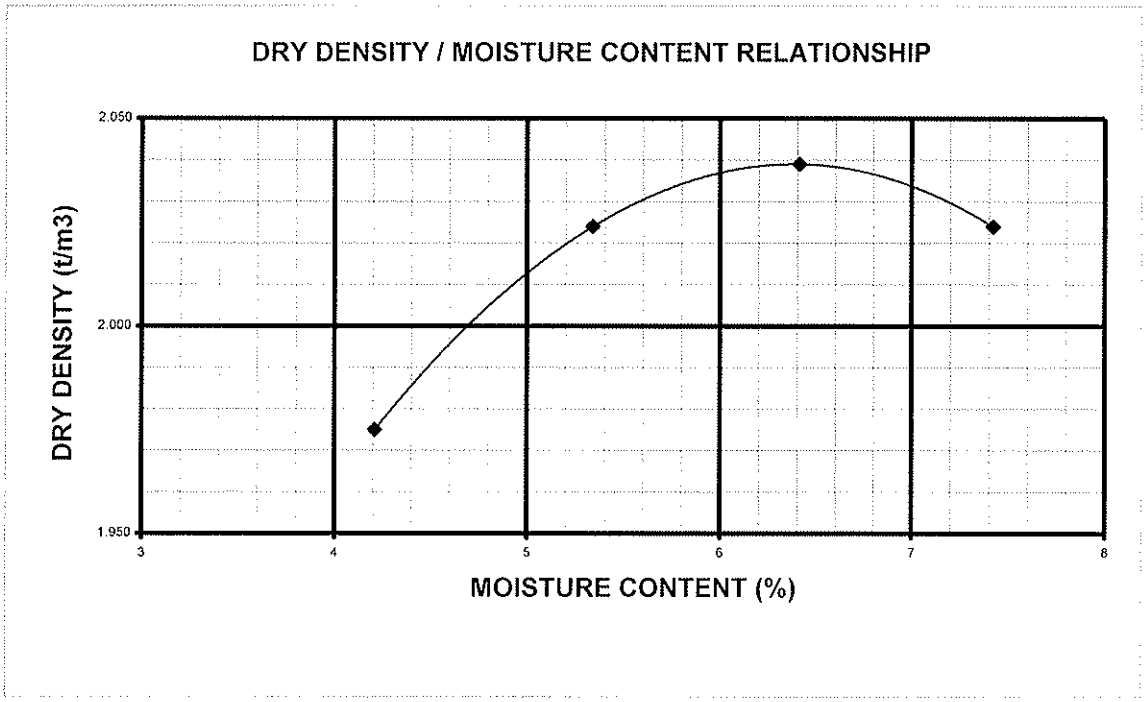
Surfnet Pty Ltd trading as Kimberley Soils Laboratory ABN 40 109 682 493
Gus Winckle Road, Broome, Australia

Mobile: 0410341636
Tel: (08) 9192 3126
Fax: (08) 9192 3012

PO Box 1897, Broome, WA 6725
E-mail: kimberleysoils@westnet.com.aum

TEST CERTIFICATE
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT
TEST METHOD AS1289 5.2.1 - MODIFIED COMPACTION

CLIENT:	Coffey	**Sample No:**	09KSL 929
PROJECT:	Supplied Sample		
LOCATION:	Broome	**Date Tested:**	2/08/2009
Sample Details:	304-TP9B-1.0-1.5		
Material Description:	Pindan		



Maximum Dry Density:	**2.039 t/m³**
Optimum Moisture Content:	**6.4 %**
Adjusted Maximum Dry Density:	**– %**
Adjusted Optimum Moisture Content:	**– %**
Oversized Material (+19.0mm):	**0.0 %**
Oversized Material (+37.5mm):	**– %**
Field Moisture Content:	**– %**

Notes: Sampled by client

NATA Accredited Laboratory Number: 14582

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Approved Signatory: _____
G. Barten

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E-mail: Kimberleysoils@westnet.com.au

TEST CERTIFICATE

CALIFORNIA BEARING RATIO (CBR)

TEST METHOD - AS1289 6.1.1

CLIENT:	Coffey	**Sample No:**	09KSL
PROJECT:	Broome Sampling		947
LOCATION:	Broome	**Date Moulded:**	15/08/2009
Sample Details:	3150 TP1 1.0-1.5	**Date Tested:**	19/08/2009
Sample Description:	Pindan	**Tested By:**	M. Robertson

Maximum Dry Density (t/m3):	2.010
Optimum Moisture Content (%):	6.5
Dry Density before soaking (t/m³):	1.943
Moisture Content at compaction (%):	7.98
Dry Density Ratio before soaking (%):	96.7
Moisture Ratio before soaking (%):	122.8
Dry Density after soaking (t/m3):	1.858
Moisture Content after soaking (%):	12.4
Dry Density Ratio after soaking (%):	92.5
Moisture Ratio after soaking (%):	190.2
Condition of test	
Desired Density Ratio:	98
Desired Moisture Ratio:	100
Number of days soaked:	4
Number of Layers:	5
Surcharge Mass used (kg):	4.5
Percentage Swell:	4.5
Moisture Content - top 30mm after soaking (%):	13.93
Moisture Content - entire sample after soaking (%):	11.35
Penetration (mm):	2.5
California Bearing Ratio (%):	**11**

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TEST CERTIFICATE

CALIFORNIA BEARING RATIO (CBR)

TEST METHOD - AS1289 6.1.1

CLIENT:	Coffey	**Sample No:**	09KSL
PROJECT:	Broome Sampling		946
LOCATION:	Broome	**Date Moulded:**	15/08/2009
Sample Details:	3150 TP6 2.0-2.5	**Date Tested:**	19/08/2009
Sample Description:	Pindan	**Tested By:**	M. Robertson

Maximum Dry Density (t/m3):	2.114
Optimum Moisture Content (%):	7.4
Dry Density before soaking (t/m³):	2.042
Moisture Content at compaction (%):	8.97
Dry Density Ratio before soaking (%):	96.6
Moisture Ratio before soaking (%):	121.3
Dry Density after soaking (t/m3):	2.041
Moisture Content after soaking (%):	9.5
Dry Density Ratio after soaking (%):	96.6
Moisture Ratio after soaking (%):	128.4

Condition of test

Desired Density Ratio:	98
Desired Moisture Ratio:	100
Number of days soaked:	4
Number of Layers:	5
Surcharge Mass used (kg):	4.5
Percentage Swell:	0.0
Moisture Content - top 30mm after soaking (%):	11.43
Moisture Content - entire sample after soaking (%):	10.07
Penetration (mm):	2.5

