Dolbys Drive Local Structure Plan
Waggrakine, Western Australia

Prepared for the Shire of Chapman Valley by GHD Pty Ltd

This structure plan is prepared under the provisions of the Shire of Chapman Valley Local Planning Scheme No. 2.

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

Date 15 August 2017

Signed for and on behalf of the Western Australian Planning Commission:

_____

an officer of the Commission duly authorised by the Commission pursuant to section 16 of the *Planning and Development Act 2005* for that purpose, in the presence of:

_____ Witness

15 August 2017 Date

15 August 2027 Date of Expiry

TABLE OF MODIFICATIONS TO PART ONE AND STRUCTURE PLAN MAP

No.	Summary of the Amendment	Amendment Type	Date approved by WAPC

TABLE OF DENSITY PLAN

Density Plan No.	Area of density plan application	Date endorsed by WAPC

EXECUTIVE SUMMARY

The Dolbys Drive Structure Plan (the structure plan) area is located within the suburb of Waggrakine, in the Shire of Chapman Valley.

The structure plan proposes the creation of approximately 1 hectare rural residential lots to facilitate rural residential living. Due to the current land ownerships and the access to the area, the structure plan proposes three options for access to the newly created lots. The preferred access option will be dependent on the staging of subdivision by landowners.

The structure plan proposes the introduction of a foreshore reservation which covers Dolby Creek. This will ensure protection of the local environmental asset and provide appropriate buffers for development.

Item	Summary		Structure Plan Ref (section no.)
Total area covered by the structure plan	38.0019 hectares		Part 2, section 1.2.2
Area of each land use proposed:	Hectares	Lot yield	
- Rural Residential	~30	30	Part 2, section 1.2.2
Estimated lot yield	30		Part 2, section 1.2.2
Estimated number of dwellings	30		Part 2, section 1.2.2
Estimated residential site density	1 dwelling per hectare		Part 2, section 1.2.2
Estimated population	84 persons*		
Number of high schools	Nil - not required		N/A
Number of primary schools	Nil - not required		N/A
Estimated commercial floor space	Not applicable		N/A
Estimated area and % of public open space			
- Regional open space	Nil		N/A
- District open space	Nil		N/A
- Neighbourhood park	Nil		N/A
- Local park	Nil		N/A
Estimated natural areas	~8 hectares (subject to variation dependent on foreshore reserve of Dolby Creek and preferred road access option)		N/A

* based on 2011 Census, average person per household for the state suburb of Waggrakine.

Contents

Dolbys Drive Structure Plan

Part One - Implementation

Implementation

1.0 Structure Plan Area

The Dolbys Drive Structure Plan (the structure plan) applies to the land contained within the structure plan as shown on the structure plan map (Plan 1).

2.0 Operation

The structure plan comes into effect on the date approved by the Western Australian Planning Commission (WAPC).

3.0 Staging

The structure plan proposes three access scenarios to ensure flexibility in the plan and will allow development to occur independent of other landowners' development intentions.

Staging of the structure plan will be influenced by access, and will radiate from access points according to market forces and aspirations of individual owners.

Each parent lot will represent a stage of subdivision; however it is not expected in the outset that each lot will subdivide to the ultimate development layout through a single subdivision stage. Staged subdivision may retain large lots around existing houses and improvements, whilst providing for part development as an interim measure.

Areas with access from Cooper St or Dolbys Drive will subdivide independently. Others will subdivide based on whichever access scenario can be achieved first. Then, lot by lot from the scenario achieved.

All access scenarios are able to be achieved subject to detailed design. Each scenario may require different construction specifications, particularly where the roads cross over Dolby Creek. Additional measures, such as demonstration of adequate sight lines and potential flood mitigation measures may also be required, depending on which scenario is progressed.

The structure plan and Local Water Management Strategy (LWMS) provide for coordinated stormwater management, with basins for the 100 year flood located within the Dolby Creek foreshore reserve. Subdivision stages occurring ahead of the development of the Dolby Creek foreshore reserve on other lots will need to incorporate temporary measures and areas for flood mitigation. The sizing, location, and decommissioning of temporary drainage infrastructure should be incorporated within Urban Water Management Plans prepared as a condition of subdivision.

The provision of infrastructure and roads will be determined at the time of subdivision.

There are no requirements for schools or additional social infrastructure within the structure plan area.

4.0 Subdivision and Development Requirements

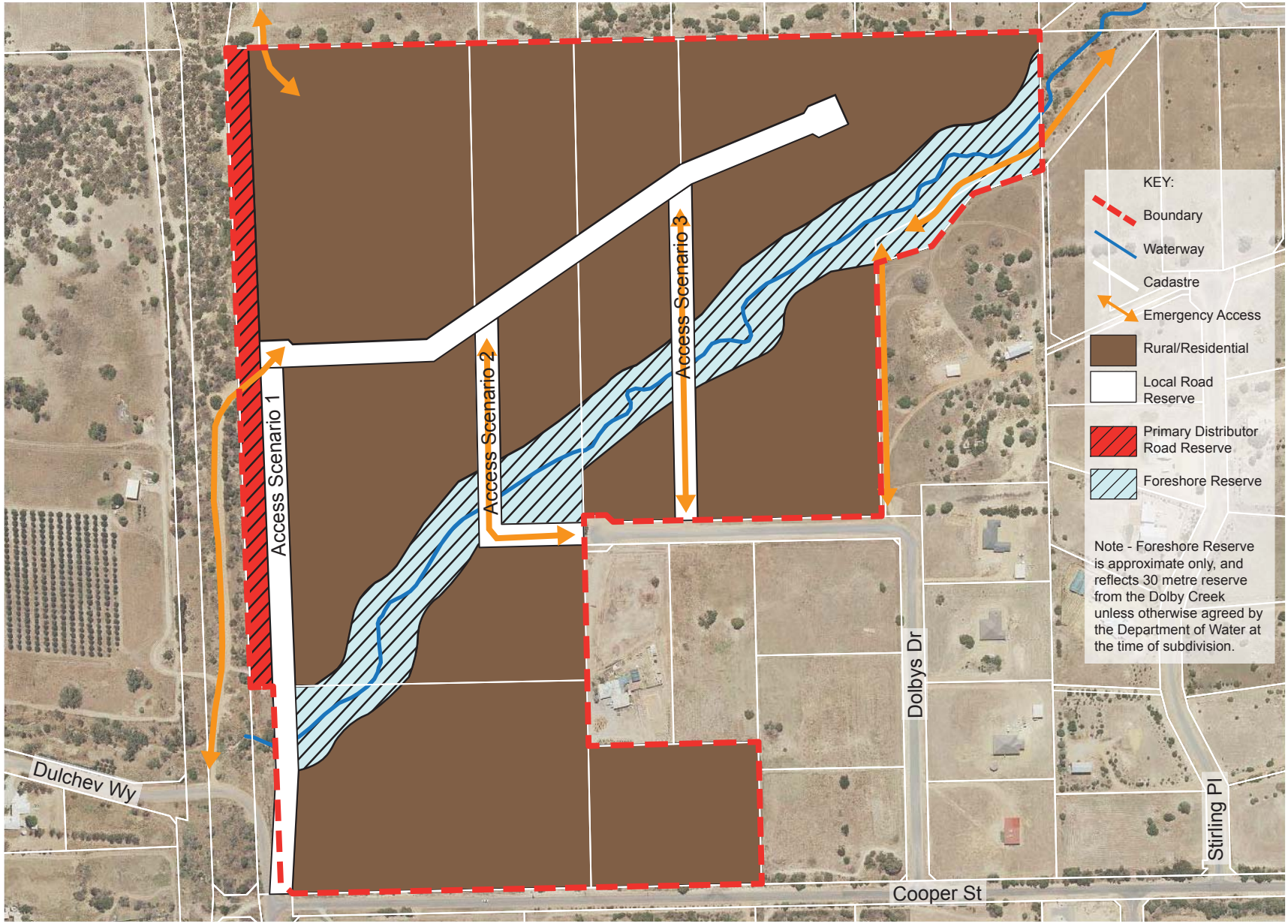
Subdivision and development is subject to the requirements of the Rural Residential zone as specified in the Shire of Chapman Valley operative planning scheme.

4.1 Subdivision Requirements

Lots are to generally be a minimum of 1.0 hectare in area. Variations may be considered where it can be satisfactorily demonstrated that the subdivision is in accordance with the general intent of the structure plan, the objectives of the Rural Residential zone and is consistent with orderly and proper planning.

The structure plan requires the following matters to be considered at the time of subdivision:

- Bushfire Management Plan
- Urban Water Management Plan
- Foreshore Management Plan



Structure Plan

0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

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Plan 1: Dolbys Drive Structure Plan

It is recommended that conditions be imposed upon lots abutting the North West Coastal Highway 'Major Road' reserve to ensure that:

- a notification is placed on the certificates of title to state that the lots are in the vicinity of a proposed transport corridor and may in the future be affected by transport noise.
- a covenant is placed on the certificates of title to prevent vehicular access to and from the 'Major Road' scheme reserve.

In addition to the above, conditions may be imposed for lots abutting Dolby Creek to require ceding of a foreshore reserve to be vested as a reserve for recreation.

4.2 Development Provisions

Development provisions are to be in accordance with the Shire of Chapman Valley operative local planning scheme. In addition, the following specific development provisions apply:

i. Sites that are likely to experience inundation during the 100 year ARI event will be required to be raised a minimum 300 mm above the maximum inundation level. Sites which are not likely to be inundated will be required to be raised 150 mm above the lowest point. The required finish floor levels are depicted on Figure 1.
ii. Reticulated sewerage is not available within the structure plan area. On-site effluent disposal will be required.

4.3 Land Use Permissibility

Land uses shall be in accordance with the Rural Residential zone of the Shire of Chapman Valley operative local planning scheme.

5.0 Local Development Plans

The structure plan does not require the preparation of local development plans.

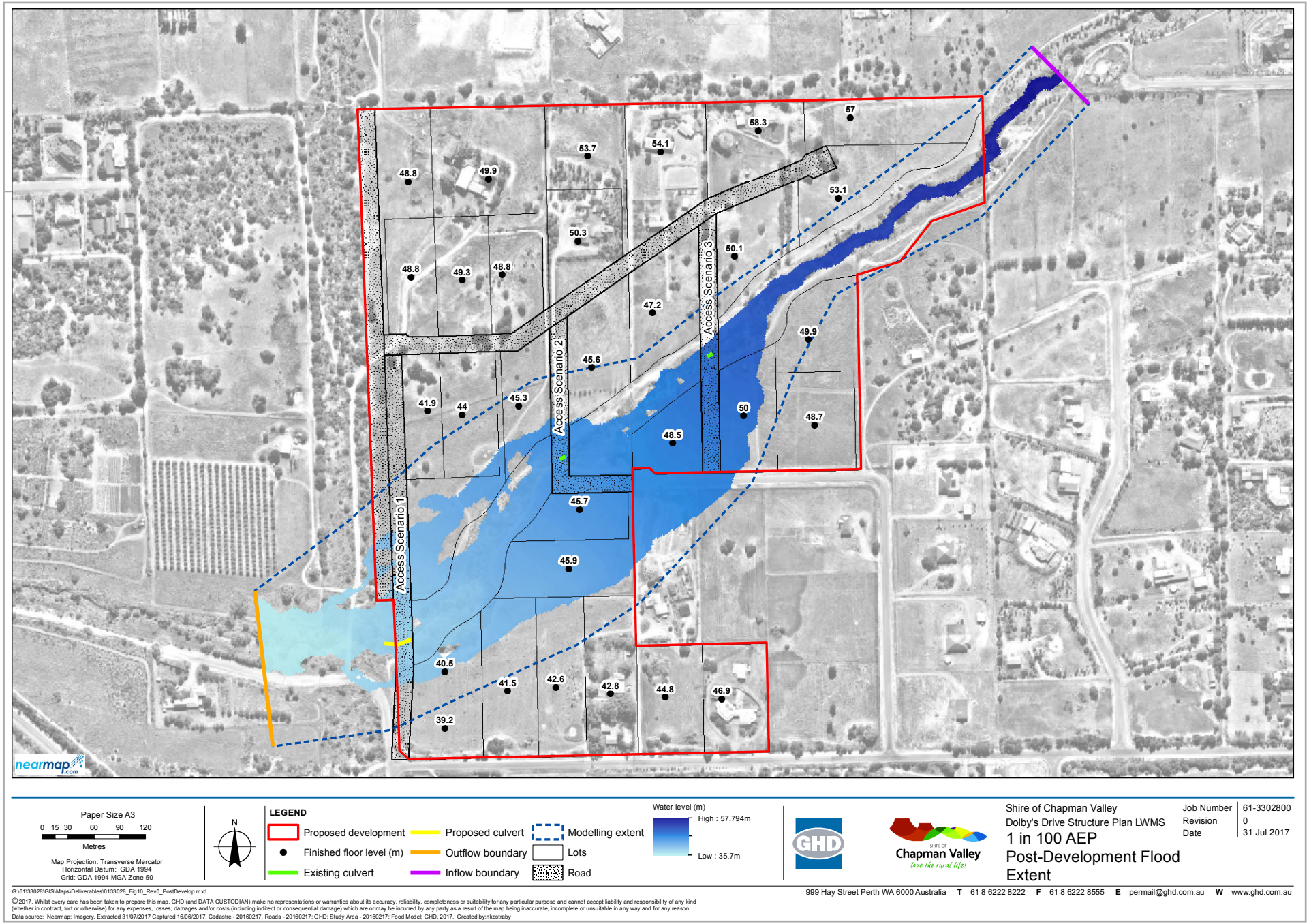


Figure 1: Post development 1 in 100 AEP flood extent (Source: Extracted from Dolbys Drive Local Water Management Strategy)

Dolbys Drive Structure Plan

Part Two - Explanatory Section

1.0 Planning Background

1.1 Introduction and Purpose

The Dolbys Drive Structure Plan (the structure plan) has been developed in accordance with Part 4, clause 15(c) of the Planning and Development (Local Planning Schemes) Regulations 2015 (the Regulations).

The intent of the structure plan is to guide development of a rural residential area, characterised by:

- Rural living lots; and
- Conservation of environmental character.

The purpose of the structure plan is:

- To coordinate access that aligns with future subdivision.
- To support conservation of environmental character and allow for low-key recreation opportunities through creation of a foreshore reserve along Dolby Creek.
- To facilitiate proper and orderly planning that accommodates fragmented land ownership within the structure plan area.

1.2 Land Description

1.2.1 Location

The structure plan area is located approximately 11 kilometres north of Geraldton, within the Shire of Chapman Valley local government area. The structure plan area abuts the City of Greater Geraldton local government area to the south and west.

The structure plan area is bounded by existing development to the north and east, Cooper Street, a local distributor road, and beyond that, existing development, to the south and future road reserve to the west. Dolby Creek cuts through the structure plan area, from southwest to northeast. The location is shown in Figure 2.

1.2.2 Area and Land Use

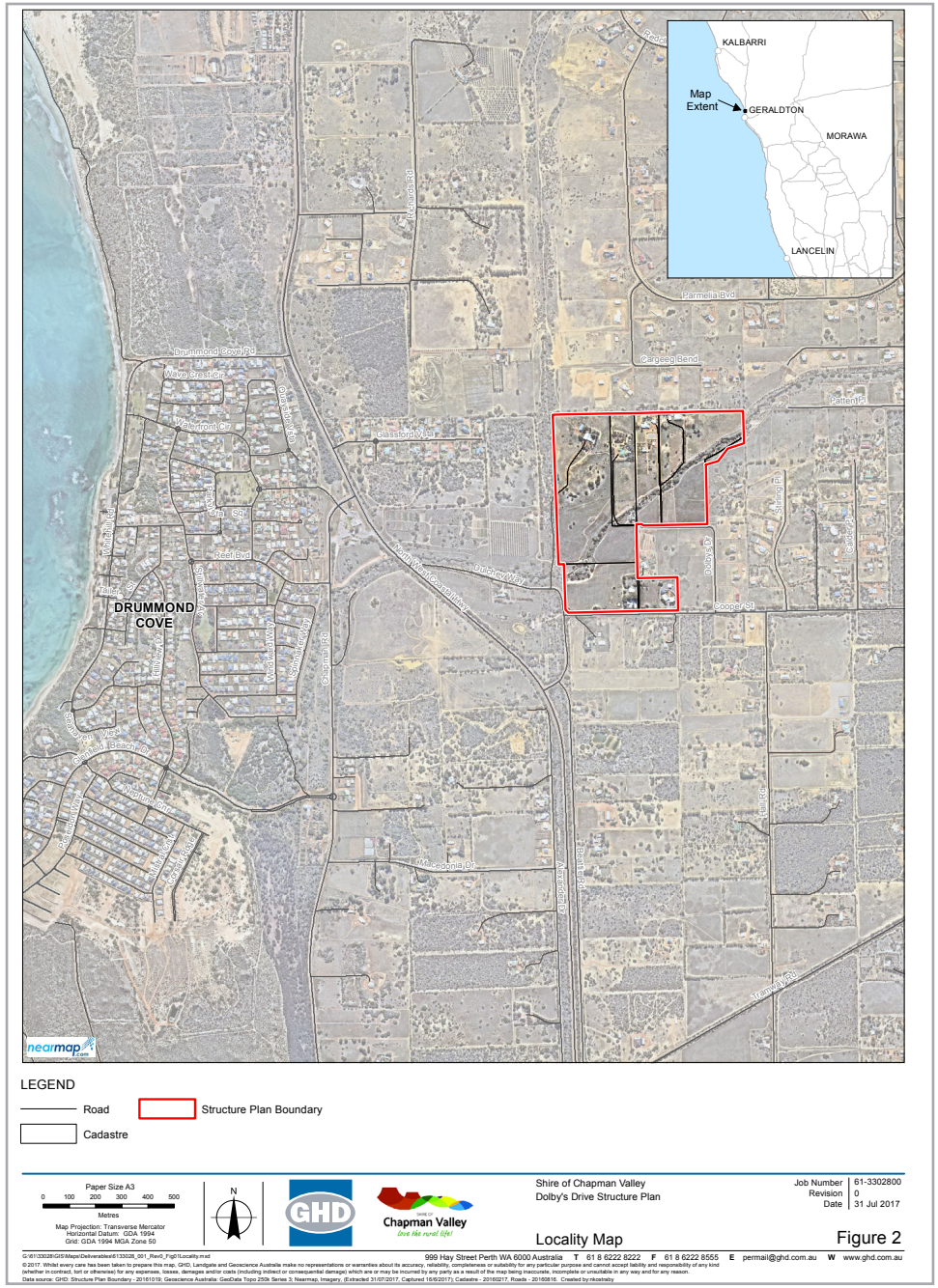
The structure plan area consists of primarily rural lifestyle land uses, including cleared areas, existing dwellings and remnant vegetation along Dolby Creek. The total area of the site is 38 hectares.

The structure plan proposes lots sizes generally of 1 hectare. In some situations the lots are smaller where part of the lot has been ceded for foreshore reserve or for access.

The structure plan has been developed in line with the local planning scheme and maintains the land use in the area as rural residential. The provisions of the scheme and this structure plan only permit one dwelling per lot. In accordance with the proposed lot layout, the structure plan potentially yields 30 dwellings.

1.2.3 Legal Description and Ownership

The structure plan area consists of six freehold lots, all in separate private ownership.



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Data source: GHD: Structure Plan Boundary - 20161019; Geoscience Australia: GeoData Topo 250k Series 3; Nearmap, Imagery, (Extracted 31/07/2017, Captured 16/6/2017); Cadastre - 20160217, Roads - 20160816. Created by:nkostraby

Figure 2: Location of the Dolbys Drive Structure Plan Area

1.3 Planning Framework

1.3.1 Zoning and Reservations

The Shire of Champan Valley Local Planning Scheme No.2 (LPS2) was gazetted on 20 November 2013. The subject land is zoned 'Rural Residential' (Rural Residential area 1) as shown in Figure 3. According to the LPS2, the objectives of the Rural Residential Zone are to:

a. Provide for residential development within a low-density environment;
b. Provide for other land-uses compatible with a high level of residential amenity;
c. Prevent the establishment of land-uses more appropriately undertaken in commercial and/or industrial areas; and
d. Protect the environmental and landscape values of the land.

LPS2 denotes a major road reserve to the western boundary of the structure plan area as well as parks and recreation reserve to the north east of the structure plan area along the existing Dolby Creek reserve, as shown in Figure 3.

Development within the Rural Residential Zone 1 is to be in accordance with schedule 1 of the scheme text. Subdivision and land use is to be in accordance with a structure plan adopted by the local government and endorsed by the WAPC.

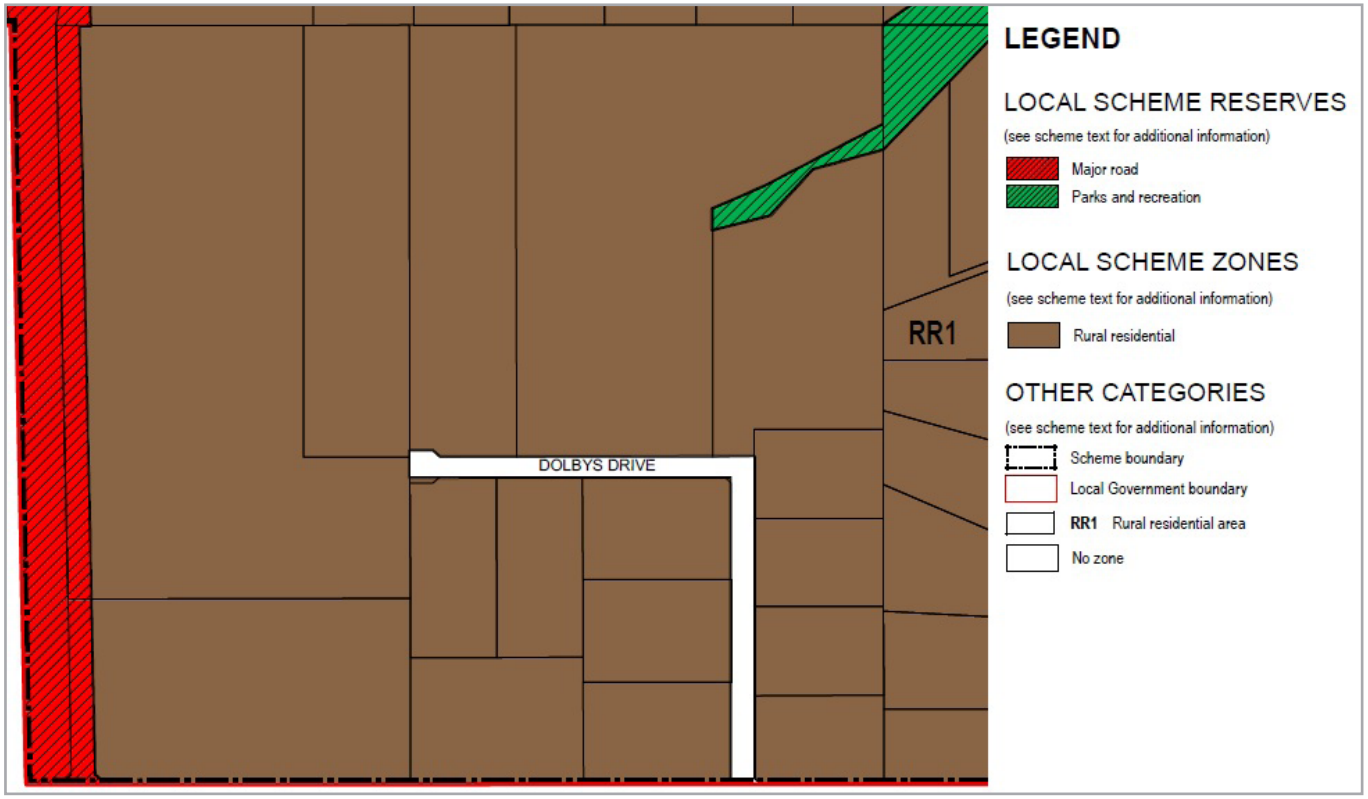


Figure 3: Local Planning Scheme No. 2

1.3.2 Regional and Sub-Regional Structure Plan

The structure plan is impacted by two broader structure plans, as detailed below and on the subsequent pages.

Greater Geraldton Structure Plan

The final Greater Geraldton Structure Plan (GGSP) was released in June 2011, and is an update of the 1999 Greater Geraldton Structure Plan. The GGSP is intended as an interim measure until local governments have prepared new local planning strategies and/or district structure plans. The GGSP is used as a basis for the preparation of wider strategic regional planning.

The structure plan area is identified within the GGSP as 'Rural Living', with 'Development Zone Four - Waggrakine' proposed for future intensification to the south, as shown in Figure 4.

Future road realignment of a 'primary road distributor', is identified to the west of the structure plan area.

