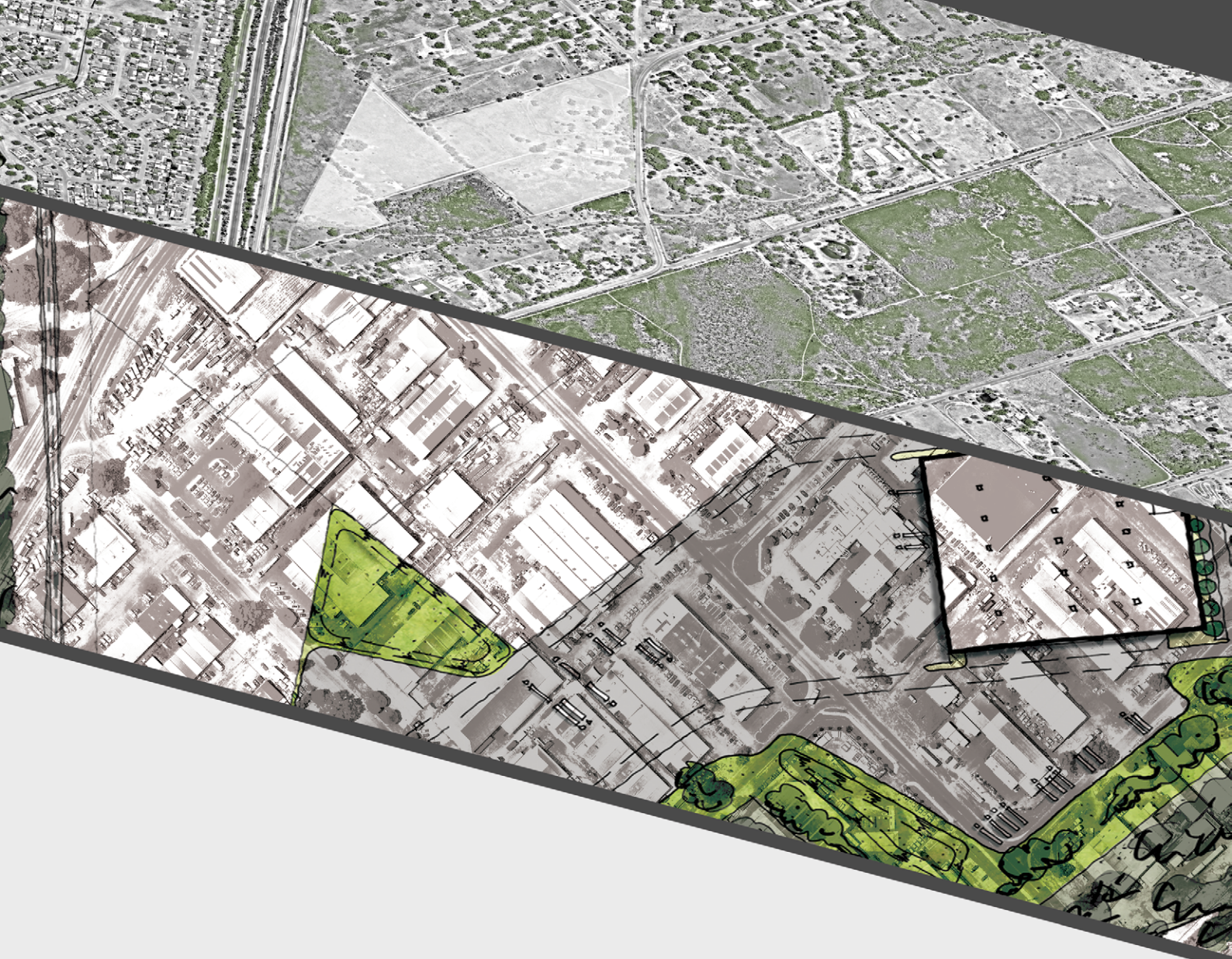




MADDINGTON KENWICK STRATEGIC EMPLOYMENT AREA PRECINCT 3A STRUCTURE PLAN AMENDMENT 1

TECHNICAL APPENDICES
JUNE 2018

**MADDINGTON KENWICK STRATEGIC EMPLOYMENT AREA
PRECINCT 3A STRUCTURE PLAN**

AMENDMENT 1
TECHNICAL APPENDICES

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- Appendix 2: Local Water Management Strategy (Emerge Associates)
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Appendix 1

Environmental Assessment Report (PGV Environmental)

LOT 414 GROVE ROAD, KENWICK

ENVIRONMENTAL ASSESSMENT REPORT

Prepared for: Grove Road Pty Ltd

Report Date: 8 June 2018

Version: 3

Report No. 2017-326



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1 INTRODUCTION

1.1 Site Location

Lot 414 Grove Road, Kenwick (the site) is located in the City of Gosnells approximately 11km south-east of the Perth Central Business District (Figure 1). The site is bounded by Grove Road to the east, neighbouring rural properties to the north and south and rail to the west. Yule Brook runs through the south-west corner of the site.

1.2 Background

The site is within Precinct 3A of the Maddington Kenwick Strategic Employment Area (MKSEA) and is largely proposed to be developed for industrial purposes, with a section in the south-west corner remaining as Rural. This report has been prepared by PGV Environmental in support of a proposed Amendment to the existing MKSEA Precinct 3A Structure Plan. The purpose of the proposed Amendment is to include Lot 414 in the Structure Plan area. The geographic area the subject of this report, and the subject of the proposed Amendment, may be described interchangeably as 'Lot 414', 'the site', or the 'Amendment area'.

2 EXISTING ENVIRONMENT

2.1 Land Use

2.1.1 Historical Land Use

In earliest aerial photography from 1953 the site is almost completely cleared with some scattered trees (Plate 1).

Plate 1: Historical aerial photograph from 1953 (Landgate, 2017)



Between 1985 and 1995 the structures were established on the site (Plate 2).

Plate 2: Historical aerial photograph from 1995 (Landgate, 2017)



2.1.2 Current Land Use and Zoning

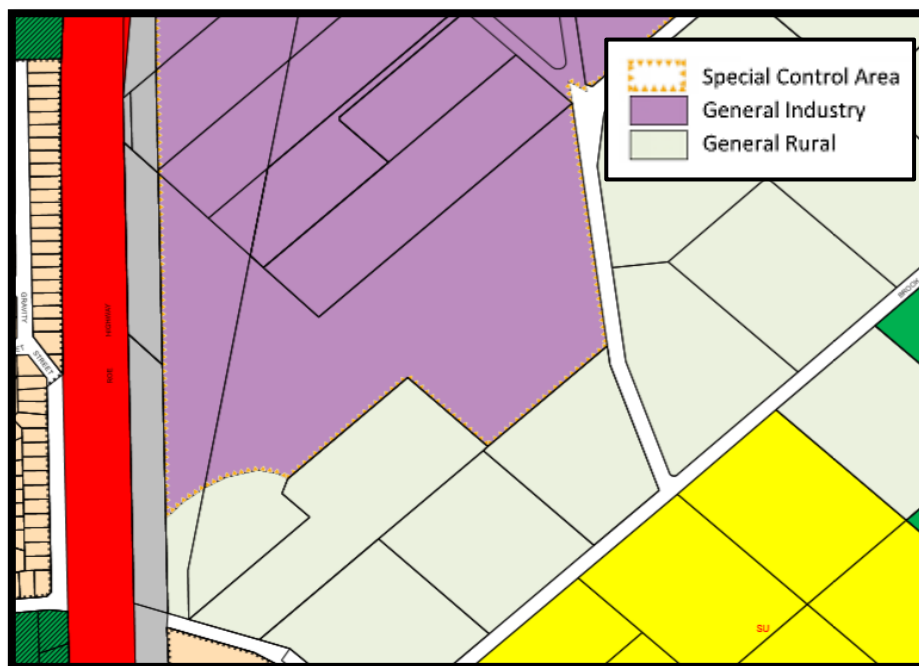
Lot 414 used currently used for horse agistment (Plate 3).

Plate 3: Cleared Horse Paddock



The site is currently zoned 'Industrial' under the Metropolitan Region Scheme (MRS) (National Map, 2018). The site is zoned 'General Industry' under the City of Gosnells Town Planning Scheme No. 6 (WAPC, 2018) over most of the lot. There is an area that extends from approximately 120m to the north of Yule Brook to the area to the south of Yule Brook zoned as 'General Rural' (Plate 4).

Plate 4: Current Zoning under the TPS (WAPC, 2018)



The site is not on the Contaminated Sites Database (DER, 2016).

2.1.3 Surrounding Land Use

The site has Roe Highway to the west and surrounding rural land to the north and south. The site is also bordered by areas of native vegetation and Grove Road to the east.

2.2 Topography

The site is predominantly low lying and gently undulating. The elevation of the site varies between approximately 7 and 10m Australian Height Datum (AHD) (Figure 2).

Some micro-topographical changes occur on site due to man-made drainage features and compaction due to tracks.

2.3 Hydrology

The Perth Groundwater Map shows the top of the groundwater table at 5m to 7m AHD which is approximately 1.8 to 3.3m below the ground surface. Groundwater is generally flowing to the south-west (DoW, 2017a). The groundwater around the wetland has geological formations that have been grouped into three distinct aquifers:

- Superficial Swan Aquifer;
- Leederville Aquifer; and
- Yarragadee North (DoW, 2017b)

The small section of Yule Brook that runs through the southwestern corner of Lot 414 has some ecological attributes and functions as it is part of a natural watercourse.

The creek line that runs through the eastern part of the property and connects to the vegetated wetland south of Lot 414 is completely bare, however it largely appears to retain its natural form (Plate 5).

Plate 5: Creekline feeding into Wetland Area



The creek has some environmental function as it provides surface water to the vegetated wetland, and ultimately to Yule Brook which runs through the southern lot. The creek on the site is dry for most of the year and only flows after large rainfall events.

Surface water in the southern part of the lot is likely to drain to Yule Brook. The quality of the water that enters the vegetated wetland is unknown. Due to the absence of native vegetation along its path, the presence of horses on Lot 414, and the alteration of the upper sections of the creek north of Lot 414 into a drain, the water quality is expected to be poor.

The meandering nature of the creek indicates that low-flow rainfall events in the catchment of the creek are slow-moving.

2.4 Wetlands

The whole of Lot 414 Grove Road is mapped in the Department of Parks and Wildlife (DPaW) Geomorphic Wetlands on the Swan Coastal Plain database as wetland (Plate 1) (National Map, 2017).

Most of the site is mapped as a Multiple Use Palusplain (UFI 15254) (shown shaded in yellow on Plate 1). Multiple Use Palusplain (UFI 15254) is a large wetland that extends from near Albany Highway to the south-west of the site and extends to Welshpool Road to the north. The wetland adjoins other palusplain wetlands further north of Welshpool Road.

Resource Enhancement (RE) Palusplain (UFI 7635) is mapped on two of the lots abutting Lot 414 to the south-east (260 Bickley Road and 41 Brook Road). The RE wetland extends onto a portion of Lot 414 in two areas; one to the west of the rectangular block (260 Bickley Rd); and one long thin area at the north-eastern boundary with 41 Brook Road.

Both wetlands mapped on the site are classified as Palusplain wetlands. A Palusplain is a seasonally inundated flat (Hill *et al.*, 1996). The wetlands on the site are part of the Keysbrook consanguineous wetland suite (National Map, 2017).

Studies by Tauss and Weston (2010) reviewed the boundaries of the wetlands and management categories and concluded that Wetland 7635 should be upgraded to a Conservation Category Wetland and the boundary contained to the boundaries of the adjoining lots and not within Lot 414 Grove Road..

PGV Environmental undertook a detailed wetland assessment to more accurately define the boundary of the wetlands specifically for wetland 7635 on and adjacent to Lot 414 Grove Road. The results are shown in Figure 4. The study concluded that the boundary of the wetland, largely coincided with mapping by Tauss and Weston (2010) but was slightly different from the cadastral boundary due to the presence of firebreaks and previously disturbed land on the adjoining lots. The assessment concluded that wetland 7635 had values consistent with a Conservation Category Wetland.

Refer to PGV Environmental (2018) for details on the methodology for the wetland assessment.

2.5 Geology and Soils

2.5.1 Geology

The site is located on the eastern side of the Swan Coastal Plain. The site is mapped as part of the Pinjarra Plain System. The Pinjarra Plain extends from the eastern side of the Bassendean Dunes to the western edge of the Darling Scarp, which joins the Ridge Hill Shelf and forms the denuded slope of the Darling Fault (Beard 1990). The Pinjarra Plain System consists of a broad low relief plain west of the foothills, comprising predominantly Pleistocene fluvial sediments and some Holocene alluvium associated with major current drainage systems. The major soils are naturally poorly drained and many swamps occur (DAFWA, 2015).

2.5.2 Soils

The soils on the site have been mapped and described by the Department of Agriculture and Food Western Australia (DAFWA) as shown in Figure 3 and outlined below:

- Pinjarra EnvGeol Ms4 Phase (213PjSWMs4) which are sandy silt soils that are light yellow brown, blocky, mottled, some fine to medium-grained sand, soft when moist with variable clay content. These soils are associated with Yule Brook;
- Pinjarra EnvGeol Sc Phase (213Pj_Sc) which is Clayey Sand, silty in part, pale grey to brown, medium to coarse-grained, poorly sorted, subangular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin. These soils are in the northern part of the site; and
- Pinjarra, Phase Gf3 (213Pj_Gf3) which are poorly drained level to very gently sloping plain with mottled yellow earths with loamy topsoil (DAFWA, 2017).

All soil types mapped on the site can be associated with wetlands.

2.5.3 Acid Sulphate Soils

Acid sulphate soils (ASS) are wetland soils and unconsolidated sediments that contain iron sulphides which, when exposed to atmospheric oxygen in the presence of water, form sulphuric acid. ASS form in protected low energy environments such as barrier estuaries and coastal lakes and commonly occurs in low-lying coastal lands such as Holocene marine muds and sands. When disturbed, these soils are prone to produce sulphuric acid and mobilise iron, aluminium, manganese and other heavy metals. The release of these reaction products can be detrimental to biota, human health and built infrastructure (WAPC, 2009).

The ASS Risk on the site has been mapped by the Department of Environmental Regulation (DER) (Landgate, 2016) as being Moderate to Low (<3m from the surface) over most of the site and a small area of Moderate to High (<3m from the surface) in association with Yule Brook (Figure 3).

2.5.4 Phytophthora Dieback

Phytophthora Dieback (*Phytophthora cinnamomi*) is a soil-borne pathogen that infects the roots of vulnerable species, limiting the roots ability to take up water, thereby weakening or killing the host plant. The spores of Phytophthora Dieback are transported by water and in soil (DPaW, 2013). The limited number of native species on the site renders it 'Uninterpretable' for Phytophthora Dieback.

2.6 Flora and Vegetation

2.6.1 Flora

The proposed development site has been cleared and grazed for a long period of time and contains no intact native vegetation. Therefore, it is highly unlikely that any Conservation Significant species occur. There are a number of Declared weed species that occur on the site such as Cape Tulip (*Moraea flaccida*) (Plate 6) and Paterson's Curse (*Echium plantagineum*) (Plate 7).

Plate 6: Cape Tulip on the site



Plate 7: Paterson's Curse on the site



2.6.2 Vegetation

The proposed development site does not contain any intact native vegetation to assign a Floristic Community Type. Therefore, no Threatened or Priority Ecological Communities occur on the site.

All the trees within the paddocks in the western part of the site are planted trees not native to the site and are primarily River Red Gum (*Eucalyptus camaldulensis*). The eastern part of the site near the horse stables and Grove Road contains a stand of young Marri (*Corymbia calophylla*) trees over grazed pasture (Plate 8).

Plate 8: Marri Trees on the site



A short section of Yule Brook passes through the southwestern corner of the site outside the proposed development site. The area around the brook is proposed to remain as Rural. The portion of the brook within Lot 414 contains some native vegetation in and on the banks, including Flooded Gum (*Eucalyptus rudis*) and Paperbark (*Melaleuca raphiophylla*) with some Bulrush (*Typha orientalis*) also present (Plate 9).

Plate 9: Riparian vegetation alongside Yule Brook



The brook is not fenced off from the adjoining paddocks on both sides and is traversed by horses at one section which offers a dry crossing. The condition of the riparian vegetation is Good to Degraded.

Native vegetation occurs on lots adjoining the site to the south. The vegetation is partly mapped as a Threatened Ecological Community 'Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain'.

2.7 Fauna

2.7.1 Habitat

The proposed area of development has limited ecological value for native fauna due to the absence of intact native vegetation. The Marri trees in the eastern part of the lot and the non-native planted River Red Gums in the paddocks and along fence lines have some value as bird habitat. The waterlogged parts of the site at the end of the diffuse creekline have some value as habitat for wading birds. Habitat for conservation significant species is discussed in Section 2.7.2.

The native vegetation on the adjoining lots to the south have a range of ecological value for birds, frogs and small mammals such as Bandicoots.

2.7.2 Conservation Significant Species

A search of DBCA Naturemap Database (Appendix 1) and the EPBC Act Protected Matters Search Tool (Appendix 2) identified 28 threatened species of fauna listed as potentially occurring within a 5km radius of the site (Table 1).

Table 1: List of Fauna Species Identified from Database Searches

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act
<i>Bettongia penicillata ogilbyi</i>	Woylie, Brush-tailed Bettong	Schedule 1 - CR	Endangered
<i>Pseudemydura umbrina</i>	Western Swamp Tortoise	Schedule 1 - CR	Critically Endangered
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum, Nguara	Schedule 1 - CR	Vulnerable
<i>Botaurus poiciloptilus</i>	Australasian bittern	Schedule 2 - EN	Endangered
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	Schedule 2 - EN	Vulnerable
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	Schedule 2 - EN	Endangered
<i>Leioproctus douglasiellus</i>	A Short-tongued Bee	Schedule 2 - EN	Critically Endangered
<i>Neopasiphae simplicior</i>	A Short-tongued Bee	Schedule 2 - EN	Critically Endangered
<i>Rostratula australis</i>	Australian Painted Snipe	Schedule 2 - EN	Endangered Marine/ Migratory
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	Schedule 3 - VU	Vulnerable
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	Schedule 3 - VU	Vulnerable
<i>Leipoa ocellata</i>	Mallee Fowl	Schedule 3 - VU	Vulnerable
<i>Setonix brachyurus</i>	Quokka	Schedule 3 - VU	Vulnerable
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	Schedule 3 - VU	
<i>Calidris ferruginea</i>	Curlew Sandpiper	Schedule 3 - VU Schedule 5 - IA	Critically Endangered
<i>Numenius madagascariensis</i>	Eastern Curlew	Schedule 3 - VU Schedule 5 - IA	Critically Endangered
<i>Apus pacificus</i>	Fork-tailed Swift	Schedule 5 - IA	Marine/Migratory
<i>Ardea alba</i> (also listed as <i>Ardea modesta</i>)	Great Egret, White Egret	Schedule 5 - IA	Migratory/ Wetland
<i>Ardea ibis</i>	Cattle Egret	Schedule 5 - IA	Migratory/ Wetland
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Schedule 5 - IA	Marine/ Migratory
<i>Calidris melanotos</i>	Pectoral Sandpiper	Schedule 5 - IA	Marine/ Migratory
<i>Merops ornatus</i>	Rainbow Bee-eater	Schedule 5 - IA	Marine
<i>Motacilla cinerea</i>	Grey Wagtail	Schedule 5 - IA	Migratory/ Marine
<i>Pandion haliaetus</i> (also listed as <i>Pandion cristatus</i>)	Osprey	Schedule 5 - IA	Marine/ Migratory
<i>Tringa glareola</i>	Wood Sandpiper	Schedule 5 - IA	Marine/ Migratory

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act
<i>Tringa hypoleucos</i> (<i>Actitis hypoleucos</i>)	Common Sandpiper	Schedule 5 - IA	Marine/ Migratory
<i>Tringa nebularia</i>	Common Greenshank	Schedule 5 - IA	Marine/ Migratory
<i>Falco peregrinus</i>	Peregrine Falcon	Schedule 7 - OS	Marine/ Migratory
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle		Marine
<i>Leioproctus bilobatus</i>	(bee)	Priority 2	
<i>Lerista lineata</i>	Perth Slider, Lined Skink	Priority 3	
<i>Neelaps calonotos</i>	Black-striped Snake	Priority 3	
<i>Ctenotus delli</i>	Dell's Ctenotus, Darling Range Heath Ctenotus	Priority 4	
<i>Hydromys chrysogaster</i>	Water-rat, Rakali	Priority 4	
<i>Macropus irma</i>	Western Brush Wallaby	Priority 4	
<i>Oxyura australis</i>	Blue-billed Duck	Priority 4	
<i>Thinornis rubricollis</i> (also listed as <i>Charadrius rubricollis</i>)	Hooded Plover	Priority 4	Marine

DPaW classifies fauna under five different Priority codes and rare and endangered fauna are classified under the *Wildlife Conservation (Specially Protected Fauna) Notice 2014* into four schedules of taxa (DPaW, 2014).

Outlined below in Table 2 is a short description of each of the species that were identified in the NatureMap Species Report search and the EPBC Protected Matters Search Tool. The preferred habitat has been compared to the habitats on the site described above and the likelihood of each species to be present was determined.

Table 2: Likelihood of Conservation Significant Species being Present on the Site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Bettongia penicillata ogilbyi</i>	Woylie, Brush-tailed Bettong	The Woylie habitat types ranged from forest to grassland, coastal and inland. During the day the Woylie shelters under patches of dense undergrowth, logs and rock-cavities and occasionally in burrows.	Highly Unlikely – Habitat too disturbed on the site
<i>Pseudemydura umbrina</i>	Western Swamp Tortoise	The Western Swamp Tortoise is restricted to very few wild populations. During winter and spring, the tortoises live in the water. This species is carnivorous feeding on insects, larvae and tadpoles (Burbidge and Kuchling, 1994). In the drier, hotter months they shelter under leaf litter and in holes and aestivate (sleep).	No – no suitable habitat on the site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum, Nguara	The Western Ringtail Possum is a medium sized nocturnal marsupial. This species occurs in and near coastal Peppermint Tree (<i>Agonis flexuosa</i>) forest and Tuart (<i>Eucalyptus gomphocephala</i>) dominated forest with a Peppermint Tree understorey.	No – no suitable habitat on the site
<i>Botaurus poiciloptilus</i>	Australasian bittern	The Australasian Bittern occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands.	No – no suitable habitat on the site
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	Baudin's Black-Cockatoo mainly occurs in eucalypt forests, especially Jarrah (<i>E. marginata</i>), Marri (<i>Corymbia calophylla</i>), also Karri (<i>E. diversicolor</i>) forest, often feeding in the understorey on proteaceous trees and shrubs, especially banksias (SEWPaC, 2012).	Possible
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	Carnaby's Cockatoo is found in the south-west of Australia from Kalbarri through to Ravensthorpe. It has a preference for feeding on the seeds of Banksia, Dryandra, Hakea, Eucalyptus, Grevillea, Pinus and Allocasuarina spp. It is nomadic often moving toward the coast after breeding. It breeds in tree hollows that are 2.5 - 12m above the ground and have an entrance 23-30cm with a depth of 1-2.5m. Nesting mostly occurs in smooth-barked trees (e.g. Salmon Gum, Wandoo, Red Morrell) (SEWPaC, 2012)	Possible
<i>Leioproctus douglasiellus</i>	A Short-tongued Bee	The species is only known from three locations within the Perth metropolitan area ranging from Cannington to Forrestdale. Specimens have been collected on two plant species, Goodenia filiformis and Anthotium junciforme (TSSC, 2013).	No – no suitable habitat on the site
<i>Neopasiphae simplicior</i>	A Short-tongued Bee	The species is restricted in range, thought to only occur in a single location within the bushland of the Forrestdale Lake Nature Reserve adjacent to Forrestdale Lake and the Armadale Golf Course, with a previous population known from Cannington. It has been collected at flowers of Goodenia filiformis, Lobelia tenuior, Angianthus preissianus and Velleia sp. It occurs in two TECs, Type 8 and Type 10a. Males roost overnight in flowers of Asteraceae.	No – no suitable habitat on the site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Rostratula australis</i>	Australian Painted Snipe	The Australian Painted Snipe has been recorded at wetlands in all states of Australia but is most common in eastern Australia. It generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. It also uses inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include a cover of vegetation, including grasses.	Highly Unlikely due to lack of cover
<i>Calyptrorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	Forest Red-tailed Black Cockatoos frequent the humid to sub-humid south-west of Western Australia from Gingin in the north, to Albany in the south and west to Cape Leeuwin and Bunbury (SEWPaC, 2012). It nests in tree hollows with a depth of 1-5m, that are predominately Marri (<i>Corymbia calophylla</i>), Jarrah (<i>Eucalyptus marginata</i>) and Karri (<i>E. diversicolor</i>) and it feeds primarily on the seeds of Marri.	Known - Forages on Marri nuts on site
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	The Chuditch have been known to occupy a wide range of habitats including woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. They are opportunistic feeders, and forage on the ground at night, feeding on invertebrates, small mammals, birds and reptiles.	Highly Unlikely due to lack of cover
<i>Leipoa ocellata</i>	Mallee Fowl	Mallee fowl have been found in mallee regions of southern Australia from approximately the 26th parallel of latitude southwards in mallee bushland.	No – no suitable habitat on the site
<i>Setonix brachyurus</i>	Quokka	Quokkas were originally very common on the Swan Coastal Plain, however, their distribution is now limited to Rottnest Island and a few isolated areas in the south-west of WA. On the mainland, they prefer densely vegetated areas around wetlands and streams, whereas on Rottnest Island they inhabit low scrubby coastal vegetation where water is not readily available year-round.	No – no suitable habitat on the site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	Carter's Freshwater Mussel is South-West Western Australia's only freshwater mussel (Murdoch University & SERCUL, 2012). Carter's Freshwater Mussel occurs in freshwater streams, rivers, reservoirs and lakes (ICUN, 2015b) and is intolerant to dehydration for more than three days and salinity (Murdoch University & SERCUL, 2012).	No – no suitable habitat on the site
<i>Calidris ferruginea</i>	Curlew Sandpiper	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms.	No – no suitable habitat on the site
<i>Numenius madagascariensis</i>	Eastern Curlew	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets.	No – no suitable habitat on the site
<i>Apus pacificus</i>	Fork-tailed Swift	The Fork-tailed Swift is almost exclusively aerial and is not known to breed in Australia. They are seen in inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. <i>Apus pacificus</i> subsp. <i>pacificus</i> is the only subspecies to migrate to Australia.	May fly over the site but unlikely to land
<i>Ardea alba</i> (also listed as <i>Ardea modesta</i>)	Great Egret, White Egret	The Eastern Great Egret has been reported in a wide range of wetland habitats and usually frequents shallow waters. This species feeds on fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammals.	No – no suitable habitat on the site
<i>Ardea ibis</i>	Cattle Egret	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands with breeding in Western Australia recorded in the far north in Wyndham in colonies in wooded swamps such as mangrove forest. This species forages away from water on low lying grasslands, improved pastures and croplands generally in areas that have livestock eating insects, frog, lizards and small mammals.	Possible intermittent visitor

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	The Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	No – no suitable habitat on the site
<i>Calidris melanotos</i>	Pectoral Sandpiper	The Pectoral Sandpiper prefers shallow fresh to saline wetlands and is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	No – no suitable habitat on the site
<i>Merops ornatus</i>	Rainbow Bee-eater	Populations that breed in northern Australia are considered to be resident, and in many northern localities the Rainbow Bee-eater is present throughout the year. The Rainbow Bee-eater nests in a burrow dug in the ground. It is found across the better-watered parts of WA including islands preferring lightly wooded, sandy country near water.	Possible intermittent visitor to the site
<i>Motacilla cinerea</i>	Grey Wagtail	The Grey Wagtail is mostly recorded in coastal areas in Western Australia (ALA, 2015) however is widespread. There is non-breeding habitat only in Australia and the species has a strong association with water, particularly rocky substrates along water courses but also lakes and marshes.	No – no suitable habitat on the site
<i>Pandion haliaetus</i> (also listed as <i>Pandion cristatus</i>)	Osprey	Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They feed on fish, especially mullet where available, and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals.	No – no suitable habitat on the site
<i>Tringa glareola</i>	Wood Sandpiper	The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially <i>Melaleuca</i> and River Red Gums <i>Eucalyptus camaldulensis</i> and often with fallen timber.	No – no suitable habitat on the site
<i>Tringa hypoleucos</i> (<i>Actitis hypoleucos</i>)	Common Sandpiper	The Common Sandpiper is mostly found around muddy margins or rocky shores. Generally the species forages in shallow water and on bare soft mud at the edges of wetlands.	No – no suitable habitat on the site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Tringa nebularia</i>	Common Greenshank	The Common Greenshank is a wader and does not breed in Australia. This species can be found in many types of wetlands and has the widest distribution of any shorebird in Australia. This species typically feeds on molluscs, crustaceans, insects, and occasionally fish and frogs.	No – no suitable habitat on the site
<i>Falco peregrinus</i>	Peregrine Falcon	The Peregrine Falcon is found in a variety of habitats but nests on high cliff ledges or artificial structures. It feeds primarily on small-medium sized birds, but occasionally taking insects, such as moths, cicadas and locusts (Birdlife Australia, 2012).	Highly Unlikely – no suitable habitat on the site
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	The White-bellied Sea-Eagle is found in coastal habitats with large areas of open water, especially those close to the sea-shore. This species feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans, and on carrion and offal.	No – no suitable habitat on the site
<i>Glossurocolletes bilobatus</i> (Previously <i>Leioproctus bilobatus</i>)	(bee)	Yellow flowering pea, <i>Gompholobium aristatum</i> (Phoenix, 2010)	No – no suitable habitat on the site
<i>Lerista lineata</i>	Perth Slider, Lined Skink	The Lined Skink is a burrowing species that occurs in pale sandy soils with coastal heath and shrubland areas in isolated populations in the south-west and mid-west coast of Western Australia. It feeds on termites and other small insects (AROD, 2014).	Unlikely due to lack of cover
<i>Neelaps calonotos</i>	Black-striped Snake	The Black-striped snake has a limited distribution, inhabiting areas with sandy soils that support heathlands and Banksia/Eucalypt Woodlands (Nevill, 2005) on the Swan Coastal Plain generally in the lower west coast from Lancelin to Mandurah (Storr et al, 1999).	Unlikely due to lack of cover
<i>Ctenotus delli</i>	Dell's Ctenotus, Darling Range Heath Ctenotus	Dell's Ctenotus is found in the north Darling Range of south-western WA in dry sclerophyll forests on stony hills and ranges (Cogger, 2014).	No – no suitable habitat on the site

Scientific Name	Common Name	Habitat	Likelihood to occur on the site
<i>Hydromys chrysogaster</i>	Water-rat, Rakali	The Water Rat generally prefers wetland habitats characterised by dense, low-lying vegetation (0–30 cm from ground), low-density canopy cover and shallow, narrow water bodies (Speldewinde et al., 2013).	No – no suitable habitat on the site
<i>Macropus irma</i>	Western Brush Wallaby	The Western Brush Wallaby is a medium sized marsupial and its optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets (DEC, 2012).	Unlikely due to absence of native vegetation
<i>Oxyura australis</i>	Blue-billed Duck	The Blue-billed Duck is found on terrestrial wetlands in temperate regions, that are freshwater to saline, and may be natural or artificial. It nests in rushes, sedges, Lignum Muehlenbeckia cunninghamii and paperbark Melaleuca (Birdlife International, 2015). The species is almost completely aquatic, and is seldom seen on land. Non-breeding flocks, often with several hundred individuals, congregate on large, deep open freshwater dams and lakes in autumn. The daylight hours are spent alone in small concealed bays within vegetation or communally in large exposed rafts far from the shore (Birds in Backyards, 2015).	No – no suitable habitat on the site
<i>Thinornis rubricollis</i> (also listed as <i>Charadrius rubricollis</i>)	Hooded Plover	The Hooded Plover primarily inhabits sandy, ocean beaches, with the highest densities on beaches with large amounts of beach-washed seaweed that are backed by extensive open dunes. In Western Australia the species also inhabits inland and coastal salt lakes (Birdlife International 2014)	No – no suitable habitat on the site

* Habitat descriptions from DotEE (2016) SPRAT Database unless otherwise indicated

Species identified in the database searches possibly using the site as habitat were:

- *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo);
- *Calyptorhynchus banksii naso* (Forest Red-tailed Black-Cockatoo);
- *Calyptorhynchus baudinii* (Baudin's Black Cockatoo);
- *Ardea ibis* (Cattle Egret); and
- *Merops ornatus* (Rainbow Bee-eater).

Evidence of Forest Red-tailed Black Cockatoos foraging on the Marris trees within Lot 414 Grove Road was observed by PGV Environmental (Plate 10). Marri trees have previously been identified as foraging habitat in the MKSEA area primarily by Forest Red-tailed Black Cockatoos in the 360

Environmental Black Cockatoo Habitat Assessment undertaken for the City of Gosnells (360 Environmental, 2012).

The Marri and River Red Gum trees are not a recorded as a roosting site and there is no evidence of the site being used for roosting. 360 Environmental recorded three night time roosting sites in the MKSEA area which were considered to be used by Forest Red-tailed Black Cockatoos. The three roosting sites were located in close proximity to Lot 414 on private property east of Grove Road.

The Marri trees do not have suitable hollows or spouts to provide breeding habitat for Black Cockatoos. 360 Environmental did not record any significant breeding habitat trees on the site in their 2012 survey.

Plate 10: Evidence of Forest Red-tailed Black Cockatoo Foraging on Marri Nuts



2.8 Heritage

The Department of Aboriginal Affairs Aboriginal Heritage Inquiry System (DAA, 2017) was used to determine if there are any Aboriginal heritage sites recorded on the site. The database did not show any listed sites (Appendix 3). There were four Heritage Places recorded in the search area of the Aboriginal Inquiry System report. Place 4340 is to the north of the lot, Place 122 is 'Stored Data / Not a Site' as the place has been assessed as not meeting Section 5 of the *Aboriginal Heritage Act 1972*.

There were two 'Other Heritage Places' that are 'Lodged' as information has been received in relation to the place, but an assessment has not been completed to determine if it meets Section 5. Place 24785 is an Artefacts / Scatter, Arch Deposit located around Yule Brook in the south-western part of the site. Place 3312 is mapped over the southern part of Lot 414 and is an Artefacts / Scatter, Camp, however the location of the place is not accurate and the place is mapped over a large area.

A search of the National (DotEE, 2017) and State (Heritage Council of WA, 2017) registers of historical sites indicated that there are no other heritage sites on the site.

3 ENVIRONMENTAL ASSESSMENT

3.1 Development Concept Plan

A Development Concept Plan has been prepared for the site by CLE Town Planning and Development as part of the LSP Amendment process (Appendix 4). The plan is indicative only but shows the site as being developed for 'General Industrial' purposes with a small area remaining as 'General Rural' in the south-west corner.

The Concept Plan includes a 30m buffer to the revised wetland boundary located on adjoining properties to the south and south-east, in accordance with the Wetland Buffer Assessment Report (PGV Environmental, 2018). The Plan also includes a 50m buffer to Yule Brook.

Two drainage basins are shown on the plan, one in the north-west corner and one adjacent to the wetland buffer.

The Concept Plan does not envisage any internal roads.

3.2 Existing Land Use

The site has been developed for 'Rural' purposes for many years and has some sheds that potentially could contain fuels and oils. There may be small localised sources of contamination that may require a Preliminary Site Investigation (PSI).

Sensitive noise receptors exist in close proximity to the site in the residential dwellings on neighbouring rural properties. Acoustic assessment for individual industries may be required as part of the approval process prior to development.

3.3 Topography

Topography is gently undulating and there are no outstanding topographical features that pose a constraint for development

3.4 Geomorphology and Soils

3.4.1 Soil Types

The Pinjarra Plain soil types on the site are prone to waterlogging. As a result, stormwater controls and appropriate separation to groundwater will need to be considered when designing any development for the site.