California Bearing Ratio (%): 12

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TEST CERTIFICATE

CALIFORNIA BEARING RATIO (CBR)

TEST METHOD - AS1289 6.1.1

CLIENT:	Coffey	**Sample No:**	09KSL
PROJECT:	Broome Sampling		948
LOCATION:	Broome	**Date Moulded:**	15/08/2009
Sample Details:	3150 TP10 1.0-1.5	**Date Tested:**	19/08/2009
Sample Description:	Pindan	**Tested By:**	M. Robertson

Maximum Dry Density (t/m3):	2.122
Optimum Moisture Content (%):	7.0
Dry Density before soaking (t/m³):	2.082
Moisture Content at compaction (%):	6.87
Dry Density Ratio before soaking (%):	98.1
Moisture Ratio before soaking (%):	98.1
Dry Density after soaking (t/m3):	1.991
Moisture Content after soaking (%):	8.2
Dry Density Ratio after soaking (%):	93.8
Moisture Ratio after soaking (%):	116.9
<u>Condition of test</u>	
Desired Density Ratio:	98
Desired Moisture Ratio:	100
Number of days soaked:	4
Number of Layers:	5
Surcharge Mass used (kg):	4.5
Percentage Swell:	4.6
Moisture Content - top 30mm after soaking (%):	13.72
Moisture Content - entire sample after soaking (%):	13.64
Penetration (mm):	2.5
California Bearing Ratio (%):	**4**

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TEST CERTIFICATE

CALIFORNIA BEARING RATIO (CBR)

TEST METHOD - AS1289 6.1.1

CLIENT:	Coffey	**Sample No:**	09KSL 945
PROJECT:	Broome Sampling		
LOCATION:	Broome	**Date Moulded:**	15/08/2009
Sample Details:	304 TP1B 0.5-1.0	**Date Tested:**	19/08/2009
Sample Description:	Pindan	**Tested By:**	M. Robertson

Maximum Dry Density (t/m3):	1.928
Optimum Moisture Content (%):	6.4
Dry Density before soaking (t/m³):	1.873
Moisture Content at compaction (%):	7.35
Dry Density Ratio before soaking (%):	97.1
Moisture Ratio before soaking (%):	114.8
Dry Density after soaking (t/m3):	1.872
Moisture Content after soaking (%):	12.2
Dry Density Ratio after soaking (%):	97.1
Moisture Ratio after soaking (%):	190.1

Condition of test

Desired Density Ratio:	98
Desired Moisture Ratio:	100
Number of days soaked:	4
Number of Layers:	5
Surcharge Mass used (kg):	4.5
Percentage Swell:	0.0
Moisture Content - top 30mm after soaking (%):	11.87
Moisture Content - entire sample after soaking (%):	11.92
Penetration (mm):	2.5
California Bearing Ratio (%):	**30**

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TEST CERTIFICATE

CALIFORNIA BEARING RATIO (CBR)

TEST METHOD - AS1289 6.1.1

CLIENT:	Coffey	**Sample No:**	09KSL
PROJECT:	Broome Sampling		944
LOCATION:	Broome	**Date Moulded:**	15/08/2009
Sample Details:	304 TP9B 1.0-1.5	**Date Tested:**	19/08/2009
Sample Description:	Pindan	**Tested By:**	M. Robertson

Maximum Dry Density (t/m3):	2.039
Optimum Moisture Content (%):	6.4
Dry Density before soaking (t/m³):	1.986
Moisture Content at compaction (%):	7.06
Dry Density Ratio before soaking (%):	97.4
Moisture Ratio before soaking (%):	110.4
Dry Density after soaking (t/m3):	1.984
Moisture Content after soaking (%):	10.0
Dry Density Ratio after soaking (%):	97.3
Moisture Ratio after soaking (%):	155.6
Condition of test	
Desired Density Ratio:	98
Desired Moisture Ratio:	100
Number of days soaked:	4
Number of Layers:	5
Surcharge Mass used (kg):	4.5
Percentage Swell:	0.1
Moisture Content - top 30mm after soaking (%):	12.35
Moisture Content - entire sample after soaking (%):	10.09
Penetration (mm):	5.0
California Bearing Ratio (%):	**20**

Appendix C

Results of Geoenvironmental Laboratory Testing

mpl Laboratories

16 - 18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
Tel: +61 8 9317 2505 / Fax: +61 8 9317 4163 / Email: laboratory@mpl.com.au
www.coffey.com/mpl

Analytical Report

Broome North

Job No : **095032**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Gabi Glur

Approved Signatory
Chris Munro

Contact: Hamish Nelson
E-mail: hamish_nelson@coffey.com
Client Reference: GEOTPERT08647AB 120PERT-4688
Date Sampled: 30/07/2009
Date Received: 3/08/2009
Date Reported: 17/08/2009
Sampled By: Client
Location: Broome

Test Method: Soil /Sediment samples analysed on an as received basis and extracted with organic solvent and analysed by gas chromatography GC-FID using external standards in accordance with MPL WILAB 7. Results expressed on a dry weight basis.

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Tel: +61 8 **9317 2505** / Fax: +61 8 **9317 4163** / Email: laboratory@mpl.com.au
www.coffey.com/mpl

Analytical Report

Job No : **095032**

Lab Id	External Idents	TRH	C6-C9	C10-C14	C15-C28	C29-C36	Surrogate
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
LQL		20	10	10	10	20	1
095032-001	CF 1	<20	<10	<10	<10	<20	70
095032-002	CF 2	<20	<10	<10	<10	<20	74
095032-003	CF 3	<20	<10	<10	<10	<20	72
095032-004	CF 4	<20	<10	<10	<10	<20	77
095032-005	CF 5	<20	<10	<10	<10	<20	77
095032-006	CF 6	<20	<10	<10	<10	<20	70
095032-007	CF 7	<20	<10	<10	<10	<20	79
095032-008	CF 8	<20	<10	<10	<10	<20	82
095032-009	CF 9	720	<10	<10	330	390	81
095032-010	CF 10	<20	<10	<10	<10	<20	89
095032-001-DUP	CF 1	<20	<10	<10	<10	<20	72

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www.coffey.com/mpl

Analytical Report

Broome North

Job No : **095032B**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Gabi Glur

Approved Signatory
Emma Rowe

Contact: Hamish Nelson
E-mail: Hamish_Nelson@coffey.com
Fax: 9347 0099
Client Reference: GEOTPERT08647AB 120 PERT-4688
Date Sampled: 30/07/2009
Date Received: 31/07/2009
Date Reported: 17/08/2009
Sampled By: Client
Location Broome

Test Method: Soil/Sediment samples analysed on an as received basis by gas chromatography GC-MS in accordance with MPL WILAB 16B. Results expressed on a dry weight basis.