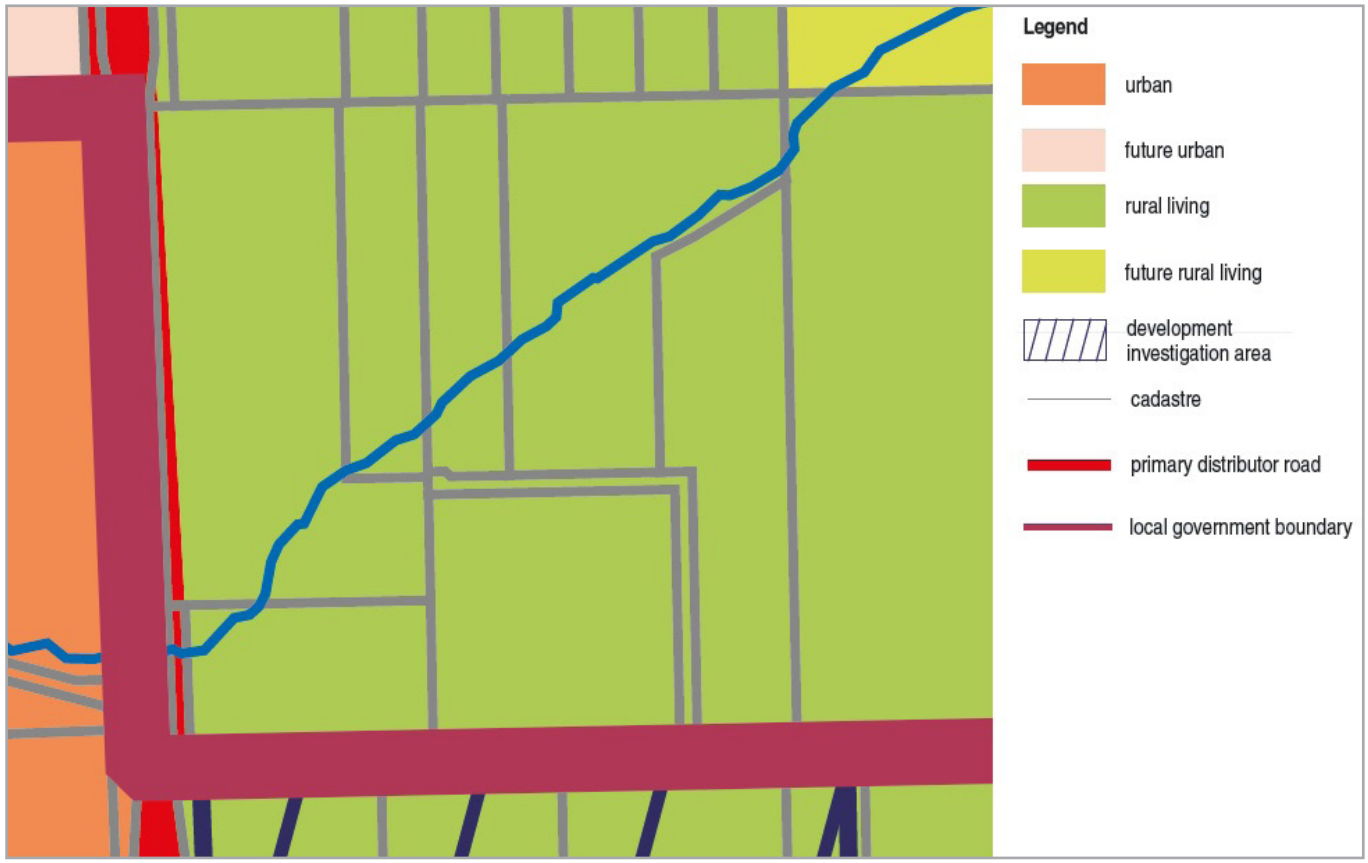


Figure 4: Greater Geraldton Structure Plan

Draft Northern Geraldton District Structure Plan

The Draft Northern Geraldton District Structure Plan (NGDSP) was released in 2006, with the purpose of providing a district structure plan that progresses key elements of the GGSP (1999). The NGDSP provides an overall guide for the future development of the area and reflects and refines key recommendations of the GGSP in terms of identifying land for rural living and residential uses (Figure 5).

The NGDSP identifies the structure plan area as 'Future Rural Residential', within the general locality (referred to as White Peak). This has now been implemented by LPS2, which identifies the land as 'Rural Residential'. The structure plan provides a plan for development in line with the rural residential use.

The NGDSP identifies a future regional distributor road to the west of the structure plan area, in accordance with the GGSP. An indicative creek setback is also shown along Dolby Creek.

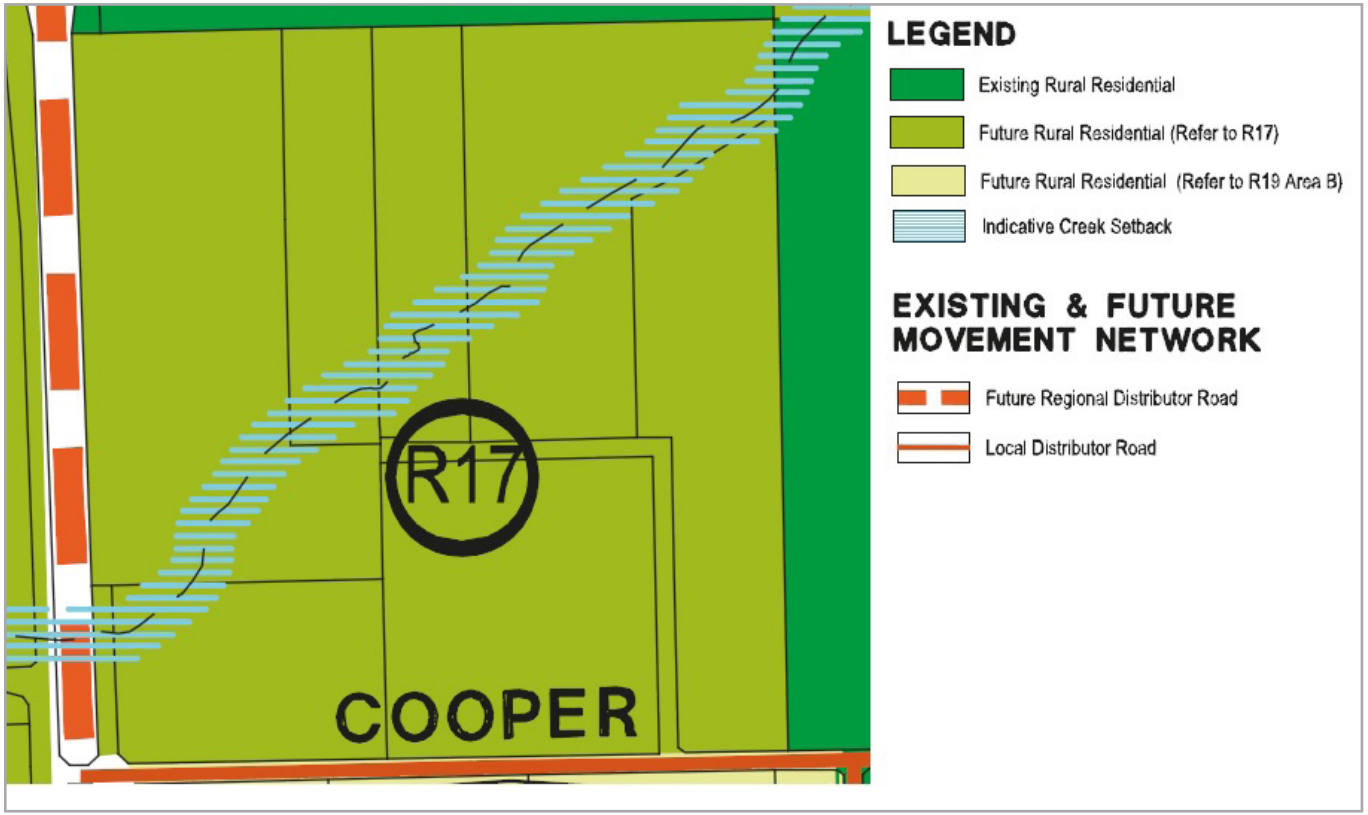


Figure 5: Draft Northern Geraldton District Structure Plan

1.3.3 Planning Strategies

Local Planning Strategy

The Shire of Chapman Valley Local Planning Strategy was endorsed by the WAPC on 20 November 2007.

The Local Planning Strategy identifies part of the structure plan area as being proposed rural residential (1-4ha) and part as existing rural residential.

1.3.4 Planning Policies

The following State Planning Policies (SPP) are considered applicable to the development of the structure plan.

State Planning Policy No 2.5 – Land Use Planning in Rural Areas (SPP2.5)

SPP2.5 outlines guidelines for supporting both rural and rural living land uses to cater for future needs. The structure plan has been developed to comply with the requirements of SPP2.5. In particular, the structure plan provides appropriate access to services, facilities and amenities, is guided by existing land supply and promotes good environmental and landscape outcomes.

The structure plan will ensure vehicle access to all lots and is supported by an LWMS to manage water and appropriate foreshore management of Dolby Creek. Lots within the structure plan are envisaged to be approximately 1 ha. As a result, at the time of subdivision, lots will have to provide water through a reticulated supply.

State Planning Policy No. 2.9 – Water Resources (SPP2.9)

SPP2.9 provides a policy basis for planning proposals and decisions to respond to integrated water cycle management. The policy is supported by detailed planning guidelines - Better Urban Water Management (WAPC 2008). Better Urban Water Management (WAPC 2008) provides a model for developers to address water related management issues at various stages of planning and presents design objectives for water conservation, stormwater and groundwater management.

A LWMS has been prepared to support the Dolbys Drive Structure Plan and can be viewed in Appendix A.

State Planning Policy No. 3 - Urban Growth and Settlement (SPP3)

SPP3 sets out principles and considerations when planning for urban growth and settlement in Western Australia. Section 5.6 refers to the management of rural-residential growth through the application of SPP2.5.

The application of SPP2.5 to the Dolbys Drive Structure Plan is discussed previously.

State Planning Policy No. 3.4 – Natural Hazards and Disasters (SPP3.4)

SPP 3.4 ensures planning for natural disasters as a fundamental element of the preparation of the structure plan to minimise adverse impacts of such an event.

The structure plan responds to the policy, and provides a spatial and planning framework to address issues associated with bushfire risk as required by SPP 3.7.

A reserve has been proposed for the Dolby Creek to manage drainage and potential flood risks.

State Planning Policy No. 3.7 – Planning in Bushfire Prone Areas (SPP3.7) and Guidelines for Planning in Bushfire Prone Areas

SPP 3.7 provides a policy framework to manage development within mapped bushfire prone areas within Western Australia. Policy provisions limit intensification of vulnerable land uses and development in areas of unacceptable bushfire risk. SPP 3.7 is supported by the Guidelines for Planning in Bushfire Prone Areas. The guidelines provide the methodology to assess bushfire risk, and sets out bushfire protection criteria for development in bushfire prone areas.

Part of the structure plan area is located within a mapped bushfire prone area, therefore bushfire hazards and compliance with bushfire protection criteria are outlined in section 2.4.

State Planning Policy No. 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP5.4)

SPP 5.4 provides a policy framework to manage conflicts that arise between sensitive land uses and road and rail transport noise.

The North West Coastal Highway, which carries some freight vehicles, is a primary road distributor and state freight road. SPP5.4 requires consideration of planning related issues across a 15-20 year horizon. The realignment of the primary road distributor to the western boundary of the structure plan area may present noise impacts to residential lots in the future.

The proposed Primary Distributor Road alignment along the western boundary of the structure plan area is contained within the former Geraldton to Northampton rail alignment which is now a reserve under the management of Main Roads WA. It should be noted that there is uncertainty over a timeframe for this alignment being constructed with it being a long term scenario. The timeframe for this alignment is likely to be further increased in the event that the Geraldton Outer Bypass/ Oakajee Narngulu Infrastructure Corridor is constructed, in which case the alignment to the west of the structure plan would not be a significant heavy haulage route and would instead serve a more intra-Geraldton function for domestic vehicle trips and may even become a local government alignment rather than a Main Roads WA alignment.

The lots proposed in the structure plan are considered to be of a large enough area to facilitate sufficient setbacks from this alignment.

1.3.5 Other Relevant State Planning Documents

Development Control Policy No. 1.1 - Subdivision of Land

DCP 1.1 sets out the general principles that are used by WAPC in determining applications for the subdivision of land. This will be applicable when future subdivision is undertaken.

Development Control Policy 2.2 Residential Subdivision

DCP 2.2 sets out the general principles that are used by WAPC in determining applications for the subdivision of residential land.

1.3.6 Pre lodgement consultation

The structure plan was advertised for public and State government agency comment for an extended period between 30 November 2016 - 31 January 2017.
A total of 13 submissions were received, 9 from state government agencies, 3 from landowners in the structure plan area and 1 from a community member.

Of the submissions received from landowners, 3 registered an objection on the submission form, although there was no objection to the overall intent of the structure plan. Key comments included:

- queries regarding potential lots sizes; and
- comments relating to water and wastewater elements of the area.

The comments have been reviewed and where appropriate, the structure plan has been amended.

2.0 Site Conditions and Environment

2.1 Biodiversity and Natural Area Assets

2.1.1 Vegetation

Vegetation within the structure plan area has for the most part been cleared, outside of the remnant vegetation existing along Dolby Creek. Remaining shrubland is located within the foreshore reserve and will not be affected by the structure plan.

2.1.2 Fauna

It is unlikely that the structure plan area provides habitat for any fauna due to the lack and degraded nature of existing vegetation. The structure plan's proposed retention of remnant vegetation along Dolby Creek and the creation of a foreshore reserve will retain its role as a wildlife corridor.

2.2 Landform and Soils

The structure plan area is located on a natural depression in the Spearwood Dune System, with the Dolby Creek running through the site from north east to south west (Land Insights 2016).

The structure plan area reaches a maximum elevation of 65 m AHD at the northern boundary, and falls south towards the Dolby Creek. The creek runs from the north east of the site at around 54 m AHD to the south west of the site at around 37 m AHD. In the most southern part of the site, the relief rises to 47 m AHD

The structure plan area is located within the Central Coast region, which is comprised primarily of Tamala limestone and its products. The Tamala dune system comprises of lithified limestone overlain by deep yellow sands and red loams.

The Geological Survey of Western Australia (1971) mapping of surface geology identifies that the structure plan area progresses from red and yellow sands to limestone from south to north. The dunal depression is dominated by alluvium, colluvium and miscellaneous soils.

The freely draining yellow sandplain overlying limestone makes up the bulk of the soils within the structure plan area. Red Spearwood sands also occur over limestone, which are freely draining and more fertile than the yellow sandplain soils.

The soil characteristics at the structure plan area should be confirmed prior to the preparation of Urban Water Management Plans to confirm the infiltration rate of soils within the structure plan area.

Mapping by Landgate indicates there is a moderate to low risk of acid sulfate soils occurring within 3 m of the surface in the Dolby Creek bed. This area will be protected with the establishment of a foreshore reserve.

2.3 Groundwater and Surface Water

A LWMS has been prepare to support the structure plan. The LWMS provides an overview of the surface and groundwater characteristics. These are summarised below and described further in the LWMS.

2.3.1 Surface water

A creek runs through the centre of the structure plan area from east to west. There are no permanent surface water features on the site.

Surface water on the structure plan area drains to Dolby Creek in the centre.

2.3.2 Groundwater

There is no groundwater quality data available for bores within the structure plan area. A single bore, WIN Site ID 20002914, has a recorded Total Dissolved Solids (TDS) result of 1519 mg/L, however it is unknown when this sample was taken.

2.4 Bushfire Hazard

2.4.1 Hazard Assessment

Parts of the structure plan area are located within a mapped, designated bushfire prone area, as shown on Figure 6. The bushfire prone area includes all land within 100 metres of intact stands of remnant vegetation.

To consider bushfire hazard, vegetation type is classified in accordance with AS 3959 Construction of buildings in bushfire-prone areas.

Remnant vegetation within the disused rail corridor, outside the structure plan area, is open scrub, reflecting the vegetation class D- scrub from AS3959. Remnant vegetation along Dolby Creek is open shrubland, reflecting vegetation class C - Woodland from AS3959, with a few pockets of class D - scrub. The majority of the structure plan area is managed pasture with an effective downslope of less than five degrees.

Based on the current Guidelines for Planning in Bushfire Prone Areas and technical appendices, scrub reflects an extreme bushfire hazard, open woodland reflects a moderate bushfire hazard, and pasture reflects a moderate bushfire hazard. These hazard levels are illustrated in Figure 7.

The structure plan does not propose any intensification of land use within areas of extreme bushfire hazard; stands of remnant vegetation are predominantly retained within the foreshore reserve.

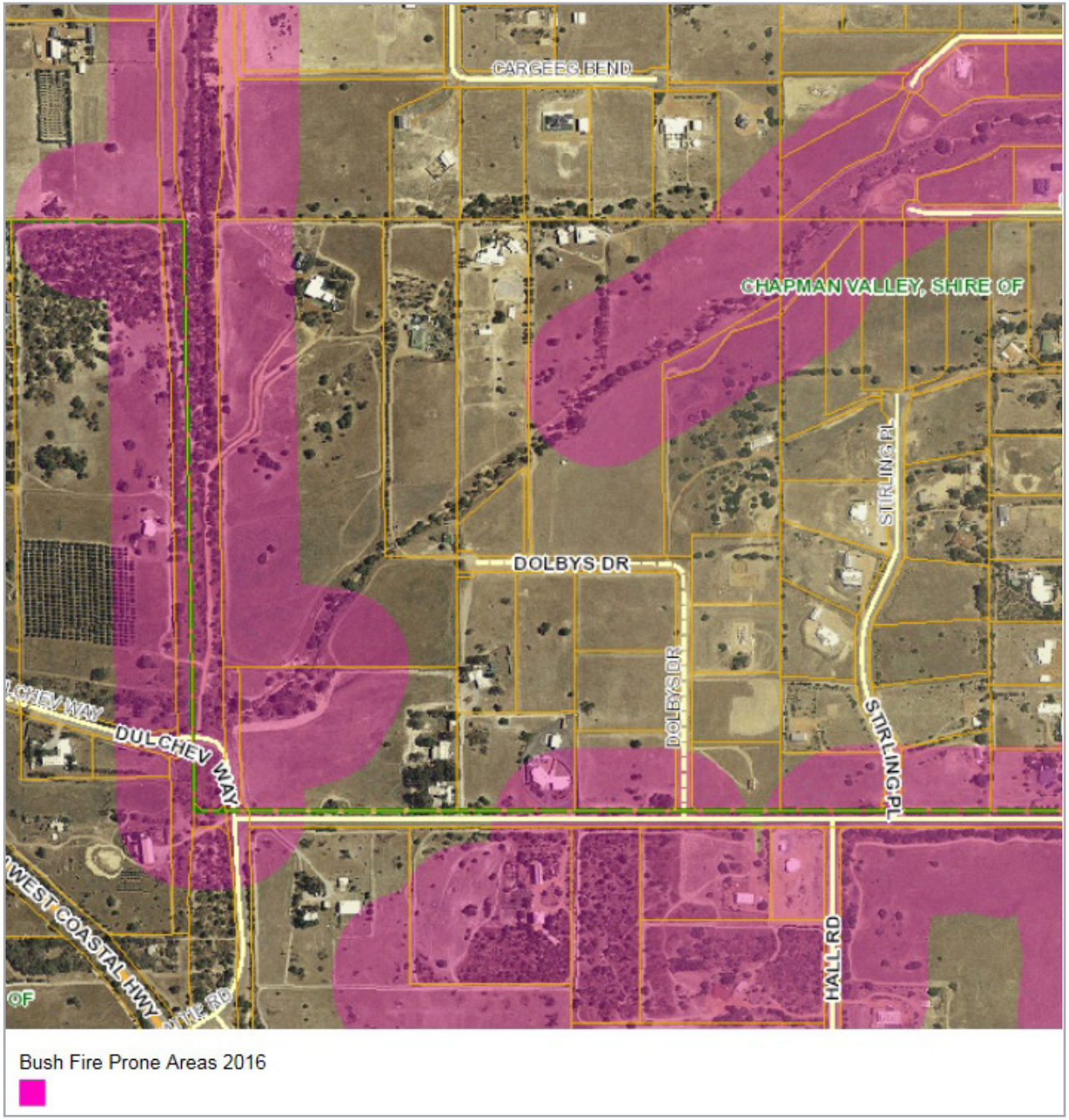


Figure 6: Bushfire prone areas (source: Office of Bushfire Risk Management, 2016)

It is possible that bushfire hazard level may increase with restoration of Dolby Creek. Figure 7 illustrates areas of the structure plan that may have an increased bushfire hazard level in future as a result of creek restoration.

Within bushfire prone areas, state planning policy and deemed provisions of the local planning scheme require that a bushfire attack level (BAL) assessment is undertaken. Bushfire Attack Level (BAL) is described in the Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas (AS 3959), as referenced in the Building Code of Australia (as amended). BAL provides a category of the level of exposure of a development to bushfire risk.

- BAL-FZ (flame zone)
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5
- BAL-Low

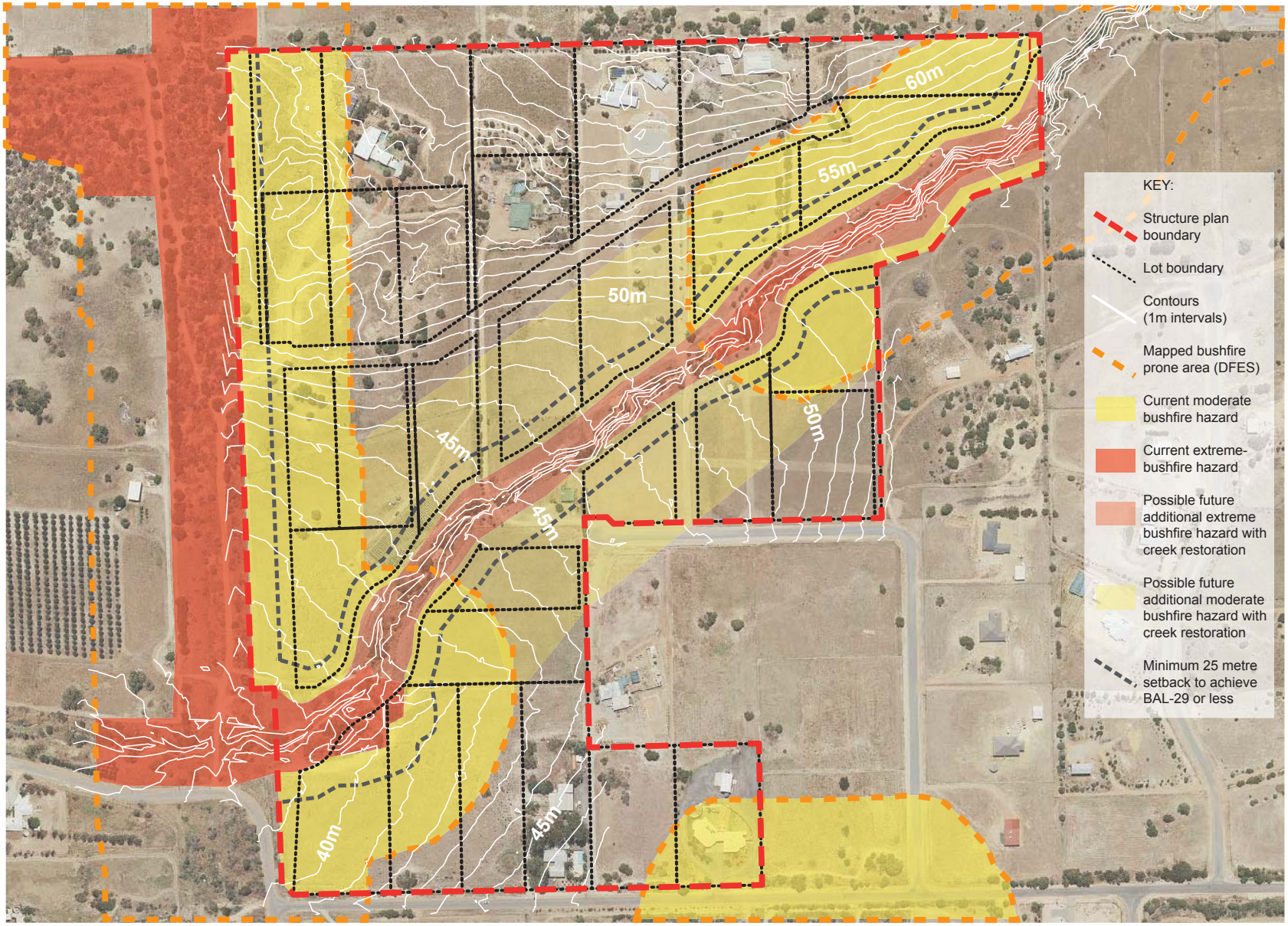
In line with state planning policy, development of habitable buildings will not be supported in areas influenced by a BAL-40 or BAL-FZ. Within the structure plan area, there is sufficient land on all proposed lots where a BAL of 29 or less can be achieved. To achieve this, based on the topography of the site (downslope >0-5 degrees), a minimum 25 metre setback from areas of woodland (creek line) will be required, and a minimum 22 metres setback from areas of scrub (western boundary), with land within at least nine metres of the house being managed grass or other low threat landscaping.This setback is shown on Figure 7, and can be easily achieved by all lots.

Pockets of scrub within Dolby Creek reflect an extreme bushfire hazard

Pockets of open woodland through Dolby Creek will increase in hazard level as restoration is undertaken.

Vegetation within the Primary Regional Road Corridor reflects a scrub vegetation class, and an extreme bushfire hazard.

Outside of the immediate creek line, land within the Dolbys Drive structure plan reflects pasture. Being within 100 metres of other vegetation, it has a moderate bushfire hazard.



Bushfire Hazard and BAL-29 setback

0 50 100 150m

SCALE 1:5000 AT ORIGINAL SIZE

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Figure 7: Bushfire hazard levels and minimum setbacks for development

2.4.1 Bushfire Protection Criteria

Appendices to the Guidelines for Planning in Bushfire Prone Areas include bushfire protection criteria to assist in the assessment of planning proposals in areas of bushfire risk. The following provides an assessment against the criteria (acceptable solutions) as relevant to the structure plan.

Element 1: Location

A1.1 Development location
The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.

As shown on Figure 7, all lots within the bushfire prone area can achieve a BAL-29 or lower, with the setback from remnant vegetation or areas of unmanaged grassland/pasture being managed as an asset protection zone.