3.4.2 Acid Sulphate Soils

The WAPC Acid Sulphate Soils Planning Guidelines (WAPC, 2009) indicate that "acid sulphate soils are technically manageable in the majority of cases". ASS Investigation and Management Plans may be required with a Development Application once the detailed design of the site is finalised. These assessments will need to be undertaken in accordance with the Acid Sulphate Soils Guideline Series: *Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes* (DEC, 2009) and *Treatment and Management of Soils and Water in Acid Sulphate Soil Landscapes* (DEC, 2011).

3.5 Hydrology

A Local Water Management Strategy (LWMS) has been prepared for the site (Emerge Associates, 2018). The LWMS proposes that water will be managed using an integrated water cycle management approach using water sensitive urban design to minimise water usage, minimise water pollution and maintain an appropriate water balance.

Stormwater will be conveyed from upstream flows via an arterial pipe network through the site and discharged to a drainage basin near the outlet to the wetland located on the property to the south. Stormwater Management Plan requires location of Flood Storage Basin in close proximity to the NE corner of Lot 4 with overflow to maintain pre-development flow rate of 1.2m³/s (100 year ARI). The basin and outlet structures will be designed to maintain the pre-development peak flows into the wetland, eastern drainage line and Yule Brook. No drainage infrastructure associated with the stormwater management system will be located within the wetland buffer.

An Urban Water Management Plan (UWMP) will be required at the Development Application stage.

3.6 Wetlands

The Multiple Use wetlands mapped on the site are not an impediment to development.

The wetland assessment undertaken by PGV Environmental (2018) on RE Wetland 7635 concluded that:

- The wetland on Lot 414 is completely cleared of native vegetation and does not have any flora or vegetation values and limited fauna values;
- An evaluation of the cleared wetland on Lot 414 results in a management category of Multiple Use as per the investigation in the Wetland Assessment (PGV Environmental, 2018);
- The boundary of wetland UFI 7635 was found to be inaccurate. Based on the presence of native vegetation the boundary would not be mapped on Lot 414 and would be 3 to 15m into the adjoining Lots 41 and 260;
- The boundary defined in the study was largely consistent with the proposed Conservation Category Wetland as mapped by a study undertaken by Tauss and Weston (2010);
- The vegetated parts of Lot 41 and 260 are rated as Conservation Category primarily due to the presence of the Muchea Limestone Threatened Ecological Community;
- The weed infested area on the southern half of Lot 260 is considered a Multiple Use wetland management category, thereby separating two CCW portions of the wetland on Lots 41 and 260;
- In accordance with EPA Guidance Statement 33 a site-specific buffer assessment was undertaken to determine a suitable setback distance, rather than apply the default 50m distance;
- The site-specific buffer assessment demonstrated through a Risk Assessment approach that a 30m buffer mitigated all the identified risks to the wetland, whereas a buffer of 20m had a higher potential of continued weed vectors impacting on the wetland. A 50m buffer did not provide any additional protection but instead had a slightly higher risk of intensifying fire, due to the distance in which a fire can go in the acceleration and equilibrium phases that could negatively impact on the wetland vegetation on the adjoining lots;

- The recommended setback to development as assessed through risk assessment is a 30m buffer vegetated with low shrubs and sedges; and
- The threats to the wetland by industrial development of Lot 414 can all be managed to have no impact on wetland UFI 7635 with a 30m buffer to the development.

A wetland buffer management plan should be prepared as part of the implementation of the Amended Precinct 3A Structure Plan, most likely as a condition of a Development Application.

A wetland management plan for wetland UFI 7635 should be prepared by adjoining landowners as part of the MKSEA 3B Precinct LSP.

A short section of Yule Brook runs through the south-western part of the site. The Water Corporation has previously advised that a buffer of 50m from the centre of the Brook should be applied as a minimum setback to development and stormwater infrastructure. The minimum buffer width is subject to the results of a hydrological study being undertaken by the City of Gosnells for the whole of Yule Brook.

A Foreshore Management Plan for the portion of Yule Brook that runs through the site should be prepared as a condition of a Development Application or subdivision approval for Lot 414.

3.7 Flora

Lot 414 is highly unlikely to contain any native species of conservation significance. Therefore, flora is not an impediment to the proposed industrial development.

3.8 Vegetation

Vegetation on the site consists of a diffuse stand of young Marri trees in the south-east part and riparian vegetation associated with Yule Brook. The riparian vegetation along Yule Brook will be retained in the development. The stand of Marri trees is unlikely to be able to be retained in the industrial development of the site. Consideration should be given to planting replacement Marri trees as landscaping within the finished development.

The vegetation on adjoining lots to the south has conservation significance. The wetland buffer management plan and the Local Water Management Strategy will outline measures to avoid direct and indirect impacts of development on the vegetation.

3.9 Fauna

Fauna habitats on the site consist of Open Eucalyptus Woodland, Banksia Woodland and Shrubland. The fauna habitat is classified as Highly Degraded or Disturbed Fauna Habitat. Species identified in the database searches possibly present on the site were:

- *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo);
- *Calyptorhynchus banksii naso* (Forest Red-tailed Black-Cockatoo);
- *Calyptorhynchus baudinii* (Baudin's Black Cockatoo);
- *Ardea ibis* (Cattle Egret); and
- *Merops ornatus* (Rainbow Bee-eater).

The Black Cockatoo species are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and approval may be required under this legislation. However, PGV Environmental consider that clearing the site would not lead to a significant impact on these species as the Marri trees total less than 1ha of foraging habitat.

Any Marri trees on the site that are cleared will be replaced with Marri plants in landscaped areas of the development.

All other conservation significant fauna species identified as potentially being present on the site are likely to be short term visitors and will not be significantly impacted by industrial development on the site.

3.10 Heritage Management

There are no registered Aboriginal Heritage or Cultural Heritage sites within the proposed development boundary. The Heritage Places on the site that have not been assessed to determine their status under the *Aboriginal Heritage Act, 1972* should be treated as potential sites and advice should be sort under Section 18 of the Act.

4 SUMMARY AND CONCLUSIONS

4.1 Summary

Lot 414 Grove Road, Kenwick was assessed for the environmental impact of the prospective development of the site for Industrial purposes. The site has the following characteristics:

- The site has been largely cleared since 1953 and used for agricultural purposes and horse agistment;
- The Pinjarra Plain soils can be prone to waterlogging and mostly have a Moderate to Low Acid Sulphate Soils risk;
- The vegetation is largely cleared. Some non-endemic species have been planted along fence lines on the site. A strip of riparian vegetation occurs in association with Yule Brook. Some isolated Marri trees occur in the south-eastern corner of the site;
- There are no Conservation Significant flora species or Threatened or Priority Ecological Communities on the site;
- The fauna habitat on the site is limited due to the absence of intact native vegetation. The Marri trees provide some foraging habitat for Black Cockatoos. Any Marri trees on the site that are cleared for development will be replaced with Marri plants in landscaped areas of the development;
- The Multiple Use wetlands on the site are not an impediment to development;
- Resource Enhancement wetland UFI 7635 has been more accurately mapped as occurring on the adjoining lots and not on Lot 414;
- The wetland buffer assessment determined that a buffer of 30m to the edge of the revised RE wetland boundary provides sufficient separation from the future industrial development;
- A wetland buffer management plan should be prepared as part of the implementation of the amended Precinct 3A Local Structure Plan, most likely as a condition of a Development Application.
- A wetland management plan for wetland UFI 7635 should be prepared by adjoining landowners as part of the MKSEA 3B Precinct LSP.
- Yule Brook and its associated riparian vegetation will remain as Rural in the Local Structure Plan and not be affected by the development of the site;
- A Foreshore Management Plan for the portion of Yule Brook that runs through the site should be prepared as a condition of a Development Application or subdivision approval for Lot 414.
- Stormwater drainage, if undertaken in accordance with the LWMS prepared for the site, will not impact on the wetland or its environmental values on the adjoining properties; and
- There are two Aboriginal Heritage Places mapped on the site. Further advice on the impact of the Heritage Places on the future development of Lot 414 should be sought from the Department of Aboriginal Affairs.

4.2 Conclusion

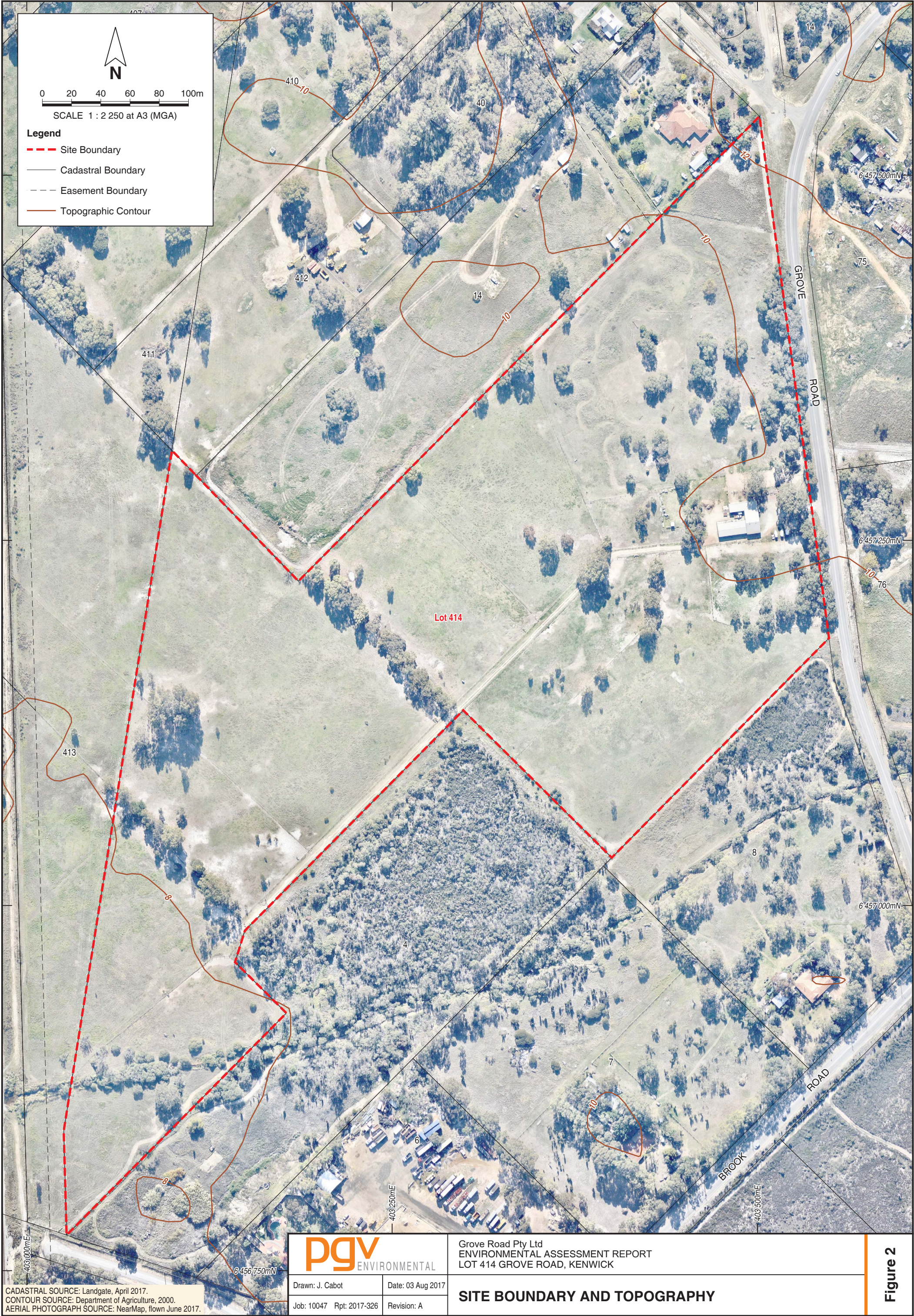
The Environmental Assessment Report concludes that development in accordance with the Development Concept Plan and other technical reports associated with the amended Precinct 3A Local Structure Plan will not have any detrimental impact on the environment on and adjacent to Lot 414 Grove Road.

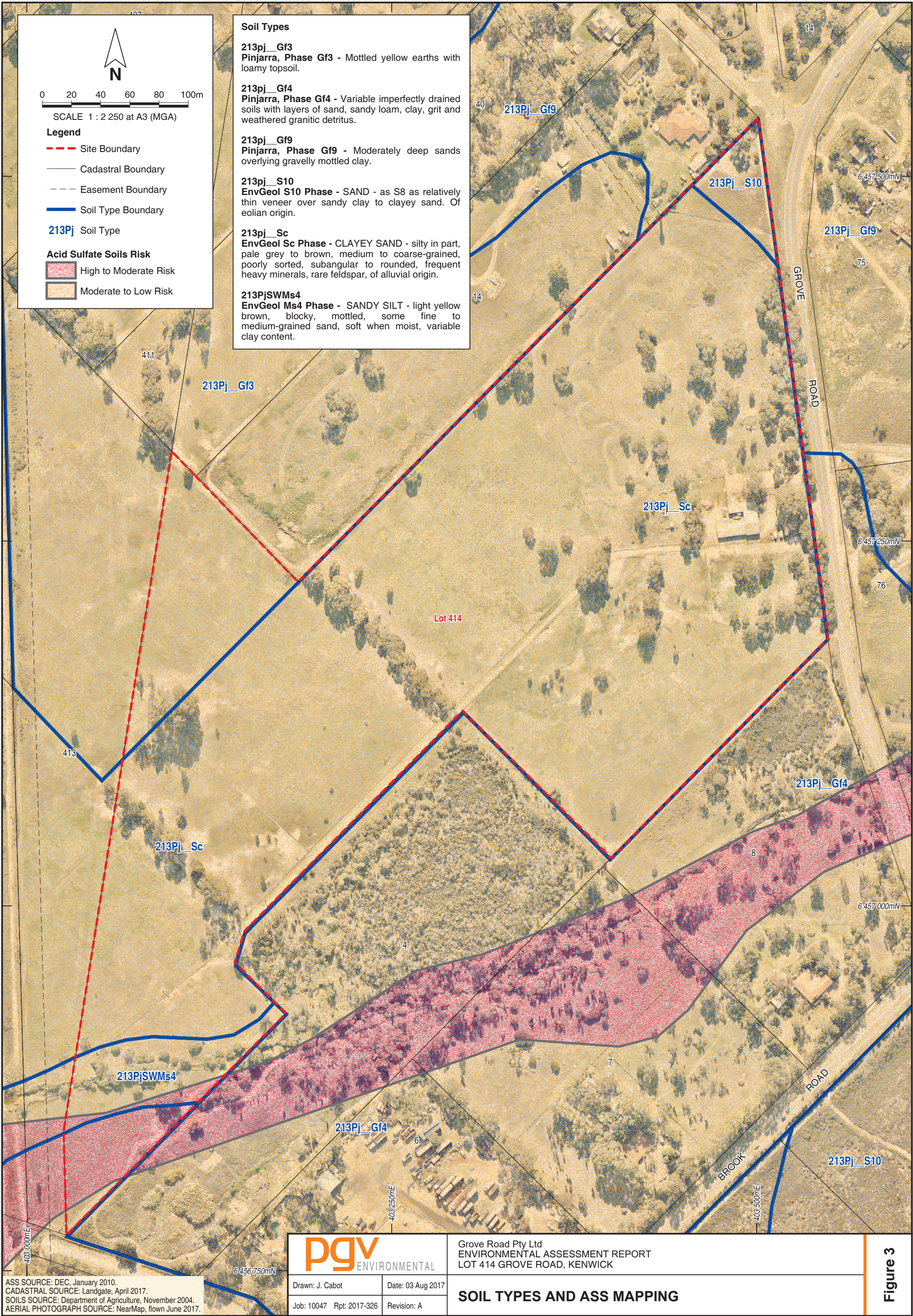
5 REFERENCES

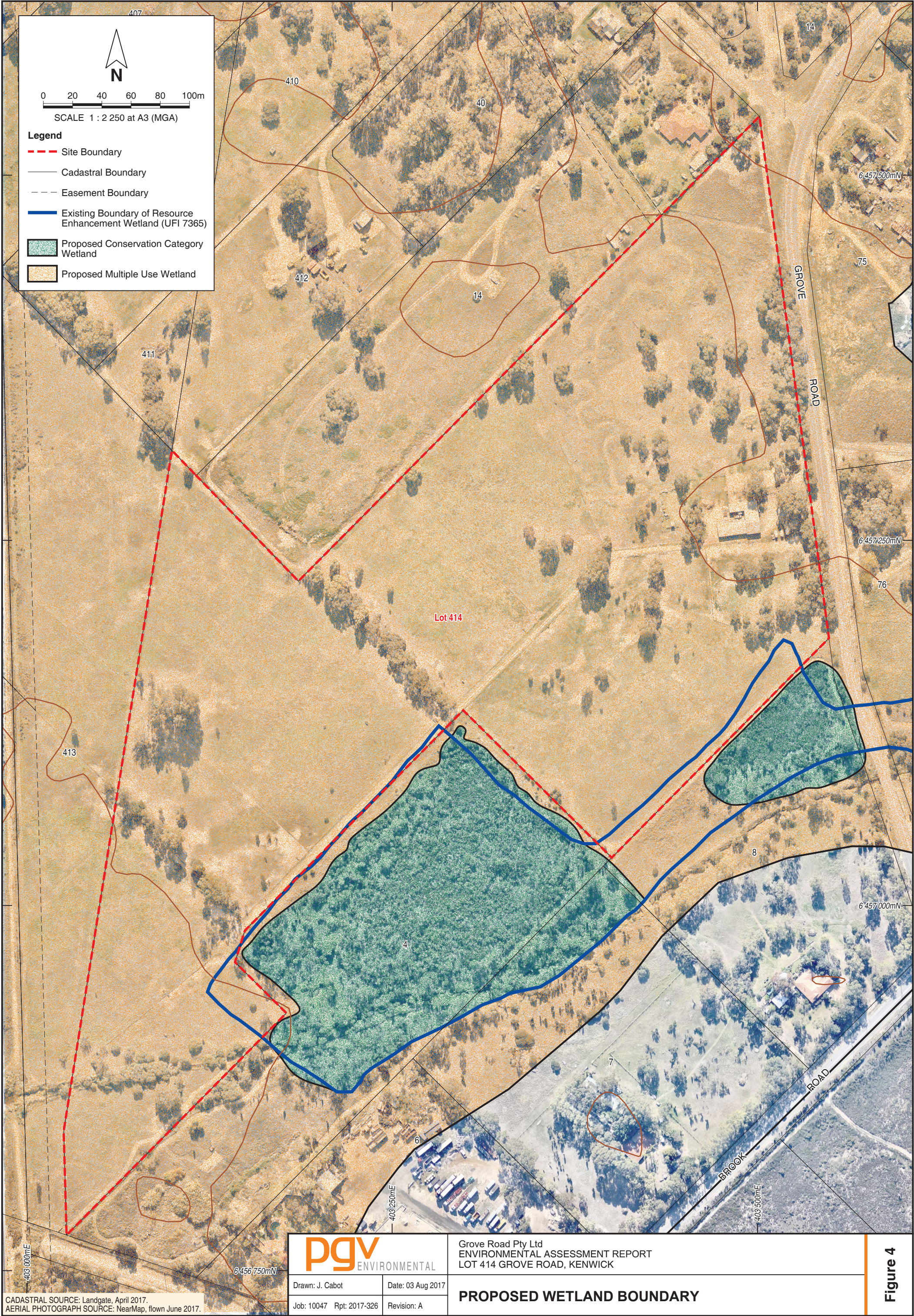
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FIGURES







APPENDIX 1

Naturemap Report

NatureMap Species Report

Created By Jackalyn Hams on 11/07/2017

Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 58' 36" E, 32° 01' 04" S
Buffer 5km
Group By Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	1286	19127
Other specially protected fauna	1	1
Priority 1	4	10
Priority 2	7	10
Priority 3	26	93
Priority 4	19	201
Protected under international agreement	5	213
Rare or likely to become extinct	24	896
TOTAL	1372	20551

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Rare or likely to become extinct				
1.	6309 <i>Andersonia gracilis</i>		T	
2.	38480 <i>Austrostipa bronwenae</i>		T	
3.	32211 <i>Banksia mimica</i> (Summer Honeypot)		T	
4.	1596 <i>Caladenia huegelii</i> (Grand Spider Orchid)		T	
5.	1213 <i>Calectasia cyanea</i> (Blue Tinsel Lily)		T	
6.	24731 <i>Calyptrorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black-Cockatoo)		T	
7.	24734 <i>Calyptrorhynchus latirostris</i> (Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo)		T	
8.	13653 <i>Calytrix breviseta</i> subsp. <i>breviseta</i>		T	
9.	13999 <i>Conospermum undulatum</i>		T	
10.	24092 <i>Dasyurus geoffroi</i> (Chuditch, Western Quoll)		T	
11.	1637 <i>Diuris purdiei</i> (Purdie's Donkey Orchid)		T	
12.	17605 <i>Eleocharis keigheryi</i>		T	
13.	17150 <i>Eremophila glabra</i> subsp. <i>chlorella</i>		T	
14.	13439 <i>Grevillea thelemanniana</i> subsp. <i>thelmanniana</i> (Spider Net Grevillea)		T	
15.	33983 <i>Leioproctus douglasiellus</i> (bee)		T	
16.	942 <i>Lepidosperma rostratum</i>		T	
17.	17106 <i>Macarthuria keigheryi</i>		T	
18.	33984 <i>Neopasiphae simplicior</i> (bee)		T	
19.	25345 <i>Pseudemys umbrina</i> (Western Swamp Tortoise, Western Swamp Turtle)		T	
20.	2753 <i>Ptilopus pyramidalis</i>		T	Y
21.	18590 <i>Synaphea</i> sp. Fairbridge Farm (D. Papenfus 696)		T	
22.	1033 <i>Tetraria australiensis</i>		T	
23.	10862 <i>Thelymitra stellata</i> (Star Orchid)		T	
24.	34113 <i>Westralunio carteri</i> (Carter's Freshwater Mussel)		T	
Protected under international agreement				
25.	41323 <i>Actitis hypoleucos</i> (Common Sandpiper)		IA	
26.	41324 <i>Ardea modesta</i> (Eastern Great Egret)		IA	
27.	24598 <i>Merops ornatus</i> (Rainbow Bee-eater)		IA	
28.	24806 <i>Tringa glareola</i> (Wood Sandpiper)		IA	
29.	24808 <i>Tringa nebularia</i> (Common Greenshank)		IA	
Other specially protected fauna				
30.	25624 <i>Falco peregrinus</i> (Peregrine Falcon)		S	
Priority 1				
31.	45014 <i>Amanita quenda</i>		P1	
32.	20096 <i>Calandrinia</i> sp. Piawaning (A.C. Beaglehole 12257)		P1	
33.	16280 <i>Schoenus</i> sp. Beaufort (G.J. Keighery 6291)		P1	
34.	20729 <i>Thelymitra magnifica</i> (Crystal Brook Star Orchid)		P1	

	Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Priority 2					
35.	14663	<i>Comesperma griffinii</i>		P2	
36.	4560	<i>Comesperma rhadinocarpum</i> (Slender-fruited <i>Comesperma</i>)		P2	
37.	16317	<i>Isotropis cuneifolia</i> subsp. <i>glabra</i>		P2	
38.	33981	<i>Leioproctus bilobatus</i> (bee)		P2	
39.	19241	<i>Lepyrodia curvescens</i>		P2	
40.	37683	<i>Melaleuca viminalis</i>		P2	
41.	999	<i>Schoenus loliaceus</i>		P2	
Priority 3					
42.	3373	<i>Acacia horridula</i>		P3	
43.	43542	<i>Amanita wadjukiorum</i>		P3	
44.	45402	<i>Babingtonia urbana</i> (Coastal Plain <i>Babingtonia</i>)		P3	
45.	32138	<i>Banksia pteridifolia</i> subsp. <i>vernalis</i>		P3	
46.	3178	<i>Byblis gigantea</i> (Rainbow Plant)		P3	
47.	759	<i>Carex tereticaulis</i>		P3	
48.	19338	<i>Chamaescilla gibsonii</i>		P3	
49.	41801	<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)		P3	
50.	41810	<i>Eryngium</i> sp. <i>Subdecumbens</i> (G.J. Keighery 5390)		P3	
51.	1469	<i>Haemodorum loratum</i>		P3	
52.	29775	<i>Isopogon drummondii</i>		P3	
53.	45081	<i>Lasiopetalum glutinosum</i> subsp. <i>glutinosum</i>		P3	
54.	25147	<i>Leisteria lineata</i> (Perth Slider, Lined Skink)		P3	
55.	33638	<i>Meionectes tenuifolia</i>		P3	
56.	6193	<i>Myriophyllum echinatum</i>		P3	
57.	25249	<i>Neelaps calonotos</i> (Black-striped Snake)		P3	
58.	11132	<i>Platysace ramosissima</i>		P3	
59.	974	<i>Schoenus benthamii</i>		P3	
60.	980	<i>Schoenus capillifolius</i>		P3	
61.	1008	<i>Schoenus pennisetis</i>		P3	
62.	17731	<i>Schoenus</i> sp. <i>Waroona</i> (G.J. Keighery 12235)		P3	
63.	18564	<i>Stylidium aceratum</i>		P3	
64.	7771	<i>Stylidium periscelanthum</i> (Pantaloons Triggerplant)		P3	
65.	48297	<i>Styphelia filifolia</i>		P3	
66.	14333	<i>Tetratheca</i> sp. <i>Granite</i> (S. Patrick SP1224)		P3	
67.	1317	<i>Thysanotus anceps</i>		P3	
Priority 4					
68.	14131	<i>Acacia oncinophylla</i> subsp. <i>patulifolia</i>		P4	
69.	141	<i>Aponogeton hexatepalus</i> (Stalked Water Ribbons)		P4	
70.	4444	<i>Boronia tenuis</i> (Blue Boronia)		P4	
71.	1123	<i>Centrolepis caespitosa</i>		P4	
72.	11388	<i>Conostylis pauciflora</i> subsp. <i>euryrhipis</i>		P4	
73.	25035	<i>Ctenotus delli</i> (Dell's Ctenotus, Darling Range Heath Ctenotus)		P4	
74.	13191	<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>		P4	
75.	5146	<i>Hibbertia montana</i>		P4	
76.	6233	<i>Hydrocotyle lemnoidea</i> (Aquatic Pennywort)		P4	
77.	24215	<i>Hydromys chrysogaster</i> (Water-rat, Rakali)		P4	
78.	25478	<i>Isodon obesulus</i> (Southern Brown Bandicoot)		P4	
79.	24153	<i>Isodon obesulus</i> subsp. <i>fusciventer</i> (Quenda, Southern Brown Bandicoot)		P4	
80.	5025	<i>Lasiopetalum bracteatum</i> (Helena Velvet Bush)		P4	
81.	24133	<i>Macropus irma</i> (Western Brush Wallaby)		P4	
82.	36200	<i>Ornduffia submersa</i>		P4	
83.	24328	<i>Oxyura australis</i> (Blue-billed Duck)		P4	
84.	1003	<i>Schoenus natans</i> (Floating Bog-rush)		P4	
85.	7756	<i>Stylidium longitubum</i> (Jumping Jacks)		P4	
86.	14714	<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>		P4	
Non-conservation taxon					
87.	19708	<i>Abutilon grandifolium</i>	Y		
88.	15466	<i>Acacia applanata</i>			
89.	3294	<i>Acacia dentifera</i>			
90.	11926	<i>Acacia drewiana</i> subsp. <i>drewiana</i>			
91.	3374	<i>Acacia huegelii</i>			
92.	3382	<i>Acacia incrassata</i>			
93.	3409	<i>Acacia lasiocarpa</i> (Panjang)			
94.	11611	<i>Acacia lasiocarpa</i> var. <i>lasiocarpa</i>			
95.	17861	<i>Acacia longifolia</i>	Y		
96.	17464	<i>Acacia longifolia</i> subsp. <i>longifolia</i>	Y		
97.	3464	<i>Acacia obovata</i>			
98.	17860	<i>Acacia podalyriifolia</i>	Y		
99.	3502	<i>Acacia pulchella</i> (Prickly Moses)			

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100.	15481	<i>Acacia pulchella</i> var. <i>glaberrima</i>			
101.	15483	<i>Acacia pulchella</i> var. <i>pulchella</i>			
102.	3527	<i>Acacia saligna</i> (Orange Wattle, Kudjong)			
103.	30033	<i>Acacia saligna</i> subsp. <i>lindleyi</i>			
104.	30032	<i>Acacia saligna</i> subsp. <i>saligna</i>			
105.	3541	<i>Acacia sessilis</i>			
106.	3557	<i>Acacia stenoptera</i> (Narrow Winged Wattle)			
107.	3574	<i>Acacia teretifolia</i>			
108.	3602	<i>Acacia willdenowiana</i> (Grass Wattle)			
109.	24260	<i>Acanthiza apicalis</i> (Broad-tailed Thornbill, Inland Thornbill)			
110.	24261	<i>Acanthiza chrysorrhoa</i> (Yellow-rumped Thornbill)			
111.	24262	<i>Acanthiza inornata</i> (Western Thornbill)			
112.	24265	<i>Acanthiza uropygialis</i> (Chestnut-rumped Thornbill)			
113.	1205	<i>Acanthocarpus canaliculatus</i>			
114.	24560	<i>Acanthorhynchus superciliosus</i> (Western Spinebill)			
115.	7811	<i>Acanthospermum hispidum</i> (Starburr)	Y		
116.	25535	<i>Accipiter cirrocephalus</i> (Collared Sparrowhawk)			
117.	25536	<i>Accipiter fasciatus</i> (Brown Goshawk)			
118.	24282	<i>Accipiter fasciatus</i> subsp. <i>fasciatus</i> (Brown Goshawk)			
119.	42368	<i>Acritoscincus trilineatus</i> (Western Three-lined Skink)			
120.	25755	<i>Acrocephalus australis</i> (Australian Reed Warbler)			
121.	6205	<i>Actinotus leucocephalus</i> (Flannel Flower)			
122.	14970	<i>Adenanthos barbiger</i>			
123.	1775	<i>Adenanthos cygnorum</i> (Common Woollybush)			
124.	11837	<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> (Common Woollybush)			
125.		<i>Afurcagobius suppositus</i>			
126.		<i>Agraptocorixa parvipunctata</i>			
127.	23474	<i>Agrostocrinum hirsutum</i>			
128.	1261	<i>Agrostocrinum scabrum</i> (Blue Grass Lily)			
129.	23501	<i>Agrostocrinum scabrum</i> subsp. <i>scabrum</i>			
130.		<i>Ainudrilus nharna</i>			
131.	184	<i>Aira caryophyllea</i> (Silvery Hairgrass)	Y		
132.	185	<i>Aira cupaniana</i> (Silvery Hairgrass)	Y		
133.		<i>Alboa worooa</i>			
134.	1056	<i>Alexgeorgea nitens</i>			
135.	1728	<i>Allocasuarina fraseriana</i> (Sheoak, Kondil)			
136.	1732	<i>Allocasuarina humilis</i> (Dwarf Sheoak)			
137.	1734	<i>Allocasuarina microstachya</i>			
138.		<i>Allodessus bistrigatus</i>			
139.		<i>Alona affinis</i>			
140.		<i>Alona cf. guttata</i>			
141.		<i>Alona rigidicaudis</i>			
142.		<i>Alona setigera</i>			
143.		<i>Alonella clathratula</i>			
144.	2648	<i>Alternanthera denticulata</i> (Lesser Joyweed)			
145.	38757	<i>Amanita xanthocephala</i>			
146.	2655	<i>Amaranthus albus</i> (Tumbleweed)	Y		
147.	7820	<i>Ambrosia artemisiifolia</i> (Annual Ragweed, Bitterweed, Hay-feverweed, Hog-weed)	Y		
148.	7821	<i>Ambrosia psilostachya</i> (Perennial Ragweed)	Y		
149.	13380	<i>Amphibromus nervosus</i>			
150.	197	<i>Amphipogon debilis</i>			
151.	199	<i>Amphipogon strictus</i> (Greybeard Grass)			
152.	200	<i>Amphipogon turbinatus</i>			
153.	13267	<i>Amyema linophylla</i> subsp. <i>linophylla</i>			
154.		<i>Aname mainae</i>			
155.		<i>Aname tepperi</i>			
156.	1058	<i>Anarthria gracilis</i>			
157.	1060	<i>Anarthria laevis</i>			
158.	24312	<i>Anas gracilis</i> (Grey Teal)			
159.	24313	<i>Anas platyrhynchos</i> (Mallard)			
160.	24315	<i>Anas rhynchotis</i> (Australasian Shoveler)			
161.	24316	<i>Anas superciliosa</i> (Pacific Black Duck)			
162.	6300	<i>Andersonia aristata</i> (Rice Flower)			
163.	6312	<i>Andersonia involucrata</i>			
164.	6314	<i>Andersonia lehmanniana</i>			
165.	11471	<i>Andersonia lehmanniana</i> subsp. <i>lehmanniana</i>			
166.	7833	<i>Angianthus preissianus</i>			
167.	47414	<i>Anhinga novaehollandiae</i> (Australasian Darter)			
168.	11470	<i>Anigozanthos bicolor</i> subsp. <i>bicolor</i>			
169.	1409	<i>Anigozanthos humilis</i> (Catspaw)			

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170.	11434	<i>Anigozanthos humilis</i> subsp. <i>humilis</i>			
171.	1411	<i>Anigozanthos manglesii</i> (Mangles Kangaroo Paw, Kurulbrang)			
172.	11261	<i>Anigozanthos manglesii</i> subsp. <i>manglesii</i>			
173.	1416	<i>Anigozanthos viridis</i> (Green Kangaroo Paw, Kurulbardang)			
174.	11566	<i>Anigozanthos viridis</i> subsp. <i>viridis</i>			
175.		<i>Anisops thienemanni</i>			
176.		<i>Anopheles annulipes</i> s.l.			
177.	17455	<i>Anredera cordifolia</i>	Y		
178.		<i>Anser anser</i>			
179.	24561	<i>Anthochaera carunculata</i> (Red Wattlebird)			
180.	24562	<i>Anthochaera lunulata</i> (Western Little Wattlebird)			
181.	12724	<i>Anthotium junciforme</i>			
182.	3686	<i>Aotus cordifolia</i>			
183.	3688	<i>Aotus gracillima</i>			
184.	1117	<i>Aphelia cyperoides</i>			
185.	1118	<i>Aphelia drummondii</i>			
186.	43548	<i>Aphelia</i> sp. Albany (B.G. Briggs 596)			
187.	24990	<i>Aprasia pulchella</i> (Granite Worm-lizard)			
188.	24991	<i>Aprasia repens</i> (Sand-plain Worm-lizard)			
189.		<i>Apsectrotanypus nr maculosa</i>			
190.		<i>Araneus senicaudatus</i>			
191.	17355	<i>Araujia sericifera</i>	Y		
192.	32314	<i>Archidium rehmannii</i>			
193.	7838	<i>Arctotheca calendula</i> (Cape Weed, African Marigold)	Y		
194.	38969	<i>Arcyria minuta</i>			
195.	24340	<i>Ardea novaehollandiae</i> (White-faced Heron)			
196.	24341	<i>Ardea pacifica</i> (White-necked Heron)			
197.	1264	<i>Arnocrinum preissii</i>			
198.		<i>Arrenurus (Micruracarus) sp. 1</i> (SAP)			
199.	25566	<i>Artamus cinereus</i> (Black-faced Woodswallow)			
200.	24353	<i>Artamus cyanopterus</i> (Dusky Woodswallow)			
201.		<i>Artema atlanta</i>			
202.		<i>Artoria linnaei</i>			
203.		<i>Artoriopsis eccentrica</i>			
204.		<i>Artoriopsis joergi</i>			
205.	1201	<i>Asparagus officinalis</i> (Asparagus)	Y		
206.	1364	<i>Asphodelus fistulosus</i> (Onion Weed)	Y		
207.	20350	<i>Astartea affinis</i> (West-coast Astartea)			
208.	20249	<i>Astartea leptophylla</i> (River-bank Astartea)			
209.	20283	<i>Astartea scoparia</i> (Common Astartea)			
210.	6327	<i>Astroloma foliosum</i> (Candle Cranberry)			
211.	6330	<i>Astroloma macrocalyx</i> (Swan Berry)			
212.	6334	<i>Astroloma pallidum</i> (Kick Bush)			
213.	6337	<i>Astroloma stomarrhena</i> (Red Swamp Cranberry)			
214.		<i>Austracantha minax</i>			
215.		<i>Austrolestes analis</i>			
216.		<i>Austrolestes io</i>			
217.	17233	<i>Austrostipa campylachne</i>			
218.	17234	<i>Austrostipa compressa</i>			
219.	17241	<i>Austrostipa hemipogon</i>			
220.	17254	<i>Austrostipa tenuifolia</i>			
221.	17257	<i>Austrostipa variabilis</i>			
222.	231	<i>Avellinia michelii</i>	Y		
223.	233	<i>Avena barbata</i> (Bearded Oat)	Y		
224.	24318	<i>Aythya australis</i> (Hardhead)			
225.	18279	<i>Babiana angustifolia</i>	Y		
226.	36441	<i>Babingtonia camphorosmae</i> (Camphor Myrtle)			
227.	45403	<i>Babingtonia pelloeae</i> (Pelloe's Babingtonia)			
228.	1382	<i>Baeometra uniflora</i>	Y		
229.		<i>Ballarra longipalpus</i>			
230.	32682	<i>Banksia armata</i> var. <i>armata</i>			
231.	1800	<i>Banksia attenuata</i> (Slender Banksia, Piara)			
232.	32580	<i>Banksia dallanneyi</i> var. <i>dallanneyi</i>			
233.	32577	<i>Banksia dallanneyi</i> var. <i>mellicula</i>			
234.	1819	<i>Banksia grandis</i> (Bull Banksia, Pulgarla)			
235.	1823	<i>Banksia incana</i>			
236.	33399	<i>Banksia incana</i> var. <i>incana</i>			
237.	1834	<i>Banksia menziesii</i> (Firewood Banksia)			
238.	32080	<i>Banksia sessilis</i> var. <i>sessilis</i>			
239.	1852	<i>Banksia telmatiaea</i> (Swamp Fox Banksia)			