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Analytical Report

Job No :	**095032B**								
Lab Id	**Units**	**LQL**	**095032B-001**	**095032B-002**	**095032B-003**	**095032B-004**	**095032B-005**	**095032B-006**	**095032B-007**	**095032B-008**
External Idents			**CF 1**	**CF 2**	**CF 3**	**CF 4**	**CF 5**	**CF 6**	**CF 7**	**CF 8**
Analyte										
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g,h,i)perylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate Recovery	%	1	71	73	81	80	81	79	77	77

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www.coffey.com/mpl

Analytical Report

Job No :	**095032B**						
Lab Id	**Units**	**LQL**	**095032B-009**	**095032B-010**	**095032B-001-DUP**	**QC Recovery%**	**Blank**
External Idents			**CF 9**	**CF 10**	**CF 1**		
Analyte							
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	99	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	106	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	98	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	110	<0.1
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	100	<0.5
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	108	<0.5
Benzo(g,h,i)perylene	mg/kg	0.5	<0.5	<0.5	<0.5	98	<0.5
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	99	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	110	<0.1
Dibenzo(a,h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	79	<0.5
Fluoranthene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	100	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	87	<0.5
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	106	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	103	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	106	<0.1
Surrogate Recovery	%	1	80	86	78	--	--

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Analytical Report

Broome North

Job No : **095032C**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Nelly Liusnaini Hislop

Approved Signatory
Ben Carpenter

Contact: Hamish Nelson
E-mail: Hamish_Nelson@coffey.com
Fax: 9347 0099
Client Reference: GEOTPERT08647AB 120 PERT-4688
Date Sampled: 30/07/2009
Date Received: 3/08/2009
Date Reported: 12/08/2009
Sampled By: Client
Location: Broome

Test Method: Soil/sediment particles less than 2mm analysed. Anions and properties analysed on a 1:5 DI extract. Metals analysis by microwave digestion (USEPA 3051), followed by ICP/AAS analysis in accordance with MPL WILAB 6, 8, 10 and 17. Results expressed on a dry weight basis.

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Analytical Report

Job No : **095032C**

Lab Id Units LQL	External Idents	Description	As mg/kg 2	Cd mg/kg 0.1	Co mg/kg 1	Cr mg/kg 1	Cu mg/kg 1	Pb mg/kg 1	Zn mg/kg 1
095032C-001	CF 1	30/07/2009	<2	0.3	<1	10	4	9	100
095032C-002	CF 2	30/07/2009	<2	0.3	<1	10	4	6	270
095032C-003	CF 3	30/07/2009	<2	0.3	<1	7	2	2	37
095032C-004	CF 4	30/07/2009	<2	0.3	<1	8	28	2	180
095032C-005	CF 5	30/07/2009	<2	0.3	<1	10	6	3	31
095032C-006	CF 6	30/07/2009	<2	0.3	<1	9	7	3	58
095032C-007	CF 7	30/07/2009	<2	0.2	<1	7	14	4	220
095032C-008	CF 8	30/07/2009	<2	0.3	<1	8	33	3	200
095032C-009	CF 9	30/07/2009	<2	0.2	<1	6	9	3	71
095032C-010	CF 10	30/07/2009	<2	0.3	<1	9	10	3	73
095032C-001-DUP	CF 1	30/07/2009	<2	0.3	<1	9	5	10	100

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Accreditation Number: 1645

LabMark
ENVIRONMENTAL LABORATORIES

Certificate of Analysis

MPL Laboratory - A division of Coffey Information.
PO Box 4223
VICTORIA PARK WA 6979

Attention: Sarah Abbott

Project	**09ENME0024432**
Client Reference	095032D
	095032D
Order Number	03221
Received Date	05/08/2009 08:30:00 AM

Customer Sample ID			**CF1**	**CF2**	**CF3**	**CF4**	**CF5**
Sample Matrix			**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**
Labmark Sample No.			**1662250**	**1662251**	**1662252**	**1662253**	**1662254**
Date Sampled			**30/07/2009**	**30/07/2009**	**30/07/2009**	**30/07/2009**	**30/07/2009**
Metals							
Test/Reference	PQL	Unit					
3200 Total Metals in Soil by ICP/AES							
Phosphorus	5	mg/kg	270	370	330	5800	610
Inorganics							
Test/Reference	PQL	Unit					
4941 Total Nitrogen in Soil by Calc							
Total Nitrogen	10	mg N/kg	590	1700	1000	2600	500
Miscellaneous							
Test/Reference	PQL	Unit					
5000 Moisture Content							
% Moisture	1	%	<1	<1	<1	1	<1

Customer Sample ID			**CF6**	**CF7**	**CF8**	**CF9**	**CF10**
Sample Matrix			**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**
Labmark Sample No.			**1662255**	**1662256**	**1662257**	**1662258**	**1662259**
Date Sampled			**30/07/2009**	**30/07/2009**	**30/07/2009**	**30/07/2009**	**30/07/2009**
Metals							
Test/Reference	PQL	Unit					
3200 Total Metals in Soil by ICP/AES							
Phosphorus	5	mg/kg	610	2600	6100	2200	1700
Inorganics							
Test/Reference	PQL	Unit					
4941 Total Nitrogen in Soil by Calc							
Total Nitrogen	10	mg N/kg	670	1800	2300	1800	2000
Miscellaneous							
Test/Reference	PQL	Unit					
5000 Moisture Content							
% Moisture	1	%	1	1	1	1	1

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

Description	**Testing Site**	**Extracted**	**Analysed**
3200 Total Metals in Soil by ICP/AES	Melbourne 1645	07/08/2009	10/08/2009
4941 Total Nitrogen in Soil by Calc	Melbourne 1645	N/A	11/08/2009
5000 Moisture Content	Melbourne 1645	N/A	06/08/2009

Labmark Internal Quality Control Review

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. Matrix spike recoveries are calculated on an 'As Received' basis; the parent sample result is moisture corrected after the % recovery is determined.
3. Proficiency trial results are available on request.
4. Actual PQLs are matrix dependant. Quoted PQLs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spike or surrogate recoveries.
6. Test samples duplicated or spiked, are for this job only and are identified in the following QC report.
7. SVOC analyses on waters are performed on homogenized, unfiltered sample, unless noted otherwise.
8. When individual results are qualified in the body of a report, refer to the qualifier descriptions that follow.
9. Samples were analysed on an as received basis.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sampling and Preservation Chart for Soils & Waters' for holding times. (LM-FOR-ADM-020)