Element 2: Siting and design of development

A2.1 Asset Protection Zone (APZ)
Every habitable building is surrounded by, and every proposed lot can achieve, an
APZ depicted on submitted plans, which meets the following requirements:

- *Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances.*
- *Location: 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 (see explanatory notes).*
- *Management: the APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones'. (see Schedule 1).*

Lot sizes within the structure plan area are sufficient to maintain a sufficient asset protection zone of 10 to 25 metres (dependant on the location and nearest vegetation class which ranges from woodland to grassland) and achieve BAL-29 or less.

Element 3: Vehicular Access

It is not possible to assess the acceptable solutions for this element at the level of the structure plan. Subdivision will confirm road locations, lot layouts, and vehicular access. The performance principle for this element is:

P3
The internal layout, design and construction of public and private vehicular access and egress in the subdivision/ development allow emergency and other vehicles to move through it easily and safely at all times.

Emergency access/egress routes are provided for all access scenarios in accordance with Element 3 - Vehicular Access in Appendix 4 of the Guidelines for Planning in Bushfire Prone Areas. Emergency access ways will be required to be provided as a right of way or public access easement in gross to ensure accessibility to the public and emergency services.

Element 4: Water

A4.1 Reticulated areas
The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.

In line with the servicing strategy, all lots will be provided with a reticulated water supply.

2.5 Heritage

A desktop analysis was undertaken to understand the heritage details for the structure plan area. The desktop revealed that the structure plan area does not contain any Registered Aboriginal Sites. The structure plan area does not contain any state or locally listed heritage properties. The western boundary of the structure plan abuts the former Geraldton to Northampton rail alignment but does not propose any development within this former rail alignment.

2.6 Foreshores

Dolby Creek flows through the structure plan area. The structure plan identifies an indicative foreshore reserve for Dolby Creek. The extent of the indicative reserve was determined onsite with the Department of Water as a nominal 30 metre reserve based on the current quality and extent of vegetation in the riparian zone, and reasonable opportunities for revegetation. This should be further refined and confirmed at subdivision, taking into account existing remnant vegetation, existing fence lines, and the nature of the creekline in certain locations. The foreshore reserve is to be ceded at the subdivision stage and vested with the Shire of Chapman Valley.

The foreshore reserve within the structure plan area will link to existing foreshore reserve along Dolby Creek to the east, and further west. Development of the foreshore reserve, with a walking trail and facilities for rest and enjoyment, will provide for recreational opportunities in the area and, over time, link the coast to the Moresby Range.

In addition to providing a buffer for Dolby Creek, the foreshore reserve can be activated for community experience with a walking trail and facilities. (Picture courtesy of the Shire of Chapman Valley)

2.7 Context and other land use constraints and opportunities

The structure plan area is located on the border of the Shire of Chapman Valley and City of Greater Geraldton local government areas.

Future primary regional road alignment

A potential primary distributor road alignment is identified by the GGSP 2011 along the western portion of the structure plan boundary. Main Roads WA is currently investigating and planning for the realignment of North West Coastal Highway to further inland to reduce the impact of freight movement on areas of Geraldton.

In the event that the inland route is constructed, the alignment to the west of the structure plan area would be used for domestic Geraldton vehicle movements rather than state heavy haulage and the timeframe for construction would likely be further delayed. Should this alignment occur, land zoned as rural residential directly abutting the reserve may need to be acquired/ceded. This may have implications for one of the access scenarios.

Dolby Creek

Dolby Creek runs diagonally through the structure plan area. An indicative foreshore reserve has been incorporated into the structure plan, on advice from the Department of Water.

Surrounding Development

The surrounding development is typically rural residential. The structure plan will facilitate subdivision in line with the existing surrounding rural residential area.

Relationship to nearby settlements

The structure plan area is less than two kilometres east of the Drummond Cove urban area and approximately 11km north of Geraldton. The area is characterised by rural residential properties.

Key opportunities

The structure plan area has a number of characteristics which positively contribute to the future development of the area. These are described below.

- Unique and extensive views to the coast, Geraldton port, and the Moresby Range.
- Cooling southerlies providing natural airflow
- Access to existing walking trails along Dolby Creek
- Nearby facilities in Drummond Cove.
- Rural amenity and access to natural assets.

Key challenges

The development of the structure plan area also has limitations and challenges which will influence the way in which is develops. These are shown on Figure 8 and described below.

- High level of fragmentation in land ownership.
- Noise impacts of North West Coastal Highway and uncertainty on timing of future realignment of the Highway further inland.
- Potential ceding of land for future realignment of Highway
- Protecting natural assets in a manner that provides development equity across multiple landholdings.
- Foreshore reserve along Dolby Creek
- Bushfire risk posed by vegetation areas retained through the subdivision process and requiring attention to bushfire hazard assessment, analysis, fire management plans with attention to firebreaks and emergency access.

2.8 Movement Network

The structure plan proposes the creation of new access roads to enable the newly created lots to be accessed either from Dolbys Drive or Dulchev Way. These options are discussed in section 2.8.2 and shown on Figure 9.

All options require the creation of a new internal road which runs somewhat parallel to Dolby Creek to enable access to the newly created lots north of the creek. This road has a cul-de-sac in the north east corner of the site. The existing development north of the structure plan does not provide an opportunity for road connections to the north. In addition, Dolby Creek precludes more than one north-south connection. The structure plan still enables emergency access points to all lots, should it be required. Therefore the presence of the cul-de-sac can be justified.

2.8.1 Road hierarchy

The current hierarchy of roads within the structure plan area are access roads as identified on the Main Roads WA website (Figure 8).

The existing roads are single carriageway with one lane in each direction, are unkerbed and approximately 6m wide, Cooper Street and Dolbys Drive are sealed.

The speed limit on Cooper Street east of Dolbys Drive is 80km/h and on Cooper Street west of Dolbys Drive is 50km/h. The speed limit on Dolbys Drive is 50km/h.

The proposed road hierarchy uses appropriate road types from Liveable Neighbourhoods (Table 1) and matches them to traffic and parking demands of the structure plan area. Throughout the structure plan area, vehicle movements are anticipated to be up to a total of 270vpd (30 dwellings x 9 trips per day) at the time of the completed subdivision and development.

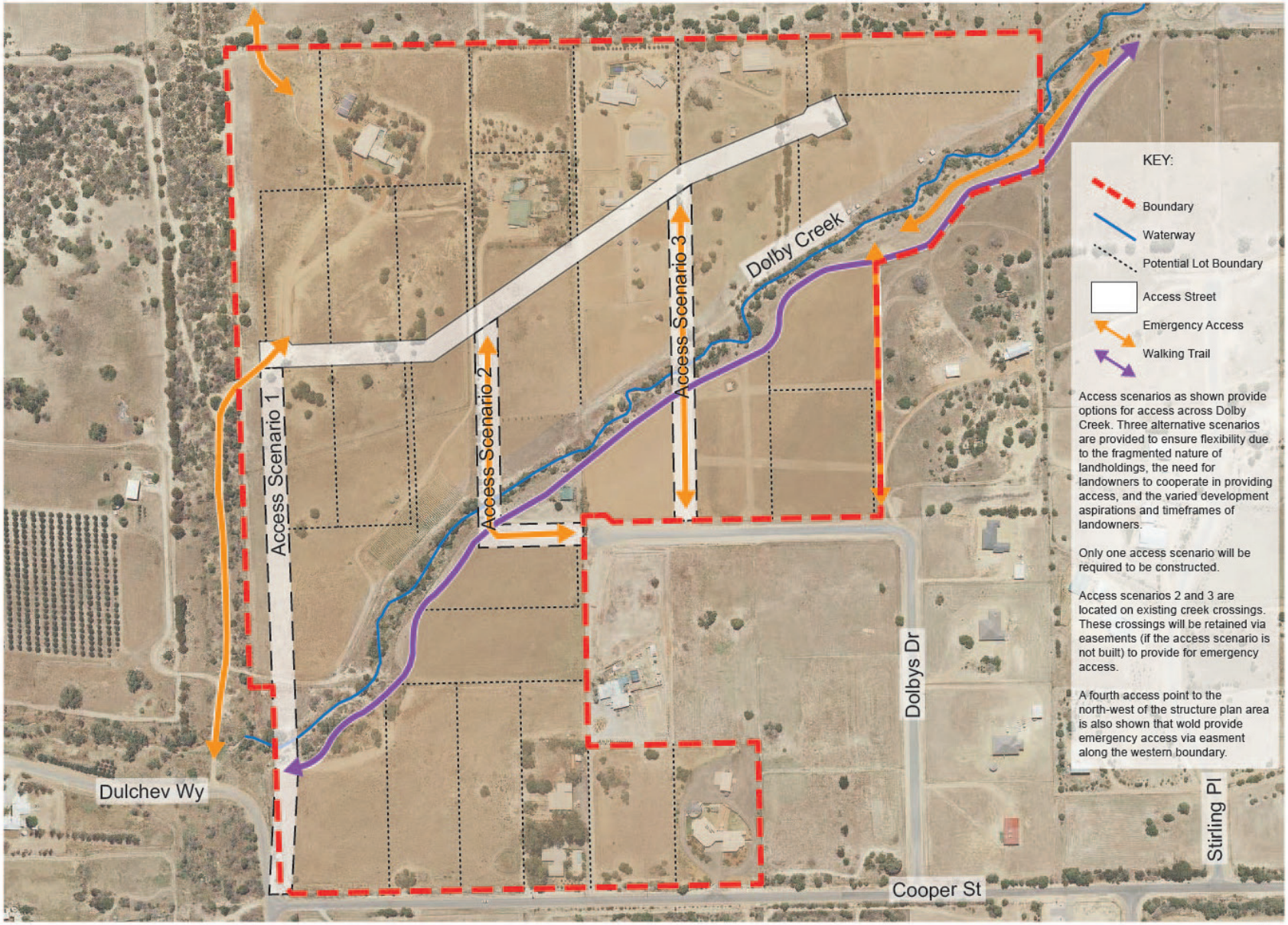
Cooper Street and Dolbys Drive are proposed as the key access and egress connectors for the structure plan area.

Access roads are designed to accommodate up to 300vpd likely to be generated by the structure plan area. Cross sections for the structure plan access roads provide for safe road access and management of storm water. A reserve width of 16 metres will be required to achieve these functions. Should more substantial stormwater management measures be required, the reserve may need to be increased to an Access Street B with a 20 metre reserve width.

Table 1: Local street function and characteristics (Source: *Liveable Neighbourhoods*, WAPC 2015)

Street name	Projected maximum volume (vehicles per day)	Indicative street reserve width (metres)	Maximum design/ target operating speed (km/hr)	Minimum street pavement width (metres)	Typical residential density
Access street D - narrow yield or give way street	1,000	15.5	50-20	5.5 typical 5.5-6 range	Less than R30

Figure 8: Road hierarchy (Source: Main Roads WA)



Movement Plan

0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

N

Figure 9: Movement

2.8.2 Access scenarios

The structure plan proposes three access scenarios. The rationale for identifying three acess options are:

- Fragmented ownership.
- Development timeframe aspirations of landowners differ, and will also change as there is likelihood that parcels may change hands (be sold) during the life of the structure plan.
- If only one access option is identified it may limit when other landowners can develop if they are dependent on others. The provision of access options will allow development to occur independent of other landowners development intentions.
- A series of possible scenarios is presented as the most flexible approach.

The structure plan currently comprises six lots and the structure plan access option will depend on which landowner chooses to subdivide first. Option one proposes an access way from Dulchev Way and options two and three propose access off Dolbys Drive.

Access scenario one

Access option runs parallel to the proposed North West Coastal Highway realignment. The proposed future highway alignment will run northwards in the old railway reserve. If the highway is constructed, it will be a dual carriageway, with one carriageway running either side of the abutments of the former railway bridge (just north of Dulchev Way). The highway reserve is approximately 40m wide (but varies), with provision for a 20m widening on the east side north of Cooper Street. Because of the need to preserve the old bridge abutments, the highway will not run directly up the centre of the reserve, but the carriageways will be deflected away from the centreline at the bridge location. This will have a greater impact on the west (northbound) carriageway as shown in Figure 10.

The indicative road layout shown in Figure 8 illustrates that access scenario one can occur even if the proposed new North West Coastal Highway alignment runs adjacent to the structure plan area.

If access scenario one does not proceed, the Cooper Street/Beattie Road intersection will be a T-intersection rather than a 4-way intersection as the road running parallel to the highway north of Cooper Street will not be required

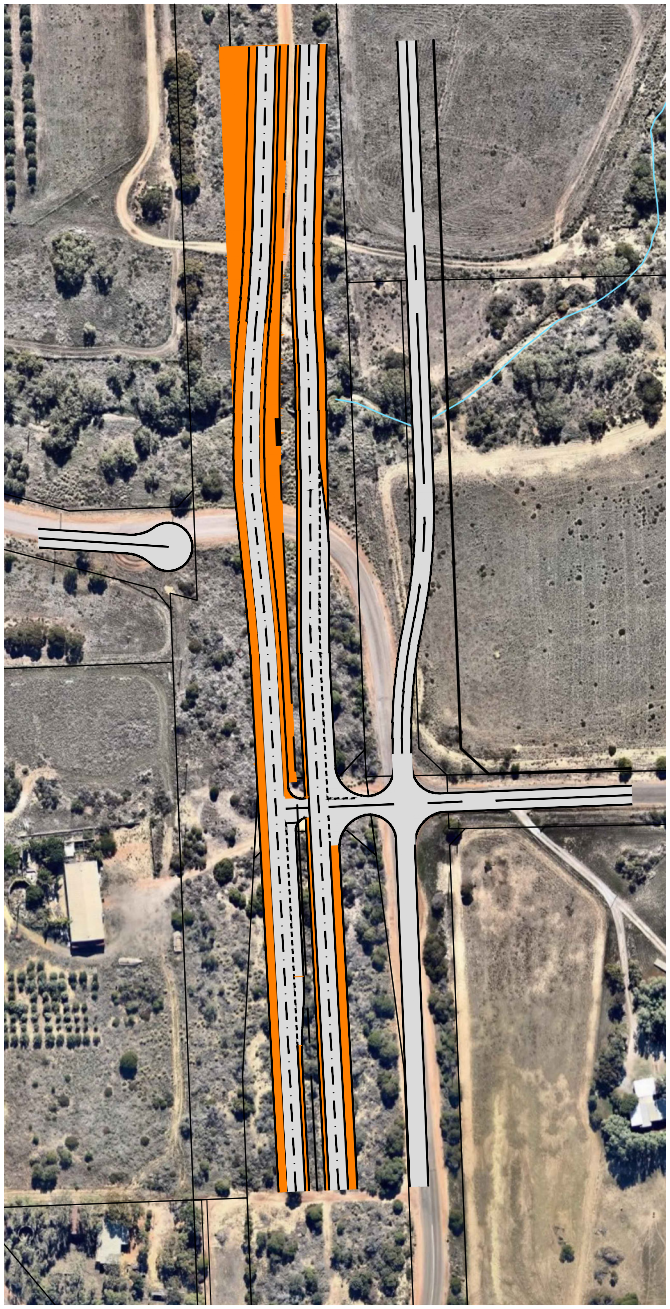


Figure 10: Indicative Road Alignments (access scenario one)

Access scenario two

Access scenario two proposes an extension of Dolbys Drive to the west and perpendicular extension to the north to enable access over the foreshore. This facilitates development on the north side of Dolby Creek.

Access scenario three

Access scenario three proposes the creation of a new road extending perpendicular from Dolbys Drive. This facilitates development on the north side of Dolby Creek by facilitating a point for crossing Dolby Creek.

2.8.3 Pedestrian network

The nature of the development proposed by the structure plan will not generate pedestrian demand. Footpaths are not required for this form of development.

Notwithstanding this, a regional pathway will provide linkages through the foreshore reserve, linking the coast to the Moresby Range over time.

2.8.4 Traffic generation and management

Traffic generation for 30 dwellings has been determined from the New South Wales Road and Traffic Authority's Guide to Traffic Generating Developments, Version 2.2 (October 2002).

According to this guide, using the rate for dwelling houses, 30 dwellings would generate 270vpd (30 dwellings x 9 daily trips per day).

The generated daily traffic volumes are considered to be very low and can be managed through the existing and proposed road network.

Walking trails within the foreshore reserve will provide an important link from the coast to the Moresby Range (Picture courtesy of the Shire of Chapman Valley)

2.9 Water Management

A separate LWMS has been prepared for the structure plan and provided as Appendix A in accordance with Better Urban Water Management (Western Australian Planning Commission, 2008). This document forms part of the structure plan, and should be utilised by developers and planning authorities in designing and considering applications for subdivision and the delivery of subdivisional works.

The LWMS states that the key 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*
- *Protect environmental values of receiving water bodies*

The LWMS provides recommendations for water conservation and efficiency, wastewater management, stormwater management and groundwater management.

Urban Water Management Plans will be required as a condition of subdivision as informed by the LWMS.

The preparation of an Urban Water Management Plan, where required, should include undertaking relevant site investigations to confirm suitability of on-site effluent disposal. In addition the Urban Water Management Plan should confirm that there will be no detrimental upstream or downstream impacts on other properties.

2.10 Infrastructure Coordination

2.10.1 Water

All lots within the structure plan will need to be connected to reticulated water at the time of subdivision. This is to be be undertaken at the cost of the subdivider .

2.10.2 Wastewater

No reticulated wastewater scheme is generally proposed for the development area, with onsite treatment and disposal of effluent through aerobic treatment units on individual lots permitted by the proposed lot sizes and relevant Government wastewater policy.

2.10.3 Power

At the time of subdivision, developers will be required to liaise with Western Power to determine the appropriate distribution augmentation requirements.

2.10.4 Telecommunications

All lots in the structure plan area have NBN service available (nbnco rollout map, 2016)

2.11 Indicative lot layout

The structure plan proposes that lots are to generally be a minimum of 1.0 hectare in area (Figure 11). Variations may be considered where it can be satisfactorily demonstrated that the subdivision is in accordance with the general intent of the structure plan, the objectives of the Rural Residential zone and is consistent with orderly and proper planning.

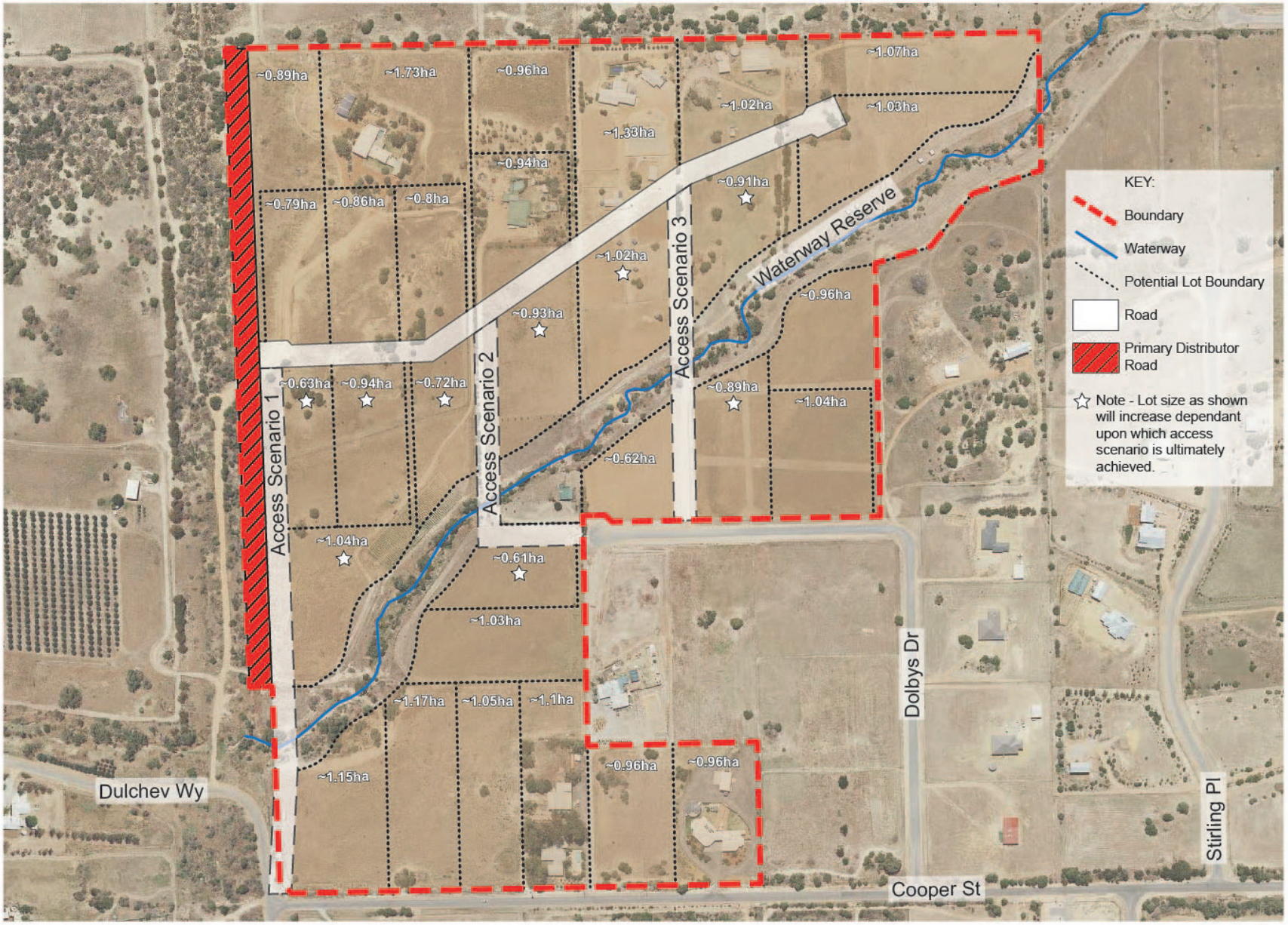
The lot layout provided in Figure 11 is indicative only. Access arrangements will be subject to further detailed design and the final lot layout will depend on which access scenario is developed.

2.12 Development Contribution Arrangements

There are no developer contributions within the structure plan area.

2.13 Implementation

Implementation of the structure plan will be through application of the provisions of Part 1 of the structure plan through subdivision processes.



Indicative Lot Layout Plan

0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

Figure 11: Indicative lot layout

3.0 References

Office of Bushfire Risk Management, 2016. Map of Bush Fire Prone Areas. Available from https://www.dfes.wa.gov.au/regulationandcompliance/bushfirepronеareas/Pages/default.aspx, 2016, nbn network rollout map, Available from http://www.nbnco.com.au/learn-about-the-nbn/rollout-map.html

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Western Australian Planning Commission, 2006. State Planning Policy 3 Urban Growth and Settlement

Western Australian Planning Commission, 2006. State Planning Policy 3.4 Natural Hazards and Disasters

Western Australian Planning Commission, 2015. State Planning Policy 3.7 Planning in Bushfire Prone Areas

Western Australian Planning Commission, 2009. State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning

Appendices

Appendix A: Local Water Management Strategy

Shire of Chapman Valley

Dolbys Drive Structure Plan

LWMS

July 2017

Executive summary

GHD Pty Ltd was commissioned by the Shire of Chapman Valley to prepare a Local Water Management Strategy (LWMS) for the Dolbys Drive Structure Plan (the site).

The Dolbys Drive Structure Plan is located approximately 7 km north of Geraldton, east of the North West Coastal Highway, in the suburb of Waggrakine. The site is bounded by the suburb of Glenfield to the west, Cooper Street and Dolbys Drive to the south and the suburb of White Peak to the north.

The Dolbys Drive Structure Plan is approximately 38 ha in size.

This Local Water Management Strategy (LWMS) has been prepared in accordance with Better Urban Water Management (Western Australian Planning Commission, 2008).

Principles

The key principles of integrated urban water management for the Dolbys Drive development area 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
- Protect environmental values of receiving water bodies

Water conservation and efficiency

To make the Dolbys Drive development a leading example of water efficiency the following measures are recommended:

- Require all new buildings to incorporate certified water efficient appliances, as set out in the Criteria for Waterwise Homes developed by the Water Corporation
- No potable water is to be used outside of homes and buildings

Wastewater management

The site will not be connected to a centralised sewage treatment plant so the proposed rural residential lots are to be serviced by onsite effluent disposal systems, such as aerobic treatment units (ATUs) to treat and dispose of all household sewage.

Stormwater management

The proposed stormwater management strategy employs the following principles for managing water quantity:

- For the 1 year ARI event lot and road runoff will be infiltrated as close to source as practical using water sensitive urban design (WSUD) measures such as infiltration devices. These include soakwells (lots) and swales (roads).
- Events greater than the 5 year ARI event and up to and including the 100 year ARI event will be collected and conveyed via road side swales to Dolby Creek. These swales have been sized to accommodate major events up to the 100 year ARI event.

Groundwater management

To ensure that existing groundwater levels and quality is maintained, the quality of the stormwater infiltration to groundwater will be maximised through use of WSUD and best management practices (BMPs) to ensure that stormwater is infiltrated as close to the source as practical.

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1. Introduction

GHD Pty Ltd was commissioned by the Shire of Chapman Valley to prepare a Local Water Management Strategy (LWMS) for the Dolbys Drive Structure Plan (the site).

The Dolbys Drive Structure Plan is located approximately 7 km north of Geraldton, east of the North West Coastal Highway, in the suburb of Waggrakine. The site is bounded by the suburb of Glenfield to the west, Cooper Street and Dolbys Drive to the south and the suburb of White Peak to the north.

The Dolbys Drive Structure Plan is approximately 38 ha in size with the Dolby Creek running through the site from north east to south west. Of this, approximately 30 ha is proposed for development as 'Rural Residential' lots (GHD 2016).

1.1 Total water cycle management

Total water cycle management, also referred to as integrated water cycle management, 'recognises that water supply, stormwater and sewage 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' (DoW 2004-2007, *Stormwater Management Manual for Western Australia*).