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240.	1855	<i>Banksia victoriae</i> (Woolly Orange Banksia)			
241.	32315	<i>Barbula calycina</i>			
242.		<i>Barnardius zonarius</i>			
243.	15037	<i>Bartsia trixago</i>	Y		
244.	740	<i>Baumea arthropphylla</i>			
245.	743	<i>Baumea juncea</i> (Bare Twigrush)			
246.	5387	<i>Beaufortia macrostemon</i> (Darling Range Beaufortia)			
247.	5393	<i>Beaufortia squarrosa</i> (Sand Beaufortia, Sand Bottlebrush, Puno)			
248.		<i>Bennelongia</i> sp.			
249.		<i>Berosus approximans</i>			
250.		<i>Berosus australiae</i>			
251.		<i>Bezzia</i> sp.			
252.		<i>Bezzia</i> sp. 2 (SAP)			
253.	24319	<i>Biziura lobata</i> (Musk Duck)			
254.		<i>Boeckella bispinosa</i>			
255.	749	<i>Bolboschoenus caldwellii</i> (Marsh Club-rush)			
256.		<i>Boletus</i> sp.			
257.	4413	<i>Boronia crenulata</i> (Aniseed Boronia)			
258.	16636	<i>Boronia crenulata</i> subsp. <i>viminea</i>			
259.	11503	<i>Boronia crenulata</i> var. <i>crenulata</i>			
260.	4414	<i>Boronia cymosa</i> (Granite Boronia)			
261.	17665	<i>Boronia purdieana</i> subsp. <i>purdieana</i>			
262.	4438	<i>Boronia ramosa</i>			
263.	11381	<i>Boronia ramosa</i> subsp. <i>anethifolia</i>			
264.	1272	<i>Borya scirpoidea</i>			
265.	1273	<i>Borya sphaerocephala</i> (Pincushions)			
266.	24251	<i>Bos taurus</i> (European Cattle)	Y		
267.	3710	<i>Bossiaea eriocarpa</i> (Common Brown Pea)			
268.		<i>Brachionus quadridentatus</i>			
269.	30142	<i>Brachyloma preissii</i> subsp. <i>obtusifolium</i>			
270.	7867	<i>Brachyscome bellidioides</i>			
271.	42381	<i>Brachyrophis semifasciatus</i> (Southern Shovel-nosed Snake)			
272.	3000	<i>Brassica tournefortii</i> (Mediterranean Turnip)	Y		
273.	244	<i>Briza maxima</i> (Blowfly Grass)	Y		
274.	245	<i>Briza minor</i> (Shivery Grass)	Y		
275.	248	<i>Bromus catharticus</i> (Prairie Grass)	Y		
276.	249	<i>Bromus diandrus</i> (Great Brome)	Y		
277.	32330	<i>Bryum argenteum</i>			
278.	1366	<i>Bulbine semibarbata</i> (Leek Lily)			
279.	1383	<i>Burchardia bairdiae</i>			
280.	12770	<i>Burchardia congesta</i>			
281.	1385	<i>Burchardia multiflora</i> (Dwarf Burchardia)			
282.	25713	<i>Cacatua galerita</i> (Sulphur-crested Cockatoo)			
283.	25714	<i>Cacatua pastinator</i> (Western Long-billed Corella)			
284.	25715	<i>Cacatua roseicapilla</i> (Galah)			
285.	25716	<i>Cacatua sanguinea</i> (Little Corella)			
286.	24729	<i>Cacatua tenuirostris</i> (Eastern Long-billed Corella)	Y		
287.	42307	<i>Cacomantis pallidus</i> (Pallid Cuckoo)			
288.	1276	<i>Caesia micrantha</i> (Pale Grass Lily)			
289.	1277	<i>Caesia occidentalis</i>			
290.	15330	<i>Caladenia arenicola</i>			
291.	1586	<i>Caladenia discoidea</i> (Dancing Orchid)			
292.	1590	<i>Caladenia ferruginea</i> (Rusty Spider Orchid)			
293.	1592	<i>Caladenia flava</i> (Cowslip Orchid)			
294.	15348	<i>Caladenia flava</i> subsp. <i>flava</i>			
295.	17760	<i>Caladenia nobilis</i>			
296.	15503	<i>Caladenia paludosa</i>			
297.	2854	<i>Calandrinia granulifera</i> (Pygmy Purslane)			
298.	2856	<i>Calandrinia liniflora</i> (Parakeelya)			
299.	1214	<i>Calectasia grandiflora</i> (Blue Tinsel Lily)			
300.	19309	<i>Calectasia narragara</i>			
301.	4717	<i>Callitriche stagnalis</i> (Common Starwort)	Y		
302.	36600	<i>Callitris pyramidalis</i> (Swamp Cypress)			
303.	5411	<i>Calothamnus hirsutus</i>			
304.	5415	<i>Calothamnus lateralis</i>			
305.	5426	<i>Calothamnus quadrifidus</i> (One-sided Bottlebrush, Kwowdjard)			
306.	35816	<i>Calothamnus quadrifidus</i> subsp. <i>quadrifidus</i>			
307.	5428	<i>Calothamnus rupestris</i> (Mouse Ears)			
308.	5431	<i>Calothamnus torulosus</i>			
309.	16492	<i>Calycopseplus paucifolius</i>			

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310.	25717	<i>Calyptorhynchus banksii</i> (Red-tailed Black-Cockatoo)			
311.	5439	<i>Calytrix angulata</i> (Yellow Starflower)			
312.	5441	<i>Calytrix aurea</i>			
313.	5458	<i>Calytrix flavescens</i> (Summer Starflower)			
314.	5461	<i>Calytrix glutinosa</i>			
315.	5476	<i>Calytrix sapphirina</i>			
316.	32461	<i>Campylopus bicolor</i> var. <i>bicolor</i>			
317.	32338	<i>Campylopus introflexus</i>	Y		
318.		<i>Candonocypris novaezelandiae</i>			
319.	754	<i>Carex divisa</i> (Divided Sedge)	Y		
320.	11351	<i>Cassytha aurea</i> var. <i>hirta</i>			
321.	2951	<i>Cassytha flava</i> (Dodder Laurel)			
322.	2952	<i>Cassytha glabella</i> (Tangled Dodder Laurel)			
323.	11501	<i>Cassytha glabella</i> forma <i>casuarinae</i>			
324.	2956	<i>Cassytha pomiformis</i> (Dodder Laurel)			
325.	2957	<i>Cassytha racemosa</i> (Dodder Laurel)			
326.	11242	<i>Cassytha racemosa</i> forma <i>pilosa</i>			
327.	11799	<i>Cassytha racemosa</i> forma <i>racemosa</i>			
328.	760	<i>Caustis dioica</i>			
329.		<i>Ceinidae</i> sp.			
330.	41564	<i>Cenchrus clandestinus</i> (Kikuyu Grass)	Y		
331.	41563	<i>Cenchrus purpureus</i> (Elephant Grass)	Y		
332.	7917	<i>Centaurea solstitialis</i> (St Barnaby's Thistle, Yellow Star Thistle)	Y		
333.	6539	<i>Centaureum erythraea</i> (Common Centaury)	Y		
334.	6542	<i>Centaureum tenuiflorum</i>	Y		
335.	6214	<i>Centella asiatica</i>			
336.	7918	<i>Centipeda cunninghamii</i> (Common Sneezewood, Gukwonderuk, Old Man Weed)			
337.	1121	<i>Centrolepis aristata</i> (Pointed Centrolepis)			
338.	1125	<i>Centrolepis drummondiana</i>			
339.	1129	<i>Centrolepis glabra</i> (Smooth Centrolepis)			
340.	1131	<i>Centrolepis inconspicua</i>			
341.		<i>Cephalodella gibba</i>			
342.		<i>Ceratopogonidae</i> sp.			
343.		<i>Ceriodaphnia</i> sp.			
344.	17685	<i>Chaetanthus aristatus</i>			
345.	24186	<i>Chalinolobus gouldii</i> (Gould's Wattled Bat)			
346.	24187	<i>Chalinolobus morio</i> (Chocolate Wattled Bat)			
347.	1280	<i>Chamaescilla corymbosa</i> (Blue Squill)			
348.	11299	<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>			
349.	8788	<i>Chamaescilla versicolor</i>			
350.		<i>Chaoboridae</i> sp.			
351.	1513	<i>Chasmanthe floribunda</i> (African Cornflag)	Y		
352.	31	<i>Cheilanthes austrotenuifolia</i>			
353.	3169	<i>Cheiranthra preissiana</i>			
354.	43380	<i>Chelodina colliciei</i> (South-western Snake-necked Turtle)			
355.	24321	<i>Chenonetta jubata</i> (Australian Wood Duck, Wood Duck)			
356.	33939	<i>Cherax cainii</i> (Marron)			
357.		<i>Cherax destructor</i>			
358.		<i>Cherax quinquecarinatus</i>			
359.		<i>Chironominae</i> sp.			
360.	17706	<i>Chordifex sinuosus</i>			
361.	763	<i>Chorizandra enodis</i> (Black Bristlerush)			
362.	764	<i>Chorizandra multiarticulata</i>			
363.	3753	<i>Chorizema dicksonii</i> (Yellow-eyed Flame Pea)			
364.	24980	<i>Christinus marmoratus</i> (Marbled Gecko)			
365.		<i>Chroicocephalus novaehollandiae</i>			
366.	25601	<i>Chrysococcyx lucidus</i> (Shining Bronze Cuckoo)			
367.		<i>Chydorus</i> sp.			
368.	6543	<i>Cicendia filiformis</i> (Slender Cicendia)	Y		
369.	24288	<i>Circus approximans</i> (Swamp Harrier)			
370.	7370	<i>Citrullus lanatus</i> (Pie Melon)	Y		
371.		<i>Coenagrionidae</i> sp.			
372.	25675	<i>Colluricincla harmonica</i> (Grey Shrike-thrush)			
373.	32999	<i>Colocasia esculenta</i> var. <i>esculenta</i>	Y		
374.	24399	<i>Columba livia</i> (Domestic Pigeon)	Y		
375.		<i>Colus pusillus</i>			
376.	4550	<i>Comesperma calymega</i> (Blue-spike Milkwort)			
377.	4551	<i>Comesperma ciliatum</i>			
378.	4564	<i>Comesperma virgatum</i> (Milkwort)			
379.	15607	<i>Conospermum acerosum</i> subsp. <i>acerosum</i>			

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380.	15041	<i>Conospermum canaliculatum</i>			
381.	16853	<i>Conospermum capitatum</i> subsp. <i>glabratum</i>			
382.	1875	<i>Conospermum huegelii</i> (Slender Smokebush)			
383.	1882	<i>Conospermum stoechadis</i> (Common Smokebush)			
384.	1885	<i>Conospermum triplinervium</i> (Tree Smokebush)			
385.	6347	<i>Conostephium minus</i> (Pink-tipped Pearl flower)			
386.	6348	<i>Conostephium pendulum</i> (Pearl Flower)			
387.	6349	<i>Conostephium preissii</i>			
388.	11826	<i>Conostylis aculeata</i> subsp. <i>aculeata</i>			
389.	1420	<i>Conostylis androstemma</i> (Trumpets)			
390.	1423	<i>Conostylis aurea</i> (Golden Conostylis)			
391.	1429	<i>Conostylis caricina</i>			
392.	12035	<i>Conostylis caricina</i> subsp. <i>caricina</i>			
393.	11695	<i>Conostylis festuacea</i> subsp. <i>festuacea</i>			
394.	1436	<i>Conostylis juncea</i>			
395.	1437	<i>Conostylis latens</i>			
396.	1454	<i>Conostylis setigera</i> (Bristly Cottonhead)			
397.	11597	<i>Conostylis setigera</i> subsp. <i>setigera</i>			
398.	5502	<i>Conothamnus trinervis</i>			
399.	20074	<i>Conyza sumatrensis</i>	Y		
400.	24361	<i>Coracina maxima</i> (Ground Cuckoo-shrike)			
401.	25568	<i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
402.	24363	<i>Coracina novaehollandiae</i> subsp. <i>subpallida</i> (Black-faced Cuckoo-shrike)			
403.		<i>Corixidae</i> sp.			
404.		<i>Cormocephalus aurantiipes</i>			
405.		<i>Cormocephalus novaehollandiae</i>			
406.		<i>Cormocephalus rubriceps</i>			
407.		<i>Cormocephalus strigosus</i>			
408.	48259	<i>Cortaderia selloana</i> subsp. <i>selloana</i>	Y		
409.	38774	<i>Cortinarius archeri</i>			
410.		<i>Cortinarius sublargus</i>			Y
411.	25592	<i>Corvus coronoides</i> (Australian Raven)			
412.	24417	<i>Corvus coronoides</i> subsp. <i>perplexus</i> (Australian Raven)			
413.	17104	<i>Corymbia calophylla</i> (Marri)			
414.		<i>Corynoneura</i> sp. (V49) (SAP)			
415.	7945	<i>Cotula coronopifolia</i> (Waterbuttons)	Y		
416.	7947	<i>Cotula turbinata</i> (Funnel Weed)	Y		
417.	24420	<i>Cracticus nigrogularis</i> (Pied Butcherbird)			
418.	25595	<i>Cracticus tibicen</i> (Australian Magpie)			
419.	24422	<i>Cracticus tibicen</i> subsp. <i>dorsalis</i> (White-backed Magpie)			
420.	25596	<i>Cracticus torquatus</i> (Grey Butcherbird)			
421.	17701	<i>Crassula closiana</i>			
422.	3137	<i>Crassula colorata</i> (Dense Stonecrop)			
423.	3138	<i>Crassula decumbens</i> (Rufous Stonecrop)			
424.	3142	<i>Crassula natans</i>	Y		
425.	15706	<i>Crassula natans</i> var. <i>minus</i>	Y		
426.		<i>Cricotopus 'brevicornis'</i>			
427.	25398	<i>Crinia georgiana</i> (Quacking Frog)			
428.	25399	<i>Crinia glauerti</i> (Clicking Frog)			
429.	25400	<i>Crinia insignifera</i> (Squelching Froglet)			
430.	35838	<i>Cristonia biloba</i> subsp. <i>biloba</i>			
431.	13470	<i>Cryptandra arbutiflora</i> var. <i>arbutiflora</i>			
432.	4809	<i>Cryptandra pungens</i>			
433.	30893	<i>Cryptoblepharus buehneri</i>			
434.	25020	<i>Cryptoblepharus plagiocephalus</i>			
435.		<i>Cryptochironomus griseidorsum</i>			
436.	24883	<i>Ctenophorus ornatus</i> (Ornate Crevice-Dragon)			
437.	25027	<i>Ctenotus australis</i>			
438.	25039	<i>Ctenotus fallens</i>			
439.	25047	<i>Ctenotus impar</i>			
440.	25049	<i>Ctenotus labillardieri</i>			
441.		<i>Culex</i> (Culex) <i>annulirostris</i>			
442.		<i>Culicoides</i> sp.			
443.	11021	<i>Cuscuta planiflora</i>	Y		
444.	15114	<i>Cyanicula gemmata</i>			
445.	768	<i>Cyathochaeta avenacea</i>			
446.	769	<i>Cyathochaeta clandestina</i>			
447.	17618	<i>Cyathochaeta equitans</i>			
448.	40661	<i>Cynogeton lineare</i>			
449.	24322	<i>Cygnus atratus</i> (Black Swan)			

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450.	283	<i>Cynodon dactylon</i> (Couch)	Y		
451.	18318	<i>Cyperus involucratus</i>	Y		
452.	806	<i>Cyperus polystachyos</i> (Bunchy Sedge)	Y		
453.		<i>Cyperus</i> sp.			
454.	815	<i>Cyperus tenellus</i> (Tiny Flatsedge)	Y		
455.	816	<i>Cyperus tenuiflorus</i> (Scaly Sedge)	Y		
456.		<i>Cypretta</i> sp.			
457.		<i>Cyprinotus cingalensis</i>			
458.	17692	<i>Cytogonidium leptocarpoides</i>			
459.	30901	<i>Dacelo novaeguineae</i> (Laughing Kookaburra)	Y		
460.	7428	<i>Dampiera coronata</i> (Wedge-leaved Dampiera)			
461.	7454	<i>Dampiera linearis</i> (Common Dampiera)			
462.	7462	<i>Dampiera pedunculata</i>			
463.	25673	<i>Daphoenositta chrysoptera</i> (Varied Sittella)			
464.	5508	<i>Darwinia citriodora</i> (Lemon-scented Darwinia)			
465.	1218	<i>Dasypogon bromeliifolius</i> (Pineapple Bush)			
466.	1220	<i>Dasypogon obliquifolius</i>			
467.	3793	<i>Daviesia angulata</i>			
468.	3799	<i>Daviesia cordata</i> (Bookleaf)			
469.	3805	<i>Daviesia decurrens</i> (Prickly Bitter-pea)			
470.	19747	<i>Daviesia decurrens</i> subsp. <i>decurrens</i>			
471.	18560	<i>Daviesia divaricata</i> subsp. <i>divaricata</i>			
472.	3815	<i>Daviesia horrida</i> (Prickly Bitter-pea)			
473.	3824	<i>Daviesia nudiflora</i>			
474.	16585	<i>Daviesia nudiflora</i> subsp. <i>nudiflora</i>			
475.	3832	<i>Daviesia physodes</i>			
476.	3834	<i>Daviesia polyphylla</i>			
477.	3845	<i>Daviesia triflora</i>			
478.		<i>Delena cancerides</i>			
479.	25766	<i>Delma fraseri</i> (Fraser's Legless Lizard)			
480.	24999	<i>Delma grayii</i>			
481.	25296	<i>Demansia psammophis</i> subsp. <i>reticulata</i> (Yellow-faced Whipsnake)			
482.	25325	<i>Dendrelaphis punctulata</i> (Green Tree Snake)			
483.		<i>Dermocybe clelandii</i>			
484.	38784	<i>Descomyces albus</i>			
485.	17691	<i>Desmocladius fasciculatus</i>			
486.	46362	<i>Desmocladius lateriflorus</i>			
487.	11636	<i>Dianella revoluta</i> var. <i>divaricata</i>			
488.		<i>Diaphanosoma</i> sp.			
489.	25607	<i>Dicaeum hirundinaceum</i> (Mistletoebird)			
490.	1287	<i>Dichopogon capillipes</i>			
491.	17838	<i>Dielsia stenostachya</i>			
492.		<i>Dingosa murata</i>			
493.		<i>Dingosa serrata</i>			
494.	1509	<i>Dioscorea hastifolia</i> (Warrine, Warram)			
495.	24939	<i>Diplodactylus polyophthalmus</i>			
496.	18589	<i>Diplopeltis huegelii</i> subsp. <i>lehmannii</i>			
497.	3867	<i>Dipogon lignosus</i> (Dolichos Pea)	Y		
498.		<i>Diptera</i> sp.			
499.	19649	<i>Disa bracteata</i>	Y		
500.	32347	<i>Ditrichum difficile</i>			
501.	7961	<i>Ditrichia graveolens</i> (Stinkwort)	Y		
502.	11049	<i>Diuris corymbosa</i>			
503.	1634	<i>Diuris laxiflora</i> (Bee Orchid)			
504.		<i>Dolichopodidae</i> sp.			
505.	15406	<i>Drakaea gracilis</i>			
506.	3095	<i>Drosera erythrorhiza</i> (Red Ink Sundew)			
507.	13217	<i>Drosera erythrorhiza</i> subsp. <i>erythrorhiza</i>			
508.	3097	<i>Drosera gigantea</i> (Giant Sundew)			
509.	15453	<i>Drosera gigantea</i> subsp. <i>gigantea</i>			
510.	3098	<i>Drosera glanduligera</i> (Pimpernel Sundew)			
511.	13195	<i>Drosera helodes</i>			
512.	3101	<i>Drosera heterophylla</i> (Swamp Rainbow)			
513.	3105	<i>Drosera leucoblata</i> (Wheel Sundew)			
514.	3106	<i>Drosera macrantha</i> (Bridal Rainbow)			
515.	14298	<i>Drosera macrantha</i> subsp. <i>macrantha</i>			
516.	3109	<i>Drosera menziesii</i> (Pink Rainbow)			
517.	11853	<i>Drosera menziesii</i> subsp. <i>menziesii</i>			
518.	13216	<i>Drosera menziesii</i> subsp. <i>penicillaris</i>			
519.	11768	<i>Drosera neesii</i> subsp. <i>neesii</i>			

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520.	3115	<i>Drosera occidentalis</i> (Western Sundew)			
521.	3117	<i>Drosera paleacea</i> (Dwarf Sundew)			
522.	29178	<i>Drosera porrecta</i>			
523.	3125	<i>Drosera pycnoblata</i> (Pearly Sundew)			
524.	3128	<i>Drosera ramellosa</i> (Branched Sundew)			
525.	8911	<i>Drosera rosulata</i>			
526.	3131	<i>Drosera stolonifera</i> (Leafy Sundew)			
527.	13205	<i>Drosera tubaestylis</i>			
528.	3135	<i>Drosera zonaria</i> (Painted Sundew)			
529.		<i>Dunhevedia crassa</i>			
530.	33500	<i>Dysphania ambrosioides</i> (Mexican Tea)	Y		
531.		<i>Dytiscidae</i> sp.			
532.	7374	<i>Ecballium elaterium</i> (Squirting Cucumber)	Y		
533.	328	<i>Echinochloa colona</i> (Awnless Barnyard Grass)	Y		
534.	11105	<i>Echinochloa crus-galli</i>	Y		
535.	329	<i>Echinochloa crus-pavonis</i> (South American Barnyard Grass)	Y		
536.	337	<i>Echinochloa pyramidalis</i> (Antelope Grass)	Y		
537.	8450	<i>Eclipta prostrata</i>	Y		
538.	25100	<i>Egernia napoleonis</i>			
539.		<i>Egretta garzetta</i>			
540.		<i>Egretta novaehollandiae</i>			
541.	347	<i>Ehrharta calycina</i> (Perennial Veldt Grass)	Y		
542.	349	<i>Ehrharta longiflora</i> (Annual Veldt Grass)	Y		
543.		<i>Elanus axillaris</i>			
544.	24290	<i>Elanus caeruleus</i> subsp. <i>axillaris</i> (Australian Black-shouldered Kite)			
545.	5187	<i>Elatine gratioloides</i> (Waterwort)			
546.	822	<i>Eleocharis acuta</i> (Common Spikerush)			
547.	352	<i>Eleusine coracan</i> (Indian Millet)	Y		
548.	353	<i>Eleusine indica</i> (Crowsfoot Grass)	Y		
549.	47937	<i>Elseyonis melanops</i> (Black-fronted Dotterel)			
550.	1643	<i>Elythranthera brunonis</i> (Purple Enamel Orchid)			
551.	39030	<i>Enerthenema papillatum</i>			
552.		<i>Eolophus roseicapillus</i>			
553.	24651	<i>Eopsaltria australis</i> subsp. <i>griseogularis</i> (Western Yellow Robin)			
554.		<i>Ephydriidae</i> sp.			
555.	1645	<i>Epiblema grandiflorum</i> (Babe-in-a-cradle)			
556.	6133	<i>Epilobium hirtigerum</i> (Hairy Willow Herb)			
557.	14289	<i>Epilobium tetragonum</i> subsp. <i>tetragonum</i>	Y		
558.	376	<i>Eragrostis curvula</i> (African Lovegrass)	Y		
559.	379	<i>Eragrostis elongata</i> (Clustered Lovegrass)			
560.	5540	<i>Eremaea fimbriata</i>			
561.	14103	<i>Eremaea pauciflora</i> var. <i>calyptra</i>			
562.	14104	<i>Eremaea pauciflora</i> var. <i>pauciflora</i>			
563.	15414	<i>Eriochilus helonomos</i>			
564.		<i>Eriophora biapicata</i>			
565.	6219	<i>Eryngium pinnatifidum</i> (Blue Devils)			
566.	18299	<i>Erythrina x sykesii</i>	Y		
567.	24379	<i>Erythronys cinctus</i> (Red-kneed Dotterel)			
568.	5580	<i>Eucalyptus camaldulensis</i> (River Gum, Yabalinyba)			
569.	5708	<i>Eucalyptus marginata</i> (Jarrah, Djara)			
570.	13547	<i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah)			
571.	5763	<i>Eucalyptus rudis</i> (Flooded Gum, Kulurda)			
572.	13511	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>			
573.	5797	<i>Eucalyptus wandoo</i> (Wandoo, Wondou)			
574.	3872	<i>Euchilopsis linearis</i> (Swamp Pea)			
575.		<i>Euchlanis</i> sp.			
576.	4648	<i>Euphorbia terracina</i> (Geraldton Carnation Weed)	Y		
577.		<i>Eupograptus kottae</i>			
578.		<i>Eurytion incisunguis</i>			Y
579.	3880	<i>Eutaxia virgata</i>			
580.		<i>Eylais</i> sp.			
581.	25621	<i>Falco berigora</i> (Brown Falcon)			
582.	25622	<i>Falco cenchroides</i> (Australian Kestrel, Nankeen Kestrel)			
583.	24472	<i>Falco cenchroides</i> subsp. <i>cenchrus</i> (Australian Kestrel, Nankeen Kestrel)			
584.	25623	<i>Falco longipennis</i> (Australian Hobby)			
585.	24041	<i>Felis catus</i> (Cat)	Y		
586.	32368	<i>Fissidens taylorii</i>			
587.	32469	<i>Fissidens taylorii</i> var. <i>taylorii</i>			
588.	27748	<i>Flavoparmelia rutidota</i>			
589.		<i>Fomitopsis lilacinogilva</i>			

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590.	25727	<i>Fulica atra</i> (Eurasian Coot)			
591.	24761	<i>Fulica atra</i> subsp. <i>australis</i> (Eurasian Coot)			
592.	39033	<i>Fuligo septica</i>			
593.	8365	<i>Fumaria bastardii</i>	Y		
594.	31532	<i>Fumaria muralis</i> subsp. <i>muralis</i>	Y		
595.		<i>Fumaria</i> sp.			
596.	32370	<i>Funaria hygrometrica</i>			
597.	907	<i>Gahnia trifida</i> (Coast Saw-sedge)			
598.	34028	<i>Galaxias occidentalis</i> (Western Minnow)			
599.	7321	<i>Galium divaricatum</i>	Y		
600.	25729	<i>Gallinula tenebrosa</i> (Dusky Moorhen)			
601.	24763	<i>Gallinula tenebrosa</i> subsp. <i>tenebrosa</i> (Dusky Moorhen)			
602.	25730	<i>Gallirallus philippensis</i> (Buff-banded Rail)			
603.	24765	<i>Gallirallus philippensis</i> subsp. <i>mellori</i> (Buff-banded Rail)			
604.		<i>Gallus gallus</i>			
605.	3887	<i>Gastrolobium acutum</i>			
606.	20475	<i>Gastrolobium capitatum</i>			
607.	20483	<i>Gastrolobium linearifolium</i>			
608.	3923	<i>Gastrolobium spathulatum</i> (Poison Bush)			
609.	16311	<i>Gazania linearis</i>	Y		
610.	32375	<i>Gemmabryum chrysoneuron</i>			
611.	32376	<i>Gemmabryum dichotomum</i>			
612.	32380	<i>Gemmabryum pachythemum</i>			
613.	25530	<i>Gerygone fusca</i> (Western Gerygone)			
614.	24271	<i>Gerygone fusca</i> subsp. <i>fusca</i> (Western Gerygone)			
615.		<i>Glacidorbidae</i> sp.			Y
616.	1518	<i>Gladiolus angustus</i> (Long Tubed Painted Lady)	Y		
617.	18298	<i>Gladiolus carneus</i>	Y		
618.	1520	<i>Gladiolus caryophyllaceus</i> (Wild Gladiolus)	Y		
619.	6143	<i>Glischrocaryon aureum</i> (Common Popflower)			
620.	17043	<i>Glyceria declinata</i>	Y		
621.	47962	<i>Glyciphila melanops</i> (Tawny-crowned Honeyeater)			
622.		<i>Glyptophysa</i> sp.			
623.	6587	<i>Gomphocarpus fruticosus</i> (Narrowleaf Cottonbush)	Y		
624.	10909	<i>Gompholobium confertum</i>			
625.	3950	<i>Gompholobium knightianum</i>			
626.	3951	<i>Gompholobium marginatum</i>			
627.	3956	<i>Gompholobium shuttleworthii</i>			
628.	3957	<i>Gompholobium tomentosum</i> (Hairy Yellow Pea)			
629.	6149	<i>Gonocarpus cordiger</i>			
630.	6159	<i>Gonocarpus nodulosus</i>			
631.	6160	<i>Gonocarpus paniculatus</i>			
632.	6161	<i>Gonocarpus pithyoides</i>			
633.	29362	<i>Goodenia coerulea</i>			
634.	12520	<i>Goodenia fasciculata</i>			
635.	7517	<i>Goodenia incana</i> (Hoary Goodenia)			
636.	12551	<i>Goodenia micrantha</i>			
637.	7538	<i>Goodenia pulchella</i>			
638.	19286	<i>Goodenia pulchella</i> subsp. <i>Coastal Plain A</i> (M. Hislop 634)			
639.	19284	<i>Goodenia pulchella</i> subsp. <i>Coastal Plain B</i> (L.W. Sage 2336)			
640.	24443	<i>Grallina cyanoleuca</i> (Magpie-lark)			
641.	14282	<i>Gratiola pubescens</i>			
642.	1964	<i>Grevillea bipinnatifida</i> (Fuchsia Grevillea)			
643.	19628	<i>Grevillea bipinnatifida</i> subsp. <i>bipinnatifida</i>			
644.	1997	<i>Grevillea endlicheriana</i> (Spindly Grevillea)			
645.	2066	<i>Grevillea pilulifera</i> (Woolly-flowered Grevillea)			
646.	15839	<i>Grevillea preissii</i> subsp. <i>preissii</i>			
647.	2107	<i>Grevillea thelemanniana</i> (Spider Net Grevillea)			
648.		<i>Griopterygidae</i> sp.			
649.		<i>Gymnopilus purpuratus</i>			
650.	1464	<i>Haemodorum brevisepalum</i>			
651.	1465	<i>Haemodorum discolor</i>			
652.	1468	<i>Haemodorum laxum</i>			
653.	1472	<i>Haemodorum simplex</i>			
654.	1474	<i>Haemodorum sparsiflorum</i>			
655.	1475	<i>Haemodorum spicatum</i> (Mardja)			
656.	2136	<i>Hakea candolleana</i>			
657.	2137	<i>Hakea ceratophylla</i> (Horned Leaf Hakea)			
658.	2143	<i>Hakea conchifolia</i> (Shell-leaved Hakea)			
659.	2158	<i>Hakea erinacea</i> (Hedge-hog Hakea)			

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660.	2166	<i>Hakea incrassata</i> (Marble Hakea)			
661.	2175	<i>Hakea lissocarpha</i> (Honey Bush)			
662.	2185	<i>Hakea myrtoides</i> (Myrtle Hakea)			
663.	2197	<i>Hakea prostrata</i> (Harsh Hakea)			
664.	2203	<i>Hakea ruscifolia</i> (Candle Hakea)			
665.	31793	<i>Hakea</i> sp. Eastern coastal plain (G.J. Keighery 8014)			
666.	2212	<i>Hakea sulcata</i> (Furrowed Hakea)			
667.	2214	<i>Hakea trifurcata</i> (Two-leaf Hakea)			
668.	2215	<i>Hakea undulata</i> (Wavy-leaved Hakea)			
669.	2216	<i>Hakea varia</i> (Variable-leaved Hakea)			
670.	24295	<i>Haliastur sphenurus</i> (Whistling Kite)			
671.		<i>Haliplus gibbus</i>			
672.	3961	<i>Hardenbergia comptoniana</i> (Native Wisteria)			
673.		<i>Hebridae</i> sp.			
674.	25410	<i>Heleioporus eyrei</i> (Moaning Frog)			
675.	25412	<i>Heleioporus psammophilus</i> (Sand Frog)			
676.	8008	<i>Helianthus annuus</i> (Sunflower, Common Sunflower)	Y		
677.	3016	<i>Heliophila pusilla</i>	Y		
678.		<i>Hemianax papuensis</i>			
679.	16933	<i>Hemiandra glabra</i>			
680.	6839	<i>Hemiandra pungens</i> (Snakebush)			
681.		<i>Hemicordulia tau</i>			
682.		<i>Hemicorduliidae</i> sp.			
683.	25115	<i>Hemiergis initialis</i> subsp. <i>initialis</i>			
684.	25119	<i>Hemiergis quadrilineata</i>			
685.	6856	<i>Hemigenia incana</i> (Silky Hemigenia)			
686.	41020	<i>Hemiphora bartlingii</i> (Woolly Dragon)			
687.	1526	<i>Hesperantha falcata</i>	Y		
688.	24961	<i>Heteronotia binoei</i> (Bynoe's Gecko)			
689.	5112	<i>Hibbertia aurea</i>			
690.	5114	<i>Hibbertia commutata</i>			
691.	19778	<i>Hibbertia glomerata</i> subsp. <i>darlingensis</i>			
692.	5134	<i>Hibbertia huegelii</i>			
693.	5135	<i>Hibbertia hypericoides</i> (Yellow Buttercups)			
694.	45534	<i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i>			
695.	5148	<i>Hibbertia mylnei</i>			
696.	5152	<i>Hibbertia ovata</i>			
697.	5162	<i>Hibbertia racemosa</i> (Stalked Guinea Flower)			
698.	5169	<i>Hibbertia serrata</i> (Serrate Leaved Guinea Flower)			
699.	5171	<i>Hibbertia spicata</i>			
700.	11481	<i>Hibbertia spicata</i> subsp. <i>spicata</i>			
701.	47965	<i>Hieraaetus morphnoides</i> (Little Eagle)			
702.	25734	<i>Himantopus himantopus</i> (Black-winged Stilt)			
703.	24491	<i>Hirundo neoxena</i> (Welcome Swallow)			
704.		<i>Hogna crispipes</i>			
705.		<i>Holasteron perth</i>			
706.		<i>Holasteron wamuseum</i>			Y
707.	6222	<i>Homalosciadium homalocarpum</i>			
708.	3966	<i>Hovea pungens</i> (Devil's Pins, Puyenak)			
709.	3968	<i>Hovea trisperma</i> (Common Hovea)			
710.	12859	<i>Hovea trisperma</i> var. <i>trisperma</i>			
711.	12741	<i>Hyalosperma cotula</i>			
712.	5216	<i>Hybanthus calycinus</i> (Wild Violet)			
713.	6223	<i>Hydrocotyle alata</i>			
714.	6226	<i>Hydrocotyle callicarpa</i> (Small Pennywort)			
715.	6229	<i>Hydrocotyle diantha</i>			
716.	6238	<i>Hydrocotyle ranunculoides</i>	Y		
717.		<i>Hydrophilidae</i> sp.			
718.		<i>Hygrocybe astatogala</i>			Y
719.	452	<i>Hyparrhenia hirta</i> (Tambookie Grass)	Y		
720.	5817	<i>Hypocalymma angustifolium</i> (White Myrtle, Kudjid)			
721.	35070	<i>Hypocalymma angustifolium</i> subsp. <i>Swan Coastal Plain</i> (G.J. Keighery 16777)			
722.	5825	<i>Hypocalymma robustum</i> (Swan River Myrtle)			
723.	8086	<i>Hypochaeris glabra</i> (Smooth Catsear)	Y		
724.	1070	<i>Hypolaena exsulca</i>			
725.	17841	<i>Hypolaena pubescens</i>			
726.		<i>Idiommatia blackwalli</i>			
727.		<i>Ilyocyptus</i> sp.			
728.		<i>Ilyodromus</i> sp.			
729.		<i>Isidorella</i> sp.			