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Acknowledgement.
If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitablity qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as an RPD

Quality Control Results

Laboratory: **EN_METALS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
1665768 [Method Blank]							
3200 Total Metals in Soil by ICP/AES							
Phosphorus	mg/kg	<5			< 5	Pass	
1663564 [Duplicate of 1662250]							
3200 Total Metals in Soil by ICP/AES			Result 2	RPD			
Phosphorus	mg/kg	340	270	23	0-30 %	Pass	

Laboratory: **EN_WATERS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
1664803 [Method Blank]							
4300 Anions in Soil by IC							
Bromide (Soluble)	mg/kg	<2			< 2	Pass	
Chloride (Soluble)	mg/kg	<2			< 2	Pass	
Fluoride (Soluble)	mg/kg	<2			< 2	Pass	
Nitrate (Soluble)	mg/kg	<2			< 2	Pass	
Nitrite (Soluble)	mg/kg	<2			< 2	Pass	
Orthophosphorus (Soluble)	mg/kg	<2			< 2	Pass	
Sulphate (Soluble)	mg/kg	<2			< 2	Pass	
1664805 [Laboratory Control Sample]							
4300 Anions in Soil by IC			Expected Value	Percent Recovery			
Bromide (Soluble)	mg/kg	520	500.0	104	75-125 %	Pass	
Chloride (Soluble)	mg/kg	530	500.0	107	75-125 %	Pass	
Fluoride (Soluble)	mg/kg	530	500.0	107	75-125 %	Pass	
Nitrate (Soluble)	mg/kg	590	500.0	118	75-125 %	Pass	
Nitrite (Soluble)	mg/kg	490	500.0	98	75-125 %	Pass	
Orthophosphorus (Soluble)	mg/kg	500	500.0	100	75-125 %	Pass	
Sulphate (Soluble)	mg/kg	520	500.0	103	75-125 %	Pass	

Laboratory: **EN_WATERS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
1663566 [Spike of 1662251]							
4300 Anions in Soil by IC			Spike Value	Percent Recovery			
Nitrate (Soluble)	mg/kg	570	500.0	114	75-125 %	Pass	
Nitrite (Soluble)	mg/kg	500	500.0	99	75-125 %	Pass	
1663567 [Spike of 1662251]							
4540 TKN in Soil by Titration			Spike Value	Percent Recovery			
Total Kjeldahl Nitrogen	mg/kg	2600	10.0	87	70-130 %	Pass	

Sample Integrity

Custody Seals Intact (if used)	No
Attempt to Chill was evident	No
Samples correctly preserved	N/A
Organic samples had Teflon liners	Yes
Samples received with Zero Headspace	No
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Ruth Callander	Client Services Officer	
Mark Herbstreit	Senior Analyst - Metals	Accreditation Number: 1645
Helen Lei	Senior Analyst - Waters	Accreditation Number: 1645

Laboratory Manager

David Elliott	Laboratory Manager - Melbourne



Final Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

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The samples were not collected by Laboratory staff.

mpl Laboratories

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www.coffey.com/mpl

Analytical Report

Organic Soil Analysis

Job No : **095035**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Gabi Glur

Approved Signatory
Chris Munro

Contact: Hamish Nelson
E-mail: Hamish_Nelson@coffey.com
Fax: 9347 0099
Client Reference: GEOTPERT08647AB 120PERT-4701
Date Sampled: 31/07/2009
Date Received: 3/08/2009
Date Reported: 17/08/2009
Sampled By: Client
Location: Unspecified

Test Method: Soil /Sediment samples analysed on an as received basis and extracted with organic solvent and analysed by gas chromatography GC-FID using external standards in accordance with MPL WILAB 7. Results expressed on a dry weight basis.

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www.coffey.com/mpl

Analytical Report

Job No : **095035**

Lab Id	External Idents	TRH	C6-C9	C10-C14	C15-C28	C29-C36	Surrogate
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
LQL		20	10	10	10	20	1
095035-001	304-TP96-0.2	<20	<10	<10	<10	<20	73
095035-002	3150-TP12-0.5	<20	<10	<10	<10	<20	82
095035-003	3150-TP7-0.1	<20	<10	<10	<10	<20	73
095035-001-DUP	304-TP96-0.2	<20	<10	<10	<10	<20	74

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www.coffey.com/mpl

Analytical Report

Organic Soil Analysis

Job No : **095035B**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Gabi Glur

Approved Signatory
Emma Rowe

Contact: Hamish Nelson
E-mail: Hamish_Nelson@coffey.com
Fax: 9347 0099
Client Reference: GEOTPERT08647AB 120PERT4701
Date Sampled: 31/07/2009
Date Received: 3/08/2009
Date Reported: 17/08/2009
Sampled By: Client
Location Unspecified

Test Method: Soil/Sediment samples analysed on an as received basis by gas chromatography GC-MS in accordance with MPL WILAB 16B. Results expressed on a dry weight basis.

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www.coffey.com/mpl

Analytical Report

Job No :	**095035B**							
Lab Id	**Units**	**LQL**	**095035B-001**	**095035B-002**	**095035B-003**	**095035B-001-DUP**	**QC Recovery%**	**Blank**
External Idents			**304-TP96-0.2**	**3150-TP12-0.5**	**3150-TP7-0.1**	**304-TP96-0.2**		
Analyte								
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	99	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	106	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	98	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	110	<0.1
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	100	<0.5
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	108	<0.5
Benzo(g,h,i)perylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	98	<0.5
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	99	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	110	<0.1
Dibenzo(a,h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	79	<0.5
Fluoranthene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	101	<0.2
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	100	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	87	<0.5
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	106	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	103	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	106	<0.1
Surrogate Recovery	%	1	81	91	87	86	--	--

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www.coffey.com/mpl

Analytical Report

Chemical Soil Analysis

Job No : **095035C**

Client: Coffey Geotechnics
Address: 89-91 Burswood Road
BURSWOOD WA 6100

Approved Checker
Ben Carpenter

Approved Signatory
Nelly Liusnaini Hislop

Contact: Hamish Nelson
E-mail: Hamish_Nelson@coffey.com
Fax: 9347 0099
Client Reference: GEOTPERT08647AB 120PERT-4701
Date Sampled: 31/07/2009
Date Received: 3/08/2009
Date Reported: 12/08/2009
Sampled By: Client
Location: Unspecified

Test Method: Soil/sediment particles less than 2mm analysed. Anions and properties analysed on a 1:5 DI extract. Metals analysis by microwave digestion (USEPA 3051), followed by ICP/AAS analysis in accordance with MPL WILAB 6, 8, 10 and 17. Results expressed on a dry weight basis.