The *State Planning Policy 2.9: Water Resources* (WAPC 2004) outlines the key principles of integrated water cycle management as:

- Considerations of all water resources, including wastewater in water planning.
- Integration of water and land use planning.
- The sustainable and equitable use of all water sources, having consideration of the needs of all water users, including the community, industry and the environment.
- Integration of human water use and natural water processes.
- A whole of catchment integration of natural resource use and management.

The principles and objectives for managing urban water as stated in the *Stormwater Management Manual for Western Australia* (DoW 2004-2007) are as follows;

- **Water Quality**: to maintain or improve the surface and groundwater quality within the development areas relative to pre development conditions
- **Water Quantity**: to maintain the total water cycle balance with the development areas relative to pre development conditions
- **Water Conservation**: to maximise the reuse of stormwater
- **Ecosystem Health**: to retain natural drainage systems and protect ecosystem health
- **Economic Viability**: to implement stormwater management systems that are economically viable in the long term
- **Public Health**: to minimise the public risk, including risk from injury or loss of life, to the community
- **Protection of Property**: to protect the built environment from flooding and water logging
- **Social Values**: to ensure that social, aesthetic and cultural values are recognised and maintained when managing stormwater

- **Development:** to ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

1.2 Planning background

In accordance with state government planning framework as outlined in Better Urban Water Management (WAPC 2008), a LWMS is required to accompany the structure plan. Urban water management plans (UWMPs) will be required to accompany the subsequent development applications where further information is required to support development (Section 8).

This LWMS has been prepared in accordance with *State Planning Policy 2.9: Water Resources* (WAPC 2004) and *Better Urban Water Management* (WAPC 2008a), on advice from the Department of Water (DoW) and Shire of Chapman Valley. *Better Urban Water Management* (WAPC 2008a) provides a model for developers to address water related management issues at various stages of planning and presents design objectives for water conservation, stormwater and groundwater management.

The planning framework for land and water planning is illustrated in Figure 1.

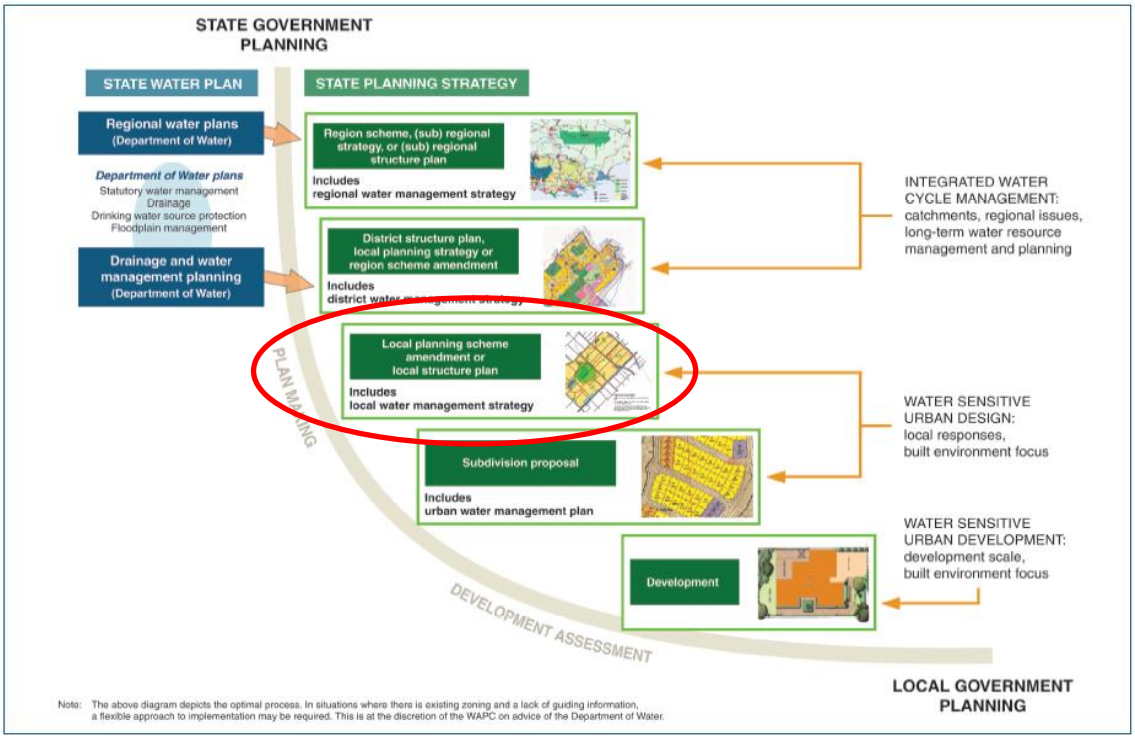


Figure 1 Framework for integrating water planning with land planning

The preparation of this LWMS is not supported by a preceding District Water Management Strategy (DWMS) or Regional Water Management Strategy (RWMS).

The strategies presented in this LWMS have been prepared to be consistent with the requirements of the following key documents:

- Better Urban Water Management (WAPC 2008a)
- Liveable Neighbourhoods: Edition 4 (2007)
- State Planning Policy 2: Environmental and Natural Resources (2003)
- State Planning Policy 2.9: Water Resources (2006)

- Geraldton Region Plan Final (WAPC 1999)
- Draft North Geraldton District Structure Plan (WAPC 2006)
- Shire of Chapman Valley Local Planning Strategy (WAPC 2008b)
- Land Development Specifications (City of Geraldton-Greenough 2007), which has been adopted by the Shire of Chapman Valley as a Local Planning Policy

1.3 Previous studies

In addition to the planning documents identified in Section 1.2, the following investigations undertaken in the Dolbys Drive locality have been used to inform the water management principles and design criteria outlined in this LWMS:

- *Coastal Management Strategy and Action Plan* (Land Insights 2016)
- *Geraldton rural-residential land capability study* (Dye *et al.* 1990)
- *Shire of Chapman Valley Local Planning Scheme No. 2 Environmental Review* (GHD 2010)
- *Dolbys Drive Local Structure Plan, Waggrakine Western Australia* (GHD 2016)

1.4 Purpose of this report

This LWMS has been prepared to support new development and redevelopment within the Dolbys Drive Structure Plan area (GHD 2016). 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.

1.5 Scope and limitations

This report: has been prepared by GHD for Shire of Chapman Valley and may only be used and relied on by Shire of Chapman Valley for the purpose agreed between GHD and the Shire of Chapman Valley as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Shire of Chapman Valley 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(s) 1 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 Shire of Chapman Valley 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 omissions in the report which were caused by errors or omissions in that information.

2. Proposed development

The Dolbys Drive Structure Plan covers a 38 ha area of land located approximately 7 km north of Geraldton. The site is bounded by the suburb of Glenfield to the west, Cooper Street and Dolbys Drive to the south and the suburb of White Peak to the north.

The site consists of primarily rural lifestyles land uses, including cleared areas, existing houses, ancillary buildings and remnant coastal bushland. The site consists of 6 freehold lots, all in private ownership.

The Shire of Chapman Valley Local Planning Scheme No. 2 (LPS2), zones the 6 lots as 'Rural Residential 1'. The proposed development as identified in the Dolbys Drive Structure Plan (Appendix A) will likely consist of:

- 1 ha residential lots;
- New access roads; and
- Dolby Creek foreshore reserve.

The study area is also identified within the Greater Geraldton Structure Plan (2011) as 'Rural Living', with a 'primary distributor road' identified along the western boundary of the site.

3. Design criteria

The design criteria adopted for this LWMS have been based on the design criteria objectives outlined in *Better Urban Water Management* (WAPC 2008). This criteria is outlined below:

3.1 Water conservation and efficiency

Principle

Achieve the sustainable management of all aspects of the water cycle within the Dolbys Drive Structure Plan and ensure that potable water use is efficient as possible.

Objectives

- Minimise total water use. The Western Australian State Water Plan (Government of Western Australia, 2007) sets a target of 100 kL/person annual water consumption, including not more than 40 – 60 kL/person/year scheme water use;
- Minimise potable water use outside of buildings;
- Substitute drinking quality water with fit-for-purpose water for non-drinking uses;
- Meet 5 Star Plus requirements; and
- Promote the use of native plants.

3.2 Stormwater quantity

Principle

Maintain post development annual discharge peak flows relative to pre development conditions, unless otherwise established through determination of ecological water requirements for sensitive environments.

Objectives

- **Ecological protection** – retain and / or infiltrate runoff from constructed impervious surfaces generated by the critical 1 year average recurrence interval (ARI) even using soakwells, rain water tanks, vegetated swales or bottomless pits in piped systems;
- **Serviceability of roads and infrastructure in minor ARI events** – runoff form the entire catchment generated by up to the 5 year ARI event should be managed within stormwater conveyance systems and landscaped areas such as swales, basins, living streams or constructed wetlands; and
- **Flood management** – manage the catchment runoff for up to the 1 in 100 year ARI event in the development area to pre development peak flows, unless otherwise indicated in an approved strategy or as negotiated with the relevant drainage service provider.

3.3 Groundwater quantity

Principle

Manage and minimise changes in groundwater levels following development.

Objectives

- Protect groundwater as a resource;
- Protect infrastructure and assets from flooding and inundation by high seasonal groundwater levels, perching and/or soil moisture; and

- Protect groundwater dependent ecosystems (GDEs) from the impacts of urban runoff.

3.4 Stormwater and groundwater quality

Principle

Maintain surface and groundwater quality at pre development levels (winter concentrations) and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.

Objectives

- 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 2004-7).*

3.5 Disease vector management

To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May stationary stormwater is fully infiltrated in less than 72 hours. Detention and infiltration areas should be free of depressions and potholes to avoid immobile water.

The proponent must ensure that onsite mosquito breeding is minimised through effective design and maintenance of water-holding infrastructure.

The 'Chironomid midge and mosquito risk assessment guide for constructed water bodies' (Midge Research Group, 2011) should be referred to during the early stages of planning to ensure that the potential for on-site mosquito breeding is minimised.

Objectives

- No permanent water bodies will be constructed on site

3.6 Commitment to best management practices

In order to meet the design criteria outlined above, the following best management practices will be employed:

- Implement controls at or near source to prevent pollutants entering the system;
- Install in-transit measures to treat stormwater and mitigate pollutants that have entered the system; and
- Implement end-of-pipe controls to treat stormwater, addressing any remaining pollutants prior to discharging to the receiving environment.

4. Pre-development environment

4.1 Study area

The Dolbys Drive Structure Plan is a 38 ha area of land located approximately 7 km north of Geraldton (Figure 2). The site is bounded by the suburb of Glenfield to the west, Cooper Street and Dolbys Drive to the south and the suburb of White Peak to the north.

The site consists of primarily rural lifestyle land uses, including cleared areas, existing houses, ancillary buildings and remnant creek vegetation. The Dolby Creek runs through the study area from north east to south west.

4.2 Climate

The site is located in the mid-west of Western Australia, which has a Mediterranean climate consisting of hot, dry summers and cool, wet winters. The closest weather station with complete rainfall record for recent years is located 13 km away at Geraldton Town (Site ID 008050).

Mean annual rainfall is 451.6 mm, and average monthly rainfall is shown in Table 1.

Table 1 Mean monthly rainfall Geraldton Town

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	5.9	8.5	13.2	23.3	68.9	113.0	90.2	64.9	30.4	18.0	7.9	3.7

4.3 Topography

The site is located on a natural depression in the Spearwood Dune System, with the Dolby Creek running through the site from north east to south west (Land Insights 2016).

The site reaches a maximum elevation of 65 m AHD at the northern boundary, and falls south towards the Dolby Creek. The creek runs from the north east of the site at around 54 m AHD to the south west of the site at around 37 m AHD. In the most southern part of the site, the relief rises to 47 m AHD (Figure 3).

4.4 Geology and soils

The Dolbys Drive Structure Plan is located within the Central Coast region, which is comprised primarily of Tamala limestone and its products. The Tamala dune system comprises of lithified limestone overlain by deep yellow sands and red loams.

The Geological Survey of Western Australia (1971) mapping of surface geology identifies that the study area progresses from red and yellow sands to limestone from south to north (Figure 4). The dunal depression is dominated by alluvium, colluvium and miscellaneous soils (Figure 4).

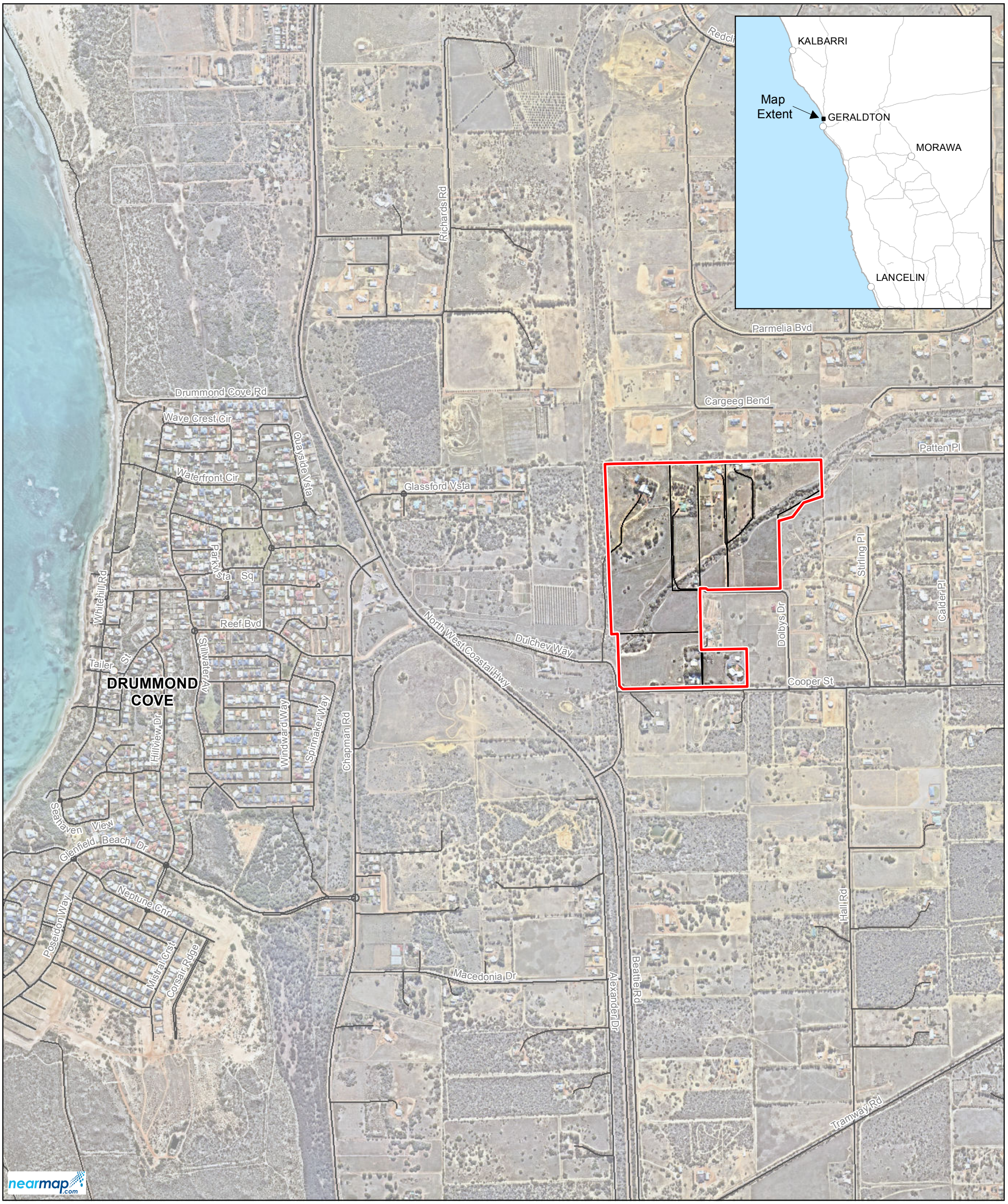
The freely draining yellow sandplain overlying limestone makes up the bulk of the soils within the study area. Red Spearwood sands also occur over limestone, which are freely draining and more fertile than the yellow sandplain soils.

The soil characteristics at the site should be confirmed prior to the preparation of Urban Water Management Plans so confirm the infiltration rate of soils within the study area.

4.4.1 Acid sulfate soils

The presence of acid sulfate soils has been recognised as an issue of concern in Western Australia since 2003. Proponents of developments that involve the disturbance of soil or the change of groundwater levels in areas susceptible to acid sulfate soils are required to conduct desktop and field based investigations. Adequate investigations are required prior to soil disturbance to determine the potential risks and to allow for the formulation of appropriate management strategies.

Mapping by Land Gate indicates there is a moderate to low risk of acid sulfate soils occurring within 3 m of the surface in the Dolby Creek bed (Figure 5). This area will be protected under the conceptual Structure Plan (Appendix A) and the establishment of a foreshore reserve.



LEGEND

Road

Structure Plan Boundary

Cadastre

Paper Size A3

0 100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

Shire of Chapman Valley
Dolby's Drive Structure Plan

Job Number	61-3302800
Revision	0
Date	31 Jul 2017

Locality Map

Figure 2

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999 Hay Street Perth WA 6000 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GHD: Structure Plan Boundary - 20161019; Geoscience Australia: GeoData Topo 250k Series 3; Nearmap, Imagery, (Extracted 31/07/2017, Captured 16/6/2017); Cadastre - 20160217, Roads - 20160816. Created by:nkostraby

Paper Size A3

0 20 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

Study Area
Watercourse
Elevation
Road
Creek Crossing

Shire of Chapman Valley
Dolby's Drive Structure Plan LWMS

Job Number	61-3302800
Revision	0
Date	31 Jul 2017

Topography

Figure 3

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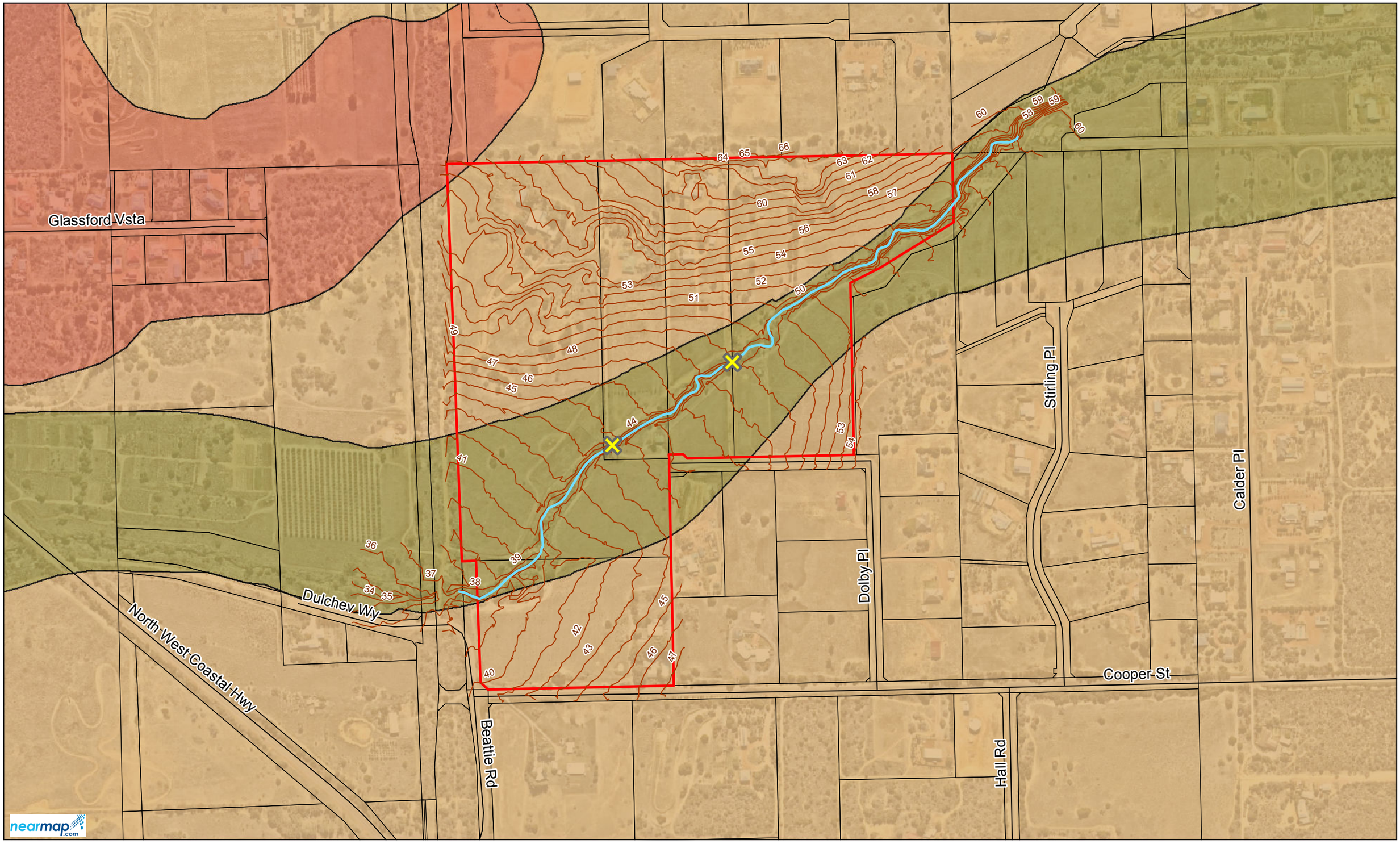
999 Hay Street Perth WA 6000 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017, Cadastre - 20160217, Roads - 20160217; GHD: Study Area - 20160217. Created by:nkostraby



Paper Size A3

0 20 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Watercourse
- Elevation
- Study Area
- Cadastre
- Creek Crossing

Geology

- Limestone
- Red and yellow sand
- Other

Shire of Chapman Valley
Dolby's Drive Structure Plan LWMS

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Surface Geology

Figure 4

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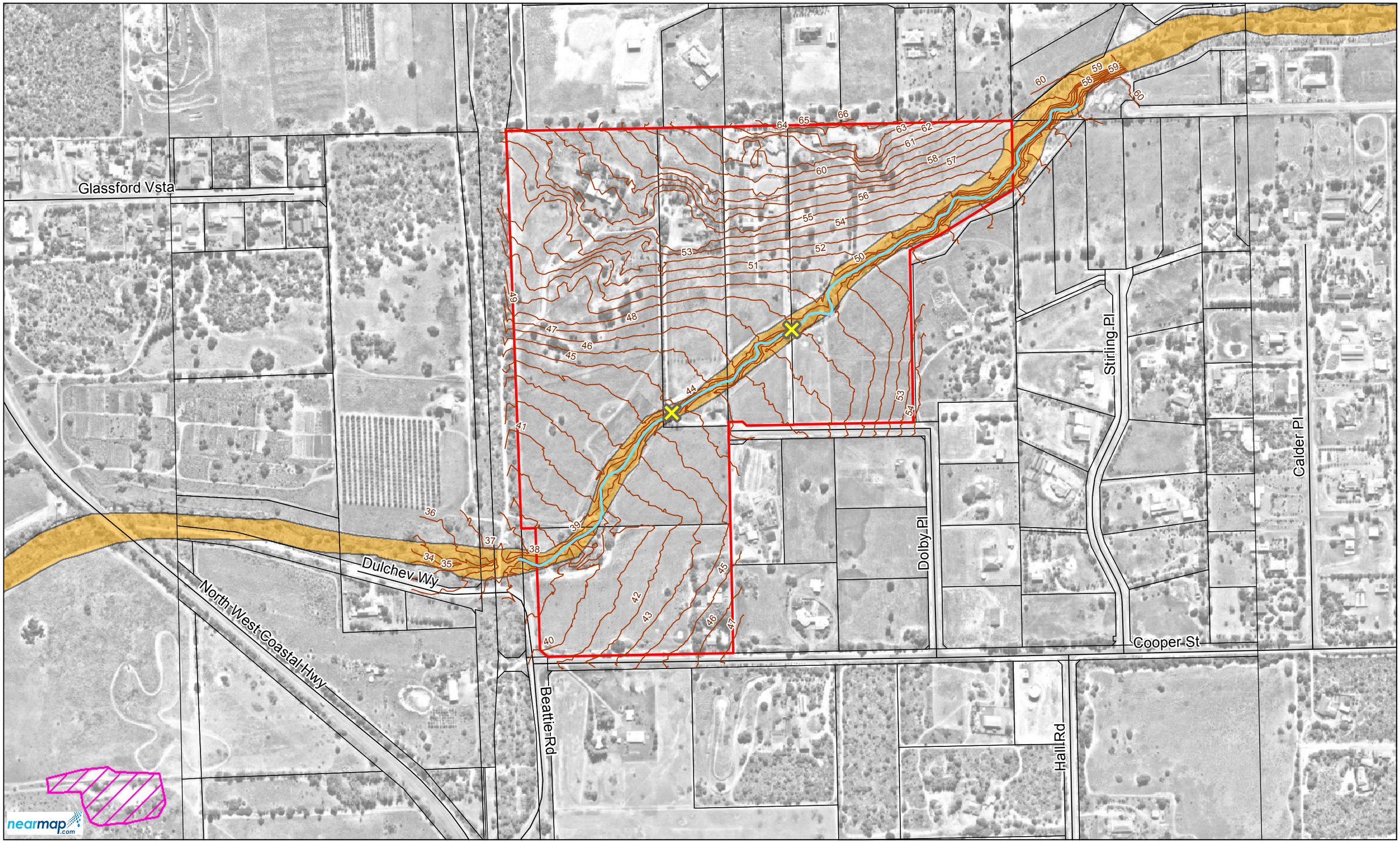
999 Hay Street Perth WA 6000 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: DMP: Geology - 20111202; Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017, Cadastre - 20160217, Roads - 20160217; GHD: Study Area - 20160217. Created by:nkostraby



Paper Size A3

0 20 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Watercourse
- Elevation
- Study Area
- Cadastre
- Creek Crossing
- Aboriginal Heritage Sites

Acid Sulfate Soils

- Moderate to low ASS disturbance risk (<3m from surface)

Shire of Chapman Valley
Dolby's Drive Structure Plan LWMS

Job Number	61-3302800
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ASS and Heritage

Figure 5

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Data source: Landgate: Cadastre - 20160217, Roads - 20160217; DIA: Aboriginal Heritage Sites - 20111202; DER: Acid Sulfate Soils - 20111202; GHD: Study Area - 20160217; Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017. Created by:nkostraby

4.5 Aboriginal heritage

There are no registered Aboriginal heritage sites within the Dolbys Drive Structure Plan (Figure 5).