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730.	910	<i>Isolepis cernua</i> (Nodding Club-rush)			
731.	20199	<i>Isolepis cernua</i> var. <i>cernua</i>			
732.	20200	<i>Isolepis cernua</i> var. <i>setiformis</i>			
733.	912	<i>Isolepis cyperoides</i>			
734.	14540	<i>Isolepis hystrix</i>	Y		
735.	917	<i>Isolepis marginata</i> (Coarse Club-rush)			
736.	919	<i>Isolepis oldfieldiana</i>			
737.		<i>Isopeda leishmanni</i>			
738.	2221	<i>Isopogon asper</i>			
739.	2229	<i>Isopogon dubius</i> (Pincushion Coneflower)			
740.	2237	<i>Isopogon sphaerocephalus</i> (Drumstick Isopogon)			
741.	7398	<i>Isotoma pusilla</i> (Small Isotome)			
742.	3992	<i>Isotropis cuneifolia</i> (Granny Bonnets)			
743.	3997	<i>Jacksonia alata</i>			
744.	3998	<i>Jacksonia angulata</i>			
745.	4010	<i>Jacksonia floribunda</i> (Holly Pea)			
746.	4012	<i>Jacksonia furcellata</i> (Grey Stinkwood)			
747.	4018	<i>Jacksonia lehmannii</i>			
748.	4025	<i>Jacksonia restioides</i>			
749.	4029	<i>Jacksonia sternbergiana</i> (Stinkwood, Kapur)			
750.	1298	<i>Johnsonia pubescens</i> (Pipe Lily)			
751.	19632	<i>Johnsonia pubescens</i> subsp. <i>pubescens</i>			
752.	20454	<i>Juncus acutus</i> subsp. <i>acutus</i>	Y		
753.	1180	<i>Juncus capitatus</i> (Capitate Rush)	Y		
754.	1188	<i>Juncus pallidus</i> (Pale Rush)			
755.	1196	<i>Juncus usitatus</i> (Common Rush)	Y		
756.		<i>Kangarosa properipes</i>			
757.	4044	<i>Kennedia prostrata</i> (Scarlet Runner)			
758.	12008	<i>Kickxia elatine</i> subsp. <i>crinita</i>	Y		
759.	1221	<i>Kingia australis</i> (Kingia, Pulonok)			
760.	5832	<i>Kunzea ericifolia</i> (Spearwood, Pondil)			
761.	5835	<i>Kunzea micrantha</i>			
762.	17461	<i>Kunzea micrantha</i> subsp. <i>micrantha</i>			
763.	3669	<i>Labichea punctata</i> (Lance-leaved Cassia)			
764.	20019	<i>Lachnagrostis filiformis</i>			
765.	19955	<i>Lachnagrostis plebeia</i>			
766.		<i>Lacrimicypris "drummondii" n.sp. (SAP)</i>			
767.		<i>Lactarius clarkeae</i>			
768.	38804	<i>Lactarius eucalypti</i>			
769.	2249	<i>Lambertia multiflora</i> (Many-flowered Honeysuckle)			
770.	14083	<i>Lambertia multiflora</i> var. <i>darlingensis</i>			
771.		<i>Lampona cylindrata</i>			
772.	28342	<i>Landoltia punctata</i> (Thin Duckweed)			
773.	6733	<i>Lantana camara</i> (Common Lantana)	Y		
774.		<i>Latonopsis brehmi</i>			
775.	4052	<i>Latrobea tenella</i>			
776.		<i>Latrodictus hasseltii</i>			
777.	4959	<i>Lawrencia squamata</i>			
778.	1307	<i>Laxmannia ramosa</i> (Branching Lily)			
779.	11911	<i>Laxmannia ramosa</i> subsp. <i>ramosa</i>			
780.	11464	<i>Laxmannia sessiliflora</i> subsp. <i>australis</i>			
781.	1309	<i>Laxmannia squarrosa</i>			
782.		<i>Leberis aenigmatica</i>			
783.	7568	<i>Lechenaultia biloba</i> (Blue Leschenaultia)			
784.	1051	<i>Lemna disperma</i> (Duckweed)			
785.	925	<i>Lepidosperma angustatum</i>			
786.	42741	<i>Lepidosperma apricola</i>			
787.	936	<i>Lepidosperma leptostachyum</i>			
788.	937	<i>Lepidosperma longitudinale</i> (Pithy Sword-sedge)			
789.	940	<i>Lepidosperma pubisquamum</i>			
790.	944	<i>Lepidosperma scabrum</i>			
791.		<i>Lepidosperma</i> sp.			
792.	29150	<i>Lepidosperma</i> sp. Margaret River (B.J. Lepschi 1841)			
793.	16284	<i>Lepidosperma</i> sp. P1 small head (M.D. Tindale 166A)			
794.	118	<i>Lepilaena australis</i> (Austral Water Mat)			
795.	1653	<i>Leporella fimbriata</i> (Hare Orchid)			
796.	1077	<i>Leptocarpus canus</i> (Hoary Twine-rush)			
797.	1078	<i>Leptocarpus coangustatus</i>			
798.	46375	<i>Leptocarpus decipiens</i>			
799.	1080	<i>Leptocarpus scariosus</i>			

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800.	<i>Leptoceridae</i> sp.			
801.	2342 <i>Leptomeria cunninghamii</i>			
802.	1085 <i>Lepyrodia glauca</i>			
803.	1088 <i>Lepyrodia macra</i> (Large Scale Rush)			
804.	1090 <i>Lepyrodia muirii</i>			
805.	25131 <i>Lerista distinguenda</i>			
806.	25133 <i>Lerista elegans</i>			
807.	6374 <i>Leucopogon conostephioides</i>			
808.	6397 <i>Leucopogon glaucifolius</i>			
809.	6427 <i>Leucopogon parviflorus</i> (Coast Beard-heath)			
810.	6439 <i>Leucopogon pulchellus</i> (Beard-heath)			
811.	6444 <i>Leucopogon sprengelioides</i>			
812.	6445 <i>Leucopogon squarrosus</i>			
813.	40803 <i>Leucopogon squarrosus</i> subsp. <i>squarrosus</i>			
814.	7676 <i>Levenhookia pusilla</i> (Midget Stylewort)			
815.	7677 <i>Levenhookia stipitata</i> (Common Stylewort)			
816.	25005 <i>Lialis burtonis</i>			
817.	<i>Libellulidae</i> sp.			
818.	25661 <i>Lichmera indistincta</i> (Brown Honeyeater)			
819.	24582 <i>Lichmera indistincta</i> subsp. <i>indistincta</i> (Brown Honeyeater)			
820.	<i>Limnodynastes shuckhardi</i>			
821.	<i>Limnodynastes</i> sp.			
822.	<i>Limnodynastes australis</i>			
823.	25415 <i>Limnodynastes dorsalis</i> (Western Banjo Frog)			
824.	<i>Limnodynastes vestitus</i> (V41)			
825.	4363 <i>Linum trigynum</i> (French Flax)	Y		
826.	36160 <i>Liparophyllum capitatum</i>			
827.	25378 <i>Litoria adelaidensis</i> (Slender Tree Frog)			
828.	25388 <i>Litoria moorei</i> (Motorbike Frog)			
829.	9289 <i>Lobelia anceps</i> (Angled Lobelia)			
830.	7407 <i>Lobelia rhytidosperra</i> (Wrinkled-seeded Lobelia)			
831.	475 <i>Lolium multiflorum</i> (Italian Ryegrass)	Y		
832.	11384 <i>Lolium temulentum</i> forma <i>temulentum</i>	Y		
833.	11073 <i>Lolium x hybridum</i>	Y		
834.	1223 <i>Lomandra caespitosa</i> (Tufted Mat Rush)			
835.	1228 <i>Lomandra hermaphrodita</i>			
836.	1229 <i>Lomandra integra</i>			
837.	1232 <i>Lomandra micrantha</i> (Small-flower Mat-rush)			
838.	14542 <i>Lomandra micrantha</i> subsp. <i>micrantha</i>			
839.	1234 <i>Lomandra nigricans</i>			
840.	1236 <i>Lomandra odora</i> (Tiered Matrush)			
841.	1239 <i>Lomandra preissii</i>			
842.	1240 <i>Lomandra purpurea</i> (Purple Mat Rush)			
843.	1243 <i>Lomandra sericea</i> (Silky Mat Rush)			
844.	1246 <i>Lomandra suaveolens</i>			
845.	<i>Longepi woodman</i>			
846.	<i>Lophocytinia isura</i>			
847.	8564 <i>Lotus subbiflorus</i>	Y		
848.	4066 <i>Lupinus cosentinii</i>	Y		
849.	4067 <i>Lupinus luteus</i> (Yellow Lupin)	Y		
850.	1097 <i>Lyginia barbata</i>			
851.	18049 <i>Lyginia imberbis</i>			
852.	<i>Lynceus</i> sp.			
853.	36375 <i>Lysimachia arvensis</i> (Pimpernel)	Y		
854.	36373 <i>Lysimachia minima</i>	Y		
855.	6456 <i>Lysinema ciliatum</i> (Curry Flower)			
856.	34736 <i>Lysinema pentapetalum</i>			
857.	5281 <i>Lythrum hyssopifolia</i> (Lesser Loosestrife)	Y		
858.	2839 <i>Macarthuria australis</i>			
859.	24132 <i>Macropus fuliginosus</i> (Western Grey Kangaroo)			
860.	<i>Macrothrix</i> sp.			
861.	24326 <i>Malacorhynchus membranaceus</i> (Pink-eared Duck)			
862.	25650 <i>Malurus elegans</i> (Red-winged Fairy-wren)			
863.	24551 <i>Malurus pulcherrimus</i> (Blue-breasted Fairy-wren)			
864.	25654 <i>Malurus splendens</i> (Splendid Fairy-wren)			
865.	24552 <i>Malurus splendens</i> subsp. <i>splendens</i> (Splendid Fairy-wren)			
866.	24583 <i>Manorina flavigula</i> (Yellow-throated Miner)			
867.	<i>Maratus pavonis</i>			
868.	<i>Maraura macracantha</i> (formerly <i>Alona macracantha</i>)			
869.	4079 <i>Medicago polymorpha</i> (Burr Medic)	Y		

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870.	4080	<i>Medicago sativa</i> (Alfalfa)	Y		
871.	25758	<i>Megalurus gramineus</i> (Little Grassbird)			
872.		<i>Megaporus</i> sp.			
873.	20639	<i>Megathyrsus maximus</i> var. <i>maximus</i>	Y		
874.	34676	<i>Meionectes brownii</i> (Swamp Raspwort)			
875.	37580	<i>Melaleuca acutifolia</i>			
876.	5881	<i>Melaleuca brevifolia</i>			
877.	40780	<i>Melaleuca citrina</i>	Y		
878.	13273	<i>Melaleuca incana</i> subsp. <i>incana</i>			
879.	5926	<i>Melaleuca lateritia</i> (Robin Redbreast Bush)			
880.	5932	<i>Melaleuca leucadendra</i>			
881.	20297	<i>Melaleuca osullivanii</i>			
882.	18394	<i>Melaleuca parviceps</i>			
883.	5952	<i>Melaleuca preissiana</i> (Moonah)			
884.	5958	<i>Melaleuca radula</i> (Graceful Honeymyrtle)			
885.	5959	<i>Melaleuca raphiophylla</i> (Swamp Paperbark)			
886.	5961	<i>Melaleuca scabra</i> (Rough Honeymyrtle, Wurru Bush)			
887.	5964	<i>Melaleuca seriata</i>			
888.	5987	<i>Melaleuca viminea</i> (Mohan)			
889.	13280	<i>Melaleuca viminea</i> subsp. <i>viminea</i>			
890.	4516	<i>Melia azedarach</i> (White Cedar)			
891.	14985	<i>Melinis repens</i>	Y		
892.	25663	<i>Melithreptus brevirostris</i> (Brown-headed Honeyeater)			
893.	24587	<i>Melithreptus chloropsis</i> (Western White-naped Honeyeater)			
894.	25184	<i>Menetia greyii</i>			
895.		<i>Mesocyclops brooksi</i>			
896.	955	<i>Mesomelaena pseudostygia</i>			
897.	957	<i>Mesomelaena tetragona</i> (Semaphore Sedge)			
898.		<i>Microcarbo melanoleucos</i>			
899.		<i>Microcyclops varicans</i>			
900.	485	<i>Microlaena stipoides</i> (Weeping Grass)			
901.	1658	<i>Microtis atrata</i> (Swamp Mignonette Orchid)			
902.	15419	<i>Microtis media</i> subsp. <i>media</i>			
903.		<i>Microvelia</i> sp.			
904.	8106	<i>Millotia tenuifolia</i> (Soft Millotia)			
905.	14344	<i>Millotia tenuifolia</i> var. <i>tenuifolia</i> (Soft Millotia)			
906.	4097	<i>Mirbelia ramulosa</i>			
907.	4100	<i>Mirbelia spinosa</i>			
908.		<i>Missulena granulosa</i>			
909.		<i>Missulena occatoria</i>			
910.		<i>Mituliodon tarantulinus</i>			
911.		<i>Mitzoruga insularis</i>			
912.	4963	<i>Modiola caroliniana</i>	Y		
913.		<i>Monohelea</i> sp. 1 (SAP)			
914.		<i>Monohelea</i> sp. 2 (SAP)			
915.	7410	<i>Monopsis debilis</i>	Y		
916.	37440	<i>Monopsis debilis</i> var. <i>depressa</i>	Y		
917.	4662	<i>Monotaxis grandiflora</i> (Diamond of the Desert)			
918.	19585	<i>Monotaxis grandiflora</i> var. <i>grandiflora</i>			
919.	19179	<i>Moraea flaccida</i> (One-leaf Cape Tulip)	Y		
920.	19178	<i>Moraea lewisiae</i>	Y		
921.	19438	<i>Moraea ochroleuca</i>	Y		
922.	1536	<i>Moraea vegeta</i>	Y		
923.	25240	<i>Morelia spilota</i> subsp. <i>imbricata</i> (Carpet Python)			
924.	25192	<i>Morethia obscura</i>			
925.	24223	<i>Mus musculus</i> (House Mouse)	Y		
926.		<i>Myandra bicincta</i>			
927.		<i>Myandra cambridgei</i>			
928.	25420	<i>Myobatrachus gouldii</i> (Turtle Frog)			
929.	14187	<i>Myriocephalus occidentalis</i>			
930.	6189	<i>Myriophyllum crispatum</i>			
931.		<i>Nannoperca vittata</i>			
932.	44496	<i>Narcissus tazetta</i> subsp. <i>italicus</i>	Y		
933.	44495	<i>Narcissus tazetta</i> subsp. <i>tazetta</i>	Y		
934.	25248	<i>Neelaps bimaculatus</i> (Black-naped Snake)			
935.		<i>Nematoda</i> sp.			
936.	24738	<i>Neophema elegans</i> (Elegant Parrot)			
937.	24739	<i>Neophema petrophila</i> (Rock Parrot)			
938.		<i>Nephila edulis</i>			
939.	492	<i>Neurachne alopecuroidea</i> (Foxtail Mulga Grass)			

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940.	<i>Nicodamus mainae</i>			
941.	25252 <i>Notechis scutatus</i> (Tiger Snake)			
942.	1381 <i>Nothoscordum gracile</i>	Y		
943.	<i>Notiasemus glauerti</i>			
944.	<i>Notonectidae</i> sp.			
945.	2401 <i>Nuytsia floribunda</i> (Christmas Tree, Mudja)			
946.	25564 <i>Nycticorax caledonicus</i> (Rufous Night Heron)			
947.	2923 <i>Nymphaea odorata</i> (Fragrant Waterlily)	Y		
948.	24407 <i>Ocyphaps lophotes</i> (Crested Pigeon)			
949.	6138 <i>Oenothera drummondii</i> (Beach Evening Primrose)	Y		
950.	16390 <i>Oenothera drummondii</i> subsp. <i>drummondii</i>	Y		
951.	20052 <i>Oenothera jamesii</i>	Y		
952.	16347 <i>Oenothera laciniata</i>	Y		
953.	6140 <i>Oenothera mollissima</i>	Y		
954.	6142 <i>Oenothera stricta</i> (Common Evening Primrose)	Y		
955.	14292 <i>Oenothera stricta</i> subsp. <i>stricta</i>	Y		
956.	2365 <i>Olax benthamiana</i>			
957.	2367 <i>Olax scalariformis</i>			
958.	8127 <i>Olearia axillaris</i> (Coastal Daisybush)			
959.	8143 <i>Olearia paucidentata</i> (Autumn Scrub Daisy)			
960.	<i>Oligochaeta</i> sp.			
961.	38816 <i>Omphalotus nidiformis</i>			
962.	<i>Onychohydrus</i> sp.			
963.	18254 <i>Opercularia apiciflora</i>			
964.	18255 <i>Opercularia vaginata</i> (Dog Weed)			
965.	5227 <i>Opuntia stricta</i> (Common Prickly Pear)	Y		
966.	<i>Oribatida</i> sp.			
967.	36177 <i>Ornduffia albiflora</i>			
968.	<i>Orthocladinae</i> sp.			
969.	<i>Orthocladinae</i> sp. C = V44 <i>Gymnometricnemus</i> (SAP)			
970.	11749 <i>Orthrosanthus laxus</i> var. <i>laxus</i> (Morning Iris)			
971.	168 <i>Ottelia ovalifolia</i> (Swamp Lily)			
972.	14531 <i>Ottelia ovalifolia</i> subsp. <i>ovalifolia</i>			
973.	4348 <i>Oxalis caprina</i>	Y		
974.	4349 <i>Oxalis corniculata</i> (Yellow Wood Sorrel)	Y		
975.	4352 <i>Oxalis glabra</i>	Y		
976.	4356 <i>Oxalis pes-caprae</i> (Soursob)	Y		
977.	4358 <i>Oxalis purpurea</i> (Largeflower Wood Sorrel)	Y		
978.	25680 <i>Pachycephala rufiventris</i> (Rufous Whistler)			
979.	24624 <i>Pachycephala rufiventris</i> subsp. <i>rufiventris</i> (Rufous Whistler)			
980.	<i>Palaemonidae</i> sp.			
981.	<i>Pandion cristatus</i>			
982.	20101 <i>Paragonis grandiflora</i>			
983.	<i>Paramerina levidensis</i>			
984.	<i>Paramphisopus palustris</i>			
985.	25253 <i>Parasuta gouldii</i>			
986.	25681 <i>Pardalotus punctatus</i> (Spotted Pardalote)			
987.	25682 <i>Pardalotus striatus</i> (Striated Pardalote)			
988.	24628 <i>Pardalotus striatus</i> subsp. <i>murchisoni</i> (Striated Pardalote)			
989.	7089 <i>Parentucellia latifolia</i> (Common Bartsia)	Y		
990.	7090 <i>Parentucellia viscosa</i> (Sticky Bartsia)	Y		
991.	527 <i>Paspalum dilatatum</i>	Y		
992.	528 <i>Paspalum distichum</i> (Water Couch)	Y		
993.	532 <i>Paspalum urvillei</i> (Vasey Grass)	Y		
994.	1546 <i>Patersonia juncea</i> (Rush Leaved Patersonia)			
995.	1550 <i>Patersonia occidentalis</i> (Purple Flag, Koma)			
996.	30472 <i>Patersonia occidentalis</i> var. <i>occidentalis</i>			
997.	43760 <i>Pauridia occidentalis</i>			
998.	43761 <i>Pauridia occidentalis</i> var. <i>occidentalis</i>			
999.	24648 <i>Pelecanus conspicillatus</i> (Australian Pelican)			
1000.	40424 <i>Pentameris airoides</i> subsp. <i>airoides</i>	Y		
1001.	40422 <i>Pentameris pallida</i>	Y		
1002.	16478 <i>Pericalymma ellipticum</i> var. <i>floridum</i>			
1003.	13911 <i>Persicaria decipiens</i>			
1004.	2255 <i>Persoonia angustiflora</i>			
1005.	2262 <i>Persoonia elliptica</i> (Spreading Snottygobble)			
1006.	2273 <i>Persoonia saccata</i> (Snottygobble)			
1007.	48060 <i>Petrochelidon ariel</i> (Fairy Martin)			
1008.	48061 <i>Petrochelidon nigricans</i> (Tree Martin)			
1009.	48066 <i>Petroica boodang</i> (Scarlet Robin)			

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1010.	24659	<i>Petroica goodenovii</i> (Red-capped Robin)			
1011.	2284	<i>Petrophile biloba</i> (Granite Petrophile)			
1012.	20391	<i>Petrophile juncifolia</i>			
1013.	2299	<i>Petrophile linearis</i> (Pixie Mops)			
1014.	2301	<i>Petrophile macrostachya</i>			
1015.	2308	<i>Petrophile seminuda</i>			
1016.	2312	<i>Petrophile striata</i>			
1017.	25697	<i>Phalacrocorax carbo</i> (Great Cormorant)			
1018.	25698	<i>Phalacrocorax melanoleucos</i> (Little Pied Cormorant)			
1019.	24667	<i>Phalacrocorax sulcirostris</i> (Little Black Cormorant)			
1020.	25699	<i>Phalacrocorax varius</i> (Pied Cormorant)			
1021.	551	<i>Phalaris minor</i> (Lesser Canary Grass)	Y		
1022.	24409	<i>Phaps chalcoptera</i> (Common Bronzewing)			
1023.	20460	<i>Pheladenia deformis</i>			
1024.	18529	<i>Philothea spicata</i> (Pepper and Salt)			
1025.	1172	<i>Philydrella drummondii</i>			
1026.	1173	<i>Philydrella pygmaea</i> (Butterfly Flowers)			
1027.	14306	<i>Philydrella pygmaea</i> subsp. <i>pygmaea</i>			
1028.	1478	<i>Phlebocarya ciliata</i>			
1029.	1479	<i>Phlebocarya filifolia</i>			
1030.		<i>Phreatoicidae</i> sp.			
1031.		<i>Phryganoporus gausapatus</i> subsp. <i>occidentalis</i>			Y
1032.	48071	<i>Phylidonyris niger</i> (White-cheeked Honeyeater)			
1033.	24596	<i>Phylidonyris novaehollandiae</i> (New Holland Honeyeater)			
1034.	16825	<i>Phyllangium divergens</i>			
1035.	4675	<i>Phyllanthus calycinus</i> (False Boronia)			
1036.	4	<i>Phylloglossum drummondii</i> (Pigmy Clubmoss)			
1037.		<i>Physidae</i> sp.			
1038.		<i>Phytophthora cinnamomi</i>			
1039.	78	<i>Pilularia novae-hollandiae</i> (Austral Pillwort)			
1040.	5231	<i>Pimelea angustifolia</i> (Narrow-leaved Pimelea)			
1041.	11928	<i>Pimelea ciliata</i> subsp. <i>ciliata</i>			
1042.	11404	<i>Pimelea imbricata</i> var. <i>major</i>			
1043.	11402	<i>Pimelea imbricata</i> var. <i>piligera</i>			
1044.	12041	<i>Pimelea suaveolens</i> subsp. <i>suaveolens</i>			
1045.	5268	<i>Pimelea sulphurea</i> (Yellow Banjine)			
1046.		<i>Planicirculus alticarinatus</i>			
1047.		<i>Planorbidae</i> sp.			
1048.	7303	<i>Plantago lanceolata</i> (Ribwort Plantain)	Y		
1049.	24841	<i>Platalea flavipes</i> (Yellow-billed Spoonbill)			
1050.	24842	<i>Platalea regia</i> (Royal Spoonbill)			
1051.	25720	<i>Platycercus icterotis</i> (Western Rosella)			
1052.	24745	<i>Platycercus icterotis</i> subsp. <i>icterotis</i> (Western Rosella)			
1053.	24751	<i>Platycercus zonarius</i> subsp. <i>zonarius</i> (Port Lincoln Parrot)			
1054.	6253	<i>Platysace filiformis</i>			
1055.	25007	<i>Pletholax gracilis</i> subsp. <i>gracilis</i> (Keeled Legless Lizard)			
1056.	38825	<i>Pluteus pauperculus</i>			
1057.	571	<i>Poa annua</i> (Winter Grass)	Y		
1058.	573	<i>Poa drummondiana</i> (Knotted Poa)			
1059.	24679	<i>Podargus strigoides</i> subsp. <i>brachypterus</i> (Tawny Frogmouth)			
1060.	8175	<i>Podolepis gracilis</i> (Slender Podolepis)			
1061.	8177	<i>Podolepis lessonii</i>			
1062.	8179	<i>Podolepis nutans</i> (Nodding Podolepis)			
1063.	8182	<i>Podotheca angustifolia</i> (Sticky Longheads)			
1064.	25510	<i>Pogona minor</i> (Dwarf Bearded Dragon)			
1065.	24907	<i>Pogona minor</i> subsp. <i>minor</i> (Dwarf Bearded Dragon)			
1066.	8188	<i>Pogonolepis stricta</i>			
1067.	24681	<i>Poliocephalus poliocephalus</i> (Hoary-headed Grebe)			
1068.		<i>Polys laciniosus</i>			
1069.		<i>Polygonarea repanda</i>			Y
1070.	2416	<i>Polygonum arenastrum</i> (Sand Wireweed)	Y		
1071.	2419	<i>Polygonum aviculare</i> (Wireweed)	Y		
1072.	582	<i>Polypogon monspeliensis</i> (Annual Beardgrass)	Y		
1073.	583	<i>Polypogon tenellus</i>			
1074.	4691	<i>Poranthera microphylla</i> (Small Poranthera)			
1075.	25731	<i>Porphyrio porphyrio</i> (Purple Swamphen)			
1076.	24767	<i>Porphyrio porphyrio</i> subsp. <i>bellus</i> (Purple Swamphen)			
1077.	2884	<i>Portulaca oleracea</i> (Purslane, Wakati)			
1078.	24771	<i>Porzana tabuensis</i> (Spotless Crane)			
1079.	109	<i>Potamogeton crispus</i> (Curly Pondweed)			

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1080.	1670	<i>Prasophyllum drummondii</i> (Swamp Leek Orchid)			
1081.	1677	<i>Prasophyllum macrostachyum</i> (Laughing Leek Orchid)			
1082.	10853	<i>Prasophyllum plumiforme</i>			
1083.		<i>Procladius paludicola</i>			
1084.		<i>Procladius</i> sp. (normal claws)			
1085.	25261	<i>Pseudechis australis</i> (Mulga Snake)			
1086.	25259	<i>Pseudonaja affinis</i> subsp. <i>affinis</i> (Dugite)			
1087.	25433	<i>Pseudophryne guentheri</i> (Crawling Toadlet)			
1088.	13255	<i>Pterochaeta paniculata</i>			
1089.	24702	<i>Pterodroma brevirostris</i> (Kerguelen Petrel)			
1090.	25710	<i>Pterodroma macroptera</i> (Great-winged Petrel)			
1091.	24173	<i>Pteropus scapulatus</i> (Little Red Flying-fox)			
1092.	1693	<i>Pterostylis recurva</i> (Jug Orchid)			
1093.	12217	<i>Pterostylis sanguinea</i>			
1094.	19709	<i>Pterostylis</i> sp. <i>Helena River</i> (G. Brockman GBB 340)			
1095.	1698	<i>Pterostylis vittata</i> (Banded Greenhood)			
1096.	2716	<i>Ptilotus declinatus</i> (Curved Mulla Mulla)			
1097.	2720	<i>Ptilotus esquamatus</i>			
1098.	2742	<i>Ptilotus manglesii</i> (Pom Poms, Mulamula)			
1099.	40841	<i>Ptilotus stirlingii</i> subsp. <i>stirlingii</i>			
1100.	4172	<i>Pultenaea ericifolia</i>			
1101.	4181	<i>Pultenaea reticulata</i>			
1102.		<i>Purpureicephalus spurius</i>			
1103.		<i>Pycnopus coccineus</i>			
1104.	16367	<i>Pyrorchis nigricans</i> (Red beaks, Elephants ears)			
1105.	8195	<i>Quinetia urvillei</i>			
1106.	2933	<i>Ranunculus muricatus</i> (Sharp Buttercup)	Y		
1107.	3061	<i>Raphanus raphanistrum</i> (Wild Radish)	Y		
1108.	24243	<i>Rattus fuscipes</i> (Western Bush Rat)			
1109.	24245	<i>Rattus rattus</i> (Black Rat)	Y		
1110.		<i>Raveniella cirrata</i>			
1111.		<i>Raveniella peckorum</i>			
1112.	6012	<i>Regelia ciliata</i>			
1113.		<i>Rhantus suturalis</i>			
1114.	48096	<i>Rhipidura albiscapa</i> (Grey Fantail)			
1115.	25614	<i>Rhipidura leucophrys</i> (Willie Wagtail)			
1116.	13312	<i>Rhodanthe pyrethrum</i>			
1117.	17020	<i>Robinia pseudoacacia</i>	Y		
1118.	1556	<i>Romulea rosea</i> (Guildford Grass)	Y		
1119.	11151	<i>Rostraria pumila</i>	Y		
1120.	44608	<i>Rosulabryum billardieri</i>			
1121.	20496	<i>Rubus laudatus</i>	Y		
1122.	2432	<i>Rumex conglomeratus</i> (Clustered Dock)	Y		
1123.	2433	<i>Rumex crispus</i> (Curled Dock)	Y		
1124.	114	<i>Ruppia maritima</i> (Sea Tassel)			
1125.	40431	<i>Rytidosperma acerosum</i>			
1126.	40425	<i>Rytidosperma caespitosum</i>			
1127.	6483	<i>Samolus junceus</i>			
1128.	2356	<i>Santalum acuminatum</i> (Quandong, Warnga)			
1129.	2593	<i>Sarcocornia quinqueflora</i> (Beaded Samphire)			
1130.	7368	<i>Scabiosa atropurpurea</i> (Purple Pincushion)	Y		
1131.	7613	<i>Scaevola glandulifera</i> (Viscid Hand-flower)			
1132.	7619	<i>Scaevola lanceolata</i> (Long-leaved Scaevola)			
1133.	13182	<i>Scaevola repens</i> var. <i>repens</i>			
1134.	11027	<i>Schinus terebinthifolius</i>	Y		
1135.	32432	<i>Schizymenium bryoides</i>			
1136.	6263	<i>Schoenolaena juncea</i>			
1137.	971	<i>Schoenus andrewsii</i>			
1138.	973	<i>Schoenus asperocarpus</i> (Poison Sedge)			
1139.	975	<i>Schoenus bifidus</i>			
1140.	978	<i>Schoenus brevisetis</i>			
1141.	979	<i>Schoenus caespitosus</i>			
1142.	984	<i>Schoenus curvifolius</i>			
1143.	985	<i>Schoenus discifer</i>			
1144.	986	<i>Schoenus efoliatus</i>			
1145.	987	<i>Schoenus elegans</i>			
1146.	991	<i>Schoenus grammatophyllus</i>			
1147.	994	<i>Schoenus humilis</i>			
1148.	996	<i>Schoenus laevigatus</i>			
1149.	998	<i>Schoenus latitans</i>			