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www.coffey.com/mpl

Analytical Report

Job No : **095035C**

Lab Id Units LQL	External Idents	Description	As mg/kg 2	Cd mg/kg 0.1	Co mg/kg 1	Cr mg/kg 1	Cu mg/kg 1	Pb mg/kg 1	Zn mg/kg 1
095035C-001	304-TP96-0.2	31/07/2009	<2	0.3	<1	8	1	3	2
095035C-002	3150-TP12-0.5	31/07/2009	<2	0.2	<1	8	1	3	2
095035C-003	3150-TP7-0.1	31/07/2009	<2	0.2	<1	9	1	3	2
095035C-001-DUP	304-TP96-0.2	31/07/2009	<2	0.3	<1	8	1	3	2

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LabMark
ENVIRONMENTAL LABORATORIES

Certificate of Analysis

MPL Laboratory - A division of Coffey Information.
PO Box 4223
VICTORIA PARK WA 6979

Attention: Sarah Abbott

Project	**09ENME0024413**
Client Reference	095035D
Order Number	03222
Received Date	05/08/2009 08:20:00 AM

Customer Sample ID			**304-TP96-0.2**	**3150-TP12-0.5**	**3150-TP7-0.1**
Sample Matrix			**SOIL**	**SOIL**	**SOIL**
Labmark Sample No.			**1662200**	**1662201**	**1662202**
Date Sampled			**31/07/2009**	**31/07/2009**	**31/07/2009**
Metals					
Test/Reference	PQL	Unit			
3200 Total Metals in Soil by ICP/AES					
Phosphorus	5	mg/kg	27	13	17
Inorganics					
Test/Reference	PQL	Unit			
4941 Total Nitrogen in Soil by Calc					
Total Nitrogen	10	mg N/kg	160	130	230
Miscellaneous					
Test/Reference	PQL	Unit			
5000 Moisture Content					
% Moisture	1	%	2	2	2

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

Description	**Testing Site**	**Extracted**	**Analysed**
3200 Total Metals in Soil by ICP/AES	Melbourne 1645	07/08/2009	10/08/2009
4941 Total Nitrogen in Soil by Calc	Melbourne 1645	N/A	10/08/2009
5000 Moisture Content	Melbourne 1645	N/A	06/08/2009

LabMark
ENVIRONMENTAL LABORATORIES

Labmark Internal Quality Control Review

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. Matrix spike recoveries are calculated on an 'As Received' basis; the parent sample result is moisture corrected after the % recovery is determined.
3. Proficiency trial results are available on request.
4. Actual PQLs are matrix dependant. Quoted PQLs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spike or surrogate recoveries.
6. Test samples duplicated or spiked, are for this job only and are identified in the following QC report.
7. SVOC analyses on waters are performed on homogenized, unfiltered sample, unless noted otherwise.
8. When individual results are qualified in the body of a report, refer to the qualifier descriptions that follow.
9. Samples were analysed on an as received basis.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sampling and Preservation Chart for Soils & Waters' for holding times. (LM-FOR-ADM-020)

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Acknowledgement.
If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitablity qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as an RPD

Quality Control Results

Laboratory: **EN_METALS**

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
1665768 [Method Blank]							
3200 Total Metals in Soil by ICP/AES							
Phosphorus	mg/kg	<5			< 5	Pass	

Sample Integrity

Custody Seals Intact (if used)	No
Attempt to Chill was evident	Yes
Samples correctly preserved	N/A
Organic samples had Teflon liners	Yes
Samples received with Zero Headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Ruth Callander	Client Services Officer	
Mark Herbstreit	Senior Analyst - Metals	Accreditation Number: 1645
Helen Lei	Senior Analyst - Waters	Accreditation Number: 1645

Laboratory Manager

David Elliott — Laboratory Manager - Melbourne



Final Report

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The samples were not collected by Laboratory staff.

Appendix D

Technical Note on The Effects of Compaction Plant on Adjacent Structures (Tynan 1973)

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

TECHNICAL NOTE

on

THE EFFECTS OF COMPACTION PLANT ON ADJACENT STRUCTURES

Based on TYNAN 1973

---

1. INTRODUCTION

Proof compaction techniques have been popular in recent years to prove the ability of the ground to support lightly-loaded structures. These techniques have been used in conjunction with conventional site investigation methods to locate deposits of loose fill and peat and to compact loose sands to depths of 2.5 to 3m.

The advent of heavy compaction equipment has resulted in plant having a static weight in excess of 10 tonnes being readily available for the proof compaction. Safeguards must be exercised when operating this plant in built-up areas to prevent damage to existing structures and to minimise distress and litigation.

The purpose of the note is to provide guide lines for safely operating compaction plant in the vicinity of domestic and/or commercial developments.

2. VIBRATION LIMITS AND HUMAN SENSITIVITY

Damage to residential/commercial structures correlates more closely with the maximum velocity of good vibrations (hereafter referred to as particle velocity) than with displacement or acceleration (Tynan, 1973). Accordingly, particle velocity is the parameter which should be controlled to prevent structural and architectural damage.

Forssblad (1966) suggested that the particle velocity should be limited to 10mm/sec (max) to minimise the risk of damage to adjacent buildings. Forssblad measured and compared vibration levels inside and outside of buildings and found that the particle velocities in the building foundations are 2 to 5 times lower. Ground vibrations with a maximum velocity of 10mm/sec thereby correspond to vibrations measured in buildings of the magnitude 2 to 5mm/sec.

People are particularly sensitive to vibration. Jackson (1967) comments that a person "who sees any possible human cause for the smallest defect or minor damage may have an associated emotional factor which can magnify any claimed damage by several orders of magnitude". The vibration limits set in the current codes recognise this characteristic.

The Forssblad findings are summarised below. The maximum permissible particle velocities are related to risk of damage and typical human reaction at each vibration level.