Site 2947 (Dulchev Way) is located outside of the structure plan area to the south-west, across North West Coastal Highway. The site is registered as 'artefacts/ scatter', has open access off of Chapman Road and Dulchev Way, and is not restricted.

4.6 Environmental assets

4.6.1 Environmentally sensitive areas

There are no environmentally sensitive areas within the Dolbys Drive Structure Plan.

4.6.2 Vegetation and flora

The site is part of the Greenough System within the Irwin District of the South-Western Botanical Province (Speck 1958). The majority of the Structure Plan area is cleared land with remnant vegetation in the waterway and proposed foreshore reserve. No detailed study has been undertaken however nearby areas have been found to contain the following vegetation types (GHD 2008):

- Dune Blowout – primarily bare sand.
- Coastal scrub / heath – includes foredune vegetation, and first stabilised dune.
- *Acacia rostellifera* / *Lycium ferocissimum* shrubland.
- *Frankenia / pauciflora* on saline flats.
- *Melaleuca cardiophylla* mixed heath on limestone ridge.
- Degraded riparian Low woodland – associated with the Buller River tributary.
- Pasture/Improved vegetation.
- Mixed degraded vegetation.

The Dolbys Drive Structure Plan is covered under the Shire of Chapman Valley *Coastal Management Strategy* which was prepared to guide sustainable coastal development, and manage development pressure from competing land uses (Koltasz Smith 2007). This document was recently updated by Land Insights, May 2016. The Site is up steam of the Drummond Cove coastal management sector (Land Insights 2016).

An on-site inspection of Dolby Creek by the DoW in February 2016 recognised African boxthorn, Agave and Crown Beard vegetation to be present.

4.7 Surface water

The Dolbys Drive Structure Plan is located 1.9 km from the coast. A creek runs through the centre from east to west. There are no permanent surface water features at the site.

Surface water runoff across the Site predominantly drains to Dolby Creek in the centre of the site, which drains to the south west.

4.7.1 Hydrology

The catchment for Dolby Creek measures 4.96 km^2, consisting of cleared agricultural land, sandy soils with low clay content. The longest flow path measures 4.7km with a gradient of

24m/km. Aerial imagery indicates light to medium vegetation in the streamlines. In the absence of a flow gauge, three regional peak flow estimates were calculated for the catchment:

- Probabilistic Rational Method (Pilgrim, 1987) for Wheatbelt Region with loamy soil catchments 75-100% cleared, notated as ARR PRM 1987
- Regional Flood Frequency Procedure (Flavell, 2012)
- Regional Flood Frequency Estimation Model (Rahman, et al., 21 June 2012), notated as ARR RFFE 2015, derived from nearby gauging stations

Referring to Figure 6, the methods were calculated for various probability events. The ARR RFFE 2015 method includes confidence intervals in dashed lined, and the ARR PRM 1987 method was extrapolated to the 1% AEP.

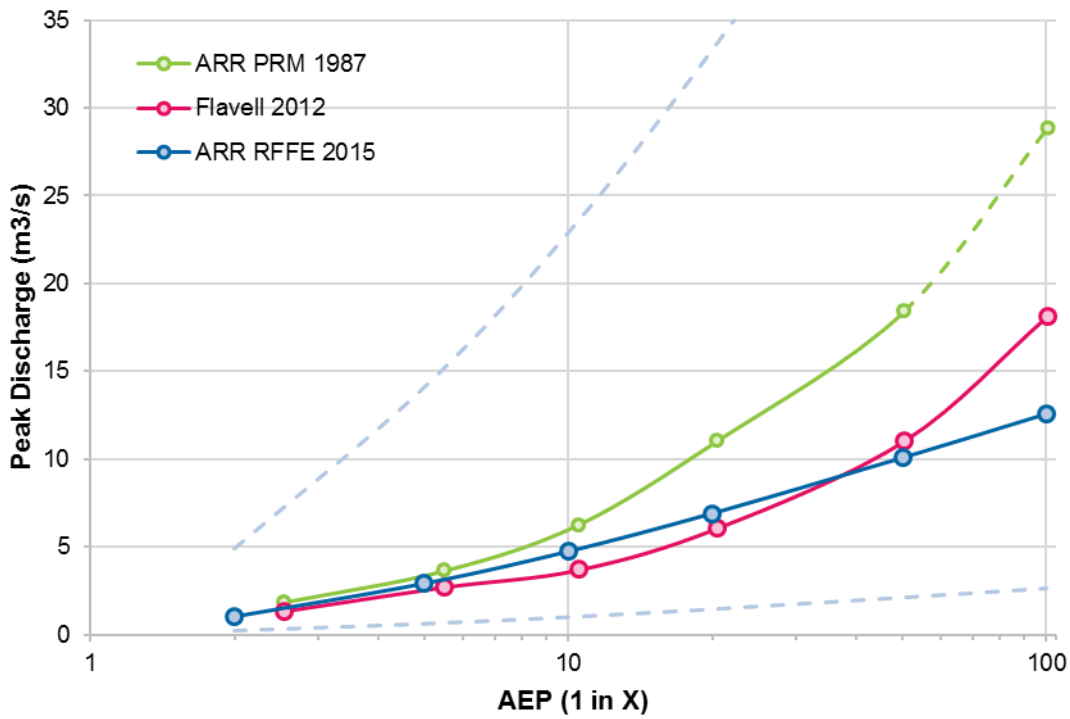


Figure 6 Peak flow estimates

The RFFE2015 method is known to have limited application in cleared agricultural catchments and is therefore discarded. The wide bands of this estimate are indicative of the range of soil types in the region and lack of gauging stations. Given the hydrologic properties of this particular catchment (particularly soils and slope) compared to other catchments in the region, the peak is likely to be in the lower half of the range. The Flavell method is based on data from larger catchments and is also discarded. Therefore, the extrapolated ARR1987 value of 29 m^3/s has been adopted for the project to for the 1% AEP flood, and represents the most conservative estimate of all methods.

4.7.2 Hydraulics

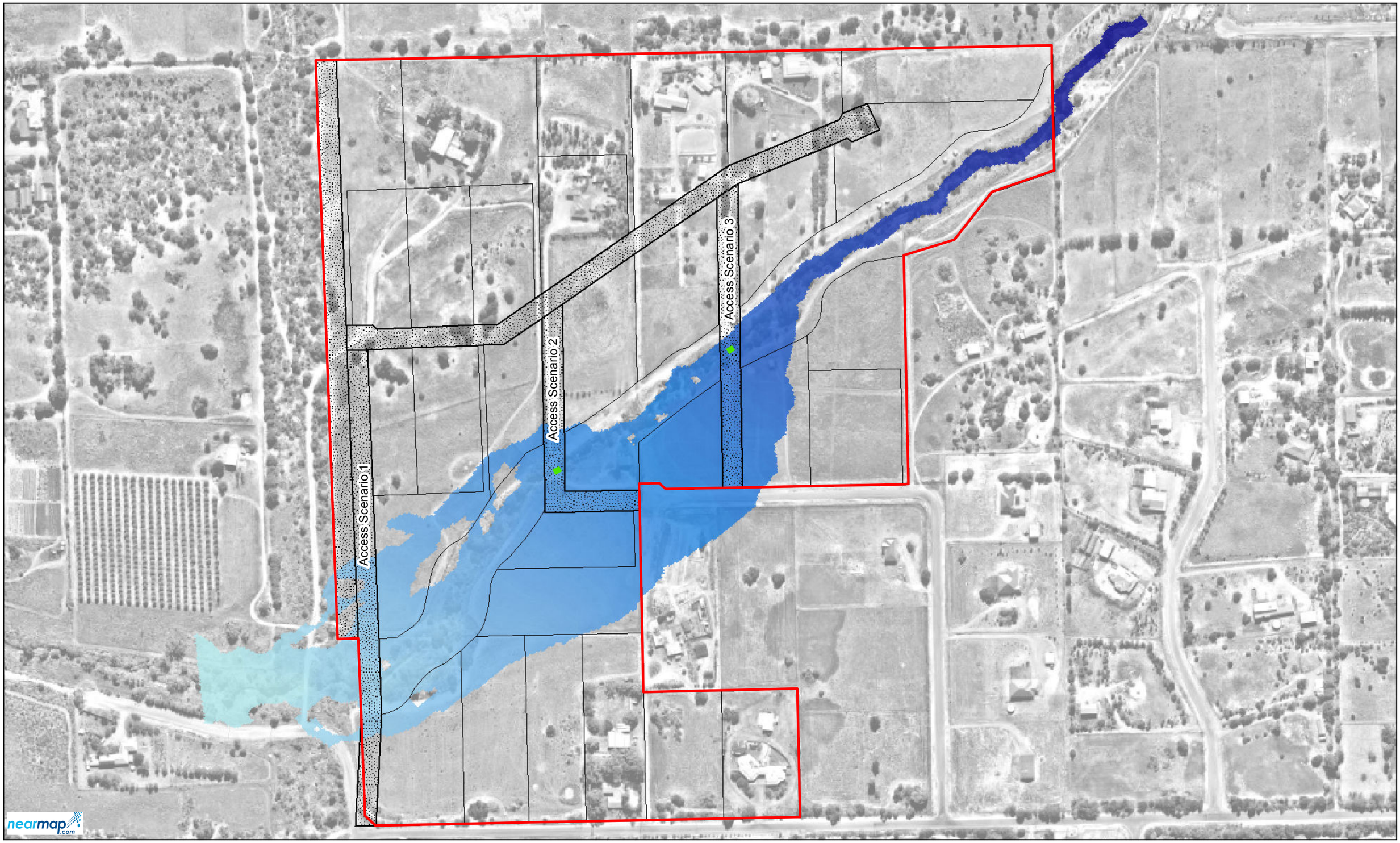
Dolbys Creek was simulated in a two-dimensional hydraulic model. TUFLOW was adopted as the modelling platform to undertake this work. TUFLOW is a computer program for simulating depth-averaged, two and one-dimensional free-surface flows such as occurs from floods and tides. It solves the full two-dimensional, depth averaged, momentum and continuity equations for free-surface flow.

The model is based on the following inputs:

1. Topographic data obtained from the UAV survey
2. Culvert dimensions and levels based on field measurements
3. Surface roughness derived from aerial imagers, ranging from 0.018 to 0.040 (Manning's "n")
4. Peak inflow obtained from the hydrologic calculation
5. A nominal tailwater depth located downstream of the site

4.7.3 Results

The existing flood depth and extent are illustrated in Figure 7. Floodwaters are contained within the channel banks for the upper reach of Dolbys Creek, up to a maximum depth of approximately 1.5m. A breakout occurs part-way through the site, forming a shallow floodplain up to approximately 150mm deep. The breakout is partially caused by the existing culvert having insufficient capacity for the 1% AEP flood.



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Existing culvert
- Proposed development
- Lots
- Road

Water level (m)

High : 57.794m

Low : 35.7m

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Pre-Development Flood Extent for 1 in 100 year Event

Figure 7

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Data source: Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017, Cadastre - 20160217, Roads - 20160217; GHD: Study Area - 20160217; Food Model; GHD, 2017. Created by:nkostraby

4.8 Groundwater

4.8.1 Groundwater level

The Department of Water WIN database identifies no bores within the site, however there are five bores located 1.5 km to the east of the site boundary (23043481, 23043480, 20002998, 20003000 and 23043803). Each of these had just one sample taken, and for two it was unknown what date the level was measured. All results were in m BGL, and are presented in Table 2.

Table 2 WIN groundwater level

WIN Site ID	Date level measured	Groundwater Level (mBGL)
20002998	1/01/1900	4.572
20003000	01/01/1900	5.1816
23043480	16/06/2000	3.96
23043481	23/06/2000	3.45
23043803	09/02/2007	4.07

Due to the sandy nature of soil on the site and the ephemeral nature of Dolby Creek, it is anticipated that there will be little interaction with groundwater in the structure plan area however geotechnical investigations are recommended prior to any earthworks at the site due to the lack of historical groundwater data.

4.8.2 Groundwater quality

There is no groundwater quality data available for bores within the site boundary. A single bore, WIN Site ID 20002914, has a recorded Total Dissolved Solids (TDS) result of 1519 mg/L, however it's unknown when this sample was taken.

5. Water use sustainability

5.1 Water conservation and efficiency

The Dolbys Drive Structure Plan will manage all aspects of the water cycle sustainably and ensure that the use of potable water is as efficient as possible.

5.1.1 In-house water efficiency

Water use efficiency is part of the “business as usual” approach and 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. The 5 star Plus Building Standards (Appendix B) introduced in September 2007 is now an addition under the *Western Australian Appendix to the Building Code of Australia (BCA)* and require:

- All tap fittings must be minimum 4 stars WELS rated
- All showerheads bust be minimum 3 stars WELS rated
- All sanitary flushing systems must be a minimum 4 stars WELS rated dual flush
- Home water heaters to be located within 5 m of major hot water using points.

5.1.2 Ex-house water efficiency

Irrigation is the single most significant water use within residential households and public spaces. Thus irrigating efficiently can have a major impact on the water consumption of a whole development.

The following waterwise measures will be encouraged at the individual property scale:

- Water efficient irrigation systems (deliver water evenly, to near the root zone, at specified rate).
- Waterwise garden design/landscaping.
- Native vegetation with low water demand.
- Group plants with similar water requirements.
- Minimise irrigated lawn/turf area.
- Soil improvers, to reduce infiltration loss below root zone.
- Mulch, to reduce evaporative loss.

Whilst not mandatory, these strategies are required to meet the Water Corporation *Criteria for Waterwise Homes* (Appendix E), and are recommended water and nutrient efficient practices that both save water and maintain water quality of existing and downstream environments.

5.1.3 Public open spaces

The nature of the land use zoning, with larger residential lots enables the creation of private open space, therefore reducing the need for formal public open space.

Public open spaces in the Dolbys Drive Structure Plan are intended to provide a range of passive and unstructured active recreational opportunities, incorporating protection of conservation areas and water sensitive urban design.

The designated public space areas will retain existing native vegetation. Any landscaping within these areas will be undertaken with water conservation in mind incorporating the following:

- Use of native species that require a local climate based low water-use and nutrient use regime.
- Any planting will be watered during establishment phase only.

5.2 Potable water

The potable water for the Dolbys Drive Structure Plan will be provided by Water Corporation. The Geraldton Water Scheme Planning and Management Strategy identifies that rural residential water supply may be difficult (ENV & Essential Environmental 2014). Options such as rainwater tanks and private bores to supplement potable water, and replace for non-potable uses, is recommended.

5.3 Water supply – fit for purpose strategy

In conjunction with water efficiency measures, supplying fit-for-purpose water can also reduce the demand for potable water. This involves substituting drinking quality water with fit-for-purpose water for non-drinking uses. Potential non-drinking water uses are;

- In-house non-drinking water such as toilets and washing machines
- Irrigation for private (domestic gardens) and public (public open spaces and road reserves) areas
- Aquifer recharge

Substituting potable water with an alternative source of non-potable water can make significant savings in potable water demand and the associated chemicals and energy required treating and delivering water to drinking water standard. Alternative water supply sources include rainwater, groundwater, stormwater and wastewater.

5.3.1 Rainwater

Rainwater tanks can be used to meet non-potable indoor and outdoor uses to reduce demand on potable water. It is important to note that rainwater supply is more suited to support in house non-portable water consumption, such as toilets and washing machine rather than irrigation demand. This is due to the fact that irrigation demands peak at the opposite time of year to peak rainfall, therefore requiring impractical tank volumes to store rainfall until it is needed..

The *Guidance on Use of Rainwater Tanks* (Australian Government 2004) estimate tank sizes to meet forecast demands. Adopting a roof size of 200 m^2, annual rainfall of 452 mm, and non-potable demand of 100 L per day, a domestic rainwater tank of 5.5 kL capacity is required to achieve 90% reliability.

The major potential risk associated with the use of rainwater tanks is the risk to public health due to poor water quality if the tank system is not maintained and managed appropriately. Rainwater quality is generally considered to be of a high standard if regular maintenance and appropriate system management is undertaken. Appropriate maintenance and management of rainwater tank systems includes;

- Installation of first flush diverters

- Prevention of access to any vermin or disease vectors
- Filter to minimise the entry of large particles and leaves
- Regular desludging to avoid build-up of sediments at the base of the tank
- Regular inspection and maintenance of gutters and downpipes

With appropriate maintenance and management, it is considered that the rainwater quality would be of a sufficient standard to be used for non-potable in-house use without further treatment.

5.3.2 Groundwater

Shallow groundwater is considered to be the easiest and usually most cost effective method of providing an alternative to scheme water for irrigation. The use of groundwater presents small risk in terms of water quality. With respect to irrigation, the presence of significant iron concentrations, hardness, alkalinity, nutrients or salinity can impact upon the receiving vegetation and soils and/or contribute to the scaling or scour of irrigation pipework.

The extraction of shallow groundwater via private bores is supported by the Shire of Chapman Valley, and will be at the expense of the landowner.

There is no information available on the quality of groundwater at the Dolbys Drive Structure Plan.

The Department of Water categorises the groundwater salinity according to the salt content and its application for public drinking, irrigation, stock water etc. Brackish groundwater of salinity 1000-3000 mg/L TDS can be used for parkland irrigation, and more saline groundwater with salinity greater than 3000 mg/L can be used for industry and stock watering (up to 10,000 mg/L TDS).

Garden bores provide a fit-for-purpose water supply for domestic irrigation that reduces demand on potable water. Private home owners will have the option of installing a garden bore in line with relevant government regulations and should refer to the Department of Water fact sheet in Appendix D.

5.3.3 Stormwater

Stormwater runoff increases during land development due to the introduction of impermeable surfaces. The increase in stormwater runoff at the Dolbys Drive Structure Plan is expected be minimal due to the low proportion of impermeably surfaces associated with the predominantly rural residential and conservation land uses proposed for the area.

Stormwater can be harvested via infiltration to the superficial aquifer at, or close to, source followed by abstraction from private bores. Collection and storage of stormwater for reuse other than by aquifer storage is considered impractical due to the small amounts of stormwater expected at the Dolbys Drive Structure Plan, and inefficient due to the need to construct large water collection infrastructure.

5.3.4 Wastewater

Wastewater includes grey water and black water. Grey water is wastewater generated from domestic activities such as laundry, dish washing and bathing, and can be reused with minimal treatment for applications such as irrigation, toilet flushing and washing machines. Black water is wastewater generated from sewage, and must undergo extensive treatment before reuse.

The Rural Residential of the Dolbys Drive Structure Plan lots will be serviced by onsite effluent disposal systems to treat and dispose of all household sewage.

The Department of Health (2010) requires that in unsewered areas the primary onsite wastewater system should be sized to receive the total wastewater flow in case any additional grey water system fails. Furthermore, the removal of grey water from the primary sewage system may adversely impact on the proper operation of that system. Therefore, land owners may find it impractical to install an additional grey water system as well as the required effluent disposal system.

The *National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water* (Agriculture and Resource Management Council of Australia 2000) applies to effluent from municipal (i.e. community) wastewater plants, and has been adopted by the Department of Health for application to individual household systems, as stated in the *Code of Practice for the Design, Manufacture, Installation and Operation of ATUs*. The strategy outlines the potential applications for black water and the level of treatment, water quality, monitoring and control requirements.

5.4 Wastewater management

The wastewater management methodology differs according to zoning and density.

5.4.1 Proposed 1 ha lot sizes

No reticulated wastewater is proposed for the 1 ha zoned lot areas, and the proposed rural residential lots are to be serviced by onsite effluent disposal systems to treat and dispose of all household sewage.

Individual lots within the rural residential development can be serviced by on-site effluent disposal systems such as Aerobic Treatment Unit (ATU) systems with the condition that use of an ATU meets the requirements outlined in Sections 5.1 and 5.7 of WAPC's Statement of Planning Policy No 2.1, and Section 5.2.2 of the *WAPC Government Sewerage Policy: Perth Metropolitan Region* (1995).The selection of an appropriate ATU for the individual lots is the responsibility of the landowner, and the unit must comply with the Department of Health Code of Practice for the *Code of Practice for the Design, Manufacture, Installation and Operation of ATUs* (Department of Health 2011).

Effluent from ATU's is able to be disposed of via irrigation areas. Disposal to surface irrigation is not considered for a suitable option for this rural residential development due to risks associated with surface disposal such as public health risks, risk of runoff, risk of surface ponding, and disinfection.

Effluent shall be disposed of via sub-surface irrigation (eg closely spaced and pressurised subsurface dripper pipework installed at a depth of 100 mm below the ground level) of a vegetated or landscaped disposal area. The sub-surface irrigation disposal area will be required to comply with setback requirements for buildings and other infrastructure.

The following measures are required to manage the risk nutrient runoff into the surrounding environment:

- Subsurface irrigation (closely spaced and pressurised subsurface dripper pipework installed at a depth of 100 mm below the ground level) is required to dispose of the effluent over a vegetated or landscaped disposal area;
- Construction of an irrigation disposal area with a minimum area of 150 m^2 which includes a layer of imported fill incorporating material that reduces phosphorus export; and
- The irrigation pad requires a minimum 1.2 m vertical separation to from the groundwater, in areas of minimal separation to groundwater, fill is required to ensure adequate separation is achieved.

- The ATU is required to be at least 6 m away from any well, bore, dam or water course that supplies domestic water or any proclaimed water catchment.
- The ATU should be situated downslope of the building wherever possible, to remove the need for diversion trenches.

The Shire of Chapman Valley and Department of Health guidelines stipulate that each onsite effluent disposal system is to be assessed individually to determine site specific characteristics and requirements. Builders and owners of the property will have to design the onsite effluent disposal system to suit local conditions and submit an "*Application to construct or install an apparatus for the treatment of sewage*" to the Shire of Chapman Valley. If the application is approved the effluent disposal system should be installed according to the conditions of approval and must then be inspected by an Environmental Health Officer and a *Permit to Use* issued before the system can be used. Additional applications and approvals are required to reuse treated blackwater.

It is the responsibility of the individual landowner and/or developer to receive approval from appropriate regulatory agencies to install an appropriate ATU system and ensure that quarterly servicing of the system is conducted by a contactor approved by the Department of Health.

5.4.2 Higher density areas

Residential densities higher than R5 may require wastewater reticulation as per advice from the Water Corporation, however the Dolbys Drive Structure Plan area does not have any current plans for high density areas with low density (1 ha) proposed lot sizes.

6. Stormwater management strategy

The post development annual discharge volumes and peak flows are to be maintained relative to pre-development conditions. To achieve this principle, the following criteria will be applied:

- To manage flows for ecological protection and manage the serviceability of roads and other infrastructure, lot and road runoff for minor rainfall events will be either captured in rainwater tanks or infiltrated as close to the source as practical. Due to the low density nature of the development it is expected that all post development stormwater runoff in excess of pre development flows for all storm events up to and including 1 year ARI events will be accommodated at the lot scale.
- The post-development area should retain all catchment runoff exceeding the pre-development level, up to and including the 100 year ARI event, while protecting infrastructure and assets from flooding.

6.1 Catchments

The Dolbys Drive Structure Plan area has an external upstream catchment to the northwest of around 496 ha, otherwise known as Dolbys Gully.

The study area consists of one pre-development catchment based on pre-development water pathways and roads depicted in the Structure Plan. This catchment directs all water into the Dolby Creek, which enters the site at the north east boundary and exits along the south west boundary. For the post-development flows, Dolbys Gully was divided into 6 sub-catchments draining to open swales, plus the remaining area which drains directly to Dolby Creek (Figure 8).

6.2 Surface water quantity management

Up to 1 year ARI event

The typically sandy soil types which are prevalent in the area are ideally suited to the promotion of infiltration at, or close to source. This has the advantage of maintaining recharge into the aquifer as well as minimising the need for drainage infrastructure. As such the most efficient and effective option for managing and reusing stormwater within the Dolbys Drive Structure Plan is infiltration of stormwater to the groundwater system at (or close to) source. However, on site soil permeability testing is recommended prior to development.

No infiltration testing has been conducted within the proposed development. An infiltration rate of 1 m/day (consistent with industry standards for long term unmaintained basins) was assumed as the preliminary infiltration rate used in design. The infiltration rate and storage required should be revised during subsequent UWMP's based on more detailed infiltration rates for the site.

Lot and road runoff for minor rainfall events up to and including 1-year ARI event will be kept on site, either captured in rainwater tanks or infiltrated to the aquifer as close to the source as practical, using water sensitive urban design (WSUD) measures such as soakwells (lots) and riffles in roadside swales (roads).

Table 3 gives the single lot storage volumes required to retain 1-year ARI events for the typical lot size (10,000 m^2). The storage is calculated as the product of the rainfall intensity and the impervious area of the lot (30% for R5 lot density (Department of Planning 2013)). Roadside swales will be designed to infiltrate the 1 year ARI event.