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1150.	1002	<i>Schoenus nanus</i> (Tiny Bog Rush)			
1151.	1006	<i>Schoenus odontocarpus</i>			
1152.	1007	<i>Schoenus pedicellatus</i>			
1153.	1009	<i>Schoenus pleiostemoneus</i>			
1154.	17614	<i>Schoenus plumosus</i>			
1155.	1011	<i>Schoenus rigens</i>			
1156.	1013	<i>Schoenus sculptus</i> (Gimlet Bog-rush)			
1157.	1016	<i>Schoenus subbarbatus</i> (Bearded Bog-rush)			
1158.	1017	<i>Schoenus subbulbosus</i>			
1159.	1018	<i>Schoenus subfascicularis</i>			
1160.	1019	<i>Schoenus subflavus</i> (Yellow Bog-rush)			
1161.	1026	<i>Schoenus unispiculatus</i>			
1162.	17409	<i>Schoenus variicellae</i>			
1163.	6033	<i>Scholtzia involucrata</i> (Spiked Scholtzia)			
1164.		<i>Scleroderma cepa</i>			
1165.	6	<i>Selaginella gracillima</i> (Tiny Clubmoss)			
1166.	32433	<i>Sematophyllum homomallum</i>			
1167.	20663	<i>Senecio multicaulis</i> subsp. <i>multicaulis</i>			
1168.	25534	<i>Sericornis frontalis</i> (White-browed Scrubwren)			
1169.	611	<i>Setaria sphacelata</i> (South African Pigeon Grass)	Y		
1170.	4980	<i>Sida hookeriana</i>			
1171.	2909	<i>Silene gallica</i> (French Catchfly)	Y		
1172.	8224	<i>Siloxerus filifolius</i>			
1173.	8225	<i>Siloxerus humifusus</i> (Procumbent Siloxerus)			
1174.		<i>Simocephalus elizabethae</i>			
1175.		<i>Simuliidae</i> sp.			
1176.	30948	<i>Smicornis brevirostris</i> (Weebill)			
1177.		<i>Sminthopsis murina</i>			
1178.	8231	<i>Sonchus oleraceus</i> (Common Sowthistle)	Y		
1179.	1312	<i>Sowerbaea laxiflora</i> (Purple Tassels)			
1180.	1558	<i>Sparaxis bulbifera</i>	Y		
1181.		<i>Spencerhydrus</i> sp.			Y
1182.	4205	<i>Sphaerolobium linophyllum</i>			
1183.	4206	<i>Sphaerolobium macranthum</i>			
1184.	635	<i>Sporobolus virginicus</i> (Marine Couch)			
1185.	6930	<i>Stachys arvensis</i> (Staggerweed)	Y		
1186.	4716	<i>Stachystemon vermicularis</i>			
1187.	24645	<i>Stagonopleura oculata</i> (Red-eared Firetail)			
1188.		<i>Steatoda grossa</i>			
1189.	13475	<i>Stenanthemum humile</i>			
1190.	24525	<i>Sterna fuscata</i> subsp. <i>nubilosa</i> (Sooty Tern)			
1191.		<i>Sternopriscus</i> sp.			
1192.	2316	<i>Stirlingia latifolia</i> (Blueboy)			
1193.	2317	<i>Stirlingia simplex</i>			
1194.		<i>Storena formosa</i>			
1195.	24426	<i>Strepera versicolor</i> subsp. <i>plumbea</i> (Grey Currawong)			
1196.	25589	<i>Streptopelia chinensis</i> (Spotted Turtle-Dove)	Y		
1197.	25590	<i>Streptopelia senegalensis</i> (Laughing Turtle-Dove)	Y		
1198.	24943	<i>Strophurus spinigerus</i> subsp. <i>inornatus</i>			
1199.	24942	<i>Strophurus spinigerus</i> subsp. <i>spinigerus</i>			
1200.	7681	<i>Stylidium affine</i> (Queen Triggerplant)			
1201.	7684	<i>Stylidium amoenum</i> (Lovely Triggerplant)			
1202.	30278	<i>Stylidium androsaceum</i>			
1203.	30276	<i>Stylidium bicolor</i>			
1204.	7693	<i>Stylidium brunonianum</i> (Pink Fountain Triggerplant)			
1205.	7694	<i>Stylidium bulbiferum</i> (Circus Triggerplant)			
1206.	7696	<i>Stylidium calcaratum</i> (Book Triggerplant)			
1207.	7699	<i>Stylidium carnosum</i> (Fleshy-leaved Triggerplant)			
1208.	7712	<i>Stylidium despectum</i> (Dwarf Triggerplant)			
1209.	7713	<i>Stylidium dichotomum</i> (Pins-and-needles)			
1210.	7716	<i>Stylidium diuroides</i> (Donkey Triggerplant)			
1211.	11808	<i>Stylidium diuroides</i> subsp. <i>diuroides</i>			
1212.	7717	<i>Stylidium divaricatum</i> (Daddy-long-legs)			
1213.	7721	<i>Stylidium emarginatum</i> (Biddy-four-legs)			
1214.	7734	<i>Stylidium guttatum</i> (Dotted Triggerplant)			
1215.	7742	<i>Stylidium inundatum</i> (Hundreds and Thousands)			
1216.	7768	<i>Stylidium obtusatum</i> (Pinafore Triggerplant)			
1217.	7772	<i>Stylidium perpusillum</i> (Tiny Triggerplant)			
1218.	7773	<i>Stylidium petiolare</i> (Horn Triggerplant)			
1219.	7774	<i>Stylidium piliferum</i> (Common Butterfly Triggerplant)			

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1220.	7782 <i>Stylidium pulchellum</i> (Thumbelina Triggerplant)			
1221.	7783 <i>Stylidium pycnostachyum</i> (Downy Triggerplant)			
1222.	33106 <i>Stylidium recurvum</i>			
1223.	7785 <i>Stylidium repens</i> (Matted Triggerplant)			
1224.	7790 <i>Stylidium roseoalatum</i> (Pink-wing Triggerplant)			
1225.	45594 <i>Stylidium tenue</i> subsp. <i>majusculum</i> (Showy Fountain Triggerplant)			
1226.	23511 <i>Stylidium thesioides</i> (Delicate Triggerplant)			
1227.	7806 <i>Stylidium utricularioides</i> (Pink Fan Triggerplant)			
1228.	40947 <i>Stylidium xanthellum</i>			
1229.	1260 <i>Stypandra glauca</i> (Blind Grass)			
1230.	6476 <i>Styphelia tenuiflora</i> (Common Pinheath)			
1231.	<i>Supunna funerea</i>			
1232.	2321 <i>Synaphea acutiloba</i> (Granite Synaphea)			
1233.	2324 <i>Synaphea petiolaris</i> (Synaphea)			
1234.	16864 <i>Synaphea petiolaris</i> subsp. <i>petiolaris</i>			
1235.	2329 <i>Synaphea spinulosa</i>			
1236.	15532 <i>Synaphea spinulosa</i> subsp. <i>spinulosa</i>			
1237.	32438 <i>Syntrichia pagorum</i>			
1238.	<i>Tabanidae</i> sp.			
1239.	25705 <i>Tachybaptus novaehollandiae</i> (Australasian Grebe, Black-throated Grebe)			
1240.	24682 <i>Tachybaptus novaehollandiae</i> subsp. <i>novaehollandiae</i> (Australasian Grebe, Black-throated Grebe)			
1241.	24331 <i>Tadorna tadornoides</i> (Australian Shelduck, Mountain Duck)			
1242.	<i>Tanypodinae</i> sp.			
1243.	<i>Tanytarsus fuscithorax</i>			
1244.	24167 <i>Tarsipes rostratus</i> (Honey Possum, Noolbenger)			
1245.	<i>Tasmanicosa leuckartii</i>			
1246.	<i>Tegenaria atrica</i>			Y
1247.	4251 <i>Templetonia drummondii</i>			
1248.	4256 <i>Templetonia retusa</i> (Cockies Tongues)			
1249.	<i>Testudinella patina</i>			
1250.	1036 <i>Tetraria octandra</i>			
1251.	4535 <i>Tetradlea hirsuta</i> (Black Eyed Susan)			
1252.	4537 <i>Tetradlea nuda</i>			
1253.	1701 <i>Thelymitra antennifera</i> (Vanilla Orchid)			
1254.	1705 <i>Thelymitra crinita</i> (Blue Lady Orchid)			
1255.	1707 <i>Thelymitra flexuosa</i> (Twisted Sun Orchid)			
1256.	11053 <i>Thelymitra macrophylla</i>			
1257.	<i>Thelymitra</i> sp.			
1258.	1715 <i>Thelymitra spiralis</i> (Curlylocks)			
1259.	1718 <i>Thelymitra villosa</i> (Custard Orchid)			
1260.	20731 <i>Thelymitra vulgaris</i>			
1261.	5087 <i>Thomasia macrocarpa</i> (Large Fruited Thomasia)			
1262.	24845 <i>Threskiornis spinicollis</i> (Straw-necked Ibis)			
1263.	1318 <i>Thysanotus arbuscula</i>			
1264.	1319 <i>Thysanotus arenarius</i>			
1265.	1338 <i>Thysanotus manglesianus</i> (Fringed Lily)			
1266.	1339 <i>Thysanotus multiflorus</i> (Many-flowered Fringe Lily)			
1267.	1343 <i>Thysanotus patersonii</i>			
1268.	46055 <i>Thysanotus</i> sp. Coastal plain (N.H. Brittan 66/63)			
1269.	1351 <i>Thysanotus sparteus</i>			
1270.	1354 <i>Thysanotus tenellus</i>			
1271.	1357 <i>Thysanotus thyrsoides</i>			
1272.	1358 <i>Thysanotus triandrus</i>			
1273.	25203 <i>Tiliqua occipitalis</i> (Western Bluetongue)			
1274.	25204 <i>Tiliqua rugosa</i> subsp. <i>aspera</i>			
1275.	25207 <i>Tiliqua rugosa</i> subsp. <i>rugosa</i>			
1276.	<i>Tipulidae</i> sp.			
1277.	25549 <i>Todiramphus sanctus</i> (Sacred Kingfisher)			
1278.	24309 <i>Todiramphus sanctus</i> subsp. <i>sanctus</i> (Sacred Kingfisher)			
1279.	6280 <i>Trachymene pilosa</i> (Native Parsnip)			
1280.	17684 <i>Tremulina tremula</i>			
1281.	11112 <i>Tribolium uniola</i>	Y		
1282.	1481 <i>Tribonanthes australis</i>			
1283.	1482 <i>Tribonanthes brachypetala</i>			
1284.	1483 <i>Tribonanthes longipetala</i>			
1285.	1485 <i>Tribonanthes violacea</i>			
1286.	48141 <i>Tribonyx ventralis</i> (Black-tailed Native-hen)			
1287.	4383 <i>Tribulus terrestris</i> (Caltrop)	Y		
1288.	39097 <i>Trichia decipiens</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
1289.	<i>Trichocerca similis</i>			
1290.	8251 <i>Trichocline spathulata</i> (Native Gerbera)			
1291.	25723 <i>Trichoglossus haematodus</i> (Rainbow Lorikeet)			
1292.	24755 <i>Trichoglossus haematodus</i> subsp. <i>moluccanus</i> (Rainbow Lorikeet)	Y		
1293.	1361 <i>Tricoryne elatior</i> (Yellow Autumn Lily)			
1294.	1362 <i>Tricoryne humilis</i>			
1295.	1363 <i>Tricoryne tenella</i>			
1296.	17145 <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	Y		
1297.	4291 <i>Trifolium arvense</i> (Hare's Foot Clover)	Y		
1298.	4292 <i>Trifolium campestre</i> (Hop Clover)	Y		
1299.	4295 <i>Trifolium dubium</i> (Suckling Clover)	Y		
1300.	4297 <i>Trifolium glomeratum</i> (Cluster Clover)	Y		
1301.	33676 <i>Triglochin calcitrapa</i>			
1302.	146 <i>Triglochin minutissima</i>			
1303.	147 <i>Triglochin mucronata</i>			
1304.	148 <i>Triglochin muelleri</i>			
1305.	18587 <i>Triglochin nana</i>			
1306.	150 <i>Triglochin stowardii</i>			
1307.	151 <i>Triglochin striata</i>			
1308.	<i>Tripletides australis</i>			
1309.	4737 <i>Tripterococcus brunonis</i> (Winged Stackhousia)			
1310.	1139 <i>Trithuria bibracteata</i>			
1311.	1141 <i>Trithuria submersa</i>			
1312.	13479 <i>Trymalium ledifolium</i> var. <i>rosmarinifolium</i>			
1313.	33418 <i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>			
1314.	<i>Tubaria rufofulva</i>			
1315.	<i>Turbellaria</i> sp.			
1316.	98 <i>Typha domingensis</i> (Bulrush, Djandjidi)			
1317.	99 <i>Typha orientalis</i> (Bulrush, Cumbungi)			
1318.	24852 <i>Tyto alba</i> subsp. <i>delicatula</i> (Barn Owl)			
1319.	24983 <i>Underwoodisaurus milii</i> (Barking Gecko)			
1320.	<i>Urocampus carinirostris</i>			
1321.	<i>Urodacus novaehollandiae</i>			
1322.	<i>Urodacus planimanus</i>			
1323.	8254 <i>Urospermum picroides</i> (False Hawkbit)	Y		
1324.	8255 <i>Ursinia anthemoides</i> (Ursinia)	Y		
1325.	38388 <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	Y		
1326.	7138 <i>Utricularia inaequalis</i>			
1327.	7148 <i>Utricularia multifida</i>			
1328.	7153 <i>Utricularia tenella</i>			
1329.	25218 <i>Varanus gouldii</i> (Bungarra or Sand Monitor)			
1330.	25225 <i>Varanus rosenbergi</i> (Heath Monitor)			
1331.	25526 <i>Varanus tristis</i> (Racehorse Monitor)			
1332.	7665 <i>Velleia trinervis</i>			
1333.	<i>Venator immansueta</i>			
1334.	<i>Venatrix pullastra</i>			
1335.	6070 <i>Verticordia acerosa</i>			
1336.	15431 <i>Verticordia acerosa</i> var. <i>acerosa</i>			
1337.	12388 <i>Verticordia acerosa</i> var. <i>preissii</i>			
1338.	6076 <i>Verticordia densiflora</i> (Compacted Featherflower)			
1339.	15432 <i>Verticordia densiflora</i> var. <i>densiflora</i>			
1340.	6088 <i>Verticordia huegelii</i> (Variegated Featherflower)			
1341.	15433 <i>Verticordia huegelii</i> var. <i>huegelii</i>			
1342.	15434 <i>Verticordia insignis</i> subsp. <i>insignis</i>			
1343.	6107 <i>Verticordia pennigera</i>			
1344.	6110 <i>Verticordia plumosa</i> (Plumed Featherflower)			
1345.	12449 <i>Verticordia plumosa</i> var. <i>brachyphylla</i>			
1346.	15618 <i>Verticordia plumosa</i> var. <i>plumosa</i>			
1347.	24206 <i>Vespadelus regulus</i> (Southern Forest Bat)			
1348.	4322 <i>Vicia sativa</i> (Common Vetch)	Y		
1349.	12070 <i>Vicia sativa</i> subsp. <i>sativa</i>	Y		
1350.	29491 <i>Vicia tetrasperma</i>	Y		Y
1351.	4325 <i>Viminaria juncea</i> (Swishbush, Koweda)			
1352.	722 <i>Vulpia bromoides</i> (Squirrel Tail Fescue)	Y		
1353.	724 <i>Vulpia myuros</i> (Rat's Tail Fescue)	Y		
1354.	7384 <i>Wahlenbergia capensis</i> (Cape Bluebell)	Y		
1355.	7389 <i>Wahlenbergia preissii</i>			
1356.	13103 <i>Watsonia borbonica</i>	Y		
1357.	1566 <i>Watsonia marginata</i>	Y		
1358.	18108 <i>Watsonia meriana</i> var. <i>bulbillifera</i>	Y		

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
1359.	18118 <i>Watsonia meriana</i> var. <i>meriana</i>	Y		
1360.	1569 <i>Watsonia versfeldii</i>	Y		
1361.	1394 <i>Wurmbea dioica</i> (Early Nancy)			
1362.	12072 <i>Wurmbea dioica</i> subsp. <i>alba</i>			
1363.	1401 <i>Wurmbea pygmaea</i>			
1364.	1249 <i>Xanthorrhoea acanthostachya</i>			
1365.	1251 <i>Xanthorrhoea brunonis</i>			
1366.	14544 <i>Xanthorrhoea brunonis</i> subsp. <i>brunonis</i>			
1367.	1252 <i>Xanthorrhoea drummondii</i>			
1368.	1256 <i>Xanthorrhoea preissii</i> (Grass tree, Palga)			
1369.	6289 <i>Xanthosia huegelii</i>			
1370.	2331 <i>Xylomelum occidentale</i> (Woody Pear, Djandin)			
1371.	1049 <i>Zantedeschia aethiopica</i> (Arum Lily)	Y		
1372.	25765 <i>Zosterops lateralis</i> (Grey-breasted White-eye, Silvereye)			

Conservation Codes

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

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

APPENDIX 2

Protected Matters Search Tool Report



EPBC Act Protected Matters Report

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

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

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 11/07/17 11:53:39

[Summary](#)

[Details](#)

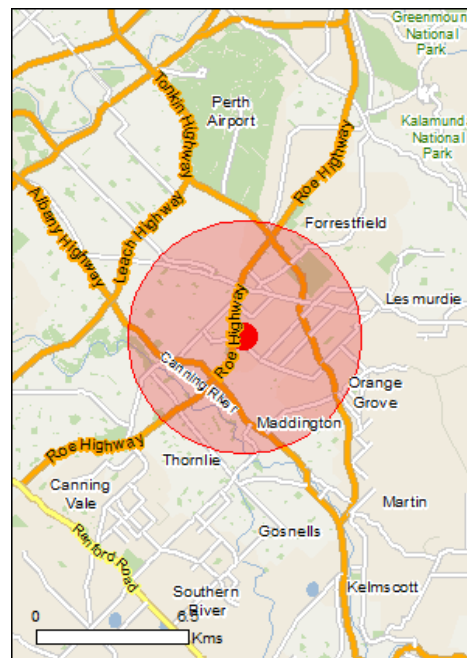
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

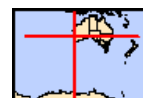
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	35
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	5
Regional Forest Agreements:	None
Invasive Species:	47
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)		[Resource Information]
Name		Proximity
Forrestdale and thomsons lakes		Within 10km of Ramsar

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
------	--------	------------------

Birds

Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area

Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area

Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area

Calyptorhynchus baudinii		
Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Roosting known to occur within area

Calyptorhynchus latirostris		
Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area

Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area

Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area

Insects

Leioproctus douglasiellus		
a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Mammals		
Bettongia penicillata Brush-tailed Bettong, Woylie [213]	Endangered	Species or species habitat may occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia anomala Grass Wattle, Chittering Grass Wattle [8153]	Vulnerable	Species or species habitat may occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat known to occur within area
Banksia mimica Summer Honey-pot [82765]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Calytrix breviseta subsp. breviseta Swamp Starflower [23879]	Endangered	Species or species habitat known to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Conospermum undulatum Wavy-leaved Smokebush [24435]	Vulnerable	Species or species habitat likely to occur within area
Darwinia apiculata Scarp Darwinia [8763]	Endangered	Species or species habitat may occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
Drakaea elastica Glossy-leaved Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat may occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within

Name	Status	Type of Presence area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Ptilotus pyramidatus Pyramid Mulla-mulla [18216]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D.Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Synaphea stenoloba Dwellingup Synaphea [66311]	Endangered	Species or species habitat may occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [\[Resource Information \]](#)

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [\[Resource Information \]](#)

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

Name
Commonwealth Land - Defence - AIRTC CANNINGTON

Listed Marine Species [\[Resource Information \]](#)

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Kenwick Wetlands	WA
Unnamed WA28740	WA
Unnamed WA37997	WA
Unnamed WA47244	WA
Unnamed WA49363	WA

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species

Name	Status	Type of Presence
Passer montanus Eurasian Tree Sparrow [406]		habitat likely to occur within area Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		

Name	Status	Type of Presence
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large- leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area
Nationally Important Wetlands		[Resource Information]
Name	State	
Brixton Street Swamps	WA	

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-32.01998 115.97538

Acknowledgements

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

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

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

Please feel free to provide feedback via the [Contact Us](#) page.

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APPENDIX 3

Aboriginal Heritage Inquiry System Reports



Search Criteria

No Registered Aboriginal Sites in Custom search area - Polygon - 115.97178460649°E, 32.0214518323958°S (GDA94) : 115.97178460649°E, 32.0135557825081°S (GDA94) : 115.980024352584°E, 32.0135557825081°S (GDA94) : 115.980024352584°E, 32.0214518323958°S (GDA94) : 115.97178460649°E, 32.0214518323958°S (GDA94)

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Aboriginal Affairs by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at heritageenquiries@daa.wa.gov.au and we will make every effort to rectify it as soon as possible.

South West Settlement ILUA Disclaimer

Your heritage enquiry is on land within or adjacent to the following Indigenous Land Use Agreement(s): Whadjuk People ILUA.

On 8 June 2015, six identical Indigenous Land Use Agreements (ILUAs) were executed across the South West by the Western Australian Government and, respectively, the Yued, Whadjuk People, Gnaala Karla Booja, Ballardong People, South West Boojarah #2 and Wagyl Kaip & Southern Noongar groups, and the South West Aboriginal Land and Sea Council (SWALSC).

The ILUAs bind the parties (including 'the State', which encompasses all State Government Departments and certain State Government agencies) to enter into a Noongar Standard Heritage Agreement (NSHA) when conducting Aboriginal Heritage Surveys in the ILUA areas, unless they have an existing heritage agreement. It is also intended that other State agencies and instrumentalities enter into the NSHA when conducting Aboriginal Heritage Surveys in the ILUA areas. It is recommended a NSHA is entered into, and an 'Activity Notice' issued under the NSHA, if there is a risk that an activity will 'impact' (i.e. by excavating, damaging, destroying or altering in any way) an Aboriginal heritage site. The Aboriginal Heritage Due Diligence Guidelines, which are referenced by the NSHA, provide guidance on how to assess the potential risk to Aboriginal heritage.

Likewise, from 8 June 2015 the Department of Mines and Petroleum (DMP) in granting Mineral, Petroleum and related Access Authority tenures within the South West Settlement ILUA areas, will place a condition on these tenures requiring a heritage agreement or a NSHA before any rights can be exercised.

If you are a State Government Department, Agency or Instrumentality, or have a heritage condition placed on your mineral or petroleum title by DMP, you should seek advice as to the requirement to use the NSHA for your proposed activity. The full ILUA documents, maps of the ILUA areas and the NSHA template can be found at <https://www.dpc.wa.gov.au/lantu/Claims/Pages/SouthWestSettlement.aspx>.

Further advice can also be sought from the Department of Aboriginal Affairs (DAA) at heritageenquiries@daa.wa.gov.au.

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Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Search Criteria

4 Other Heritage Places in Custom search area - Polygon - 115.970261111757°E, 32.0209606233532°S (GDA94) : 115.970261111757°E, 32.0130281420383°S (GDA94) : 115.980689540407°E, 32.0130281420383°S (GDA94) : 115.980689540407°E, 32.0209606233532°S (GDA94) : 115.970261111757°E, 32.0209606233532°S (GDA94)

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Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Aboriginal Heritage Inquiry System

List of Other Heritage Places

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Aboriginal Affairs to the place.

Status:

- Registered Site: The place has been assessed as meeting Section 5 of the Aboriginal Heritage Act 1972.
- Other Heritage Place which includes:
 - Stored Data / Not a Site: The place has been assessed as not meeting Section 5 of the Aboriginal Heritage Act 1972.
 - Lodged: Information has been received in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of the Aboriginal Heritage Act 1972.

Access and Restrictions:

- File Restricted = No: Availability of information that the Department of Aboriginal Affairs holds in relation to the place is not restricted in any way.
- File Restricted = Yes: Some of the information that the Department of Aboriginal Affairs holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Aboriginal Affairs receives written approval from the informants who provided the information. To request access please contact heritageenquiries@daa.wa.gov.au.
- Boundary Restricted = No: Place location is shown as accurately as the information lodged with the Registrar allows.
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact DAA.
- Restrictions:
 - No Restrictions: Anyone can view the information.
 - Male Access Only: Only males can view restricted information.
 - Female Access Only: Only females can view restricted information.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

Aboriginal Heritage Inquiry System

List of Other Heritage Places

ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
122	YULE BROOK FARM	No	No	No Gender Restrictions	Stored Data / Not a Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	403053mE 6457085mN Zone 50 [Unreliable]	S02969
3312	WATTLE GROVE, PERTH.	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter, Camp	*Registered Knowledge Holder names available from DAA	403639mE 6456649mN Zone 50 [Unreliable]	S00208
4340	EDWARD/GROVE STREETS	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	403339mE 6457599mN Zone 50 [Unreliable]	S00750
24785	Yule Brook Farm 02	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter, Arch Deposit	*Registered Knowledge Holder names available from DAA	403088mE 6456869mN Zone 50 [Reliable]	



Search Criteria

6 Heritage Surveys containing 6 Survey Areas in Custom search area - Polygon - 115.968930736086°E, 32.0212153246766°S (GDA94) : 115.968930736086°E, 32.0122275782549°S (GDA94) : 115.980775371096°E, 32.0122275782549°S (GDA94) : 115.980775371096°E, 32.0212153246766°S (GDA94) : 115.968930736086°E, 32.0212153246766°S (GDA94)

Disclaimer

Heritage Surveys have been mapped using information from the reports and / or other relevant data sources. Heritage Surveys consisting of small discrete areas may not be visible except at large scales. Reports shown may not be held at DAA. Please consult report holder for more information. Refer to www.daa.wa.gov.au/heritage for information on requesting reports held by DAA.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Aboriginal Affairs by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at heritageenquiries@daa.wa.gov.au and we will make every effort to rectify it as soon as possible.

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Access

Some reports are restricted.

Spatial Accuracy

The following legend strictly applies to the spatial accuracy of heritage survey boundaries as captured by DAA.

Very Good	Boundaries captured from surveyed titles, GPS (2001 onwards) submitted maps georeferenced to within 20m accuracy.
Good / Moderate	Boundaries captured from GPS (pre 2001) submitted maps georeferenced to within 250m accuracy.
Unreliable	Boundaries captured from submitted maps georeferenced to an accuracy exceeding 250m.
Indeterminate	Surveys submitted with insufficient information to allow boundary capture.

Aboriginal Heritage Inquiry System

List of Heritage Surveys

Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
21817	Ballaruk (traditional owners) Aboriginal site recording project	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
21818	Ballaruk (traditional owners of Whadjuk territorial boundaries the lands of the Ballaruk Peoples) Aboriginal site recording project : additional material	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
22955	Results of an Aboriginal cultural heritage survey of the Yule brook flow reduction dam site, Kenwick	Gifford, Peter.	1	Archaeological & Ethnographic	The survey area comprises two paddocks on the edge of the railway line, adjacent to Roe Highway. The area is bisected by Yule Brook.	Good	Field and Desktop
102670	Preliminary Report on the Survey of Aboriginal Areas of Significance in the Perth Metropolitan & Murray River Regions July 1985.	O'Connor, R	1	Ethnographic	Perth Metropolitan & Murray River Regions. A roughly triangular region, with Yanchep National Park as the Northern point, Gidgegannup as the Eastern point and Pinjarra as the Southern point.	Indeterminate	Field and Desktop
103564	An Archaeological Survey Project: The Perth Area, Western Australia. Apr 1972.	University of Western Australia.	1	Archaeological	The Perth Area. 103 site locations in 67 site groups were investigated.	Indeterminate	Field and Desktop
105660	Report on a survey for Aboriginal Sites on the Roe Highway Welshpool Road to South Street section	O'Connor, R	1	Archaeological	Roe Highway, Welshpool Road to South Street Section. The proposed development involves 15.5km of roadworks within the MRD road reserve varying between 70 and 300m in width for the proposed Roe Highway (12km) between Welshpool Road, East Cannington, and South Street Leeming. Plus the Wimbeldon Street Deviation (3.5km), Beckenham as shown in Fig. 1	Unreliable	Field and Desktop

APPENDIX 4

Development Concept Plan (CLE Town Planning and Design)



Appendix 2

Local Water Management Strategy (Emerge Associates)

Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick
Strategic Employment Area

Project No: EP17-055(01)

**Prepared for Grove Road Pty Ltd
June 2018**

Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



Document Control

Doc name: Local Water Management Strategy Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area					
Doc no.: EP17-055(01)--005 ASC					
Version	Date	Author		Reviewer	
1	November 2017	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				
A	December 2017	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				
B	February 2018	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				
C	February 2018	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				
D	February 2018	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				
E	June 2018	Aisha Chalmers	ASC	Rachel Evans	RLE
	For issue to CoG, DWER and DBCA				

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Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



Executive Summary

Grove Road Pty Ltd (the proponent) proposes to develop the majority of Lot 414 Grove Road within the Maddington Kenwick Strategic Employment Area (MKSEA) for industrial land uses, as part of the Precinct 3A Structure Plan amendment.

Lot 414 is currently zoned 'industrial' under the Metropolitan Region Scheme (MRS); however, is zoned 'general industry' and 'rural' under the CoG Town Planning Scheme (TPS) No. 6 (CoG 2002). The portion of Lot 414 proposed for development is located within Precinct 3A of the MKSEA consistent with the TPS 'general industry' zone with the remainder of Lot 414 within Precinct 3B (area zoned as 'rural' in the TPS). Any proposed works within the Lot 414 Grove Road are required to be consistent with the allowable uses relevant to the zone in which they are located.

This local water management strategy (LWMS) is intended to support the proposed land use within Lot 414 Grove Road to the north of the Yule Brook (referred to herein as 'the water management area (WMA)'). This LWMS does not support development outside of the WMA and any proposed changes across the remainder of Lot 414 Grove Road would need to be supported by additional studies and an addendum to this LWMS. The LWMS has been developed in consideration of the objectives and principles detailed in *Better Urban Water Management* (WAPC 2008) and other guidelines and policies relevant to the site.

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

- The WMA receives 820.3 mm of average annual rainfall with the majority of rainfall received between May and August.
- Topography of the WMA is low-lying with elevations ranging from approximately 12 m Australian height datum (AHD) in the north eastern corner to 7 m AHD in the south western corner.
- The WMA is underlain by fine to coarse grained sand and silty sand overlying low to high plasticity sandy clay.
- Acid sulfate soil (ASS) risk mapping indicates that the WMA is classified as having a moderate to low risk of ASS occurring within 3 m of the natural surface.
- Native vegetation exists along the Grove Road with degraded riparian vegetation ranging in width from three to 28 m exists along the banks of Yule Brook.
- The majority of the WMA is classified as a multiple use wetland (MUW). A small portion of the WMA along the southern boundary is mapped as part of the adjacent resource enhancement wetland (REW). A revised REW boundary has been proposed following a review of onsite characteristics (PGV Environmental 2017b).
- An existing surface water channel flows into the WMA from Lot 14 Edward Street at a peak flow of 0.8 m³/s for the 100 year average recurrence interval (ARI) event. This channel discharges from the WMA into the REW at a peak flow of 1.2 m³/s for the 100 year ARI event. Ultimately, flows from this channel discharge into Yule Brook to the south.

Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



- The 100 year ARI event top water level (TWL) within the adjacent Yule Brook has been indicated by Water Corporation as 9.7 m AHD, assuming both a 50 m and 100 m floodplain channel.
- Surface water quality within Yule Brook is generally consistent upstream and downstream of the WMA, with total nitrogen (TN) and total phosphorous (TP) concentrations within guideline trigger values.
- Depth to peak groundwater ranges between approximately 0.35 m and 1.1 m below the surface.
- Elevated TN and TP concentrations have been recorded in locations across the WMA. Concentrations are typical of agricultural land uses.

The WMA is proposed to be used for general industrial purposes incorporating hard stand areas and small buildings for associated office use. Following approval of the Precinct 3A Structure Plan amendment the proponent intends to develop the WMA as a single lot with future works (including internal road network, buildings and associated drainage infrastructure) supported by a development application.

The overall objective for integrated water cycle management for industrial developments is to minimise pollution and maintain an appropriate water balance. The design objectives seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management objectives for:

- Water supply and wastewater
- Stormwater quantity and quality management
- Groundwater management
- Wetland and waterway management
- Environmental Protection.

The overall approach to water supply is to utilise scheme water and implement water conservation measures (e.g. water efficient fixtures, use of WSUD measures, and planting of waterwise species) to reduce water requirements.

Wastewater is water that is associated with buildings/site offices (except roof runoff) and any specific industrial uses. Appropriate wastewater infrastructure design will protect the surrounding environment and therefore achieve stormwater quality, groundwater quality and wetland and waterway management requirements.

Stormwater management focuses on conveyance of upstream flows, maintaining peak flows entering the wetland and surface water quality. Groundwater management focuses on protecting finished floor levels of habitable buildings from inundation by groundwater and groundwater quality. These strategies have been developed in consideration of the hydrological requirements of the adjacent REW and Yule Brook.

Conveyance of upstream flows through the WMA will be captured within an arterial pipe and conveyed through the WMA (and other WSUD measures) before discharging at the outlet to the wetland. Pre-development peak flows are maintained into the wetland and Yule Brook through the provision of detention basins and appropriately designed outlet structures. To ensure the adjacent wetland is protected a 30 m buffer will be provided; no drainage infrastructure associated with the development will be located within the proposed wetland buffer.

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Sand fill will be used across the WMA and will ensure the required clearances from finished floor levels of habitable buildings to groundwater, and TWL within detention basins and the Yule Brook floodplain are achieved.

Treatment of stormwater runoff is provided through planting of detention basins with species suitable for nutrient removal, and provision of high phosphorous retention index (PRI) soils beneath basins. Groundwater quality is maintained by reducing the total nutrient load into groundwater that originates from the WMA through use of WWG principles in any landscape areas and treatment of stormwater runoff from across the WMA. These measures also ensure water quality within the adjacent wetland is maintained.

The proposed design criteria and the manner in which they are proposed to be achieved are presented in **Table E 1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management in the WMA have actually been achieved.

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

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Table E 1 Water management criteria and compliance summary

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water conservation	WC1	Ensure the efficient use of all water resources.	All buildings use water efficient fittings where appropriate	Proponent	Building construction
			Drainage reserves and buffer areas will be planted during winter with waterwise species	Proponent	Landscape implementation
Stormwater management	SW1	Maintain pre-development peak flow rates leaving the WMA (up to the 100 year ARI event).	Use of three detention basins and an arterial pipe network from FSA A to FSA C.	Proponent	Detailed design
	SW2	Surface flows will be appropriately treated prior to discharge from WMA.	Detention basins will be vegetated with appropriate plant species and underlain by high PRI soils to remove nutrients prior to stormwater being discharged from WMA.	Proponent	Landscape implementation
			Length of swale along Grove Road that is retained will be vegetated.	Proponent	Landscape implementation
			Use of appropriate primary and secondary wastewater treatment structures or removal procedures appropriate for the proposed land use.	Proponent	Detailed design
	SW3	Provide conveyance of upstream flows through the WMA.	Use of arterial pipe to convey upstream inflows into FSA A and through to the wetland.	Proponent	Detailed design
	SW4	Finished floor levels of habitable buildings should have a 300 mm clearance from the 100 year ARI TWL within flood detention structures.	Earthwork levels will ensure finished flood levels of habitable buildings achieve the required clearances.	Proponent	Detailed design
	SW5	Finished floor levels of habitable buildings should have a 500 mm clearance from the 100 year ARI TWL within Yule Brook.			
Stormwater management	SW6	Apply appropriate non-structural measures to reduce pollutant loads.	Maintenance of WSUD structures including detention basins, primary and secondary wastewater treatment structures.	Proponent	Ongoing until alternative management authority is identified

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Table E 1 Water management criteria and compliance summary (continued)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management	SW6	Apply appropriate non-structural measures to reduce pollutant loads.	Minimising fertiliser use to establish and maintain vegetation within drainage reserves and wetland and waterway buffers.	Proponent	Ongoing until alternative management authority is identified
			Drought tolerant plant species that require minimal water and nutrients will be used.	Proponent	Landscape implementation
			Education of tenants regarding fertiliser use and nutrient absorbing vegetation species.	Proponent	Ongoing
Groundwater management	GW1	Finished floor levels of habitable buildings should have a minimum 500mm clearance from MGL.	Use of sand fill across the WMA.	Proponent	Detailed design
	GW2	Inverts of flood detention structures to be set at or above MGL or the underlying clay layer.	Use of sand fill across the WMA and locating invert of detention basins above the clay layer.	Proponent	Detailed design
	GW3	Maintain groundwater quality leaving the WMA.	Planting drainage reserves and buffers with waterwise species.	Proponent	Landscape implementation
			Appropriate design, installation and maintenance of ATUs.	Proponent	Detailed design
			Appropriate treatment or disposal of any industrial wastewater produced.	Proponent	Detailed design

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Appendix A

LSP Amendment Conditions and Structure Plan

Appendix B

Relevant Bore Logs

Appendix C

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Appendix D

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Appendix E

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Appendix F

Water Corporation Correspondence and Mapping

Appendix G

Modelling Assumptions Report

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Abbreviation Tables

Table A1: Abbreviations – General terms

General terms	
ARI	Average recurrence interval
ATU	Alternative treatment unit
DA	Development application
DO	Dissolved oxygen
DWMS	District water management strategy
EC	Electrical conductivity
FRP	Filterable reactive phosphorous
FSA	Flood storage area
GPT	Gross pollutant trap
LPP	Local planning policy
LPS	Local planning scheme
LWMS	Local water management strategy
MGL	Maximum groundwater level
MKSEA	Maddington Kenwick Strategic Employment Area
MRS	Metropolitan Region Scheme
MUW	Multiple use wetland
NO ₂ -N	Nitrite
NO ₃ -N	Nitrate
NWQMS	National Water Quality Management Strategy
PRI	Phosphorous retention index
REW	Resource enhancement wetland
SCWQIP	Swan Canning Water Quality Improvement Plan
SP	Structure plan
TDS	Total dissolved solids
TKN	Total kjeldahl nitrogen
TN	Total nitrogen
TP	Total phosphorous
TPS	Town planning scheme

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Table A1: Abbreviations – General terms (continued)

General terms	
TSS	Total suspended solids
TWL	Top water level
UWMP	Urban water management plan
WMA	Water management area
WSUD	Water sensitive urban design

Table A2: Abbreviations – Organisations

Organisations	
ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
CoG	City of Gosnells
CoK	City of Kalamunda
DBCA	Department of Biodiversity, Conservation and Attractions
DoH	Department of Health
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
SRT	Swan River Trust (now DBCA)
WAPC	Western Australian Planning Commission

Table A3: Abbreviations – units of measurement

Units of measurement	
°C	Degrees Celsius
ha	Hectare
m	Metre
m ²	Square metre
m AHD	Metres in relation to the Australian Height Datum
mm	Millimetre
mg/L	Milligrams per Litre
mS/cm	Mili-siemens per centimetre
µS/cm	Micro-siemens per centimetre

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1 Introduction

1.1 Background

Grove Road Pty Ltd (the proponent) proposes to develop the majority of Lot 414 Grove Road within the Maddington Kenwick Strategic Employment Area (MKSEA) in the City of Gosnells (CoG), for industrial purposes, as part of the Precinct 3A Structure Plan amendment. The portion of Lot 414 proposed for development is located within Precinct 3A of the MKSEA, with the remaining area located in Precinct 3B. The MKSEA Precinct boundaries (as illustrated in the District Water Management Strategy, detailed in **Section 1.1.3.1**) are provided in **Appendix A**.