TABLE 1 SUMMARY OF VIBRATION EFFECTS

MAXIMUM PERMISSIBLE PARTICLE VELOCITY* mm/sec	EFFECTS ON BUILDINGS	HUMAN REACTION
2	Risk limit for ruins and ancient monuments	Vibrations perceptible
5	Risk limit for "architectural" damage to normal dwelling houses with plastered walls and ceilings.	Vibrations annoying
10	Risk limit for damage to normal dwelling houses.	Vibrations unpleasant
10-40	Risk limit for concrete buildings, industrial buildings etc.	Vibrations unpleasant to not acceptable

Reference: Forssblad (1966)

* vibrations measured in building foundations

3. OPERATING SAFEGUARDS

3.1 Proximity Limits

The Australian Road Research Board (Tynan 1973) suggested that the following proximity limits should be complied with when operating vibrating rollers next to residential and commercial structures.

TABLE 2 SUGGESTED PROXIMITY LIMITS FOR THE USE OF VIBRATING ROLLERS TO PREVENT DAMAGE TO BUILDINGS

ROLLER CLASS	ROLLER WEIGHT (STATIC RANGE) AND CENTRIFUGAL FORCE (CF) (TONNES)	RESTRICTION: DISTANCE TO NEAREST BUILDING (METRES)
(i) Very Light	Maintenance and patching rollers, less than 1.25 (CF 1-2)	Generally not restricted for normal road use. (3)*
(ii) Light	1-2 (CF 2-5)	Generally not restricted for normal road use. (5)*
(iii) Light - Medium	2-4 (CF 5-10)	5+ (10)*
(iv) Medium - Heavy	4-6 (CF 10-20)	Not advised for city and suburban streets. 10+ (20)*
(v) Heavy	7-11 (CF 20-30)	Restricted. Not advised for built-up areas. 20+ (40)*
(vi) Very Heavy	12 and over (CF over 30)	Restricted, major construction rural areas away from structures and buildings.

* Values in brackets are those suggested to keep claims and complaints to an acceptably low level. For no complaints in residential area, these values would possibly be needed to be increased still further.

\+ To prevent architectural and structural damage to buildings.

3.2 Instrumentation/Monitoring

Where the above suggested proximity limits can not be complied with due to access restrictions, it is recommended that the vibrations in the adjacent structures be recorded using standard vibration meters. If damage to adjacent buildings is to be minimised, rolling should then be discontinued when the particle velocities recorded by the vibration meters approach the maximum permissible values presented in Table 1.

3.3 Inspection

A systematic pre-inspection of buildings, with emphasis on existing cracks and defects, is often desirable before starting construction work within or close to residential areas. It may be desirable to make a photographic record of this inspection.

4. SETTLEMENT CONSIDERATIONS

Sands and gravels are the easiest soil types to compact by vibration. A minor increase in density can be achieved at accelerations which are as low as 0.2 to 0.5g (Forssblad). In the frequency range normally used for soil compaction by vibrations, an acceleration of 0.2g corresponds to a particle velocity in the order of 10mm/sec, which is the same criteria as given with regard to damages directly caused by vibrations. Consequently, the likelihood of vibratory soil compaction generating additional settlements beneath adjacent structures is considered to be very low providing that the above safeguards are adhered to.

Slopes however, may become unstable under vibratory forces. Even very slight vibrations may, under unfavourable circumstances, initiate settlement and movements.

Coffey Geosciences Pty Ltd would be pleased to assist in any aspect of vibration induced damage or in its avoidance.

* * * * *

BIBLIOGRAPHY

1. "Ground Vibrations: Damaging Effects to Buildings"
   A E Tynan (1973) Special Report #11 Australian Road Research Board.
2. "Vibratory Soil and Rockfill Compaction" Lars Forssblad (1981).
3. "Investigation of Soil Compaction by Vibration" Lars Forssblad (1966). Division Hydraulics R Inst Tech Stockholm.
4. "Vibrations of Soils and Foundation" Richart et al (1970).
5. "Thresholds of Damage due to Ground Motion" Jackson M M (1967).
   Proc. Int. Symp. Wave Prop. Dyn. Props. Earth Mats. New Mexico.

Appendix H – Water Corporation Liaison

Nicholas Deeks

From: Frank Kroll <Frank.Kroll@watercorporation.com.au>
Sent: Friday, 20 December 2013 8:30 AM
To: Brian Farrell
Subject: Water & Wastewater Servicing for Broome North LDP3 Area
Attachments: 201312110819.pdf; 201312110821.pdf

Hi Brian

With reference to your enquiry dated 16 December 2013, whether the Broome North LDP3 area, as shown on your plan, can be serviced with a scheme water and wastewater service.

The area has existing planning that covers the site, hence in principle it will be able to be served, pending augmentation and upgrades to specific headworks components (pump stations and mains 300mm and over), and reticulation mains (under 300mm). Subject to orderly planning, staging, and scheduling of works, the Corporation will fund headworks, and the developer will be responsible for funding reticulation works.

A plan of the existing water and wastewater infrastructure is attached.

Water Supply:-

A water supply scheme covers the proposed development area. Cable Beach Tank that services the Cable Beach zone where the proposed development is located. Upgrading of mains from the borefield and additional storage tanks are proposed, as development and demand proceeds. An additional pipeline is proposed along Fairway Drive in the short term. Additional land will be required in approximately 2015 to expand the Tank site. When a suitable structure plan is available for the development area, a reticulation plan will need to be prepared, with water sourced from the DN450 in the west.

Wastewater:-

A wastewater scheme plan covers the proposed development area. The scheme shows two catchment areas gravitating towards the two existing pump stations Broome No. 5 pumping to South Broome No. 3, from whence wastewater is pumped to the Broome North WWTP. This will guide detailed reticulation planning. A portion of the wastewater scheme is attached showing the catchment areas.

Planning Reviews:-

The existing planning would need to be reviewed once further information of development in terms of no. of development lots is provided, and staging of development is known so that our works are able to be scheduled.

Water Efficiency:-

It is our expectation that the principles of Better Urban Water Management (Department of Water) will be followed – 100 kl/person/year with 40-60 kl/person/year from scheme water, the remainder being made up with non-potable water. If only scheme water is available, a target figure for Broome will need to be established.

Should you require further information, do not hesitate to contact me. Please note that I will be on leave from COB today till 29 January 2014. If the matter is urgent please contact Peter Howard.

Regards

Frank Kroll
Senior Development Planner
Development Services Branch

Water Corporation
Planning & Capability Group

629 Newcastle Street Leederville 6007
Telephone: (08)9420 2221
Fax: (08)9420 3193
Email: frank.kroll@watercorporation.com.au

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Kelsey Hunt

From: Frank Kroll <Frank.Kroll@watercorporation.com.au>
Sent: Tuesday, 25 November 2014 2:11 PM
To: Nick Deeks
Subject: RE: Water servicing for Broome North LDP3

Hi Nicholas

A reply has been given by our Regional Asset people with the following general adsvice.