Table 3 Single lot storage volumes

Rainfall Event	1 year ARI, 1 hr
Rainfall Intensity (mm/hr)	17.5
Storage required (m^3/ha)	52.5

1-year ARI up to 5-year ARI

For this range of storm events, the objective is to provide drainage serviceability in accordance with the engineering requirements of the Shire of Chapman Valley. Roadside swales and table drains will collect and convey stormwater safely to Dolby Creek whilst maintaining road serviceability.

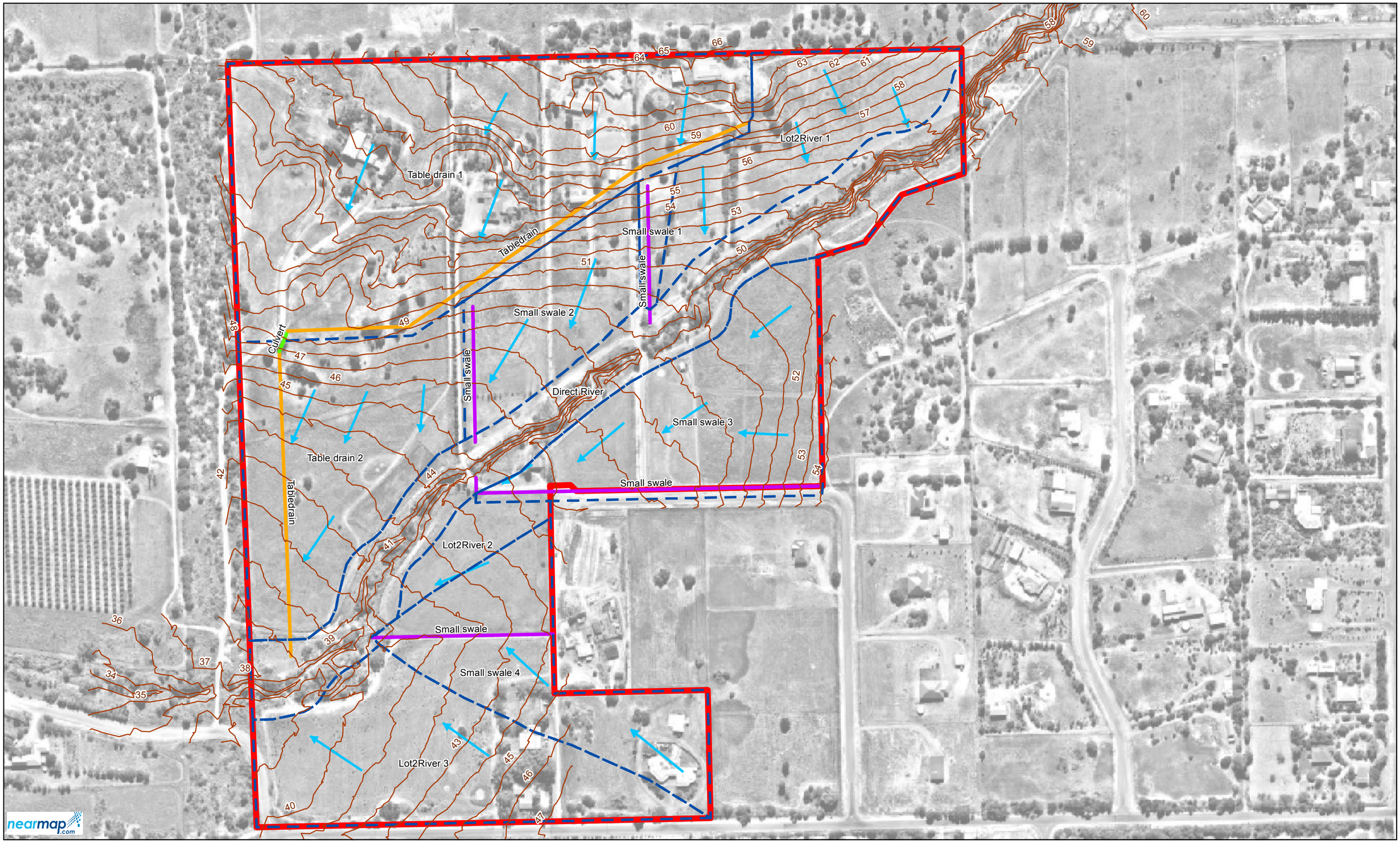
5 year up to 100 year ARI event

Events greater than the 5-year ARI event and up to and including the 100 year ARI event will be collected and conveyed via the road reserve into Dolby Creek, located within the centre of the site. Figure 8 shows the sub-catchment and drainage layout.

The proposed swales are to have 1 in 4 side slopes.

Opportunities for infiltrating road runoff, using infiltration areas and infiltration swales will be investigated within the subsequent UWMP's so as to distribute the required storage throughout the catchment.

As noted previously no infiltration testing has been conducted within the proposed development. An infiltration rate of 1 m/day (consistent with industry standards for long term unmaintained basins) was assumed as the preliminary infiltration rate used in design. It is likely a higher infiltration rate would be expected for the sands present at this site and as such total storage volumes should be revised during subsequent UWMP's based on more detailed infiltration rates for the site.



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Elevation
- Culvert
- Small swale
- Tabledrain
- Post-development flow path
- Study Area
- Post-development catchment

GHD

Shire of Chapman Valley
Dolby's Drive Structure Plan LWMS

Job Number	61-3302800
Revision	0
Date	31 Jul 2017

Drainage plan

Figure 8

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Data source: Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017, Cadastre - 20160217, Roads - 20160217; GHD: Study Area - 20160217; Drainage Plan, GHD, 2017. Created by:nkostraby

Road drainage

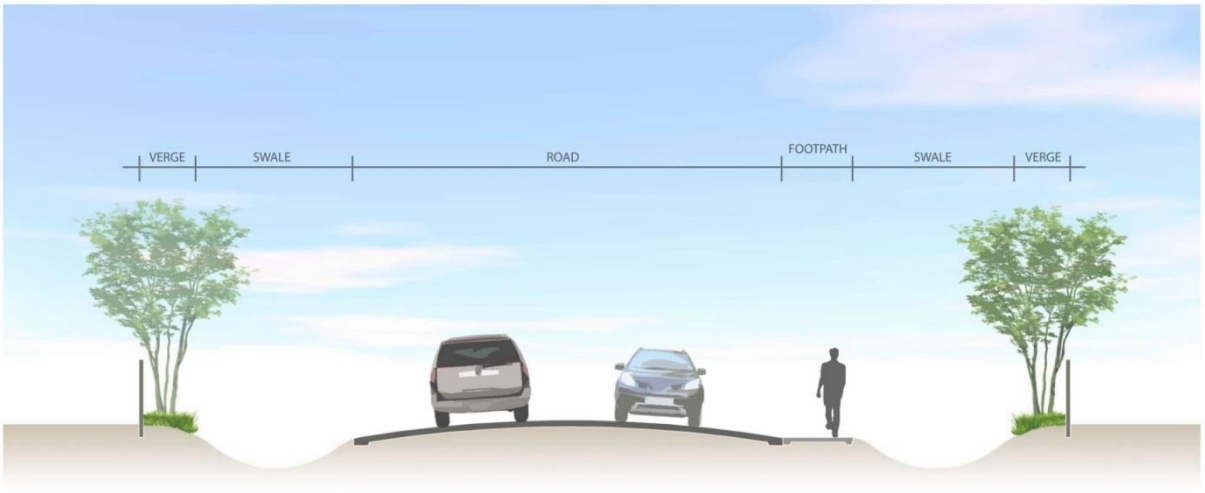
The road drainage system will comprise shallow roadside swales to infiltrate small events and convey larger events from the paved surface.

Peak flows resulting from the 100 year ARI event will result in overland flow occurring through lots. Therefore habitable floors are required to be at least 300 mm above the 100 year ARI flood or storage level at all locations. It is noted that this is unlikely to be an imposition on landowners as it is standard practice in this area for a 500 mm sand pad to be placed on-site prior to residence construction by local builders.

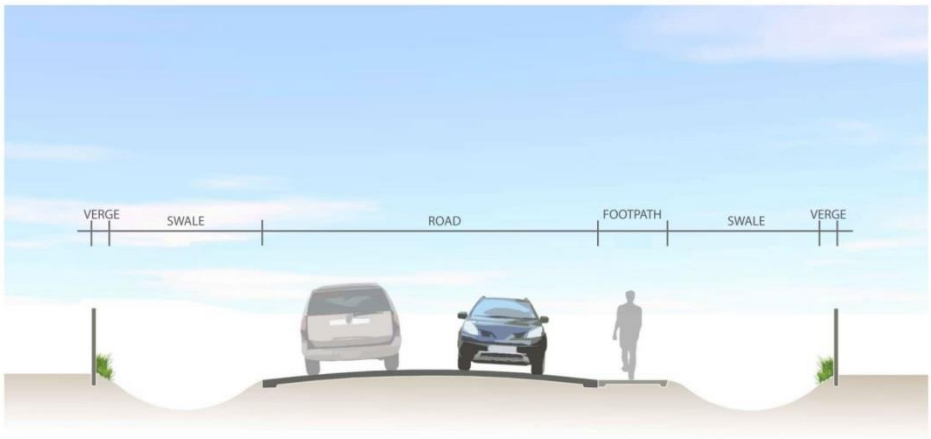
The swales will be bunded at regular intervals to ensure that they do not concentrate the flows. Where kerbing is required at roundabouts and intersections, soakwells may be used in conjunction with kerb openings.

Swales may be landscaped with appropriate native vegetation to ensure high nutrient control, low/no water usage and easy maintenance.

Figure 9 provides typical sections of road reserves within the Dolbys Drive Structure Plan area, showing the conceptual location of the roadside swales. To size the road reserve, two swale designs have been prepared depending on the contributing catchment size. Small swales have a top width of 4 m, whilst large swales have a top width of 7 m. Individual swale widths should be determined through preparation of Urban Water Management Plans at the time of subdivision.



NEIGHBOURHOOD CONNECTOR



ACCESS ROAD

Figure 9 Roadside swales within indicative road cross sections

6.2.1 Dolby Creek

Model Setup

The two dimensional hydraulic model used for the existing scenario was modified to simulate the 10 and 100 year ARI post-development scenarios. The model consists of 2 m grids and modelling time step of 0.5 seconds. The model has one inflow boundary on the east and one outflow boundary on the west as shown in Figure 10. The inflow used for the model was described in Section 4.7.1. The outflow boundary has a constant water level is set at 35.7 m.

Culverts

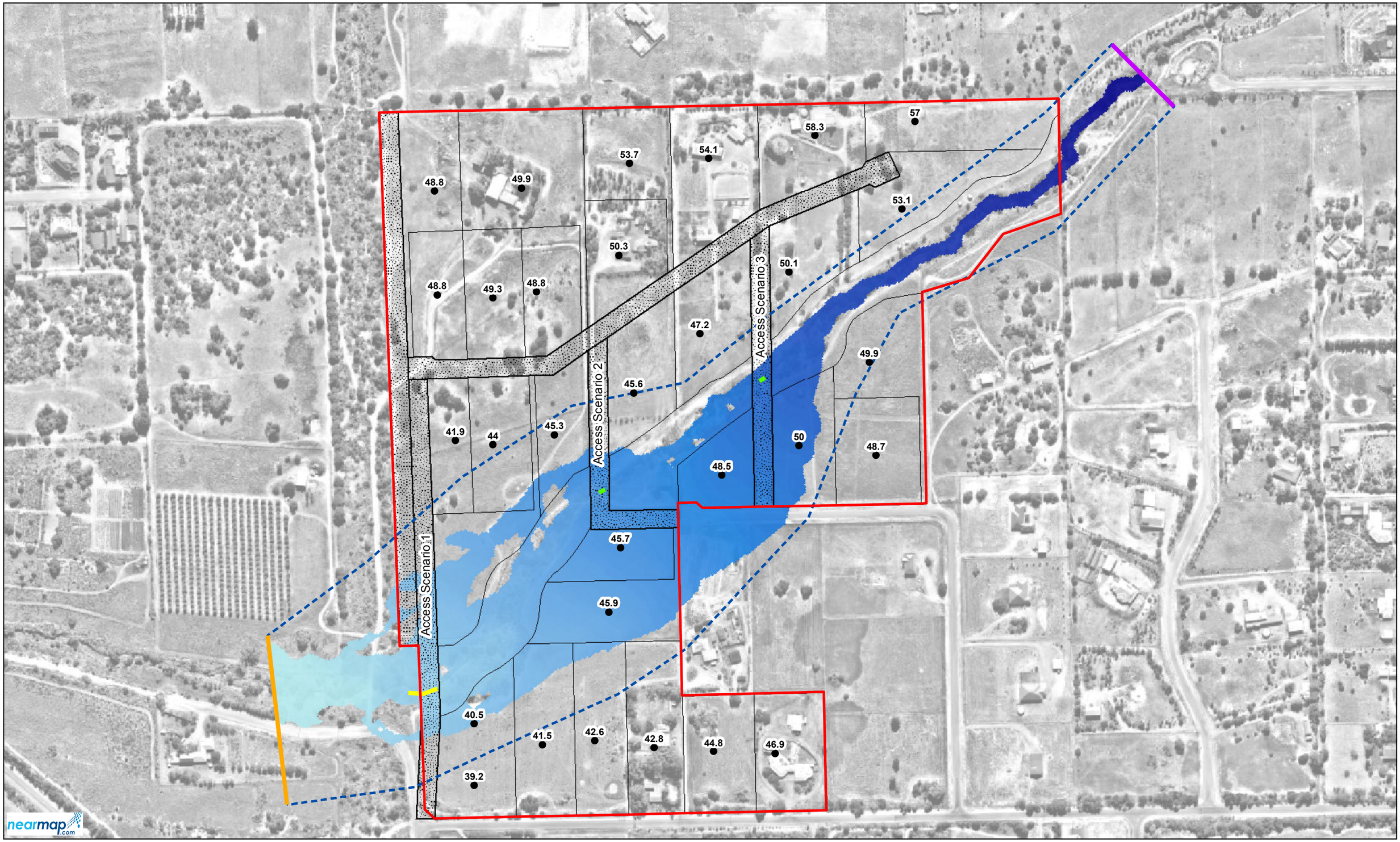
Culverts are being represented as one dimensional network in TUFLOW, which is linked to the 2D domain. Currently, there are two culverts that cross Dolby Creek. These culverts are combined with road floodways to convey flows exceeding the capacity of the culverts. If the western access road (Access Scenario 1) proceeds, it is proposed that a third culvert/floodway

will be built downstream of the two existing culverts, rendering the existing culverts redundant. To represent the worst case scenario, the model was simulated with all three culverts in place. Whichever crossing progresses, it is recommended that redundant culverts are removed to improve the hydraulic performance of the waterway and potentially lower flood levels.

To maintain similar flood levels and provide a 10-year ARI level of service, it is suggested to construct three circular culvert barrels with a diameter of 900 mm, under a floodway crossing with a capacity of 26 m^3/s. The 10-year ARI level of service is adopted based on Main Roads WA standards for bridges and culverts, where wet serviceability of minor roads is defined as 200 mm of floodway flow in the 10-year ARI event. Further detailed analysis and design of any future Dolby Creek crossing will be required at UWMP stage to ensure that any impact on flood levels from the proposed culvert and floodway configuration is reflected in flood hazard mapping and finished floor levels.

Finished floor levels

The finished floor levels (FFLs) of each proposed lot was derived with the assumptions that sites that are likely to be inundated during the 100-year ARI event will be raised a minimum 300 mm above the maximum inundated level whereas sites that are not likely to be inundated will have a minimum FFL of 150 mm above the surrounding topography. The FFLs of each lot is shown in Figure 10.



Paper Size A3

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Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Proposed development
- Finished floor level (m)
- Existing culvert
- Proposed culvert
- Outflow boundary
- Inflow boundary
- Modelling extent
- Lots
- Road

Water level (m)

High : 57.794m

Low : 35.7m

Shire of Chapman Valley
Dolby's Drive Structure Plan LWMS

1 in 100 AEP Post-Development Flood Extent

Job Number	61-3302800
Revision	0
Date	31 Jul 2017

Figure 10

G:\61\33028\GIS\Maps\Deliverables\6133028_Fig10_Rev0_PostDevelop.mxd

999 Hay Street Perth WA 6000 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Nearmap; Imagery, Extracted 31/07/2017 Captured 16/06/2017, Cadastre - 20160217, Roads - 20160217; GHD: Study Area - 20160217; Food Model; GHD, 2017. Created by:nkostraby

6.3 Surface water quality management

The post-development water quality is to be maintained at pre-development levels (winter concentrations) and if possible, the quality of water leaving the development area is to be improved to maintain and restore ecological systems. To achieve this principle, the following criteria will be applied:

- Ensure that all surface and groundwater contained in the drainage infrastructure network receives treatment prior to discharge to receiving environment consistent with the Stormwater Management Manual for Western Australia (Department of Water, 2004- 2007).

Urban runoff is a significant source of nutrients and other contaminants that are discharged to the shallow aquifer. Runoff water quality from roads and other paved surfaces can be variable and is dependent on local soil types, land use and climate. Maintaining pre-development discharge rates and volumes from developed catchments is expected to prevent the majority of contaminants from reaching the receiving environment by ensuring that the majority of flows from high-frequency events are retained or infiltrated on site.

Provided that the initial flow of more significant events is subject to the same retention and treatment received by high-frequency events, surface runoff that occurs during more significant events represents a lower risk to water quality. This is because nutrients and other contaminants that represent a threat to water quality are typically transported within the 'first flush' of an event.

Managing water quality has been divided into categories: Structural measures and non-structural measures.

6.3.1 Structural measures

Use WSUD elements and best management practices (BMPs) promoting retention, infiltration and treatment of events up to the 1 year ARI events as close to the source as practical, in accordance with the Stormwater Management Manual for Western Australia (Department of Water, 2004- 2007).

The key WSUD element to be incorporated into the design of the development area is grassed swales, with infiltration as close to source as possible. Bunds within the drain will allow infiltration of the 1 year 1 hour event.

6.3.2 Non-structural measures

Nutrient control and landscaping

- Implement the swales relatively early to avoid temporary facilities and allow new vegetation to establish before housing construction of the developed lots is completed.

Sediment and litter control and construction management

- Require all development construction projects, including lot development, road and infrastructure construction, to implement sediment and erosion control measures.
- Ensure that drainage basins area cleared biannually to ensure functionality.

7. Groundwater management strategy

7.1 Groundwater levels

To ensure that existing groundwater levels are maintained, stormwater runoff will be infiltrated as close to source as practical using WSUD and BMPs. The specification for groundwater separation for residential lots greater than 800 m^2 is “no criteria, with the expectation that design of lots will include site specific consideration of appropriate levels of amenity” (IPWEA 2016). As such, this should be addressed at the UWMP stage. Where lots are 400 m^2 to 800 m^2, 300 mm of coarse sand will need to be applied to anticipated garden areas in the rear of lots above the 50% AEP phreatic surface.

7.2 Groundwater quality

The post development groundwater quality is to be maintained at pre-development levels (winter concentrations) and, if possible, the quality of water leaving the site is to be improved to maintain and restore ecological systems.

To ensure that existing groundwater quality is maintained, the quality of the stormwater infiltration to groundwater will be maximised by using WSUD and BMPs to ensure that stormwater is infiltrated as close to source as possible.

7.3 Impact on Groundwater Dependant Ecosystems

Since there is no groundwater dependent ecosystem (GDE) within or adjacent to the site and it is proposed to contain stormwater runoff within the site there will be no impact on GDEs.

7.4 Matters to be addressed in UWMPs

Infiltration testing should be carried out in conjunction with geotechnical investigations to confirm that the site is suitable for the proposed infiltration methods and to identify appropriate infiltration rates to enable further refinement of modelling at the UWMP stage, where required.

8. Implementation framework

As the Dolbys Drive study area features fragmented ownership it is anticipated that implementation of this local water management strategy will occur over extended time frames and on an ad-hoc basis, as development proposals are approved and constructed.

8.1 Monitoring

Surface water

Stormwater generated on site drains to Dolby Creek. Surface water quality monitoring is recommended at the upstream and downstream ends of Dolby Creek.

Monitor upstream and downstream; nutrients, physicals, heavy metals etc,

Groundwater

No groundwater level monitoring was conducted as part of this LWMS. There is no existing groundwater quality or level data for the site. As the proposed lot size is above 800 m^2 and this will not require separation from groundwater, no monitoring is proposed. (take reasons for no GW monitoring from GW section)

Exemption from groundwater monitoring should be discussed in consultation with the Department of Water. Where groundwater at the site is indicated to be within 5 m of ground level, it is recommended that site specific groundwater monitoring be undertaken to confirm local groundwater levels. This information will inform potential requirements for fill and will be required to design and assess operation of onsite effluent disposal systems.

Groundwater monitoring should occur prior to the preparation of UWMPs, where required, to confirm groundwater levels in the area.

8.2 Requirements for future planning and development

This local water management strategy provides guidance on water management within the Dolbys Drive study area.

Urban water management plans are not anticipated to be required to support development of single lots across the majority of the study area.

Urban water management plans may be required to support urban development where:

- Local Development Plans are required for vegetation protection areas as identified in the Dolbys Drive Local Structure Plan (Appendix A).
- Development is proposed that will significantly alter the hydrology or drainage of a site or is unable to meet the design criteria identified in Section 3.

Where an urban water management plan is required it should be consistent with the requirements of the Department of Water's *Urban water management plans: Guidelines for preparing plans and complying with subdivision conditions* (DoW 2008). The urban water management plan should demonstrate that water management within the subdivision will meet the objectives and criteria in the local water management strategy, except where alternative agreement has been reached with the Department of Water and the Shire of Chapman Valley.

8.2.1 Subdivision

Small scale subdivision should be undertaken in accordance with the structure plan and the objectives, strategies and design criteria in this local water management strategy. An urban water management plan will generally not be required unless the Department of Water or Shire of Chapman Valley require additional information to demonstrate compliance with this local water management strategy, or where proposed development may have an impact on significant resources.

Developers subdividing land for residential development are required to provide a stormwater drainage system. The drainage system should consider the total contributing catchment area, ensuring that the ultimate design is capable of carrying the ultimate design flow from the upstream catchment. Developers whose land shares a common drainage catchment have a shared responsibility for ensuring that the whole of the catchment, including roads, is drained.

8.3 Responsibilities

Table 4 sets out the roles and responsibilities for the actions outlined for the future planning for the development area. This strategy is based on the concept Dolbys Drive Structure Plan prepared by GHD in July 2016. Should the Structure Plan be altered, the LWMS will be reviewed.

Table 4 Roles and responsibilities

Role	Responsibility	Requirement and Period
Prepare an urban water management plan	Developer/ landowner if required	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. Maintain infrastructure for a minimum of 2 years after practical completion, until successful handover to Shire of Chapman Valley.
ATU's/rainwater tanks: *Requirements*	Shire of Chapman Valley	Ensure lots meet requirements relating to ATUs and rainwater tanks
ATU's/rainwater tanks: *Implementation and maintenance*	Developer/ landowner	Ensure onsite water and wastewater infrastructure is installed by a licensed contractor and appropriately maintained.
Structural control compliance	Shire of Chapman Valley after practical completion	Drainage structures to be cleared biannually for a period of two years from practical completion and monitored to ensure functionality
Non-structural controls *Land use and management*	Developer	Sediment and erosion control during construction
Non-Structural Controls: *Public awareness*	Shire of Chapman Valley	Sustainability information packs, including educational information

campaigns		regarding non-structural control measures, such as fertiliser application, native gardens, herbicide use, weed control and waste management, to be provided at settlement.

9. References

Australian Government (2004) *Guidance on Use of Rainwater Tanks*

Department of Health (2010) *Code of Practice for the Reuse of Greywater in Western* Australia 2010, Perth

Department of Health (2011) *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs),* Perth

Department of Water (2004-2007) *Stormwater Management Manual for Western Australia,* Perth

Dye, R.A.,Van Vreeswyk, A.M.E. and Moore, G.A. (1990) *Geraldton Rural Residential Land Capability Study*, Department of Agriculture, Land Resources Series No. 4, June 1990

ENV & Essential Environmental (2014), *Greater Geraldton Water Planning and Management Strategy*, prepared for the City of Greater Geraldton, November 2013, updated by City of Greater Geraldton January 2014

GHD (2008) *Shire of Chapman Valley, Buller Locality Town Planning Scheme Flora and Fauna Survey*, prepared for the Shire of Chapman Valley, October 2008

GHD (2010) *Shire of Chapman Valley Local Planning Scheme No. 2 Environmental Review*, prepared for the Shire of Chapman Valley, April 2010

GHD (2014) *Dongara – Port Denison District Structure Plan District Water Management Strategy*, Report for Shire of Irwin, October 2014

Institute of Public Works Engineering Australia (IPWEA) (2016) *Specification separation distances for groundwater controlled urban development*, prepared by the Land development in groundwater constrained landscapes Steering Group, Version 2 February 2016

Kolsatz Smith (2007) *Shire of Chapman Valley Coastal Management Strategy*, prepared for Shire of Chapman Valley, July 2007.

Land Insights (2016) *Shire of Chapman Valley, Coastal Management Strategy Action Plan*, prepared for the Shire of Chapman Valley, May 2016.

Speck, N.H. (1958) *The vegetation of the Darling-Irwin Botanical Districts*, Ph.D. Thesis (Botany) unpublished, University of Western Austalia.