This local water management strategy (LWMS) is intended to support the proposed land use within Lot 414 Grove Road to the north of the Yule Brook (referred to herein as 'the water management area (WMA)'). This LWMS does not support development outside of the WMA and any proposed changes across the remainder of Lot 414 Grove Road would need to be supported by additional studies and an addendum to this LWMS.

The general location, current aerial and WMA are shown in **Figure 1**. The Precinct 3A Structure Plan amendment and concept layout plan are provided in **Appendix A**.

1.1.1 Town planning context

Lot 414 Grove Road is currently zoned 'industrial' under the Metropolitan Region Scheme (MRS), as shown in the MRS mapping provided in **Appendix A**.

Under the CoG Town Planning Scheme (TPS) No. 6 (CoG 2002), the area proposed for industrial development within Lot 414 is zoned 'general industry', with the remainder zoned 'rural', as illustrated in the TPS mapping provided in **Appendix A**. Any changes proposed within the rural zoned areas should be consistent with the allowable uses within rural zones detailed in TPS 6.

Local Planning Policy 5.8 MKSEA Planning Framework (LPP 5.8) (CoG 2014) was prepared by the CoG to guide future phases of the planning and development process within the MKSEA. In accordance with both the LPP 5.8 and recently amended Local Planning Scheme (LPS) No. 6 – amendment 165, a Structure Plan (SP) is to be prepared for Special Control Areas identified in the MKSEA, which are primarily located in MKSEA Precinct 3 and adjacent to sensitive wetland areas. LPS 6 – amendment 165 is provided in **Appendix A** for reference.

A concept plan to support and guide future industrial development within Lot 414 Grove Road is provided in **Appendix A**. Following approval of the Precinct 3A Structure Plan amendment, industrial development will be achieved through development applications (DA) in accordance with the approved layout and technical requirements identified in this LWMS.

1.1.2 Policy framework

There are a number of State Government policies of relevance to the WMA. These policies include:

- *TPS No. 6* (CoG 2002)
- *LPS No. 6 - amendment 165* (CoG 2016)

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- *State Water Strategy* (Government of WA 2003)
- *State Water Plan* (Government of WA 2007)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006a)
- *State Planning Policy 2.10: Swan and Canning River System* (WAPC 2006b)
- *Liveable Neighbourhoods Edition 4* (WAPC 2007)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009)
- *Local Planning Policy 5.8: Maddington Kenwick Strategic Employment Area Planning Framework* (CoG 2014)
- *Local Planning Policy 4.7: Planning and development of public open space and streetscapes* (CoG 2015).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve.

These are key inputs that relate either directly or indirectly to the WMA and include:

- *Australian Rainfall and Runoff* (Engineers Australia 1987)
- *National Water Quality Management Strategy* (NWQMS) (ANZECC 2000)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Stormwater Management Manual for Western Australia* (DoW 2007)
- *Better Urban Water Management* (WAPC 2008)
- *Developing a Local Water Management Strategy* (DoW 2008a)
- *Draft Decision Process for Stormwater Management in Western Australia* (DoW 2016)
- *Swan and Canning Water Quality Improvement Plan* (SCWQIP) (SRT 2009).

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

1.1.3 Previous studies

1.1.3.1 District Water Management Strategy

The *MKSEA Precincts 2 and 3 DWMS* (TME 2014b) was prepared to support rezoning of MKSEA Precinct 2 and 3 to 'industrial'. The relevant design and management objectives detailed in the DWMS can be summarised as follows:

- Water quality and environmental protection
 - Utilise structural (e.g. swales), management (e.g. buffers), maintenance (i.e. of planted areas) and monitoring (e.g. post-development groundwater monitoring) measures to protect the Yule Brook and adjacent wetlands.
- Flood protection
 - No development to be within the 100 year average recurrence interval (ARI) floodways in the Yule Brook.

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- Protect habitable buildings, other infrastructure and downstream environments from flooding.
- Stormwater management
 - Utilise water sensitive urban design (WSUD) measures to treat, store, convey, control and discharge stormwater runoff in a managed practice that is consistent with the pre-development hydrological regime.
 - Encourage non-structural best management practices to reduce flow rates and potential contamination.
- Groundwater management
 - Ensure development has no negative impact on the groundwater resource, or ecosystems dependent on the resources.
 - Protect habitable buildings and other infrastructure from groundwater inundation.
- Water conservation and servicing
 - Development is to be connected to a potable reticulated water supply.
 - Use appropriate water conservation measures.
 - Implement wastewater collection and treatment that considers WMA constraints and will protect the surrounding environment.

1.1.3.2 Precinct 3A Local Water Management Strategy

The approved *Local Water Management Strategy MKSEA Precinct 3A Outline Development Plan* (MKSEA LWMS) (Emerge Associates 2017) was prepared to support structure planning of the majority of Precinct 3A, to the north of the Lot 414 Grove Road.

The relevant design and management objectives detailed in the LWMS can be summarised as follows:

- Water conservation
 - Minimise water use within lots and for the establishment and maintenance of landscaped areas.
- Groundwater management
 - Protect habitable buildings from groundwater inundation.
 - Ensure functionality of conveyance swales, subsoil drains and flood detention structures by setting inverts at or above pre-development maximum groundwater level (MGL), the underlying clay layer or existing drain inverts.
 - Maintain or improve groundwater quality leaving the site.
- Stormwater management
 - Provide conveyance of 100 year ARI flows which currently enter the site from upstream catchments.
 - Treat runoff within each lot and from road pavements in roadside swales.
 - Detain flows up to the 100 year ARI event within each lot utilising WSUD structures to maintain pre-development peak flow rates at key discharge locations.
 - Protect habitable buildings from flooding.
 - Apply appropriate non-structural measures to reduce pollutant loads.

The area covered within the MKSEA LWMS is directly adjacent to the WMA (along the northern boundary, as shown in **Figure 1**). Details provided in the MKSEA LWMS are therefore relevant to the

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WMA (specifically relating to surface flows entering the WMA) as well as overarching water management principles that have informed some of the designs presented in this LWMS.

1.1.4 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in the overarching DWMS and *Better Urban Water Management* (WAPC 2008). It is intended to support the proposed development within the WMA and is based on the following major objectives:

- Provide a broad level stormwater management framework to support future industrial development.
- Maintain existing arterial flow pathways through the WMA to service upstream catchments and adjacent downstream wetlands.
- Minimise the amount of fill that needs to be imported to develop the land.
- Maintain overall existing peak flow rates from and through the WMA.
- Incorporate appropriate best management practices into the drainage system that address the environmental and stormwater management issues identified.
- Minimise ongoing operation and maintenance costs for the land owners and CoG.
- Develop a water conservation strategy for the WMA that will ensure the efficient use of all water resources.
- Gain support from DWER, Department of Biodiversity, Conservation and Attractions (DBCA) and CoG for the proposed method to manage stormwater within the WMA and potential impacts on downstream areas.

Detailed design criteria for water management within the WMA are further discussed in **Section 4**.

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2 Proposed Development

The WMA covers 14.1 ha and incorporates 13.2 ha of industrial zoned land, proposed to be used for general industrial purposes incorporating warehouses and ancillary offices, hard stand and car parking areas. Uses within the WMA will comply with the allowable land uses for each zoning specified in Table 1 of TPS No 6 (CoG 2002).

Development of the WMA is proposed in consideration of Yule Brook and the adjacent wetland (see **Sections 3.6.1** and **3.6.2**). This is achieved through the identification of appropriate buffer areas, and implementation and maintenance of appropriate water management practices (see **Sections 6** through **8**). Detention basins will be provided across the WMA to treat surface runoff and, along with additional piped network, ensure flows are maintained to the adjacent wetland as required.

Following approval of the Precinct 3A Structure Plan amendment the proponent intends to develop the WMA as a single lot with future works (including internal road network, buildings and associated drainage infrastructure) supported by a DA. Subdivision of the WMA is not proposed at this time.

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3 Pre-development Environment

3.1 Sources of information

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

- *Weather and climate statistics data* (BoM 2017)
- *LiDAR elevation dataset, Swan coastal plain* (DoW 2008b)
- *Armada part sheets 2033 I & 2133 IV, Geological Survey of WA* (Gozzard 1986)
- *Kenwick Rail Corridor, Western Australia: Detailed Site Investigation for Potential Contamination* (Western Environmental 2017)
- *LWMS MKSEA Precinct 3A Outline Development Plan* (Emerge Associates 2017).

The CoG and City of Kalamunda (CoK) have previously commissioned a range of studies and investigations across the MKSEA to understand the environmental attributes and values of the area, and to demonstrate the feasibility of industrial development. Various reports associated with these investigations have been reviewed as part of the preparation of this document and include:

- *MKSEA Engineering Feasibility Study* (GHD 2005)
- *MKSEA Environmental Review: Flora, Vegetation, Fauna and Wetlands* (Cardno BSD 2005)
- *MKSEA Preliminary Transport Study* (Cardno BSD 2006)
- *MKSEA Surface Water and Groundwater Investigation and Monitoring Program* (Aquaterra 2008)
- *Preliminary Investigation of Aboriginal Heritage – City of Gosnells MKSEA* (ACHM 2009)
- *The Flora, Vegetation and Wetlands of the MKSEA* (Tauss and Weston 2010)
- *MKSEA Surface Water and Groundwater Monitoring and Investigation Report* (Endemic 2012).

A number of site specific studies have also been completed to support development of the WMA and include:

- *Geotechnical Investigation Report Proposed Industrial Development Lot 414 Grove Road, Kenwick* (JDSi 2017)
- *Lot 414 Grove Road, Kenwick Wetland and Wetland Buffer Assessment* (PGV Environmental 2017b)
- *Lot 414 Grove Road, Kenwick Environmental Assessment* (PGV Environmental 2017a)
- *Lot 414 Grove Road Infrastructure Servicing Report* (TABEC 2017)
- Flora and vegetation survey of Yule Brook adjacent to WMA (see **Section 3.5**).

3.2 Climate

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. Average evaporation in the region is approximately 1800 mm per annum. An average of 820.3 millimetres (mm) of rainfall is recorded annually at the closest weather station to the WMA (i.e. Gosnells City weather station number 9106). The majority of this rainfall is received between the months of May and August (BoM 2017).

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3.3 Geotechnical conditions

3.3.1 Topography

The WMA is low-lying with elevations ranging between approximately 12 m Australian height datum (AHD) in the north eastern corner and 7 m AHD in the south western corner. Topographic contours are shown in **Figure 2**.

3.3.2 Geology and soils

Regional mapping indicates that the majority of the WMA is underlain by clayey sand (Sc), with a small area of sand (S8) in the north-eastern corner (Gozzard 1986), as shown in **Figure 3**.

The geotechnical investigation report (provided in **Appendix C**) describes the soil profile within the WMA as fine to coarse grained sand and silty sand overlying low to high plasticity sandy clay (JDSi 2017). The sandy clay layer was encountered from shallow depths (from 0.2 to 0.4 m below the surface) across the WMA. At depth, the sandy clay layer included traces of calcareous gravel. Hand auger borehole locations are shown in **Figure 3**.

Bore logs recorded for groundwater monitoring bores installed within and adjacent to the WMA as part of the pre-development monitoring program (shown in **Figure 2** and detailed further in **Section 3.7**) show that the underlying soil profile is generally consistent with regional mapping. Bore logs for EMW01, EMW02, MW3 and MW7 are provided in **Appendix B**.

3.3.3 Acid sulfate soils

Regional acid sulfate soils (ASS) risk mapping indicates that the WMA is classified as having a moderate to low risk of ASS occurring within 3 m of the natural surface (DWER 2017). ASS mapping is shown in **Figure 4**.

3.4 Existing and historical landuse

The WMA has predominantly been used for rural lifestyle and small scale agricultural land uses. The land is currently used for horse agistment with the building in the east of the WMA used as an office. The existing and historical land use of the WMA has influenced the existing environmental context of the WMA, as discussed in the following sections.

3.5 Flora and vegetation

Previous studies of the vegetation across the WMA indicate that the WMA consists of two areas of native vegetation along Grove Road and one very small area of native vegetation along the north-eastern boundary of Lot 4 (Tauss and Weston 2010). Vegetation along Grove Road comprises low woodland to low open forest of *Corymbia calophylla* over non-native understorey (Tauss and Weston 2010). Vegetation on the boundary with Lot 4 has since been reviewed by PGV Environmental (PGV Environmental 2017a) and confirmed to consist of 'Marri trees and introduced Eucalypts over grassy weeds', thus not considered to be intact native vegetation (Van der Moezel, P [PGV Environmental] 2018, *pers. comm.*, 2 February).

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Degraded native vegetation has also been recorded along Yule Brook adjacent to the south-western boundary of the WMA during a site survey conducted by Emerge Associates in August 2017 (detailed further in **Section 3.6.1**).

3.6 Surface water

3.6.1 Yule Brook

A section of Yule Brook is located adjacent to the south-western corner of the WMA (though within Lot 414 Grove Road). The alignment of Yule Brook identified in the DWER dataset '*Hydrography Linear*' (shown in **Figure 5**), is not consistent with the on-ground conditions, which have been confirmed through site survey (illustrated in **Figure 6** and discussed in **Section 8**) with the brook channel running along the south-western boundary of the WMA.

Yule Brook conveys flows from upstream towards the west, beneath Roe Highway and ultimately to the Canning River. Yule Brook is also part of the Water Corporation local drainage network.

A biophysical assessment of northern banks of the Yule Brook located in the south-west of the WMA was undertaken in order to identify the foreshore area associated with Yule Brook within the WMA. The assessment included the length of the brook from Roe Highway to the boundary of the adjacent resource enhancement wetland (REW) (UFI 7365 shown in **Figure 5** and detailed in **Section 3.6.2**). The biophysical assessment included identification of riparian vegetation associated with Yule Brook, as well as other physical characteristics of the WMA and brook.

Riparian vegetation was primarily confined to a narrow strip between three and 28 m wide along the banks of Yule Brook and had the following characteristics:

- Vegetation comprises a canopy of native *Melaleuca raphiophylla* and *M. preissiana* with occasional *Eucalyptus rudis* trees. The understorey is dominated by non-native species such as **Cenchrus macrourus* (African feather grass) and **Watsonia meriana* var. *bulbillifera* (bugle lily). Some native species that often form dense swards such as *Typha* sp. (bulrush) are also present. The location of native riparian vegetation associated with Yule Brook adjacent to the WMA is shown in **Figure 5**.
- The riparian vegetation was deemed to be in 'degraded' condition due to the low diversity of native flora species and altered vegetation structure.
- One species listed as a 'declared pest' pursuant to the Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), **Zantedeschia aethiopica* (arum lily), was recorded in the riparian vegetation.

Additional characteristics observed in relation to Yule Brook within the WMA include:

- A defined channel is present with flat to steep low banks, and the surrounding land is flat. As shown in **Figure 3**, the brook is underlain by sandy silt.
- At the time of the flora and vegetation survey (discussed above), stagnant pools of water were present in the brook. The majority of these pools were clear and not dominated by algae or other organisms.

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- The majority of the brook banks are covered by vegetation (primarily African feather grass) and subsequently showed no signs of erosion where vegetation was present during the flora and vegetation survey.
- The brook is accessible to stock and a crossing is present near the eastern end of the riparian vegetation mapped in **Figure 5**. The crossing is bare of understory vegetation and some evidence of erosion was present.
- Beyond the narrow strip of riparian vegetation, paddock of non-native grasses are currently used for horse grazing.

The biophysical assessment findings have been used in identification of appropriate buffer areas for Yule Brook (along with other pertinent data) which is discussed further in **Section 8**.

Information provided by Water Corporation indicates the 100 year ARI event top water level (TWL) associated with the Yule Brook is 9.7 m AHD (at the upstream end of the WMA) based on both a 50 m and 100 m floodplain design option (discussed further in **Section 8.2**).

3.6.2 Wetlands

A review of the *Geomorphic Wetlands on the Swan Coastal Plain* dataset (DBCA 2017) indicates that the majority of the WMA is classified as a multiple use wetland (MUW) (UFI 15254). Small areas of the WMA along the south-eastern boundary are mapped as part of the adjacent REW (UFI 7635). Mapped wetlands are shown in **Figure 5**.

3.6.2.1 Wetland boundary assessment

A review of the extent and classification of the adjacent REW (wetland 7635) has been carried out by PGV Environmental and is detailed in the *Lot 2008 Grove Road, Kenwick Wetland Assessment* (PGV Environmental 2017b). The findings are summarised below:

- The mapped wetland located on Lot 414 is completely cleared of native vegetation and does not have any flora or vegetation values, and limited fauna values associated with wetland communities.
- An evaluation of the cleared wetland on Lot 414 results in a management category of multiple use.
- The boundary between the cleared parts of the wetland and the native vegetation extends from 5 to 15 m into the adjoining lot to the south-east (Lot 8, 41 Brook Road).
- The vegetated parts of wetland 7635 are rated as conservation category primarily due to evidence of the presence of the Muchea Limestone threatened ecological community.

The wetland assessment has confirmed that the *Geomorphic Wetlands on the Swan Coastal Plain* dataset (DBCA 2017) is not representative of the wetland features onsite. A revised boundary for wetland 7635 has been identified (shown in **Figure 5**) to better reflect the conditions on ground (prepared by PGV Environmental 2017). This revised boundary has been used to inform the associated buffer requirements to wetland 7635, which is discussed further in **Section 8**.

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3.6.2.2 Wetland water balance

Wetland 7635 depends on multiple facets of the hydrological cycle including surface water flows and groundwater. A high level wetland water balance has been prepared to highlight the key hydrological factors in the existing wetland system that are required to maintain its health based on the current hydrological regime. Key factors are shown in **Plate 1**, with defined quantities detailed in the referenced sections.

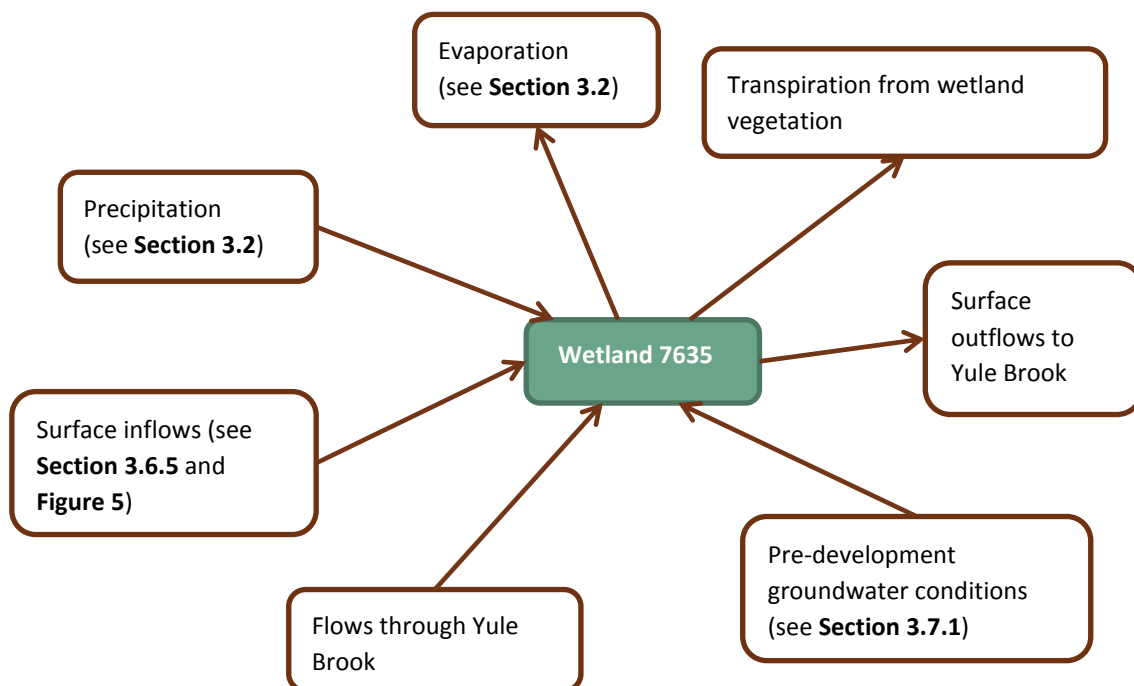


Plate 1 Wetland water balance considerations

3.6.3 Existing drainage network

An existing surface water channel flows into the WMA from Lot 14 Edward Street (along the northern boundary of the WMA) and discharges from the WMA into wetland 7635 (located in Lot 4 Bickley Road), discussed in **Section 3.6.2**. Flows continue through the wetland and ultimately discharge into Yule Brook to the south. This flowpath is a natural channel that has been significantly impacted by historical landuses across the local area and is an extension of a more formal agricultural drainage network in the area. The channel does not have any riparian vegetation associated with it and is largely grassed with shallow depth and side slopes. The existing surface water channel and flow direction are shown in **Figure 5**.

3.6.4 Surface water monitoring

Surface water monitoring was carried out by Endemic between June 2009 and December 2010 across the greater MKSEA area, and included (Endemic 2012):

- Surface water streamflow monitoring within the Yule Brook.
- Surface water level monitoring within the Yule Brook and road verge drainage swales.
- Surface water quality monitoring within the Yule Brook and road verge drainage swales.

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- Wetland water level monitoring.

There are no surface water monitoring locations within the WMA however there are two locations within the Yule Brook. M1 is upstream of the WMA near Welshpool Road and M2 is located downstream of the WMA near Roe Highway (shown in **Figure 5**).

3.6.4.1 Flow rates

A peak flow rate of 1.70 m³/s was recorded at M1 (upstream of the WMA) in August 2009 (Endemic 2012) with a peak flow rate of 2.65 m³/s recorded at M2 (downstream of the WMA) in July 2009. These flow rates have not been attributed to a specific rainfall event, and are therefore only useful as a general indication of possible baseflow conditions within Yule Brook.

3.6.4.2 Surface water quality

Water quality monitoring at M1 and M2 was undertaken on 14 occasions between June 2009 and October 2010 (Endemic 2012). The results of the monitoring are summarised in **Table 1** with the full data set provided in **Appendix D**.

Table 1 Pre-development surface water quality results

Analyte	Units	NWQMS guideline trigger*	SCWQIP guideline trigger**	M1		M2	
				Average	St.dev	Average	St.dev
Temperature	°C	-	-	14.39	2.28	14.75	2.48
pH	-	6.5-8.0	-	7.44	0.61	7.50	0.47
Electrical Conductivity (EC) ***	mS/cm	0.12-0.30	-	0.81	1.55	1.12	2.19
Dissolved oxygen (DO)	mg/L	-	-	7.75	1.11	7.18	1.23
Redox	mV	-	-	3.52	50.01	-9.17	65.97
Total suspended solids (TSS)	mg/L	-	-	20.38	21.41	17.67	17.89
Total dissolved solids (TDS)	mg/L	-	-	343.69	610.25	247.38	162.40
Total nitrogen (TN)	mg/L	1.2	1 - 2	0.90	0.28	0.94	0.38
NO _x -N	mg/L	0.15	-	0.35	0.21	0.44	0.34
Nitrite (NO ₂ -N)	mg/L	-	-	0.02	0.01	0.01	0.00
Nitrate (NO ₃ -N)	mg/L	-	-	0.36	0.22	0.41	0.31
Total kjehldahl nitrogen (TKN)	mg/L	-	-	0.55	0.32	0.54	0.26
Total phosphorous (TP)	mg/L	0.065	0.1 - 0.2	0.08	0.14	0.07	0.14
Filterable reactive phosphorous (FRP)	mg/L	0.04	-	0.01	n/a	0.01	n/a

* ANZECC and ARMCANZ (2000), ** SRT (2009) *** measured EC concentrations detailed in the Endemic monitoring data provided in **Appendix D** appear to be incorrectly labelled as mS/cm and should be µS/cm, when taken in context with recorded TDS concentrations.

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Surface water quality within Yule Brook is generally consistent upstream and downstream of the WMA. Both TN and TP concentrations are within guideline trigger values provided in the SCWQIP (SRT 2009) and NWQMS (ANZECC 2000).

3.6.5 Pre-development surface runoff modelling

As discussed in **Section 3.6.3**, upstream flows enter the WMA via a man-made channel and discharge to Yule Brook through the adjacent wetland. Stormwater runoff from the eastern portion of the WMA is conveyed as sheetflow into this channel and ultimately discharges to the south. Based on WMA topography (shown in **Figure 2**), stormwater runoff from the remainder of the WMA will be conveyed towards the west into Lot 413 Grove Road and ultimately into Yule Brook, or into the Yule Brook directly.

Surface water inflow and outflow locations relevant to the WMA are shown in **Figure 5**. Pre-development modelling was completed to support the DWMS (TME 2014a) and the MKSEA LWMS (Emerge Associates 2017). Pre-development 10 year and 100 year ARI event peak flows for these locations, as presented in the MKSEA LWMS (Emerge Associates 2017) are provided in **Table 2**.

Table 2 Pre-development peak flows

Location	100 year ARI (36 Hour) peak flow (m ³ /s)	10 year ARI (36 Hour) peak flow (m ³ /s)
Inflow	0.8	0.5
Outflow	1.2	0.6

Pre-development surface runoff modelling of Yule Brook has not been carried out in relation to the WMA. Details relating to post-development flooding widths and associated buffer requirements to Yule Brook are discussed in **Section 8.2**.

3.7 Groundwater

A number of groundwater monitoring bores have been installed across the wider MKSEA:

- Endemic installed monitoring bores in 2009 to support the DWMS (Endemic 2012).
- Emerge Associates installed bores in 2016 to support Precinct 3A.
- Western Environmental installed monitoring bores in 2016 to support the Kenwick Rail Corridor (Western Environmental 2017).

Two of these bores (MW3 and MW7 by Western Environmental) are located within Lot 414 Grove Road. To provide greater resolution of data across the WMA, two additional monitoring bores (EMW01 and EMW02) were installed adjacent to the REW boundary in July 2017. The location of groundwater monitoring bores is shown in **Figure 2** with associated bore logs provided in **Appendix B**.

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3.7.1 Groundwater levels

3.7.1.1 Regional data

The *Water Register* (DWER 2017) indicates that groundwater beneath the WMA is a multi-layered system comprised of the following:

- Perth – Superficial Swan unconfined aquifer
- Perth – Leederville confined aquifer
- Perth – Yarragadee North confined aquifer.

The *Perth Groundwater Atlas* (DWER 2017) shows groundwater levels across the WMA ranging between 5 and 7 m AHD with groundwater flowing in a south-westerly direction. Regional groundwater contours are shown in **Figure 2**.

3.7.1.2 Local data

Calibrated MGL contours were determined for Precinct 3A based upon monitoring conducted across the precinct within nine bores installed in 2016. These were presented in the MKSEA LWMS (Emerge Associates 2017) and have been reproduced in **Figure 2** for local context.

MW3 and MW7 were monitored on one occasion in October 2016 for the *Kenwick Rail Corridor, Western Australia: Detailed Site Investigation for Potential Contamination* (Western Environmental 2017). Groundwater at MW3 and MW7 was measured at 7.9 and 6.5 m AHD, respectively.

3.7.1.3 WMA specific data

Groundwater levels were measured at EMW01, EMW02, MW3 and MW7 from July 2017 in order to capture the winter peak for the WMA. Levels recorded between July and November 2017 are provided in **Table 3**. The 2017 MGL was recorded in August. Site specific monitoring shows that depth to peak groundwater beneath the WMA ranges from approximately 350 mm to 1.1 m below the surface.

Table 3 Measured groundwater levels (m AHD)

Bore ID	27/7/2017	25/8/2017	12/9/2017	20/10/2017	16/11/17
EMW01	7.10	7.63	7.47	7.30	6.93
EMW02	7.64	8.19	8.03	7.82	7.40
MW3	7.32	8.28	8.07	7.84	7.39
MW7	6.82	6.88	6.64	6.44	6.04

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3.7.2 Groundwater quality

3.7.2.1 Local data

Groundwater quality was tested at MW3 and MW7 once in October 2016 (see **Appendix E** for the full dataset) (Western Environmental 2017). Quality results for MW3 and MW7 are provided in **Table 4**.

3.7.2.2 WMA specific data

Groundwater quality was tested at EMW01 and EMW02 once in July 2017. Field parameters and nutrient concentrations at EMW01 and EMW02, as well as any corresponding analytes measured are provided in **Table 4**.

Table 4 Pre-development groundwater quality results

Analyte	Units	NWQMS guideline trigger*	SCWQIP guideline trigger**	MW03 (18/10/16)	MW07 (18/10/16)	EMW01 (27/7/17)	EMW02 (27/7/17)
Temperature	°C	-	-	-	-	19.2	17.6
pH	-	6.5-8.0	-	7.2	8.1	7.5	6.9
EC	mS/cm	0.12-0.30	-	1.18	2.83	0.78	3.47
DO	mg/L	-	-	17.8	11.8	7.31	7.09
Redox	mV	-	-	58.4	69.4	219.1	261.9
TN	mg/L	1.2	1 - 2	0.9	0.3	2.0	1.1
NO _x -N	mg/L	0.15	-	0.34	0.06	1.27	0.19
NO ₂ -N	mg/L	-	-	<0.01	0.01	0.02	<0.01
NO ₃ -N	mg/L	-	-	0.34	0.05	1.25	0.19
Ammonia (NH ₃ -N)	mg/L	-	-	0.04	0.02	0.07	0.06
TKN	mg/L	-	-	-	-	0.7	0.9
TP	mg/L	0.065	0.1 - 0.2	4.7	5	0.15	0.5
FRP	mg/L	0.04	-	0.01	0.08	0.1	<0.01

* ANZECC and ARMCANZ (2000), ** SRT (2009)

Groundwater quality across the WMA is variable. TN measured within EMW01 and EMW02 slightly exceed the SCWQIP (SRT 2009) guideline value. TP guideline values were exceeded at all bores, though the concentrations measured within MW03 and MW07 were notably high. Elevated nutrient concentrations, especially organic forms of nitrogen and TP, are typical of agricultural areas due to the presence of livestock and use of fertilisers. This is consistent with the existing land use across the WMA and wider region (discussed in **Section 3.4**).

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3.8 Summary of existing environment

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

- The WMA receives 820.3 mm of average annual rainfall with the majority of rainfall received between May and August.
- Topography of the WMA is low-lying with elevations ranging from approximately 12 m AHD in the north eastern corner to 7 m AHD in the south western corner.
- The WMA is underlain by fine to coarse grained sand and silty sand overlying low to high plasticity sandy clay.
- ASS risk mapping indicates that the WMA is classified as having a moderate to low risk of ASS occurring within 3 m of the natural surface.
- Native vegetation exists along the Grove Road with degraded riparian vegetation ranging in width from three to 28 m exists along the banks of Yule Brook.
- The majority of the WMA is classified as a MUW (UFI 15254). Small areas of the WMA are mapped as part of the adjacent REW (UFI 7635). A revised REW boundary has been proposed following a review of onsite characteristics (PGV Environmental 2017b).
- An existing surface water channel flows into the WMA from Lot 14 Edward Street at a peak flow of 0.8 m³/s for the 100 year ARI event. This channel discharges from the WMA into the REW at a peak flow of 1.2 m³/s for the 100 year ARI event. Ultimately, flows from this channel will discharge into Yule Brook to the south.
- The 100 year ARI event TWL within Yule Brook has been indicated by Water Corporation as 9.7 m AHD assuming both a 50 m and 100 m floodplain channel.
- Surface water quality within Yule Brook is generally consistent upstream and downstream of the WMA, with TN and TP concentrations within guideline trigger values.
- Depth to peak groundwater ranges from approximately 350 mm to 1.1 m below the surface.
- Elevated TN concentrations were recorded at some groundwater bores with elevated TP concentrations recorded at all groundwater bores. Concentrations are typical of agricultural land uses.

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4 Design Criteria and Objectives

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and *Better Urban Water Management* (WAPC 2008) endorse the promotion of integrated water cycle management and application of WSUD principles to provide improvements in the management of stormwater, to increase the efficient use of other existing water supplies and to protect environmental assets across and adjacent to the site.

The key principles of integrated water cycle management include:

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

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

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management
- Environmental protection.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the WMA has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines, and site specific studies undertaken in and around the WMA that were detailed in **Sections 1.1.2** and **1.1.3**.

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

4.2 Water conservation

Water conservation design criteria are proposed which are consistent with the guidelines presented in *Better Urban Water Management* (WAPC 2008) and in consideration of the criteria proposed in the DWMS (TME 2014a). This LWMS proposes the following water conservation criteria:

Criteria WC1 Ensure the efficient use of all water resources.

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

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4.3 Stormwater management

The principle behind stormwater management for the WMA is to mimic the pre-development hydrological conditions, as described in **Section 3.6**. This principle and the guidance documents discussed in **Section 1.1.3** and **1.1.4** have guided the stormwater management criteria which include:

Criteria SW1 Maintain pre-development peak flow rates leaving the WMA (up to the 100 year ARI event).

Criteria SW2 Surface flows will be appropriately treated prior to discharge from the WMA.

Criteria SW3 Provide conveyance of upstream flows through the WMA.

Criteria SW4 Finished floor levels of habitable buildings should have a 300 mm clearance from the 100 year ARI TWL within surface water detention structures.

Criteria SW5 Finished floor levels of habitable buildings should have a 500 mm clearance from the 100 year ARI TWL within Yule Brook.

Criteria SW6 Apply appropriate non-structural measures to reduce pollutant loads.

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

4.4 Groundwater management

The principle behind the groundwater management strategy is to maintain the existing groundwater hydrology. This LWMS proposes the following groundwater management criteria:

Criteria GW1 Finished floor levels of habitable buildings should have a minimum 500mm clearance from MGL.

Criteria GW2 Inverts of flood detention structures to be set at or above MGL or the underlying clay layer.

Criteria GW3 Maintain groundwater quality leaving the WMA.

The manner in which these objectives will be achieved is further detailed in **Section 7**.

4.5 Wetland and waterway management

The principles behind wetland and waterway management are to maintain the existing hydrological regime and ensure protection of water quality within the wetland. Design criteria presented for stormwater and groundwater management are also relevant to the successful management of the wetland (specifically **Criteria SW1, SW2, SW6, GW2** and **GW3**). Additional criteria are therefore not proposed specifically for wetland and waterway management to avoid repetition.

The manner in which the criteria detailed for stormwater and groundwater management are achieved relevant to wetland and waterway management is detailed in **Section 8**.

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5 Water Supply and Wastewater

5.1 Water Supply

5.1.1 Fit for purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted.

The Lot 414 Grove Road development operates within the Water Corporation Integrated Water Supply System and will be supplied by scheme water for potable and non-potable uses. The development is capable of being serviced by the existing DN150 main along Grove Road that currently supplies the existing property (TABEC 2017).