The requested volume was not included in the Corporation's Scheme Plan.
There may be an opportunity to supply the requested 24kL/d (8.8ML/A) as a short term arrangement however needs to be assessed on the case by case basis, and more information would be required from you. There is some possibility this may be granted.
If the request is a permanent arrangement, then we need to understand impact to our system based on the requested rate of demand however this would take quite some time as it has to be assessed by our Planning Branch, and there is no guarantee that it may yield a positive result for you.

In both cases we would need peak instantaneous rate, demand pattern, and in the former case a timeframe as well.

A query I have is whether this would be an expectation for other parts of Broome as well, or is this just a requirement for this development.

Perhaps a phone call from you may be in order to talk this through.

Regards

Frank Kroll
Senior Development Planner
Development Services Branch

Water Corporation
Planning & Capability Group

629 Newcastle Street Leederville 6007
Telephone: (08)9420 2221
Fax: (08)9420 3193
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From: Nicholas Deeks [mailto:Nicholas.Deeks@ghd.com]
Sent: Tuesday, 21 October 2014 2:18 PM
To: Frank Kroll
Cc: Yang Yang
Subject: RE: Water servicing for Broome North LDP3

Frank, apologies but I messed up the units: 8.8 MLPA

Regards

Nicholas Deeks
Manager - Water Resources

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T: +61 8 6222 8956 | V: 618956 | M: +61 4 0401 4609 | E: nicholas.deeks@ghd.com
239 Adelaide Tce, Perth WA 6004 Australia | www.ghd.com
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From: Nicholas Deeks
Sent: Tuesday, 21 October 2014 2:14 PM
To: 'Frank Kroll'
Cc: Yang Yang
Subject: RE: Water servicing for Broome North LDP3

Hi Frank,

Attached is the site water balance, using the Water Corporation tool, showing a demand of 8.8 kL/a. Can this be supplied?

Regards

Nicholas Deeks
Manager - Water Resources

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From: Frank Kroll [mailto:Frank.Kroll@watercorporation.com.au]
Sent: Thursday, 25 September 2014 1:39 PM
To: Nicholas Deeks
Cc: Yang Yang
Subject: RE: Water servicing for Broome North LDP3

Hi Nicholas

I have briefly discussed this today with our Manager Assets North West Region, who has given the following advice:-

Corporation does not scheme plan to supply potable water to POS or dust suppression.
Supply however can be considered for an interim period
We need to know the demand before we can consider
Subject to available capacity, urban development has priority

If you are in a hurry for this, please take up directly with our Asset Manager Mr Yang Yang, as I will be on leave over the next two weeks, his direct phone no. is 9186 8276.

Regards

Frank Kroll
Senior Development Planner
Development Services Branch

Water Corporation
Planning & Capability Group

629 Newcastle Street Leederville 6007
Telephone: (08)9420 2221
Fax: (08)9420 3193
Email: frank.kroll@watercorporation.com.au

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From: Nicholas Deeks [mailto:Nicholas.Deeks@ghd.com]
Sent: Monday, 22 September 2014 3:59 PM
To: Frank Kroll
Subject: RE: Water servicing for Broome North LDP3

Hi Frank,

When will you be able to respond to this enquiry? It's the last action remaining for LSP approval, and LandCop are keen to get this finished.

Regards

Nicholas Deeks
Manager - Water Resources

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239 Adelaide Tce, Perth WA 6004 Australia | www.ghd.com
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From: Nicholas Deeks
Sent: Wednesday, 10 September 2014 4:40 PM
To: 'Frank.Kroll@watercorporation.com.au'
Subject: Water servicing for Broome North LDP3

Hi Frank,

I am working for LandCorp for the Broome North LDP3 development. I am preparing a Local Water Management Strategy to support the Local Structure Plan. Referring to the attached email, you previously provided Tabec with advice that a water supply scheme covers the proposed development area. It is proposed to use potable water for irrigation demand in the development due to the absence of alternative fit-for-purpose water sources. The DoW have requested that we receive correspondence from Water Corporation that the water supply scheme can cater for POS irrigation and dust suppression demands. Can you please respond to this email accordingly?

Regards

Nicholas Deeks
Manager - Water Resources

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239 Adelaide Tce, Perth WA 6004 Australia | www.ghd.com

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Appendix I – Site Water Balance

H2Options

WATER CORPORATION

Input

Please enter numeric data as numbers only, i.e. for 70% enter 70, for 1,450.5 m² enter 1450.5

Name of developer	LandCorp
Name of development	Broome North LDP3
Date of entry	10 September 2014
Location of development	Broome, WA
Total development area (m²)	1,305,000

1. Residential

Household type	No. of Lots	Households per lot	Average Area per lot (m²)	Irrigated area per lot (m²)
Traditional	528	1	600	180
Terrace	0	0	0	0
Cottage	284	1	220	22
Apartment	0	0	0	0
Lifestyle/semi-rural	45	1	1,500	250

Percentage of lots with rainwater tanks (%)	0
Percentage of lots with greywater recycling systems (%)	0
Total residential area (m²)	446,780
Total irrigated area (m²)	112,538

2. Schools

	No. of Students	No. of Staff	Total Area (m²)	Irrigated area (m²)
School 1	0	0	0	0
School 2	0	0	0	0
School 3	0	0	0	0

Total school area (m²)	0
Total Irrigated area (m²)	0

3. Commercial and industrial

Industry type	Unit	No. of units	Total Area (m²)	Irrigated area (m²)
Hotel	Room	0	0	0
Shopping centre	m² GLA	0	0	0
Hospital	Bed	0	0	0
Nursing home	Bed	0	0	0
Light industrial	m² GLA	0	0	0
Commercial laundry	Entity	0	0	0
Aquatic centre	Entity	0	0	0
Municipal building	m² GLA	0	0	0
Office building	m² GLA	0	0	0

Industry type	Unit	No. of units	Total Area (m²)	Irrigated area (m²)	Total annual demand (kL/year)
Other	Tourist Park (estimate only)	50	209,471	83,788	2,800

Total commercial and industrial area (m²)	209,471
Total commercial and industrial irrigated area (m²)	83,788

4. Public Open Space (POS)

	Area (m²)	Amenities (kL/year)
Active POS	0	0
Other Irrigated POS	14,642	
Street scaping	0	
Non-irrigated POS	82,973	