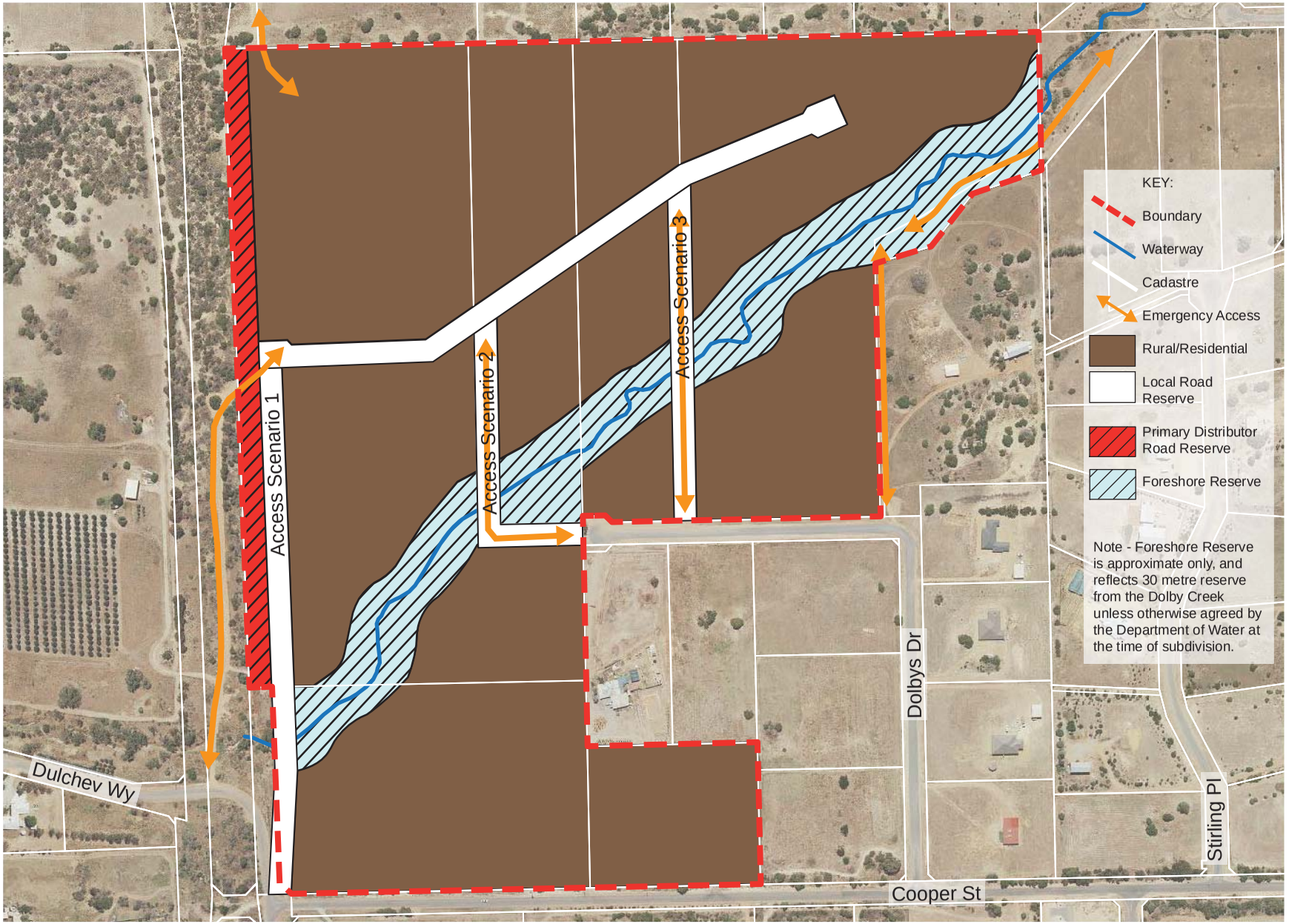
(WAPC) Western Australian Planning Commission (2006) *Draft Northern Geraldton District Structure Plan*, Perth

(WAPC) Western Australian Planning Commission (2008a) *Better Urban Water Management,* Perth

(WAPC) Western Australian Planning Commission (2008b) *Shire of Chapman Valley Local Planning Strategy*, Perth (unpublished)

Appendices

Appendix A – Dolbys Drive Structure Plan and Northern Geraldton District Structure Plan



Structure Plan

0 50 100 150m

SCALE 1:5000 AT ORIGINAL SIZE

N

RECOMMENDATIONS

COASTAL

R1 Coastal Foreshore Reserve / Setback subject to more detailed assessment at Local Structure Planning stage in accordance with SPP2.6.

R2 Promote showrooms along road frontages with warehouse type uses on larger lots located closer to Waste Water Treatment Plant. No development or subdivision is to take place within the Mixed Business Area until a development guide plan is prepared and endorsed by the Shire and WAPC.

R3 Future High School site to incorporate existing remnant vegetation for conservation purposes. This vegetation forms part of a green linear link to extend south through mixed use and district centre sites.

R4 Investigate the possibility of linking the coastal access road between Whitehill Road and the new part of Drummond Cove in the vicinity of the existing park.

R5 This area is subject to further community consultation and planning to determine the potential for the creation of freehold titles based on current leasehold arrangements and to resolve other related development issues.

R6 This area is proposed to be developed in the medium term for residential purposes. A Local Structure Plan will be required to be endorsed by the Shire of Chapman Valley and the WAPC over this area prior to any development taking place. There will be a need to provide appropriate linkages to the north and south ensuring an integrated pattern of development.

R7 This area will be developed in the long term for the purpose of single lot urban and tourist type uses. There may be a need for lower density development along the northern edge of the Buller Locality. A neighbourhood centre, an adjacent mixed use area and government primary school may be developed in this area, depending on demand being established for these uses. An integrated Local Structure Plan will be required to be endorsed by the Shire of Chapman Valley and the WAPC over this area prior to any development taking place.

R8 This area comprises an existing dune blowout that will require detailed assessment to determine land capability for road (proposed coastal access road) and house construction that will include (but not limited to) investigation of past dune movements.

R9 Oakajee Industrial Buffer Area.

GLENFIELD

R10 This area is not a special residential area. For this reason, a residence should only be approved as an incidental use. Uses other than a residence will need to demonstrate compatibility with a residential environment. Commercial uses (such as fast food outlets, showrooms, offices, convenience stores and shops) would not be permitted. Development objectives, preferred land uses and development standards will be determined through a Special Use zoning.

R11 Main Roads approved intersection point with North West Coastal Highway.

R12 This is the preferred location for an intersection with North West Coastal Highway. Main Roads approval is still required to confirm the suitability of this intersection location. In this regard, Main Roads will undertake a broader study to determine the location of new Main Roads approved intersections and the future design and reserve requirements for all Main Roads approved intersections along the Brand/North West Coastal Highway route through Greater Geraldton.

R13 Alexander Road and proposed north-south local distributor road to be designed with various traffic calming devices and strategically located POS to ensure these roads do not detract from the function of Chapman Road and North West Coastal Highway.

R14 The development of a private school, government primary school and church sites depend on future acquisition of land by private educational institute/religious organisations and the WA Department of Education and Training.

R15 A minimum lot size of 2000m² will be required along land adjoining Chapman Road and Alexander Road, as shown on the District Structure Plan. Any subdivision Plan would need to show building envelopes that adequately setback dwellings from Chapman Road and the North West Coastal Highway to protect the residential amenity of the area.

R16 All landowners within the Glenfield Structure Plan Area will be required to contribute 10% public open space by means of land or cash in lieu. Where a landowner is required to contribute more than 10% of land to POS in accordance with the District Structure Plan, then the owner will be duly compensated for the land value in excess of 10% from cash in lieu contributions from other owners within Glenfield Structure Plan Area.

RURAL RESIDENTIAL AND CREEKLINE

R17 No subdivision is to be approved until Local Structure Plans have been endorsed by Council and the WAPC. The Local Structure Plans are to be supported by a visual impact assessment in terms of the Moresby Range.

R18 There is a need for a buffer or foreshore reserve (where adjoining residential development) on both sides of the creek line. The actual width of the buffer or reserve is to be determined through individual site survey in the manner outlined in Section 4.7.4 of the NGDSP Report. As a guide the buffer or reserve should be in the order of 30m on both sides of the river (ie.60m).

R19 The Waggrakine Rural Residential Structure Plan needs to be finalised before subdivision can occur. Retention of remnant vegetation, revegetation and a presumption against battleaxe lots are planning principles that will be incorporated into that structure plan. The Shire will also investigate the merits of a "Conservation through Subdivision" scheme for the area, whereby subdividers would contribute towards a fund to purchase particular areas containing remnant vegetation in the locality.

A As a guide a lot size range of 1.5ha to 4ha is recommended in Area A.*

B As a guide a lot size range of 1ha to 3ha is recommended in Area B.*

* variations can be considered where required to meet planning and conservation objectives (ie. an additional lot to offset the cost of road construction).

NORTHERN WHITE PEAK AND RIVER

R20 The Rural Small Holdings Area reflects the existing land use and subdivision pattern and as such there is a general presumption against further subdivision. Notwithstanding this, any future development (such as dwellings or rural buildings) and/or subdivision proposals (if justified) are to be supported by a visual impact assessment in terms of the Moresby Range.

R21 There is a preference for a Service Station/Roadhouse/Truck Stop to be located at the North West Coastal Highway / Oakajee intersection further north of the Study Area.

R22 There is a need for a buffer or foreshore reserve (where adjoining residential development) on both sides of the river. The actual width of the buffer or reserve is to be determined through individual site survey in the manner outlined in Section 4.7.4 of the NGDSP Report. As a guide the buffer or reserve should be in the order of 50m on both sides of the river (ie.100m).

WAGGRAKINE URBAN

R23 Access to the neighbourhood centre and mixed use sites will be restricted to Hall Road. Any development application lodged for the site would need to address the intersection treatment at Chapman Valley Road/Hall Road.

R24 The development objective for this site is to provide a central focus area for the Waggrakine Urban Area that would need to be compatible with adjacent residential and commercial uses. Planning for the site would need to be determined through a Special Use Zone under Draft Shire of Greenough Town Planning Scheme No. 5 that would specify development objectives, preferred land uses and development standards. Generally, any future development and subdivision plans would need to promote an integrated design, suitable development treatments (landscaping, building appearance and location of parking) along the Chapman Valley Road frontage and appropriate access arrangements. The Draft Waggrakine Guided Development Scheme will need to be amended to reflect the development guidelines and land use intentions for the site.

MORESBY

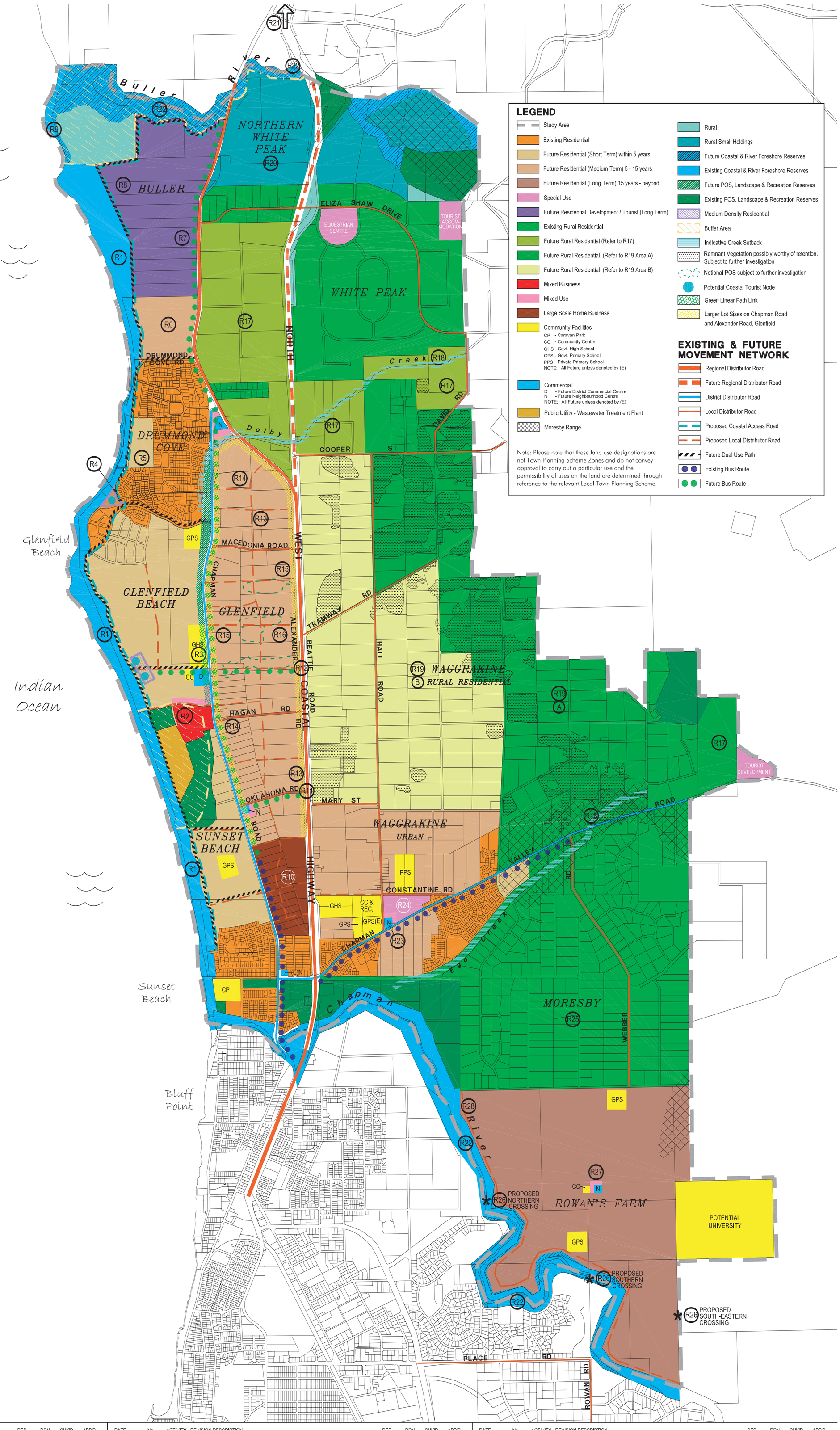
R25 Any infill subdivision in Moresby would be assessed according to its integration within the existing subdivision design and there would be a presumption against battleaxe lots.

ROWAN'S FARM

R26 The southern and northern crossing options have been identified to provide alternative convenient access to the Geraldton City Centre for residents north-east of the Chapman River. The preferred option is to be determined through further analysis (including traffic modelling) by the Shire of Greenough, City of Geraldton and Main Roads prior to subdivision. The south eastern crossing would be outside the Study Area but has been identified as a possible future local airport access road.

R27 The location of the local distributor road linking Webber Road and the future Chapman River Crossing is to be determined as part of the Local Structure Plan.

R28 Location of the road is dependent on the final width of the river foreshore and is to be determined through a Local Structure Plan.



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
16.12.05	G	Modification as requested by Steering Committee (Nov 2005)	ADW	SB	LVE	LVE
13.06.05	B	Additional notes added to legend	ADW	SB	ADW	LVE
20.06.05	C	Additional notes added to legend	ADW	SB	ADW	LVE
27.07.05	D	Additional changes as requested by DPI	LVE	SB	ADW	LVE
20.10.05	E	Alteration made as requested by DPI	LVE	SB	ADW	LVE
03.11.05	F	Modification to R26 text block	LVE	SB	ADW	LVE

PROJECT **NORTHERN GERALDTON DISTRICT STRUCTURE PLAN**

DRAWING TITLE **DISTRICT STRUCTURE PLAN**

PRINCIPAL **WESTERN AUSTRALIAN PLANNING COMMISSION**

This drawing has been prepared in accordance with the BSD Quality Management System.

SCALE: 1:20000@A1 (0 – 0.2km – 0.4 – 0.6 – 0.8 – 1.0km – 1.2 – 1.4 – 1.6 – 1.8 – 2.0km)

Cardno BSD
CONSULTING ENGINEERS
TOWN PLANNERS
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ENVIRONMENTAL CONSULTANTS
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Western Australia 6904
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Project Number	Drawing Number	Revision	Original
P04016	P759-SK01	G	A1

Designed ADW | Checked LVE | Date 10.02.05
Drawn SB | Approved LVE | Sheet 1 Of 1
Local Authority Geraldton, Greenough, Chapman Valley

Appendix B – 5 Star Plus Building Standards

Department of Housing and Works
Government of Western Australia

5 Star Plus

A New Standard in Sustainable Housing

for Western Australians

Playing our part in building better communities

MESSAGE
from the Minister

I am delighted to introduce 5 Star Plus – a new standard for sustainable housing in Western Australia.

We all are concerned about global climate change and we all have a role to play in addressing this problem and working towards a sustainable future.

Each time we use water and energy in our homes we contribute significantly to the production of greenhouse gas emissions.

We can act now to minimise our impact on the environment by adopting simple conservation measures such as fitting a water efficient shower head, installing a solar or 5 Star gas hot water system or providing an adequate level of insulation in our homes.

5 Star Plus is a State Government initiative designed to improve the energy and water efficiency of our homes. It is based around two new Codes: the **Energy Use in Houses Code** and the **Water Use in Houses Code** that will be mandatory for new homes approved after 1 September 2007.

The Codes can also be used as a guide by existing homeowners seeking to improve their water and energy efficiency.

As well as helping to save our environment and reduce greenhouse gas emissions, 5 Star Plus will also provide cost savings in household energy and water bills.

I am certain that the immediate and long-term benefits of 5 Star Plus will be appreciated by Western Australians, now and for generations to come.

Hon Michelle Roberts MLA
Minister for Housing and Works

5 Star Plus

Playing our part in building better communities for Western Australia

5 STAR PLUS – What Is It?

The Western Australian Government is committed to developing sustainable housing throughout the State.

In May 2006, Western Australia adopted the minimum 5 Star energy efficiency provisions of the **Building Code of Australia** (BCA) for all new homes. Known as 5 Star, the provisions encourage better design resulting in environmental benefits such as reduced energy consumption and real savings in heating and cooling.

5 Star ensures that new houses in Western Australia meet minimum standards for energy efficiency by including requirements such as:

- wall, roof and floor insulation;
- appropriate size, type, orientation and shading of windows;
- controlling draughts to reduce the loss of warm or cool air;
- the use of ceiling fans and innovative ventilation systems to create ample air movement; and
- insulating hot water pipes and air-conditioning ductwork.

Now the Government has gone further and introduced 5 Star Plus – that builds on the energy efficiencies of 5 Star and adds the benefits of water reduction measures for homes right across the State.

5 Star Plus is a simple and effective way to ensure that our homes are minimal in their impact on the environment

did you know?

USING AN EFFICIENT SOLAR WATER HEATER INSTEAD OF AN ELECTRIC SYSTEM SAVES AROUND FOUR TONNES OF CARBON DIOXIDE EMISSIONS PER ANNUM WHICH IS AS MUCH AS AN AVERAGE LARGE CAR PRODUCES IN A YEAR.

5 STAR PLUS

As from 1 September 2007 the new 5 Star Plus standards will be introduced to build on the energy efficiency benefits of 5 Star. These new standards will for the first time also address the issue of water efficiency in homes.

5 Star Plus is based around two new Codes:

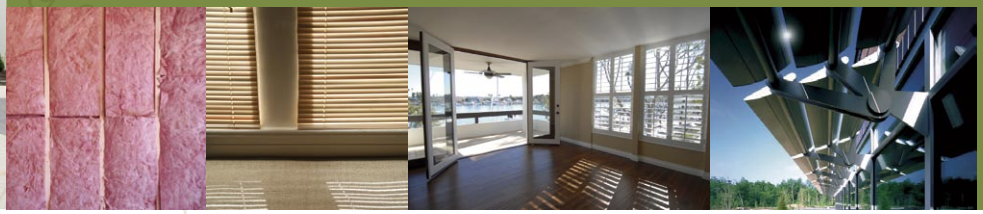
energy

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 that reduces greenhouse gas emissions.

To comply with the Code a building must be designed and constructed to meet minimum 5 Star energy efficiency standards under the Building Code of Australia.

The Code also requires a minimum standard of hot water system such as:

- a solar hot water system;
- a 5 Star rated gas hot water system; or
- a high energy efficient electric heat pump.



did you know?

5 STAR PLUS SAVES MONEY AND THE ENVIRONMENT

INSTALLING 5 STAR PLUS WATER EFFICIENCY FEATURES IN YOUR NEW HOME CAN SAVE MORE THAN 100,000 LITRES PER YEAR. THIS IS EQUIVALENT TO 2.5 BACKYARD SWIMMING POOLS.

The **Water Use in Houses Code** aims to reduce the consumption of water in houses.

From 1 September 2007 all new houses must ensure:

- 3 or 4 Star rated water efficient fittings and fixtures are fitted; and
- all hot water outlets in new homes be located close to the hot water system or a recirculating hot water supply to minimise wastage of energy and water.

In addition, all homeowners installing a new outdoor swimming pool must ensure that it is fitted with a cover to reduce water evaporation.

During 2008 the Code will also require:

- new homes be plumbed so that they can be connected to an approved alternative water supply at a later date (an alternative water supply may include water tanks, bore water and third pipes).
- new homes on suitable lots be plumbed to enable connection at a later time to a grey water diversion system (grey water is the water that comes from your shower and laundry);
- new homes with a high water demand for landscaping have an approved alternative water supply for appropriate non-potable use; and
- new homes with a high water demand for internal use have an approved alternative water supply for appropriate non-potable use.

water

While 5 Star Plus is mandatory for new homes built after 1 September 2007, existing homeowners can also use these Codes to improve energy and water efficiency in their homes.

5 STAR PLUS
Frequently Asked Questions

Q. What is 5 Star?

A. 5 Star is the standard for energy efficiency in houses required under the Building Code of Australia.

Q. What is 5 Star Plus?

A. 5 Star Plus is a new standard for sustainable housing in Western Australia that will improve water and energy efficiency in homes. It is based around two new codes: the Water Use in Houses Code and the Energy Use in Houses Code.

Q. How does it affect me?

A. If you are planning to build a new home after 1 September, 2007 you will need to comply with the new 5 Star Plus provisions. This means that you will need to ensure that you and your builder adopt the provisions of the new Codes as outlined in this brochure in the design of your home.

If you are an existing homeowner you do not need to comply with 5 Star Plus, however you can use the Codes to improve energy and water efficiency within your home through your choice of appliances such as solar hot water systems, 5 star rated gas hot water systems and water saving shower heads.

Q. Will it cost me more to build a house?

A. Most progressive builders are already incorporating most of the 5 Star Plus measures into the homes they design and build such as water efficient taps, shower heads and toilets and even solar hot water systems. 5 Star Plus now locks in these measures as the minimum standard for housing.

Q. Will 5 Star Plus result in more 'red tape'?

A. Definitely not. One of the key advantages of 5 Star Plus is that it can be quickly and easily implemented into the existing building regulations and approvals processes.

Q. What are the benefits of 5 Star Plus to me?

A. Implementing 5 Star Plus in your home will result in lower water and energy bills to the householder. For example, by switching from an electric hot water system to a solar hot water system, and using an efficiently controlled booster, you can reduce your hot water bills by up to 75% in Perth per annum. This can add up to thousands of dollars saved over the lifetime of the system.

Q. What are the other benefits?

A. Not only will you have lower water and energy bills but you will also be helping the environment by reducing greenhouse gas emissions and conserving our precious water resources.

For example by installing a water efficient dual flush toilet you can save up to 30,000 litres of water per annum. By using a cover on your swimming pool, you can save more than the entire volume of water in your pool that is lost through evaporation in a year.

May 2007

Appendix C – Waterwise Criteria

Guidelines for waterwise homes and gardens criteria

With the implementation of mandatory minimum water efficiency requirements for all new homes, through the Building Codes of Australia, the benchmark has been set. Therefore the use of fittings and fixtures better than those mandated, the use of water saving technology, alternate water supplies and waterwise garden design have become increasingly important for those wishing to raise the bar in terms of household water efficiency.

Properties that showcase water efficiency both inside and outside the home typically have the following water saving features incorporated (see Attachment 1 for detailed descriptions).

Inside:

- Showerheads installed are better than the minimum mandated WELS 3 Star (9 Litres per minute).
- Taps installed are better than the minimum mandated WELS 4 Star (6 Litres per minute).
- Dual flush toilets installed are better than the minimum mandated WELS 4 Star (Average 3.5 Litre flush).
- Water using appliances installed are rated WELS 4 Star or better.

Outside:

- Garden design incorporates waterwise or endemic plant species and includes a functional mix of paved areas, garden beds and lawn.
- Only use turf species endorsed by the UWA Turf Industries Research Steering Committee (Attachment 2).
- Improve the soil prior to planting and laying down lawn.
- Garden beds are mulched to a minimum of 5cm with Smart Approved WaterMark mulch certified to Australian Standard AS4454.
- The irrigation system has been installed to Irrigation Australia Ltd Standards (Attachment 3).

Attachment 1

Detailed Criteria for Waterwise Homes
Water Saving Features

INSIDE

Please refer to the Building Codes of Australia for mandated standards.

- Showerheads installed should be better than the minimum mandated WELS 3 Star (9 Litres per minute).
- Taps installed should be better than the minimum mandated WELS 4 Star (6 Litres per minute). Consider the following:
    - Aerators - reduce flow, reduce splash, improve wetting.
    - Spring-loaded controls - prevents running taps.
- Dual flush toilets installed should be better than the minimum mandated WELS 4 Star (Average 3.5 Litre flush).
- Baths are low volume and small surface area.
- Spas are not encouraged.
- Hot water system should be located less than the minimum mandated 20m from points of use and / or a recirculation or heat pump system is installed. Consider the following:
    - Group fixture relative to their need for heated water,
    - Multiple water heaters
    - Pipe work configuration (i.e. where to branch off for off-takes) and lagging pipes for insulation.
- Pressure control - consider the installation of a pressure control device to regulate water pressure to a maximum of 35 metres. High pressures contribute to poor water efficiency; pipe leakage, dripping taps, etc.
- If evaporative air conditioners are installed use models with an auto dump triggered by salinity rather than the continuous discharge type. Provide advice to future homebuyers on the appropriate use of an evaporative air conditioner to limit water wastage.
- Water using appliances installed, such as washing machines and dishwashers should be rated WELS 4 Star or better.