Total POS area (m²)	97,615
Total irrigated POS area (m²)	14,642

5. Miscellaneous

Misc. type	Total demand (kL/year)	Comments
Environmental Cultural Corrid	0	
Roads	0	
	0	

Total other area (m²)	551,134

Area Summary

Residential (m²)	446,780
Schools (m²)	0
Commercial and industrial (m²)	209,471
Public open space (m²)	97,615
Miscellaneous (m²)	551,134
Total development area (m²)	1,305,000
Area Gap - if any (m^2)	0

H2Options

WATER CORPORATION

Assumptions

1. Residential

	Value	Unit	Comments
Water use			
Indoor water use	56	kL/person/year	
Pool, spa and handwatering (outdoor except irrigation)	5	kL/person/year	
Irrigation	0.46	kL/m^2/year	
Number of residents by household type			
Traditional	2.7	No. of residents	
Terrace	1.7	No. of residents	
Cottage	1.8	No. of residents	
Apartment	1.5	No. of residents	
Lifestyle/semi-rural	2.7	No. of residents	
Demand by water type			
Indoors			
Drinking water indoors	100	%	
Non-drinking water indoors	0	%	
	Value changed		
Outdoors			
Drinking water outdoors	100	%	
Non-drinking water outdoors	0	%	
	Value changed!		
Rainwater supply			
Residential rainwater tank yield (2kL, plumbed)	55	kL/tank/year	
Greywater supply			
Greywater produced	36	kL/person/year	

2. Schools

	Value	Unit	Comments
Water consumption			
Water use indoors, drinking, outside taps	5	kL/person/year	
Water use for irrigation	0.83	kL/m²/year	
Demand by water type			
Drinking water indoors	70	%	
Non-drinking water indoors	30	%	
Drinking water irrigation	0	%	
Non-drinking water irrigation	100	%	

3. Commercial and industrial

	Value	Unit	Comments
Average total water consumption by industry type			
Hotel	150	kL/room/year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	
Shopping centre	1	kL/m² GLA /year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	
Hospital	220	kL/bed/year	
Drinking water demand	90	%	
Non-drinking water demand	10	%	
Nursing home	120	kL/bed/year	
Drinking water demand	90	%	
Non-drinking water demand	10	%	
Light industrial	1	kL/m² GLA /year	
Drinking water demand	60	%	
Non-drinking water demand	40	%	
Commercial laundry	45,000	kL/entity/year	
Drinking water demand	5	%	
Non-drinking water demand	95	%	
Aquatic centre	14,600	kL/entity/year	
Drinking water demand	80	%	
Non-drinking water demand	20	%	
Municipal building	1	kL/m² GLA/year	
Drinking water demand	50	%	
Non-drinking water demand	50	%	
Office building	1	kL/m² GLA/year	

Drinking water demand	60	%
Non-drinking water demand	40	%

Other

Drinking water demand	100	%
Non-drinking water demand	0	%

Value changed!

4. Public open space (POS)

	Value	*Unit*	*Comments*
Average water consumption			
Active POS	1.3	kL/m²/year	
Other irrigated POS	0.6	kL/m²/year	
Verges / street scapes	0.65	kL/m²/year	
Demand by water type			
Drinking water	100	%	
Non-drinking water	0	%	

Value changed!

5. Miscellaneous

	Value	*Unit*	*Comments*
Demand by water type			
Drinking water	60	%	
Non-drinking water	40	%	

H2Options

WATER CORPORATION

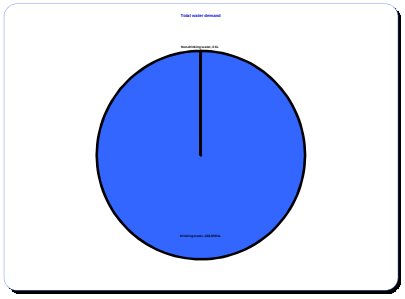
Water Balance Results

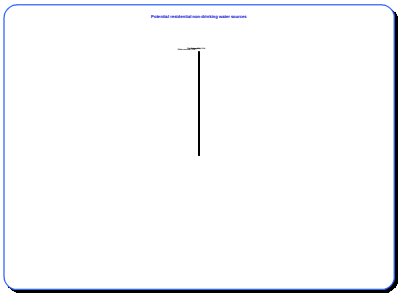
Name of developer	**LandCorp**
Name of development	**Broome North LDP3**
Date of entry	**10 September 2014**
Location of development	**Broome, WA**
Total development area (m²)	**1,305,000**

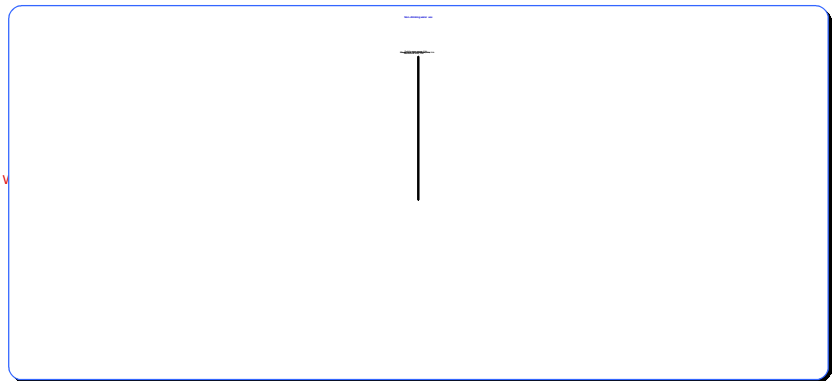
	DEMAND (kL/year)	REQUIRED SUPPLY (kL/year)	
		Drinking water	Non-drinking water
Residential indoor	115,265	115,265	0
Residential outdoor	62,059	62,059	0
Residential total	**177,324**	**177,324**	**0**
School irrigation	0	0	0
School non-irrigation	0	0	0
School total	**0**	**0**	**0**
Commercial and industrial	**2,800**	**2,800**	**0**
Public open space	**8,785**	**8,785**	**0**
Miscellaneous	**0**	**0**	**0**
Development total	**188,909 kL**	**188,909 kL**	**0 kL**
kL / person / year	**91.78**		

Potential residential non-drinking water sources (kL/year)

Rainwater	Greywater	Other sources
0	0	0







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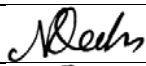
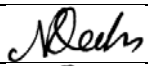
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Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	K. Hunt	N Deeks		N Deeks		26/6/2014
1	K. Hunt	N. Deeks		N. Deeks		28/5/2015

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