To determine the star rating for products visit the WELS website and search by brand name and product.

OUTSIDE

- Garden design should incorporate waterwise or endemic plant species and includes a functional mix of paved areas, garden beds and lawn. Use the Waterwise Plants for WA directory on the Corporation's website to find waterwise plants suitable for regions throughout WA.
- Plants should be grouped according to their water needs (hydrozones) and garden beds should be densely planted where appropriate to maximise irrigation effectiveness, and appearance.
- Only use turf species endorsed by the UWA Turf Industries Research Steering Committee (Attachment 2). Lawn areas should be minimised and verges planted with waterwise plants instead of turf.
- Soil in the garden and lawn areas should be improved prior to planting. Improved soils retain more moisture around the root zone longer, soils improved with soil conditioners certified to AS4454 are recommended to a minimum depth of 150mm to lawn areas and 300mm for garden beds.
- Mulches dramatically reduce surface evaporation, and break down to improve the moisture holding capabilities of the soil. Garden beds should be mulched to a minimum of 5cm with Smart Approved WaterMark mulch certified to Australian Standard AS4454.
- Windbreaks; artificial (fences, walls, pergolas) or natural (mounds, shrubs, trees) should be used to reduce irrigation losses and protect plants from heat and stress as wind is a significant element in evaporation and transpiration.
- The irrigation system should be installed to Irrigation Australia Ltd Standards (Attachment 3).

Garden beds should:

- Use dripper systems or subsurface irrigation, or if overhead watering is required, use large drop sprinklers. The use of microsprays is not encouraged due to their poor efficiency rating.

Lawn areas (if not watered by greywater) should:

- Use sprinklers with coarse drop sprays (e.g. MP rotators) to minimise evaporation.
- Have spray patterns and layouts which minimise overspray.
- Have sprinkler placements which optimise water distribution.
- Not have different types of sprinklers on the one watering station.

Irrigation:

- Irrigation system should be sufficiently sophisticated to allow:
    - Separation of zones.
    - No watering station to service more than one hydrozone.
    - No watering station to service more than one style of sprinkler.
- Controller to be set to apply the "Standard Drink" (10mm) per watering period.
- Controller set to comply with permanent watering rosters as defined on the Water Corporation's website
- Controller is adjusted to water according to the seasons (i.e. turned off during the Winter Sprinkler Ban, reduced during autumn and spring)
- Irrigation system includes a rain sensor or soil moisture sensor that is connected to the irrigation controller and designed to shut off the automatic system when it rains.
- Alternate non-potable water supply sources should be considered:
    - Rainwater tanks should be plumbed in to the house and utilised to flush toilets and/or for washing machine use.
    - Grey water re-use systems should be plumbed in to the house and utilised to flush toilets and/or water the garden.
    - In areas deemed suitable for a bore by the Department of Water, garden bores should be installed and used to water the garden in accordance with the permanent water efficiency measures.

OTHER

- Affordability – demonstrates the ability to save water without compromising the cost of the development, or ongoing maintenance and/or running costs (including energy).
- Waterwise aesthetics.
- Plants and lawn in good health, none dead.
- No large water features installed, especially in full sun.
- Pool blanket on the pool, not on the roller.
- Property showcases a range of water efficiency options available for both inside and outside the home.

Attachment 2

UWA Turf Water Use Research Project

Turf Types Demonstrating Water Efficient Characteristics
(when tested at UWA Turf Research Site Shenton Park, updated May 2014)

Scientific name	Common name	Cultivar or selection
Cynodon dactylon	Couch or Bermuda grass	Wintergreen Windsor Green CT-2 Note: others were not tested.
C. dactylon x *C. transvaalensis*	Couch hybrid or Bermuda grass hybrid	Santa Ana
Paspalum vaginatum	Saltene or Seashore Paspalum	
Stenotaphrum secundatum	Buffalo or St. Augustine grass	Traditional-style and soft-leaf types
Pennisetum clandestinum	Kikuyu grass	
Zoysia japonica	Zoysia grass (may be referred to by growers as Empire Grass, or Empress Grass)	

Attachment 3

Irrigation Australia Limited (WA Region) Standards for Domestic Irrigation Installation

1. Activities Prior to Commencement

Prior to commencement of a domestic irrigation installation, the Irrigation Contractor shall:

1.1 Conduct a flow test, using a 'Flow and Pressure Testing device' and record the flow/s at the appropriate pressure/s recommended by the manufacturers of the components of the irrigation system.

1.2 Present to the Client a written quotation detailing all works and activities that will be conducted.

1.3 Present the client with a design of the proposed irrigation system.

2. System design and components

Irrigation system design and product selection shall comply with appropriate Australian Codes and standards and conform to the manufacturer's recommendations for the products used. These include:

2.1 System design to be according to the flow test results in 1.1 (above) with individual station demand (at the manufacturer's recommended operating pressure) no greater than the tested flow. Where station demand is less than the tested flow a pressure regulating device/s must be installed where such is required to ensure operation to manufacturers' recommended operating pressure.

2.2 Pipe will be sized to ensure water velocity does not exceed 1.5 metres per second at design flow.

2.3 Sprinklers shall be spaced at no more than the radius of throw specified by the manufacturer's recommendations.

2.4 Sprinklers shall operate at the manufacturer's recommended operating pressure.

2.5 Mainlines shall be minimum PN9 PVC, PN8 polyethylene or other appropriate material of no lesser pressure rating; pipe under live mains pressure should be minimum PN12 rating or as otherwise specified by Water Corporation regulations.

2.6 Valves under live mains pressure shall be Water Corporation approved 'tested' valves.

2.7 Sprinklers on any station shall be fitted with matched precipitation nozzles.

2.8 Part-Circle Sprinklers shall be used in locations where they will prevent wasteful overspray.

2.9 Where an irrigation controller is installed to operate stations of different water requirements it shall be a minimum three-program controller and must be programmable to comply with Water Corporation and Department of Water guidelines or restrictions.

3. Installation of the system

The installation of the irrigation system shall be conducted to meet the requirements of applicable statutory regulations, including backflow prevention:

3.1 The Client shall be advised of all installation work that, as a requirement of law, will be completed by a licensed tradesperson.

3.2 Master solenoid valves shall be used when connecting to scheme water supply and when installing more than two station valves.

3.3 Solenoid wires shall be buried under pipework. Where wires do not run with such pipework they should be placed in electrical conduit.

3.4 A colour code for solenoid wires shall be used, black for "Common" wires, red for 'Master Valve' control wires and white for 'spare' wires. Spare wires shall be taped (or otherwise waterproofed) at their field termination point. Station valves shall be installed with cable colours other than those listed. Wire from each valve to the controller shall be one single colour.

3.5 Solenoid wire connections shall be made only at valve boxes and a minimum 300mm loop of wire left at each valve for ease of service.

3.6 Solenoid wire connections shall be either crimped or soldered and covered with heat shrink material or made with gel-filled or silicone grease type electrical cable connectors made for this purpose.

3.7 All pipework shall be buried other than where expressly stated.

3.8 Mainline and lateral piping shall be buried to the minimum recommended cover of 150mm.

3.9 Low Density poly pipe shall be secured at all connections by ratchet clamps or other device according to manufacturer's specifications.

3.10 All valves shall be located in valve boxes designed for this purpose, the lid thereof to be no higher than surrounding material.

3.11 All systems shall have a minimum of 150mm of pipe either side of valve to enable service removal of valve and replacement without major disruption.

3.12 All irrigation stations should be established to water areas of similar demand (hydrozones).

4. Completion and handover

4.1 At the completion of the work the site is to be left in neat and tidy state.

4.2 The Irrigation Contractor shall perform a system "hand-over", including a working demonstration of all functions of the irrigation controller. The installer is to install a program (compliant with current Water Corporation and Department of Water regulations and recommendations) and explain same to the client.

4.3 The Client shall be given a recommended watering schedule for peak demand, with recommended seasonal reduction (as a percentage of maximum) detailing all stations (with description of each) plus an estimated P.R. (Precipitation Rate) for each station.

4.4 If the installed controller requires a battery, a battery of the type recommended by the manufacturer is to be supplied and installed by the Irrigation Contractor prior to hand-over.

5. Warranty

5.1 The Irrigation Contractor to specify a minimum one-year warranty on all parts and labour.

6. General

6.1 Where any variations from these standards have occurred the Irrigation Contractor will provide detail of these, and the requirements for the changes, to the client as well as a clear indication that such changes do not comply with the "Standards for Domestic Irrigation Installation" of Irrigation Australia Ltd (WA Region).

Disclaimer:

The Standards for Domestic Irrigation Installation have been developed by members of Irrigation Australia Ltd's Western Australian region. These Standards have been designed for use in Western Australia and are based on current knowledge and practice at the time of the preparation of this material (October 2002, Revised 2007).

These Standards are issued as a guide only. Their use is of a voluntary nature and the IAL is not liable for any loss, injury, damages, costs or other consequences of any kind that result from their use. All persons conducting or procuring domestic irrigation installation should comply strictly with the manufacturer's recommendations for the use and installation of equipment. The IA reserves the right to modify, add to or delete Standards prescribed herein at any time.

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Appendix D – Groundwater bore fact sheet

Government of **Western Australia**
Department of **Water**

Reprinted reference

Water facts WF12

Bore water use in Perth gardens

See back cover for information on reprinted reference materials and contact details

Looking after all our water needs

Water facts 12

GOVERNMENT OF WESTERN AUSTRALIA WATER AND RIVERS COMMISSION AUGUST 1998

Bore water use in Perth gardens

People in most areas of Perth are able to draw on shallow groundwater by sinking private bores.

Each year in Perth, about 70 million kilolitres of high-quality household scheme water is used on Perth's gardens. This is more than the entire contents of Mundaring weir. Instead of using scheme water, many people use shallow groundwater pumped from their own bores to water their gardens.

Perth's groundwater resources

The Swan Coastal Plain, upon which Perth is situated, is covered by a veneer of sediments, particularly sand and limestone. These sediments have been deposited over thousands of years by water and wind. The superficial sediments extend to a depth of about 100 metres (average 50 metres) over the top of older and often less permeable sediments. Rainwater percolates into the superficial sediments and accumulates as groundwater.

Shallow groundwater is an important source of water for Perth's scheme supply and is also extracted through bores for watering private gardens, parks, sporting areas and market gardens.

A distinguishing characteristic of the shallow groundwater that we draw upon for garden watering is that it is generally at the same pressure as the atmosphere. This means that most householders can dig down several metres into the sand to reach the top of the saturated soil, called the watertable, but then must lift the water up to the surface for use. Perth's early settlers lowered a bucket on a rope but most people now have electric pumps to draw the water up. In contrast, deeper sources of groundwater, sometimes called artesian aquifers, hold groundwater under pressure. When a drill is used to bore down through the confining rock, the groundwater may rise to the surface.

Who has bores?

There are estimated to be 130 000 private bores in Perth. The number of private bores increased rapidly when water restrictions were imposed in the late 1970s due to a long dry spell of weather.

The number of bores in an area depends on:

- depth to the watertable — installation costs can be discouraging where the watertable is more than 10 metres deep;
- difficulty — coastal areas have fewer bores possibly because of the high cost of drilling into limestone;
- chance of success — bores are fewer in some eastern suburbs particularly in areas of clay or granite where bore yields are generally low.

Activities removing large volumes of groundwater require an abstraction licence from the Water and Rivers Commission. However, household bores in the Perth metropolitan area do not need a licence mainly due to the relatively minor amounts of water they remove. If you are unsure if a licence is required for your property, please contact the Commission on the phone numbers provided.

Perth's garden bore strategy

In 1997 the Minister for Water Resources launched a campaign to promote the use of garden bores. Currently almost a third of Perth's scheme water supply is used on gardens. Instead of using this high quality water, garden bore owners use shallow groundwater.

Where clean and accessible groundwater exists in areas suitable for garden bores, they are a good way of utilising this resource.

The Commission recently released the 'Perth Groundwater Atlas' to provide information on the areas suitable for garden bores. The Groundwater Atlas is a source of easily accessible groundwater information to assist drillers, irrigators and the public. This publication is available at many libraries, and through the Commission.

Although groundwater may be readily available, it should still be considered a precious resource. Groundwater is very important to the environment and should be used in a responsible manner.

Given that in many areas gardens are not as large as they used to be, consideration should be given to sharing a bore between neighbours. This will provide all the benefits of owning a bore while allowing the cost of installation to be shared.

Groundwater prior to urbanisation

Groundwater is part of a dynamic water cycle. Where the Swan Coastal Plain is still covered in native vegetation, an average of about 10% to 20% of rainwater percolates down into the shallow aquifer to become groundwater. The groundwater then moves very slowly under the force of gravity until it discharges into rivers and the ocean. However, much is returned to the atmosphere along the way via evaporation from wetlands and transpiration by vegetation.

Groundwater is important to the health of the coastal plain environments. The Swan Coastal Plain was once a patchwork of wetlands (lakes and swamps) and many still remain despite draining for agriculture and urban development. These wetlands depend on the groundwater level being at or near the surface. The natural vegetation also relies on groundwater. In many areas, the plants are able to survive and even continue to grow through the summer by reaching down to the watertable.

Groundwater levels have a seasonal cycle. The watertable of the Swan Coastal Plain rises in winter with rainfall recharging the groundwater, and then gradually drops over the summer months. The wetland and woodland vegetation and animals have adapted to this cycle.

Changes with clearing and urbanisation

Since European settlement, the groundwater balance has been altered in three ways:

- Clearing — the natural vegetation, which removed much of the groundwater through transpiration, has been cleared in many areas, causing the watertable to rise.
- Drainage — the watertable has been lowered in low-lying land in and around wetlands, often for agriculture and housing. The excess water is drained to the river, ocean and a few wetlands which have been set aside as permanently inundated collection points, such as Lake Monger.
- Sealing of surfaces — covering the ground with houses, roads and paving increases the amount of water runoff from rainfall. Through much of Perth, these large volumes of runoff are concentrated into compensation basins and into the ground, adding to high watertable problems.

Raised watertables have meant that many suburbs need to be drained to keep houses dry in winter — 520 million cubic metres (twice the scheme water supply) is drained annually from an area of 84 000 hectares in northern, central and southern Perth. Some reduction in watertable levels back toward the natural balance has occurred in the older suburbs where gardens and parklands are well established. However, the current tendency to increase housing density, with increased roof and pavement runoff, is likely to reverse this trend.

The permanently higher watertable and need for drainage has upset the natural balance. In particular, some of the wetlands that have not been drained have grown broader and deeper. Many previously seasonal wetlands are now permanently inundated. The higher watertables have killed trees in and around the water and lakes have lost birds that rely on seasonally receding mudflats.

Private bores can be a good thing

There are many parts of Perth where bores should be encouraged for garden irrigation. In areas where the watertable is close to the surface, a drainage system exists to prevent further groundwater level rises. Using groundwater for irrigating gardens in these areas will reduce the amount that has to be drained to wetlands, rivers or the ocean. The combined effect of many bores can be to draw the watertable down more in summer than at present, but this can help to restore a seasonal cycle.

The benefits are several:

- scheme water savings — use of groundwater for irrigation purposes reduces draw on scheme water supplies, delaying the time when new resources (dams and wellfields) are needed;
- recycling of local water — using the excess groundwater brought about by urbanisation for irrigating gardens is a good idea whereas 'importing' scheme water for garden irrigation adds to the already high groundwater levels.

Waterwise garden bore use

Groundwater bores should be used efficiently. Even though groundwater is readily available in most areas, watering your garden with bore water should still be undertaken responsibly and in a Waterwise manner.

You can be Waterwise by:

- only watering enough to meet the garden's needs
- using plants that require less water (e.g. native species)
- not watering during the daylight hours

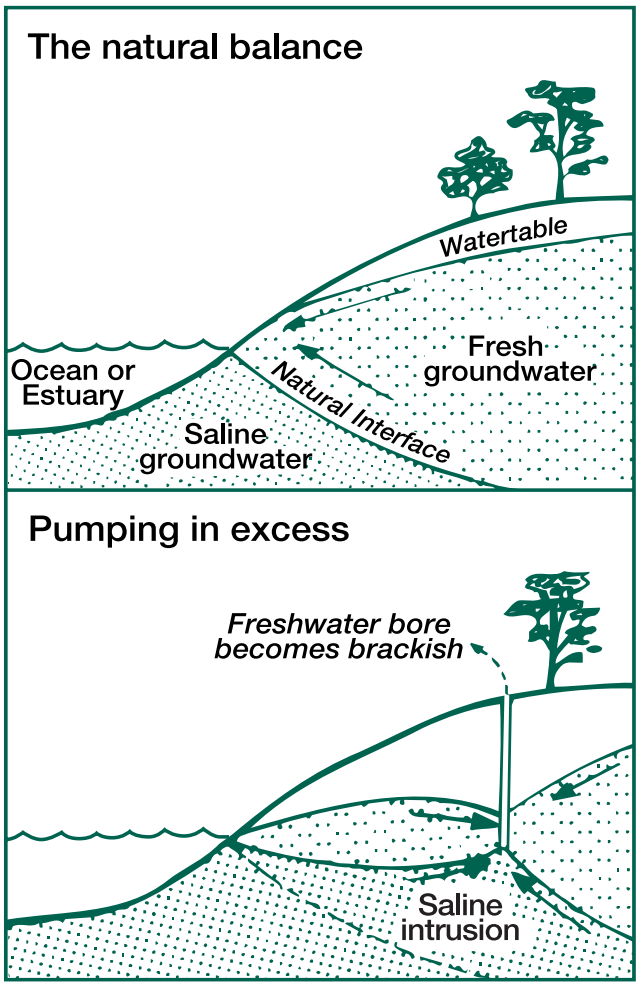
While bores offer a range of benefits, their excessive use can contribute to a number of environmental problems:

- Groundwater draw-down — overpumping can lower the watertable to undesirable levels in about 10% of suburban areas and be detrimental to the environment.
- Nutrient loss — most of Perth soils are very poor in nutrients and do not readily bind fertiliser. Over-watering will leach out the fertilisers that gardeners need to add to their lawns and flower-beds. This is an unnecessary cost to the gardener and risks polluting the groundwater and local wetlands with nutrients (nitrogen and phosphorus).
- Saltwater intrusion — in areas prone to saltwater intrusion (close to the coast or Swan River estuary) excessive bore use is a major contributing factor to the influx of saline water.

Possible constraints on bores

Bores are an excellent water supply for garden use in much of Perth. However, not all areas of Perth are suitable for bores.

- In some places, the watertable is deep beneath the ground surface or the rock type encountered makes drilling for water difficult and expensive.
- Near the foothills and in places where there are clay soils, groundwater supplies may be limited and bore yields may be low.
- Other areas are environmentally sensitive. Wetlands, and the plants and animals that depend on them, need groundwater to maintain water levels. Pumping out too much water near wetlands could disrupt the natural water cycle and cause environmental damage. Wetlands of conservation value are depicted in the 'Perth Groundwater Atlas'. If you plan on installing a bore near such a wetland (within 500 metres), please contact the Commission.
- In areas near the Swan River estuary or the ocean, saltwater may be drawn into the bores if they are excessively pumped. Because the water within the ocean and estuaries is saline, a wedge-shaped boundary (or interface) is formed between this saline groundwater and the fresh groundwater below the land. This saltwater wedge may extend more than a kilometre inland. For example, all of the Cottesloe peninsula is underlain by saline groundwater.



Saltwater intrusion into bores

- Where there is or has been industrial activity, and in areas near old waste disposal sites, the groundwater may be contaminated. The Perth Groundwater Atlas shows the location of known and inferred contaminated sites in the metropolitan area.

Areas suitable for bores

Throughout the Perth area the Commission's 'Perth Groundwater Atlas' provides information such as the depth to groundwater, groundwater salinity and identifies areas unsuitable for garden bores. The areas which are generally suitable for drilling garden bores include:

- the northwestern urban corridor;
- the central sandy areas north and south of the Swan River;
- the northeastern urban corridor in areas without clay;
- suburbs west of Jandakot;
- suburbs around Winthrop.

Areas not suitable for bores

Areas generally unsuitable for drilling more garden bores include:

- the Cottesloe peninsula (saltwater intrusion)
- suburbs around Secret Harbour and Port Kennedy (limited groundwater resources)
- within 200 metres of the ocean or the Swan River estuary (saltwater intrusion)
- areas in and around the foothills (groundwater is limited)
- near wetlands (possible excessive lowering of groundwater if bores are overpumped)
- near contaminated areas (groundwater may be polluted)

Groundwater contamination

Groundwater contamination occurs in some Perth suburbs, but is generally of little concern provided that water from household bores is only used for watering gardens and is not used for drinking. Groundwater contamination is most likely to be detected in bores near existing or old commercial or industrial areas.

Pumping from bores can affect groundwater flow and alter the movement of a contaminant plume towards the bore. Garden bores that are located in areas of groundwater contamination may pump contaminated water. While this may or may not harm plants, the contaminated groundwater may be harmful to humans, if consumed. The Water and Rivers Commission strongly recommends that the water from garden bores is not used for drinking unless analysed and certified safe by the Health Department of Western Australia.

The Water and Rivers Commission advises that bores should not be located in areas of groundwater contamination. If in doubt, please contact the Water and Rivers Commission. For more information on groundwater contamination, see Water Facts 10, Groundwater Pollution.

For more information

Copies of the Commission's 'Perth Groundwater Atlas' are available for sale from the Water and Rivers Commission and for viewing in a number of local libraries. The atlas provides easy access to groundwater information for assist drillers, irrigators and the public.

Groundwater and bores: If you wish to find out more about the groundwater resources of Perth and the wise use and management of these resources, contact the Commission on (08) 9278 0300.

Information on Waterwise gardening is also available from the Water Corporation on (08) 9420 2420.

Sinking a bore: Irrigation and reticulation installation companies that are members of the Irrigation Association of Australia can advise on practical aspects of sinking bores. If you are interested in sharing a bore with your neighbours, then some corporate members of the Irrigation Association are able to provide information on agreements that may be used to confirm the arrangement.

To ensure consumer protection, the Australian Drilling Industry Association recommends the use of drillers certified by the ADIA (or suitably equivalent qualifications). The ADIA can provide information on suitably qualified drillers in your area.
Phone: (08) 9354 8436.

Limitations of information

While particular areas are considered suitable for bores, the actual yield and quality of groundwater cannot be guaranteed. Both are highly variable and depend on a number of factors including the precise location and depth of the bore.

For more information contact

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COMMISSION
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This Water facts sheet is one in a series providing information on water issues of interest to the community.

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About Reprinted Reference materials

In 2006, the Department of Water was established to replace the Water and Rivers Commission.

Proclamation on 31 January 2008 of the Water Resources Legislation Amendment Act 2007 formally abolished the Water and Rivers Commission and transferred all functions to the Minister for Water Resources and the Department of Water.

This has consolidated all water-related functions performed by the commission and some other agencies under one agency to ensure a central focus for planning and managing the states water resources.

As a result some valuable water related reference materials are now not easily identified under the new management structure and contain contact details that are out of date.

The Reprinted Reference 'wrap around' cover provides identity with the new management structure and provides up to date contact information.

This allows us to continue to make many of these reference materials available without the expense to the public sector of costly reproduction.

Contacting the **Department of Water**

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You can find details for our other offices around the state, together with an office directory, under Contact Us on our website.

www.water.wa.gov.au

Appendix E - Modelling Summary

Modelling Discussion

GHD built a DRAINS hydrologic and one-dimensional hydraulic model of the existing development, and simulated the model for a range of design storms. DRAINS is a computer program for simulating catchment hydrology and one-dimensional flows in conduits and open channels. Data is input via tables and a graphical user interface, and results are produced graphically and in GIS and tabular format. The Rational Flood Frequency Estimation (ARR 2015) method was adopted to estimate peak flows which were then used in TUFLOW to map the 100 year ARI flood levels. TUFLOW is a computer program for simulating depth-averaged, two and one-dimensional free-surface flows such as occurs from floods and tides.

Time varying surface runoff generated by the runoff routing model discharges into the hydraulic network. The hydraulic network consists of interconnected nodes (manholes, basins and outfalls) and links (pipes, open channels and culverts).

The hydrology was simulated using the RORB model, based on the parameters listed below.

Modelling assumptions

- All roads connected to an at source infiltration system sized for the 1 year 1 hour storm (18 mm)
- All lots to hold 1 year 1 hour storm (18 mm) on site
- Infiltration rates assumed 1 m/day
- Conservative parameterisation

Modelling parameters

DRAINS used the RORB routing model to generate rainfall runoff from identified catchments. The runoff model consists of three components: initial loss, soil model (assumed as type B moderate infiltration rates and moderately well-drained soils) and roughness (runoff routing value). Each sub catchment is divided in three surface runoff types with runoff properties described in the table below.

Runoff Surface	Surface Type	Runoff Routing Value	Initial Loss Value (mm)
1	Pervious	0.030	8
2	Impervious (infiltration at source)	0.015	18
3	Impervious	0.015	1

Note: Impervious (infiltration at source) is included to account for lot infiltration using soakwells as specified.

The percentage of surface types for individual catchment was calculated from existing land use and local structure plan based on the land use surface breakdown as reported in Forrestdale ADS (DoW, 2009).

Land Use Category	Runoff Area 1 (%)	Runoff Area 2 (%)	Runoff Area 3 (%)	Equivalent Runoff Coefficient (approximate)
Open Space	100	0	0	0.1
Road	40	0	60	0.7
Urban	70	30	0	0.2

Conduits roughness values are typical values for the identified conduit type.

Drain Type	Manning's Coefficient of Roughness
Concrete Pipe	0.013
Maintained Open Drain	0.030
Overland Flow Route	0.035

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