5.1.2 Water conservation measures

The water conservation strategy proposes that all buildings use water efficient fittings where appropriate. Water efficient fittings and toilets are mandated through the building licence process. The use of water efficient fittings will assist in achieving **Criteria WC1**. Given the large lot industrial uses the water savings achieved by these measures are likely to be nominal.

Drainage reserves (discussed further in **Section 6.1**) and wetland and waterways buffers (discussed further in **Section 8**) and any landscaping associated with the office/car park areas and Grove Road road verge (required by the CoG) will be planted during winter with waterwise species, with a focus on using local native species. The WMA is not proposed to require establishment or ongoing irrigation, which assists in achieving **Criteria WC1**.

5.2 Wastewater

Wastewater is water that is associated with buildings/site offices (except roof runoff) and any specific industrial uses. Stormwater runoff is treated as a separate, independent system and is discussed in detail in **Section 6**.

Appropriate wastewater infrastructure design will protect the surrounding environment and achieve water management **Criteria SW2, SW6 and GW3**, identified in **Section 4** and discussed further in **Section 6** and **Section 7**.

5.2.1 General building wastewater

Aerobic treatment units (ATU) will be utilised for the management of wastewater from buildings/site offices. It is assumed that wastewater requirements are consistent with general office uses (i.e. toilets, sinks, showers etc.) with wastewater loading rates consistent with those stipulated in Table 2 of the Department of Health (DoH) *Supplement to Regulation 29 and Schedule 9 - Wastewater system loading rates* (DoH 2016).

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DoH approved systems, as listed in the *Approved Aerobic Treatment Units* (DoH 2015) document, will be utilised with installation carried out in line with the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (DoH 2001). Where larger systems are required designs will need to be assessed and approved by DoH on a case by case basis. All ATU systems will need to be detailed as part of the DA process to ensure consistency with these guidelines.

5.2.2 Industrial process wastewater

Any wastewater produced from industrial processes (additional to general building wastewater, discussed in **Section 5.2.1**) will be treated appropriately, in accordance with *WQPN 51: Industrial wastewater management and disposal* (DoW 2009). Any onsite facilities are to provide appropriate buffers to the adjacent sensitive environments (i.e. Yule Brook and wetlands discussed in **Sections 3.6.1** and **3.6.2**). Where appropriate treatment is not achievable within the WMA, industrial process wastewater will be captured and removed from the WMA to an appropriate treatment facility.

Whether wastewater treatment plants or removal of waste from the WMA is proposed, risk management and contingency plans will be required to be prepared to ensure the surrounding sensitive environments are protected should spills or plant failures occur, in accordance with *WQPN 10: Contaminant spills - emergency response* (DoW 2006).

Considering the expected land uses (discussed in **Section 2**), the production of wastewater from industrial processes is not anticipated. However, this will be confirmed and any additional treatment required detailed as part of the DA process.

5.2.3 Hazardous materials

A risk assessment is required to decide the appropriate level of containment required for hazardous materials that may be held on site (DoW 2007).

Primary containment includes the tanks in which hazardous materials are contained and must be fit for purpose. Secondary containment devices and practices are related to the capture of spills for treatment should they occur and can be local or remote (DoW 2007).

Local containment devices (discussed in **Section 5.2.4**) are preferred with remote containment (such as floating booms installed on the inlets to ponds or wetlands) considered a short-term emergency response to spills only (DoW 2007). The storage of any hazardous materials associated with the proposed land use will be required to be detailed along with any associated containment requirements as part of the DA process.

5.2.4 Secondary containment devices

5.2.4.1 Gross pollutant traps

Runoff from impervious areas can transport nutrients and gross pollutants to downstream water bodies. A gross pollutant trap (GPT) is considered a primary level treatment system, removing a proportion of these large pollutants and, in some cases, the smaller particles such as sediments and hydrocarbons. The pollutants captured in GPTs must be regularly removed to ensure the efficiency of the device.

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GPTs are best suited to areas with high gross pollutants such as commercial uses. Given the uses expected across the WMA, it is unlikely that GPTs will be utilised.

5.2.4.2 Grease and sediment traps

Certain land uses can produce sediments and hydrocarbons to a level that cannot be treated by GPTs. Grease and sediment traps can be used as a secondary level treatment system to remove these smaller particles. Grease and sediment traps must be regularly maintained to ensure the efficiency of the device.

Depending on the final nature of the development and specific land use, these may be applicable to some portions of the WMA. These are more likely to be required where there is either a high vehicle/traffic load, or where vehicle servicing/maintenance is to be carried out onsite.

5.2.4.3 Oil-water separators

Oil-water separators can be used to provide water quality treatment at a small scale, particularly for small industrial or commercial areas where larger containment devices are not feasible due to site constraints. There are a range of systems available which incorporate some combination of filtration media, hydrodynamic sediment removal, oil and grease removal, or screening to remove pollutants from stormwater.

Oil-water separators are best used in commercial, industrial and transportation type land uses i.e. areas that are expected to receive high sediment and hydrocarbon loadings, such as car parks and service stations. Depending on the final nature of the development and specific land use, these may be applicable to some portions of the WMA.

The requirement for GPTs, grease and sediment traps and oil-water separators will be confirmed as part of the DA process when the specific land use is confirmed.

5.3 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria, and how these are addressed within the WMA is provided in **Table 5**.

Table 5 Water conservation compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
WC1	Ensure the efficient use of all water resources.	All buildings use water efficient fittings where appropriate
		Drainage reserves and buffer areas will be planted during winter with waterwise species

A summary of how the wastewater management measures respond to the associated stormwater and groundwater management criteria are detailed in **Sections 6.4** and **7.3** respectively.

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6 Stormwater Management Strategy

The stormwater management strategy aims to mimic the pre-development hydrological conditions and manage stormwater quality. The strategy focusses on the following aspects:

- Conveyance of upstream flows through the WMA.
- Maintaining peak flows entering the wetland (described in **Section 3.6.2**).
- Stormwater runoff quality.

Each component of the stormwater management network has been designed to achieve the objectives and criteria stated in **Section 4.3**.

6.1 Development drainage strategy

A number of structural measures are provided across the development and within Grove Road along the development boundary to achieve the objectives detailed above.

6.1.1 Arterial drainage

There is an existing surface flow path through Lot 414 Grove Road which conveys flows from upstream catchments through to the adjacent wetland (discussed in **Section 3.6**).

Upstream flows enter the WMA along the north eastern boundary, as illustrated in **Figure 6** and detailed in the *MKSEA LWMS* (Emerge Associates 2017). Inflows to the WMA will be maintained, with a pipe network provided to convey flows to the existing outlet to the wetland (shown in **Figure 6**). Peak flow rates will be maintained through the use of detention basins across the WMA, discussed further in **Section 6.1.2**.

The proposed pipe network has been sized using surface runoff modelling software XPSWMM, detailed further in **Section 6.2**.

6.1.2 Detention basins

Surface runoff from across Lot 414 will be conveyed to detention basins prior to discharge from the WMA. Conveyance will be via an internal pipe network or as sheet flow (in major events). This detail will be confirmed at DA when final configuration of the development has been confirmed.

Two basins (FSA A and FSA C, shown in **Figure 6**) provide detention for both runoff from the WMA and arterial flows and have been configured to ensure peak flow rates into the adjacent wetland are maintained at pre-development levels.

An additional detention basin (FSA B) is provided in the south-west corner of the WMA to provide detention of runoff from the western portion of the WMA prior to discharging into the Yule Brook (as shown in **Figure 6**). Peak flow rates entering the Yule Brook from FSA B have been identified using a proportional calculation of the contributing catchment area and per hectare peak flow rates identified in the *MKSEA LWMS* (Emerge Associates 2017).

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All basins and associated infrastructure will be located outside of any buffer areas (i.e. wetland and Yule Brook buffers), as detailed in **Section 8**. Earthwork levels will ensure finished flood levels of habitable buildings provide a minimum clearance of 300 mm from the TWL in detention basins and 500 mm from the TWL of the Yule Brook, thus achieving **Criteria SW5**. Preliminary earthworks levels are shown in **Figure 6**.

Required detention basin capacities, outlet configurations and peak flow rates are detailed in **Section 6.2**. Detailed designs of drainage structures will need to confirm that required peak flow rates are achieved as part of the DA process.

6.1.3 Surface water treatment measures

Detention basins (discussed in **Section 6.1.2**) will be vegetated with plant species capable of removing nutrients from surface runoff, consistent with the *Vegetation guidelines for stormwater biofilters in the south-west of Western Australia* (Monash University 2014).

Detention basins will also be underlain with high (>10) phosphorous retention index (PRI) soils to provide removal of phosphorous from water infiltrating directly to groundwater which then flows toward the wetland and Yule Brook (as detailed in **Section 3.7**).

6.1.4 Grove Road drainage

The WMA is bounded to the east by the existing Grove Road reserve. While Grove Road is not located within the WMA itself, runoff from the eastern half of road pavement is conveyed to existing surface verge swales that run along the western boundary of the WMA.

The existing Grove Road verge swale along the length of the property (with the exception of 10 m at the southern end) will be replaced with a 225 mm diameter drainage pipe, as shown in **Figure 6**. The southern 10 m section of the existing swale will be retained and planted with vegetation capable of nutrient removal to provide treatment of flows conveyed through the pipe network. The retained swale section will continue south into the existing swale, consistent with the existing environment.

6.2 Drainage design assessment

Detailed hydrologic and hydraulic modelling software (XPSWMM) has been used to determine the appropriate configuration of detention basins and confirm that pre-development flow rates entering the wetland are maintained (as required by DBCA).

Inflows to the WMA have been informed by data presented in the *MKSEA LWMS* (Emerge Associates 2017). Initial sizing of detention basins was informed by the design approach presented in the *MKSEA LWMS* and as required by Water Corporation. These were then reviewed and optimised in order to achieve the additional constraint of the wetland inflow requirements. The proposed drainage design was provided to Water Corporation for review in relation to their internal modelling (October 2017). Preliminary advice provided received from Water Corporation indicates that the proposed design is sufficient to meet the storage requirements for the lot (G.Undale [Water Corporation] 2017, *pers. comm.*, November 11). Water Corporation correspondence is provided in **Appendix G** for reference.

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Assumptions used in the modelling are provided in **Appendix H**, with details of the drainage design presented in the following sections.

6.2.1 Detention basin configurations

As discussed in **Section 6.1.2**, detention basins will be used to detain flows from upstream and across the WMA to maintain peak flow rates leaving the WMA, consistent with the pre-development environment. The configuration of detention basins is provided in **Table 6**, with their locations illustrated in **Figure 6**.

Table 6 Detention basin configuration

Detention basin	Area (m ²)	Volume (m ³)	Depth (m)	Invert level (m AHD)	Outlet configuration	Outlet invert (m AHD)
FSA A	3,730	3,500	1.2	8.4	Arterial 900 mm pipe to FSA C	8.3
					Low flow 300 mm pipe	8.4
					Intermediate flow 600 mm pipe	8.7
					V-shaped weir, 1:2 side slopes	9.24
FSA B	2,560	2,000	1.0	7.0	Low flow 150 mm pipe	7.0
					4 m broad weir	8.0
FSA C	1,880	1,500	1.1	8.2	Low flow 150 mm pipe	8.2
					V-shaped weir, 1:2 side slopes	8.98

Detailed engineering designs will need to comply with the drainage design presented within this LWMS and therefore the associated design criteria can be achieved (detailed in **Section 4**).

6.2.2 Inflows and outflows

Table 7 provides details of the assumed inflow rates to the WMA (informed by the *MKSEA LWMS*) and outflow rates resulting from the proposed drainage design. A comparison to the pre-development environment is also presented. Inflow and outflow locations are indicated in **Figure 6**.

Table 7 Inflows and outflows

Location	1 year 1 hour ARI event peak flow rate (m ³ /s)		10 year ARI event peak flow rate (m ³ /s)		100 year ARI event peak flow rate (m ³ /s)	
	Pre-development	Post-development	Pre-development	Post-development	Pre-development	Post-development
Northern inflow	NA	NA	0.50	0.50	0.80	0.80
Outflow to REW	0.10	0.10	0.60	0.60	1.20	1.20

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Table 7 Inflows and outflows (continued)

Location	1 year 1 hour ARI event peak flow rate (m ³ /s)		10 year ARI event peak flow rate (m ³ /s)		100 year ARI event peak flow rate (m ³ /s)	
	Pre-development	Post-development	Pre-development	Post-development	Pre-development	Post-development
Outflow to Yule Brook	NA	NA	NA	0.03	NA	0.04
Grove Road outflow	NA	NA	NA	0.02	NA	0.02

6.3 Non-structural stormwater management measures

The structural measures proposed within the WMA provide both a storage and treatment function to stormwater runoff, as detailed in **Section 6.2**. Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). A number of non-structural measures will also be implemented across the WMA to help reduce nutrient loads within stormwater runoff. These measures include:

- Maintenance of WSUD strategies.
- Minimising fertiliser use to establish and maintain vegetation within drainage reserves and wetland and waterway buffers.
- Drought tolerant plant species that require minimal water and nutrients will be used.
- Education of tenants regarding fertiliser use and nutrient absorbing vegetation species.

The above measures will assist in achieving **Criteria SW2** and **SW6**.

6.4 Stormwater criteria compliance summary

A summary of the proposed stormwater design criteria and how these are addressed is given in **Table 8**.

Table 8 Stormwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Maintain pre-development peak flow rates leaving the WMA (up to the 100 year ARI event).	Use of three detention basins and an arterial pipe network from FSA A to FSA C.
SW2	Surface flows will be appropriately treated prior to discharge from the WMA.	Detention basins will be vegetated with appropriate plant species and underlain by high PRI soils to remove nutrients prior to stormwater being discharged from the WMA.
		Length of swale along Grove Road that is retained will be vegetated.
		Use of appropriate primary and secondary wastewater treatment structures or removal procedures appropriate for the proposed land use.

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Table 8 Stormwater management compliance summary (continued)

Criteria number	Criteria description	Manner in which compliance will be achieved
SW3	Provide conveyance of upstream flows through the WMA.	Use of arterial pipe to convey upstream inflows into FSA A and through to the wetland.
SW4	Finished floor levels of habitable buildings should have a 300 mm clearance from the 100 year ARI TWL within flood detention structures.	Earthwork levels will ensure finished flood levels of habitable buildings achieve the required clearances.
SW5	Finished floor levels of habitable buildings should have a 500 mm clearance from the 100 year ARI TWL within Yule Brook.	
SW6	Apply appropriate non-structural measures to reduce pollutant loads.	Maintenance of WSUD structures including detention basins, primary and secondary wastewater treatment structures.
		Minimising fertiliser use to establish and maintain vegetation within drainage reserves and wetland and waterway buffers.
		Drought tolerant plant species that require minimal water and nutrients will be used.
		Education of tenants regarding fertiliser use and nutrient absorbing vegetation species.

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7 Groundwater Management Strategy

The groundwater management criteria provided in **Section 4.4** can be achieved through the methods described below.

7.1 Groundwater level management

The preliminary earthworks levels shown in **Figure 6** show that approximately 500 mm to 1.5 m of sand fill will be utilised across the WMA. As described in **Section 3.7.1**, the groundwater levels measured in August represent the 2017 winter peak (shown in **Figure 2**). Therefore, the preliminary earthworks will provide at least a 1 m clearance to the underlying MGLs.

DoH require ATUs to provide a minimum 500 mm clearance from the invert of the discharge pipe of the unit or the irrigation area to known groundwater levels, thereby allowing an absorption zone (DoH 2001). Any proposed ATUs that have less than 500 mm clearance from MGL will be required to import additional fill into the appropriate proportion of the building envelope to facilitate the ATU surface irrigation area required. Where reduced irrigation areas to the standard requirement (detailed in the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (DoH 2001)) are proposed, additional clearance from MGL may be required. The design of all ATUs will be approved by DoH prior to installation to ensure that the Code of Practice has been followed.

The use of fill will ensure that finished floor levels of any habitable buildings are 500 mm above the MGL and any proposed ATU irrigation areas are at least 500 mm above MGL.

Detention basins (discussed in **Section 6.1.2**) will be set with inverts at, or above, measured MGL for the WMA and will be provided low flow outlets to ensure they can drain following rainfall events.

Control of groundwater levels across the WMA via subsoil drains is therefore not proposed.

It is noted that detailed engineering earthworks levels will need to comply with the design criteria (detailed in **Section 4.4**) and drainage design presented within this LWMS and confirmed as part of the DA process.

7.2 Groundwater quality management

The main objective of the management of groundwater quality is to maintain the existing groundwater quality. This can be achieved by reducing the total nutrient load into groundwater that originates from newly developed areas and by treatment of surface water runoff prior to infiltration to groundwater. This will be achieved across the WMA by:

- Planting drainage reserves and buffers with waterwise species (see **Section 5.1.2**)
- Appropriate design, installation and maintenance of ATUs (see **Section 5.2.1**)
- Appropriate treatment or disposal of industrial wastewater (see **Section 5.2**)
- Appropriate treatment of stormwater runoff (see **Section 6.1**)
- Removal of stock from across the WMA and accessing Yule Brook (see **Section 3.4**).

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7.3 Groundwater criteria compliance summary

A summary of the proposed groundwater design criteria and how these are addressed is given in **Table 9**.

Table 9 Groundwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Finished floor levels of habitable buildings should have a minimum 500mm clearance from MGL.	Use of sand fill across the WMA.
GW2	Inverts of flood detention structures to be set at or above MGL or the underlying clay layer.	Use of sand fill across the WMA and locating invert of detention basins above the clay layer.
GW3	Maintain groundwater quality leaving the WMA.	Planting drainage reserves and buffers with waterwise species.
		Appropriate design, installation and maintenance of ATUs.
		Appropriate treatment or disposal of any industrial wastewater produced.
		Treatment of stormwater runoff.

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8 Wetland and Waterway Management Strategy

As discussed in **Section 3.6**, the WMA is adjacent to a REW (wetland 7635) and the Yule Brook. The stormwater and groundwater management strategies detailed in **Sections 6** and **7** respectively have been progressed in consideration of the hydrological requirements of both the wetland and Yule Brook, as detailed in the following sections.

8.1 Wetland 7635

8.1.1 Wetland buffer study

As discussed in **Section 3.6.2.1**, a revised boundary for wetland 7635 has been identified based on existing vegetation condition and extent (PGV Environmental 2017b). A formal amendment to the wetland mapping and category has not been progressed however the values and condition of the wetland have guided the buffer required to be provided between development within Lot 414 Grove Road and the wetland boundary.

An environmental assessment report and associated wetland buffer study completed by PGV Environmental (2017b) has determined that a 30 m buffer between the revised wetland boundary and the proposed development in Lot 414 Grove Road is sufficient to protect the health of the waterway (PGV Environmental 2017b). The 30 m wetland buffer is shown in **Figure 6**.

The 30 m wetland buffer will be revegetated by the proponent using plant species consistent with that currently present in wetland 7635. The surface flow path indicated in **Figure 6** (that provides inflows to the wetland from the WMA and upstream catchments) will be maintained in the existing configuration. No drainage infrastructure associated with the development will be located in the wetland buffer.

8.1.2 Post-development wetland water balance

Wetlands are sensitive hydrological systems that require a specific water balance to maintain their health and condition. As discussed in **Section 3.6.2**, the hydrological influences to wetland 7635 include surface inflows and outflows, groundwater conditions, evaporation, and transpiration characteristics of the vegetation contained within the system.

The proposed development of Lot 414 has considered the ongoing health of wetland 7635 through the water management strategies detailed in **Sections 6** and **7**. Maintenance of the wetland's water balance in the post-development environment is demonstrated in **Plate 2**.

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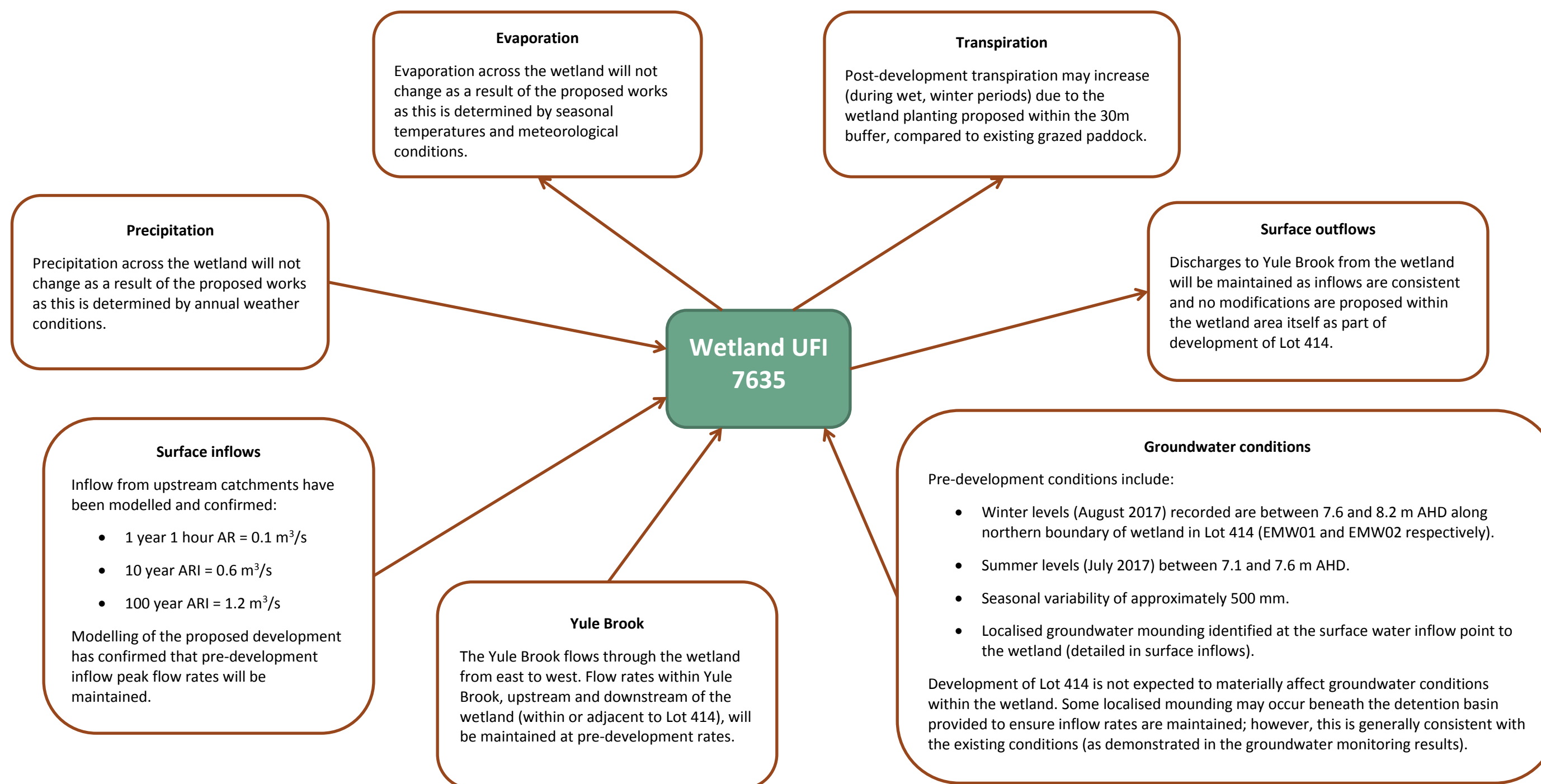


Plate 2 Pre-to-post development comparison water balance for wetland 7635 (as impacted by works proposed in Lot 414 Grove Road only)

Note: This wetland water balance has been prepared in response to Condition 6.10.3.1 of LPS6 - amendment 165 (CoG 2016). A high level, qualitative assessment has been carried out following discussions with Jennifer Higbid of DBCA on 13th July 2017 and confirmation that a box model approach will be sufficient to satisfy DBCA. Detailed modelling of groundwater conditions and transpiration characteristics of the wetland have not been carried out as works proposed are not within the wetland area. Based on the qualitative assessment of the WMA the proposed development is not expected to detrimentally impact the wetland from a hydrological perspective.

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Water quality within the wetland will be maintained through the treatment of surface runoff prior to discharge into the wetland, as discussed in **Section 6**. Ongoing management and maintenance of drainage infrastructure is detailed in **Section 9.1.4** and will ensure the quality of runoff entering the wetland is sufficient to maintain its health.

8.2 Yule Brook

A short section of Yule Brook is located along the boundary of the WMA (in the south-west corner), outside of the identified wetland areas. As discussed in **Section 3.5**, Emerge Associates carried out a site visit in August 2017 to determine the biophysical characteristics of Yule Brook adjacent to/within the WMA. The riparian vegetation associated with Yule Brook identified on site is illustrated in **Figure 5**. The route of the Yule Brook along this section has been confirmed based on observations made during the site visit and review of detailed Lidar data, and is illustrated in **Figure 6**. This alignment differs slightly to the DWER mapping of Yule Brook (detailed in **Section 3.6.1** and illustrated in **Figure 5**).

Detailed post-development modelling of the Yule Brook has not been completed for this LWMS. However, it is understood that a drainage corridor of between 50 and 100 m width is sufficient to contain the post-development 100 year ARI flood event associated with the Yule Brook (see Water Corporation floodplain mapping provided in **Appendix G**).

Discussions with DWER (J. Mackintosh 2017, *pers.comm.*, July 13) confirmed that drainage infrastructure associated with the development must be located outside of any foreshore area identified through a biophysical assessment.

Discussions with Water Corporation have indicated that drainage infrastructure is not to be located within 50 m of the Yule Brook channel (assuming the maximum 100 m corridor will be required to contain the post-development flows within the Yule Brook).

The specific buffer requirements for the Yule Brook will be confirmed as part of future works being completed by the CoG in relation to the Precinct 3B structure planning process which will include agreement on any changes to the configuration of the Yule Brook channel, upstream storage requirements and any resulting changes to the floodway and flood fringe areas for Yule Brook.

The riparian vegetation associated with Yule Brook within the WMA is situated within 50 m from the Yule Brook channel (shown in **Figure 5**). Detention basin FSA B will be located outside of the currently indicated 50 m buffer and therefore does not impact on the riparian vegetation identified in this location. Should a reduced buffer be identified following future technical studies relating to the Yule Brook based on detailed flood modelling the location of basin FSA B may be reviewed. Any change to the basin location will be informed by final the foreshore area identified as part of future studies ensuring that all drainage remains outside of the foreshore area (as required by DWER).

8.3 Wetland and waterway management

Maintenance of the buffers to the wetland and Yule Brook will be confirmed as part of the UWMP/DA process however, an alternative management body is expected to be identified as part of the wider wetland and waterway system studies being progressed by the CoG.

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Ongoing management and maintenance of the buffer areas will include:

- Regular visual inspections of buffer areas.
- Weed control and infill planting to be carried out in buffers as necessary.
- Maintenance of the existing flow path into wetland 7365 within the buffer to ensure inflows can continue to reach the wetland, including removal of vegetation/weeds and sediments that may build up and reduce the flow capacity of the channel.

A revegetation and buffer management plan will be prepared to support works within the wetland buffer (as required under Condition 6.10.4.1 of LPS6 – amendment number 165 (CoG 2016), which is provided in **Appendix A**) detailing the management and maintenance requirements for these areas.

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9 Future Development

Development of areas progressed under DA may not be required to prepare additional water management plans (i.e. UWMP) to support the application. In this case, detailed designs presented in DAs should be reviewed in conjunction with the design criteria presented in this LWMS to ensure the appropriate elements of the water management strategy discussed herein are implemented.

Where conditions of a DA require the preparation of a UWMP, it should follow the guidance provided in *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008c). While strategies have been provided within this LWMS that address planning for water management within the WMA, it is a logical progression that any UWMP or DA application will clarify details not provided within the LWMS. The main areas that may require further clarification include:

- Construction period management plan
- Wastewater treatment
- Treatment and detention structures
- Management and maintenance requirements.

These are further detailed in the following sections.

9.1.1 Construction period management plan

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

9.1.2 Wastewater treatment

ATUs will be utilised to treat general building wastewater (as detailed in **Section 5.2.1**). All ATU systems will be designed and constructed consistent with DoH guidelines and specifications. Industrial wastewater is required to be appropriately treated prior to discharge from the WMA or stored and removed from the WMA for treatment at an appropriate facility, as discussed in **Sections 5.2.2 to 5.2.4**.

The design, construction and ongoing maintenance of all wastewater systems are the responsibility of the proponent and are to be appropriate for the proposed land use. All designs are to be approved by the CoG as part of the DA and building approvals process with additional approval from DoH and DWER sought as necessary.

9.1.3 Treatment and detention structures

The stormwater management strategy assumes that stormwater runoff will be detained to ensure pre-development flows are maintained (see **Section 6**). Treatment of small event runoff will also be provided (see **Section 6**). Surface runoff modelling has been completed to support this LWMS and supported in principle by the Water Corporation (see **Section 6.2** and **Appendix J**).

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Detailed earthworks plans and civil designs will be required to demonstrate compliance with the designs presented in this LWMS, specifically in relation to maintaining peak flow rates entering the wetland and Yule Brook, and storage requirements confirmed by Water Corporation. It is the proponent's responsibility to ensure that the appropriate treatment and storage is provided, which should be clearly documented in any UWMP or designs presented with DA applications.

9.1.4 Management and maintenance requirements

The ongoing management of drainage infrastructure (described in **Section 6.1**) within the WMA will be the responsibility of the proponent. Buffers to the wetland and Yule Brook will be maintained by the proponent until such time as the wetland and associated buffer areas are handed over to an alternative management body. It is expected that any future UWMP or DA application will either refer to other management plans (e.g. wetland buffer management plan) or detail the required management and maintenance regime. This should set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions).

An indicative monitoring plan is presented in **Section 10** designed to demonstrate that the management and maintenance of the development and associated buffer areas are achieving the required outcomes in relation to water quality associated with the WMA.

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10 Monitoring

Monitoring is proposed in order to demonstrate that the WSUD measures implemented, together with any management and maintenance measures proposed (discussed in **Section 9.1.4**) are working as intended. Monitoring will begin after the completion of civil works and planting of drainage reserves, and will continue for a period of two years.

As stated in **Section 2**, drainage infrastructure located within the WMA will be maintained by the proponent, while wetland and waterway buffers will be maintained until such time that an alternative management authority is identified. Therefore, monitoring records will be kept by the proponent until a handover process is instigated.

10.1 Condition monitoring

A visual assessment of the drainage reserves will occur on a bi-annual basis, with the aim to ascertain that maintenance activities are achieving the overall objectives of the development. The parameters that will be monitored include:

- Gross pollutants
- Sediments
- Terrestrial weeds
- Vegetation density.

10.2 Water quality monitoring

Surface water quality monitoring within Yule Brook will occur on five occasions during two winter periods. Samples will be taken upstream and downstream of the WMA within Yule Brook (proposed locations indicated in **Figure 6**). Samples will be tested for the parameters listed in **Table 1**, consistent with the pre-development monitoring. Monitoring of surface flows coming into the WMA from the upstream catchments will also occur where possible to identify any possible quality issues that may arise from development to the north.

Groundwater quality monitoring within EMW01 and EMW02 (see **Figure 2**) will occur quarterly. Samples will be tested for the parameters listed in **Table 4**.

To ascertain whether the development is negatively impacting water quality within the adjacent wetland and/or Yule Brook, downstream concentrations will be compared to upstream concentrations. Water quality results will also be compared to pre-development monitoring results, as well as guideline values from SCWQIP (SRT 2009) and NWQMS (ANZECC 2000).

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Should this analysis indicate that the development may be impacting the adjacent wetland and/or Yule Brook, a number of contingency actions may be employed. The first action that should be undertaken is to repeat the monitoring to remove the potential for sampling error. If downstream concentrations are >20% higher than upstream concentrations, the following actions should be undertaken:

- Identify the potential source from within the WMA and remove, if possible.
- Review implementation of management and maintenance practices.
- Remove sediments from internal piped and arterial networks.
- Scarify surface between plants and remove accumulated sediment (e.g. top 2 cm to 5 cm) if signs of sediment accumulation / clogging are evident within detention basins, swale or wetland buffer.
- Investigate whether additional maintenance is required if poor plant health or coverage is evident within swale or detention basins.
- Manually remove of excess plant material within swale or detention basins to maintain plant densities.

Following the implementation of the above contingency measures the water quality will be resampled. If the results demonstrate a continued issue, CoG will be informed of the results, and the proponent will work with CoG to determine whether any additional contingency actions or monitoring needs to be implemented onsite.

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11 Implementation

The development of this LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area to a sufficient level of detail should development of the WMA occur through DA without a UWMP being required.

11.1 Roles and responsibility

This LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State and Local Government policies and have been endorsed by the CoG. The responsibility for working within the framework established within this LWMS rests with the proponent.

11.2 Funding

The WMA includes a single landholding and all costs will be borne by the proponent.

11.3 Review

It is not anticipated that this LWMS will be reviewed, unless additional land parcels/lot areas are added to the WMA and proposed development area prior to DA, or the Precinct 3A Structure Plan amendment undergoes significant change post-lodgement of the LWMS. If additional areas outside of the WMA are required to be covered an addendum to cover these areas could be prepared. If the structure plan amendment is substantially modified, surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.

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Department of Water and Environmental Regulation (DWER) 2017, *Acid Sulfate Soil – Swan Coastal Plain Database*, viewed August 2017, <<https://catalogue.data.wa.gov.au/dataset/acid-sulphate-soil-risk-map-swan-coastal-plain>>.

Department of Water and Environmental Regulation (DWER) 2017, *Perth Groundwater Map*, viewed August 2017, <<https://maps.water.wa.gov.au/#/webmap/gwm>>.

Department of Water and Environmental Regulation (DWER) 2017, *Water Register*, viewed August 2017, <<https://maps.water.wa.gov.au/#/webmap/register>>.

Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



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Figures



Figure 1: Location Plan

Figure 2: Topographic and Groundwater Contours

Figure 3: Geological Mapping

Figure 4: Acid Sulfate Soil Risk

Figure 5: Surface Water Features and Wetlands

Figure 6: Stormwater Management Plan

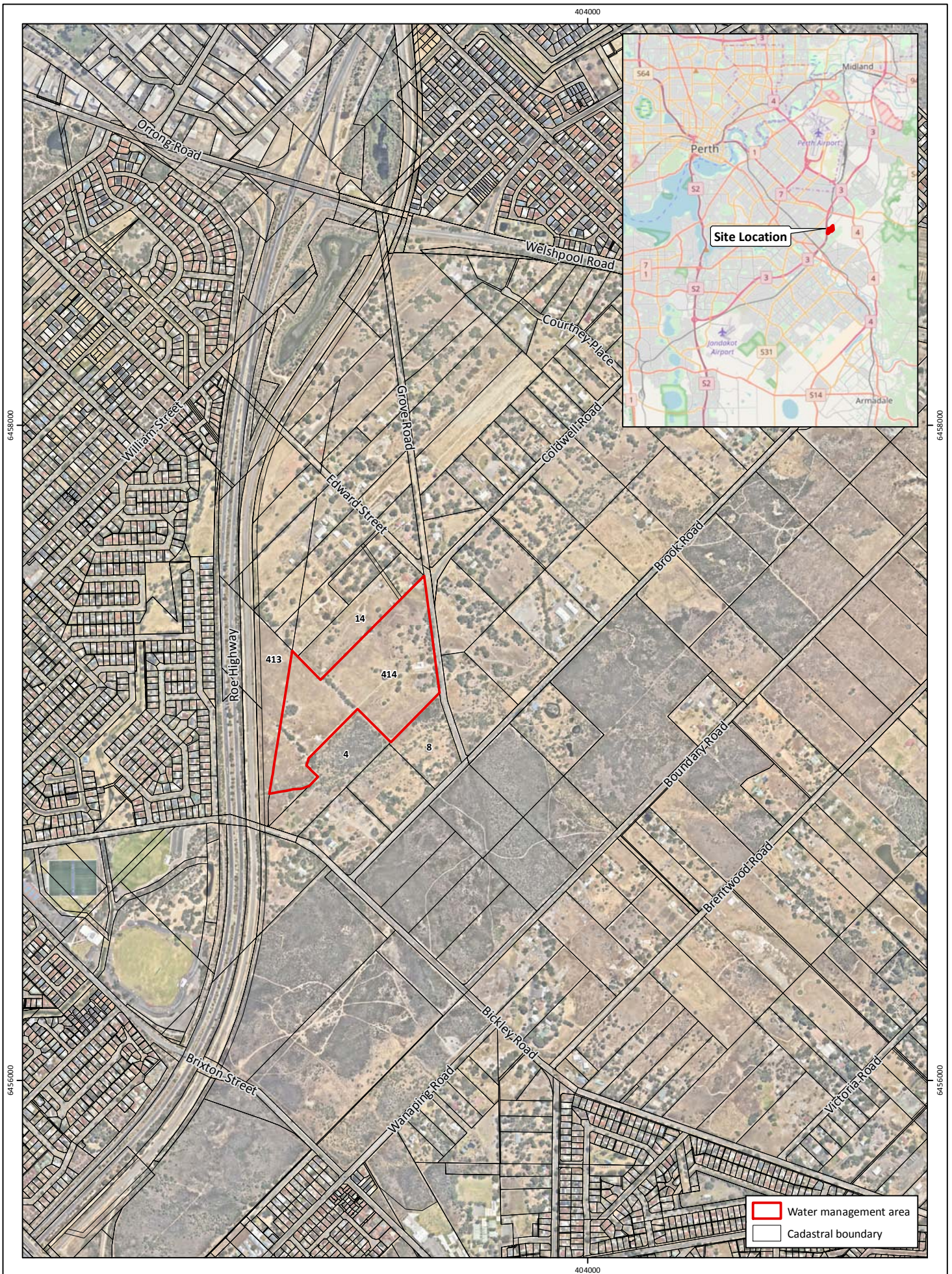


Figure 1: Location Plan

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F01b
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



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



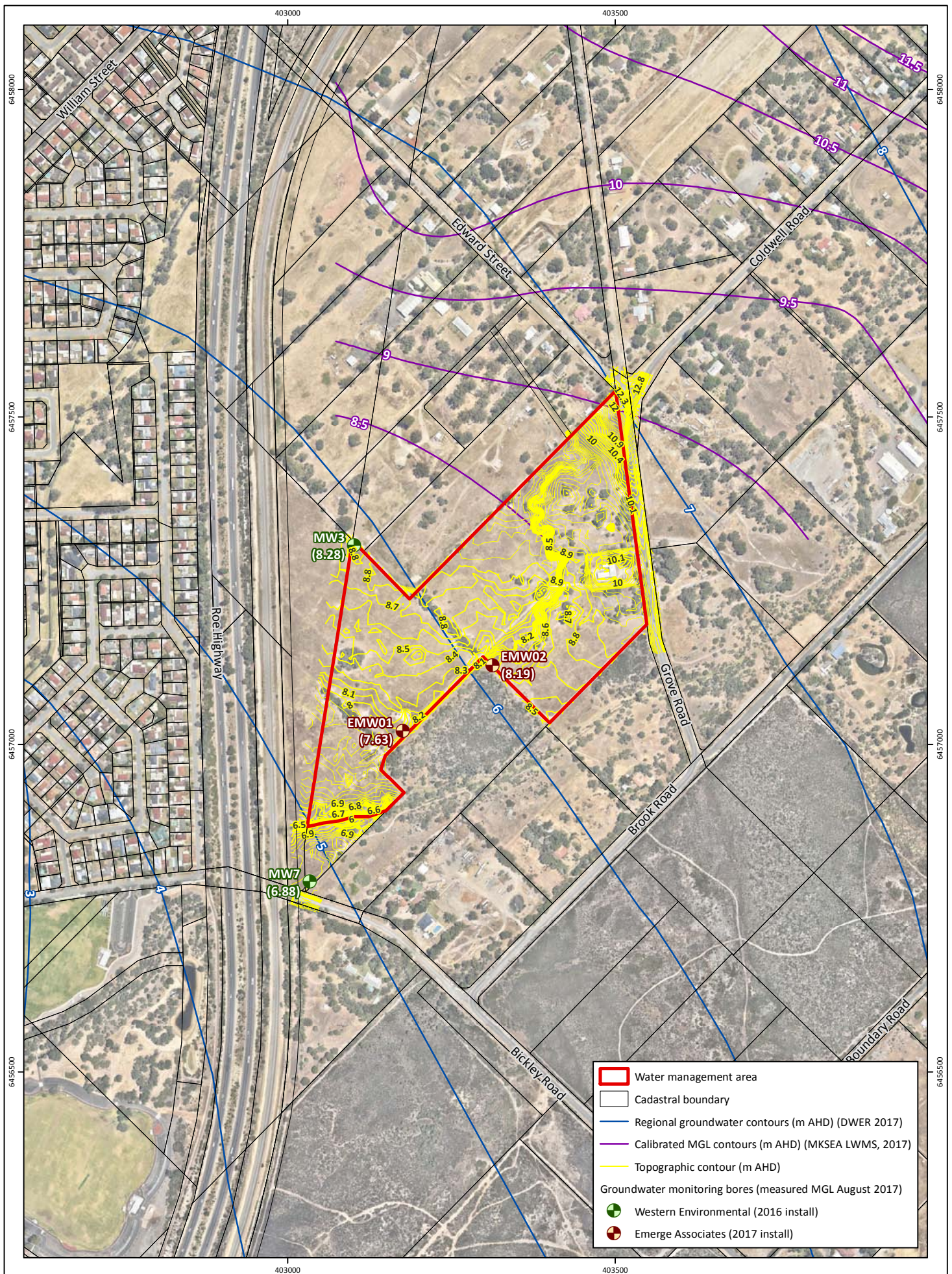


Figure 2: Topographic and Groundwater Contours

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F02b
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



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 GDA 1994 MGA Zone 50



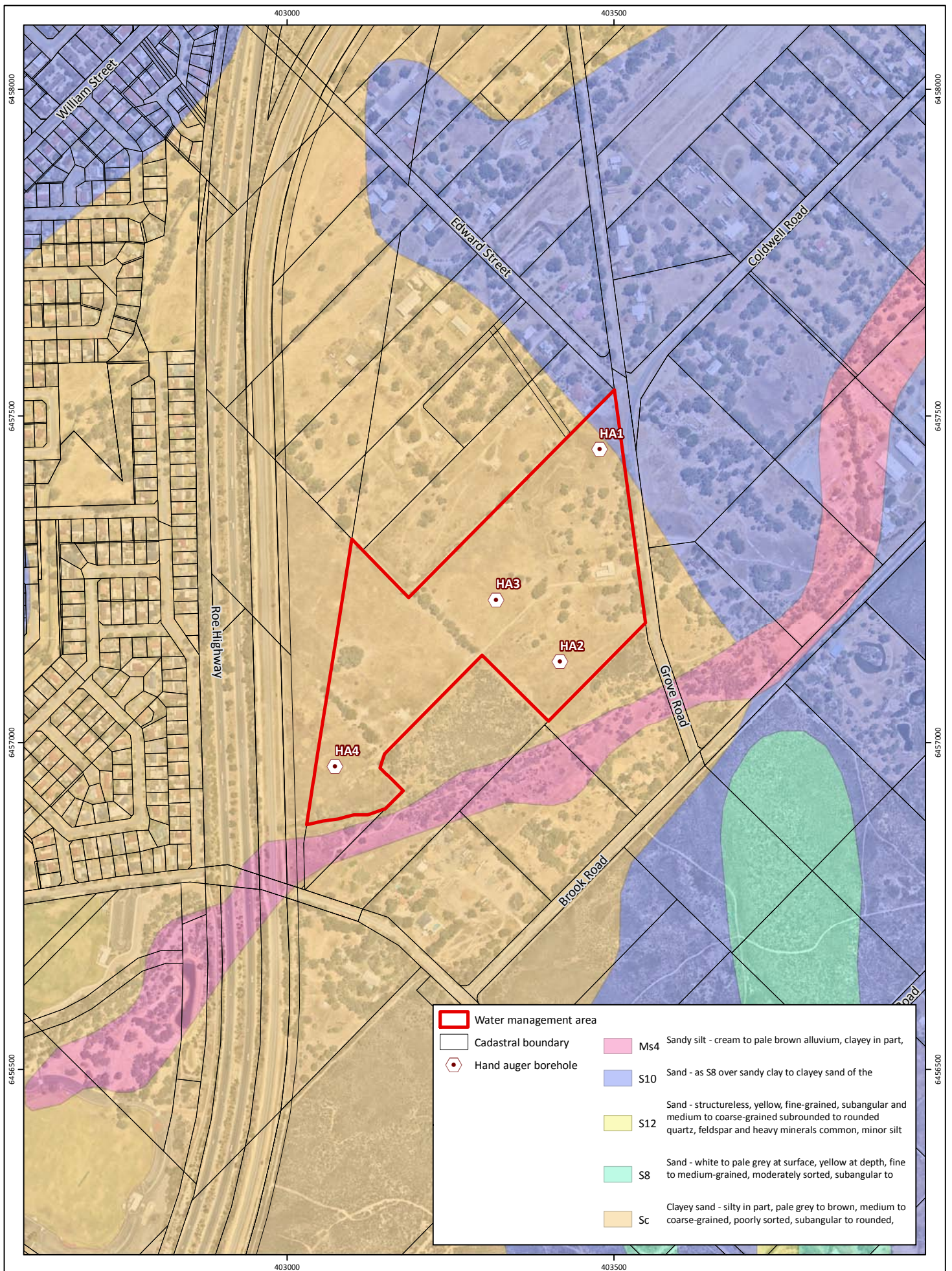


Figure 3: Geological Mapping

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F03b
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



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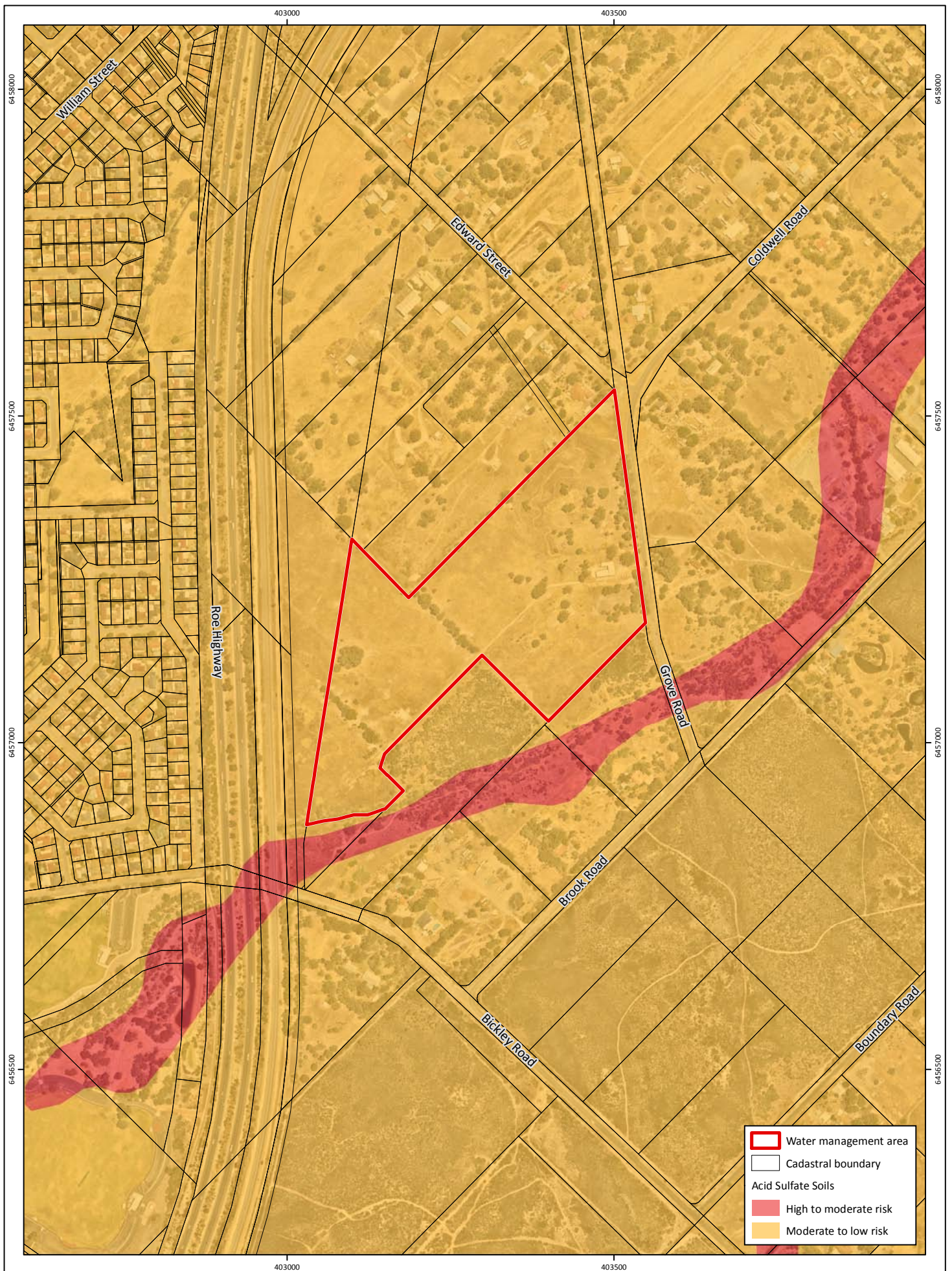


Figure 4: Acid Sulfate Soil Risk

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F04b
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



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Scale: 1:7,500@A4
 GDA 1994 MGA Zone 50



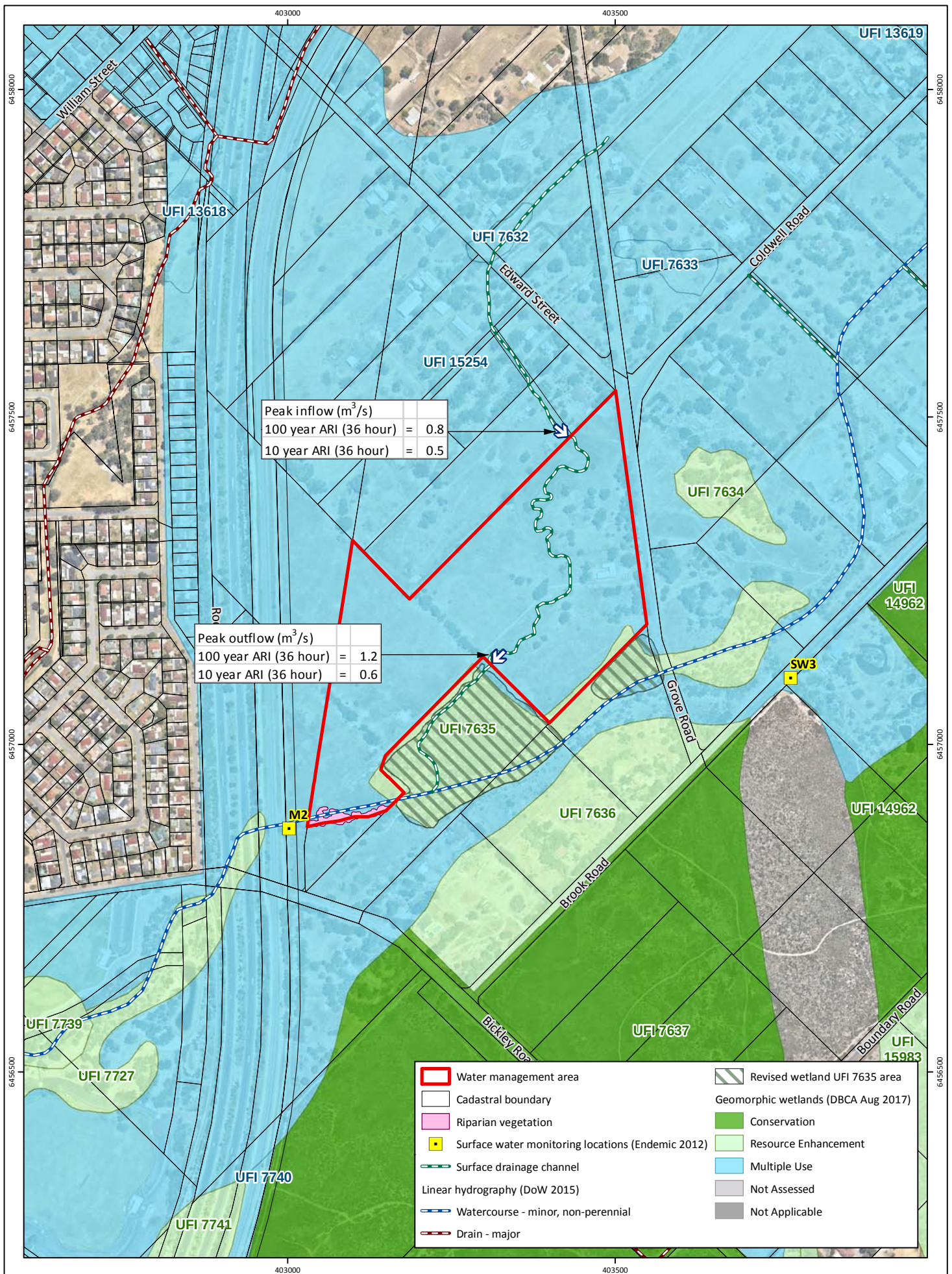


Figure 5: Surface Water Features and Wetlands

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F05b
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



Scale: 1:7,500@A4
 GDA 1994 MGA Zone 50



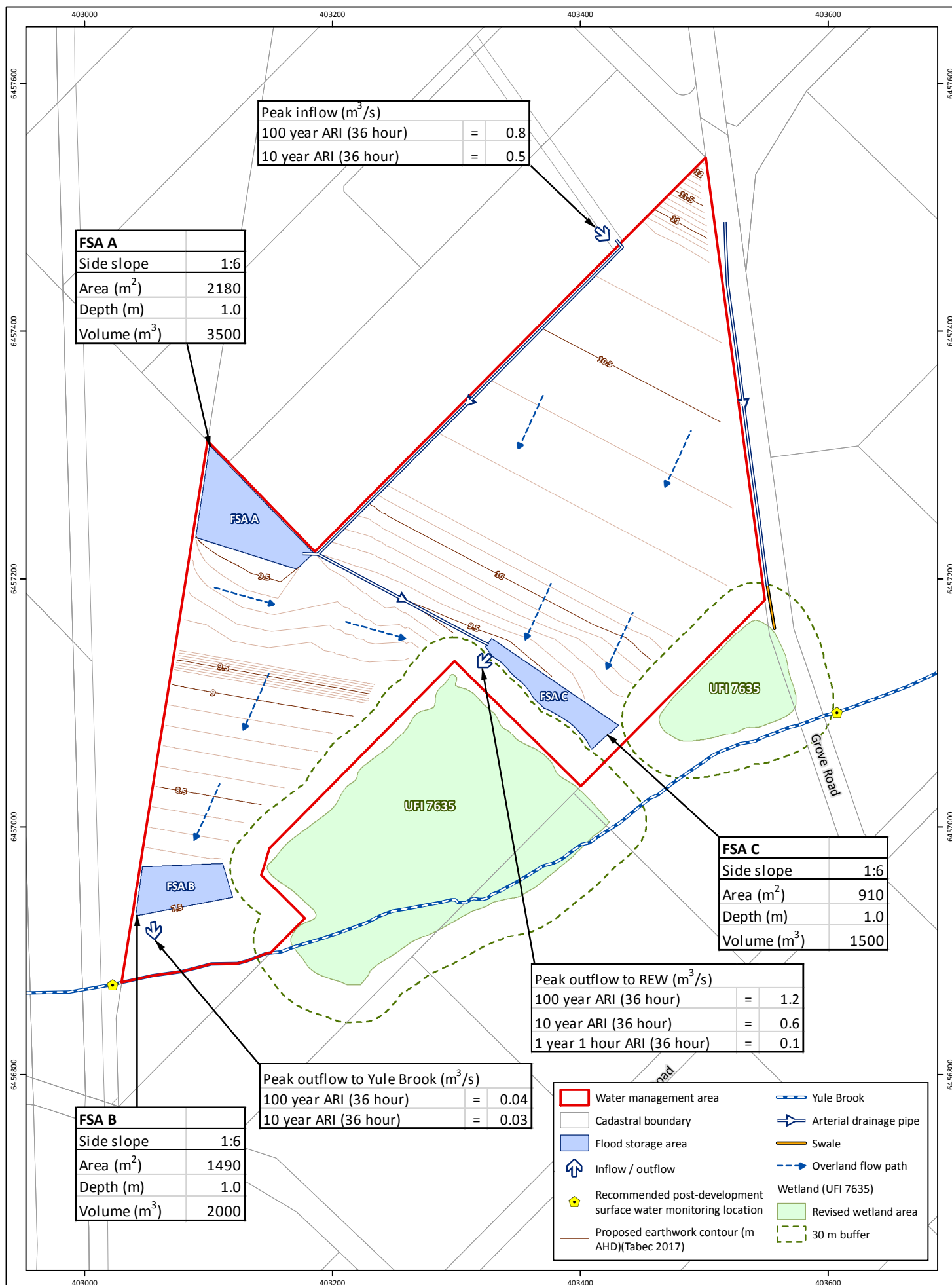


Figure 6: Stormwater Management Plan

Project: Local Water Management Strategy
Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area

Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F08c
Drawn: KNM
Date: 07/02/2018
Checked: RLE
Approved: DPC
Date: 07/02/2018



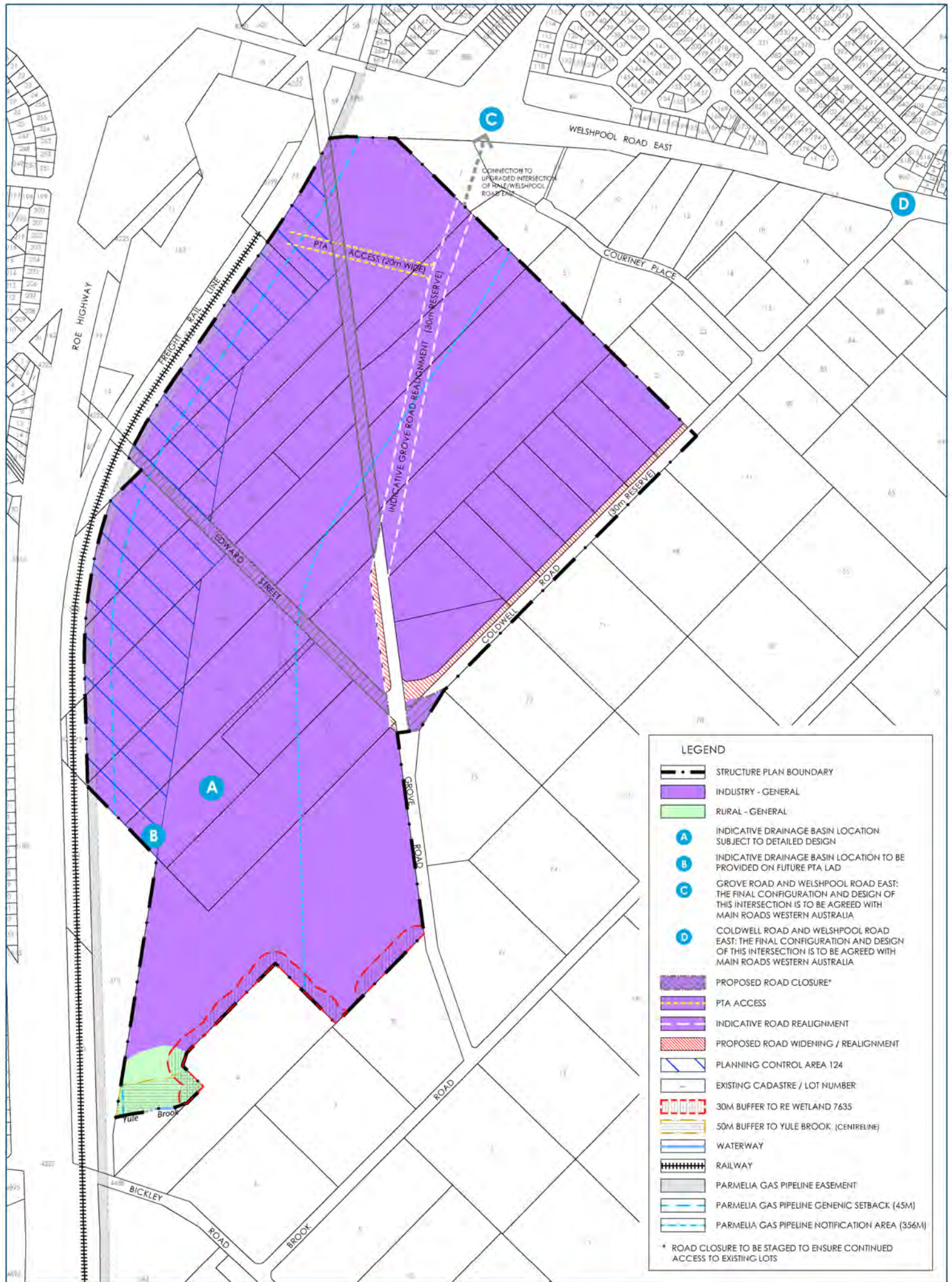
0 50 100
Metres
Scale: 1:4,000@A4
GDA 1994 MGA Zone 50

emerge
ASSOCIATES

Appendix A

LSP Amendment Conditions and Structure Plan







PLANNING

PL401

**PLANNING AND DEVELOPMENT ACT 2005
APPROVED LOCAL PLANNING SCHEME AMENDMENT***City of Gosnells*

Local Planning Scheme No. 6—Amendment No. 165

Ref: TPS/1879

It is hereby notified for public information, in accordance with section 87 of the *Planning and Development Act 2005* that the Minister for Planning approved the City of Gosnells Local Planning Scheme amendment on 12 December 2016 for the purpose of—

1. Rezoning land contained generally within Precinct 3A of the Maddington Kenwick Strategic Employment Area from General Rural to General Industry.
2. Establishing a Special Control Area generally over Precinct 3A of the Maddington Kenwick Strategic Employment Area and inserting the associated provisions into the Scheme text—
 - (a) Inserting a new provision (i) in Clause 6.1.1 as follows—
 - (i) Maddington Kenwick Strategic Employment Area—Precinct 3A—subject to structure planning.
 - (b) Inserting a new Clause 6.10 as follows—

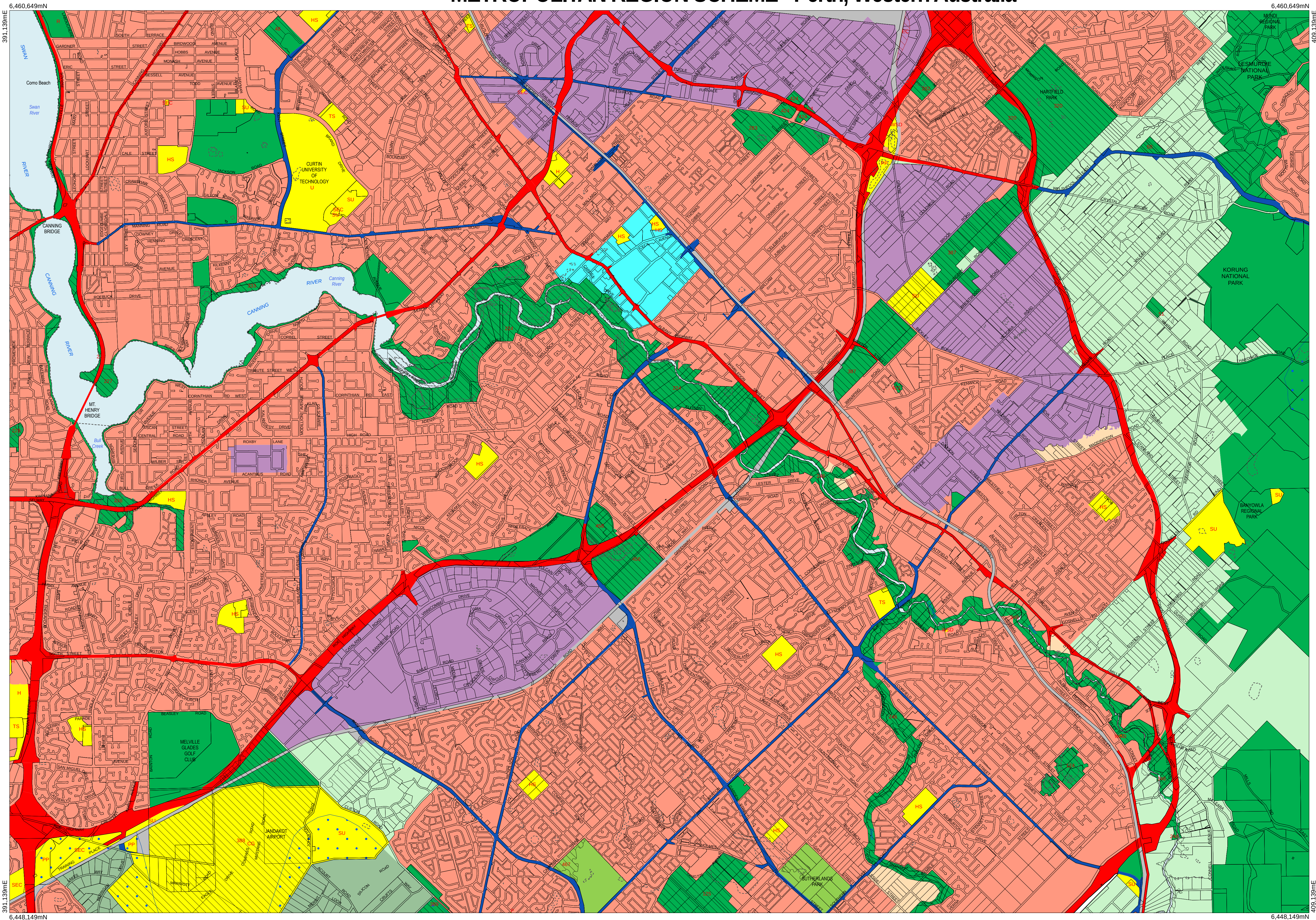
**6.10 MADDINGTON KENWICK STRATEGIC EMPLOYMENT AREA
PRECINCT 3A**

- 6.10.1 Prior to subdivision or development being undertaken within the Maddington Kenwick Strategic Employment Area Precinct 3A Special Control Area a structure plan, or plans, will be required to be prepared and approved over all or part of the Special Control Area for the purpose of Schedule 2 Part 4 clause 15(a)(ii) of the *Planning and Development (Local Planning Schemes) Regulations 2015*.
- 6.10.2 Notwithstanding Table 1, the use class of 'Warehouse' as defined in Schedule 1 is designated as a 'P' use within the Special Control Area for the purpose of clause 4.3.
- 6.10.3 To ensure the identification and protection of significant environmental values within and adjacent to the amendment area, the following information is required to accompany Structure(s) Plan (or subdivision/development applications where a Structure Plan is not required) where planning has the potential to impact significant environmental values.
 - 6.10.3.1 Investigations to determine the water balance and buffer requirements for occurrences of the Threatened Ecological Community and wetland identified as UFI 7635 in the Geomorphic Wetlands Swan Coastal Plain dataset occurring adjacent to the Amendment area, prepared on advice by the Department of Parks and Wildlife and to the satisfaction of the Environmental Protection Authority.
 - 6.10.3.2 A boundary definition study for wetland UFI 7635 prepared on advice by and to the satisfaction of Department of Parks and Wildlife.
 - 6.10.3.3 Local Water Management Strategy(s) informed by the outcomes of the water balance and buffer investigations (where there are potential impacts to significant environmental values) prepared on advice of Department of Parks and Wildlife and responsible authority, to the satisfaction of the Department of Water.
 - 6.10.3.4 Investigations to examine the occurrences of *Eucalyptus gomphocephala* (Tuart) potentially occurring on Muchea Limestone near Coldwell Road to enable assessment of their significance, prepared on advice of and, to the satisfaction of the Environmental Protection Authority.
- 6.10.4 To ensure management of the significant environmental values within and adjacent to the Special Control Area, the following information is required to accompany subdivision and development applications—
 - 6.10.4.1 Detailed Vegetation, Wetland and/or Buffer Management Plans for wetland UFI 7635 and occurrences of Threatened Ecological Communities, Declared Rare and Priority Flora and retained areas of significant vegetation including Declared Rare and Priority Flora (where applicable), on advice from Department of Parks and Wildlife and to the satisfaction of the responsible authority.

O. SEARLE, Mayor.

I. COWIE, Chief Executive Officer.

METROPOLITAN REGION SCHEME - Perth, Western Australia



Legend

Scheme boundary

Reserved lands

- Parks and recreation
- Restricted public access
- Railways
- Port installations
- State forests
- Civic and cultural
- Waterways
- Public purposes - denoted as follows:
 - Hospital
 - High school
 - Technical school
 - Car park
 - University
 - Commonwealth Government
 - State Energy Commission
 - Special uses
 - Water Authority of WA
 - Prison

Reserved roads

- Primary regional roads
- Other regional roads

Zones

- Urban
- Urban deferred
- Central city area
- Industrial
- Special industrial
- Rural
- Rural - water protection
- Private recreation

Notice of delegation

- (Site No) Bush forever area

Redevelopment schemes

- Redevelopment scheme/act area

Special control areas

- Water catchments
- Environmental conditions

METROPOLITAN REGION SCHEME

This map has been derived from an electronic version of the scheme held and maintained by the Department of Planning.

This map is one of a set of 38 which depicts the zones and reservations of the Metropolitan Region Scheme as adopted on 30 October 1963. The information shown is correct up to the date shown below as far as the Department and the Commission are aware.

Amended to: 14th October 2016

METROPOLITAN REGION SCHEME MAP
1:25000 MAP SERIES

MAP SHEET 20

MAP NAME: Langford

Important notes

This map series forms part of the Metropolitan Region Scheme (MRS), and should be read in conjunction with the Metropolitan Region Scheme Text (MRS Text).

Environmental condition areas are not shown on these maps; refer to the MRS Text for details of environmental conditions.

Redevelopment scheme areas are shown on these map, although they are not within the jurisdiction of the Western Australian Planning Commission. Refer to the relevant redevelopment authority's scheme and maps for details.

For Port Kennedy locality refer to the Port Kennedy Development Agreement Act 1992.

Production notes

Published by the Department of Planning (Department), Gordon Stephenson House, 140 William Street, Perth, WA 6000

The scheme is not intended to indicate the land use allocation under any local government provision.

© Western Australian Planning Commission 2015. This map may not be reproduced wholly or in part without the written permission of the Department.

Data Sources

Cadastral data: generalised cadastral to show road casement and land parcels greater than 1 hectare as at 27 June 2013 - generated from the Western Australian Land Information Authority Spatial Cadastral Database (SCDB) - permission no. LI 782-2015-3

Topographic features derived from StreetSmart Street Directory 2013

Technical notes

Horizontal datum - Geocentric datum of Australia 1994

Grid base - Map Grid of Australia

Projection - Transverse Mercator, graphically projected in zone 50

Contacts

Website - www.planning.wa.gov.au - to access electronic copies of the MRS

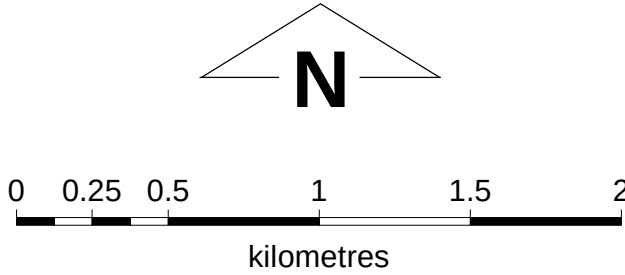
Email - spatialdata@planning.wa.gov.au for digital data or for written permission



Department of
Planning

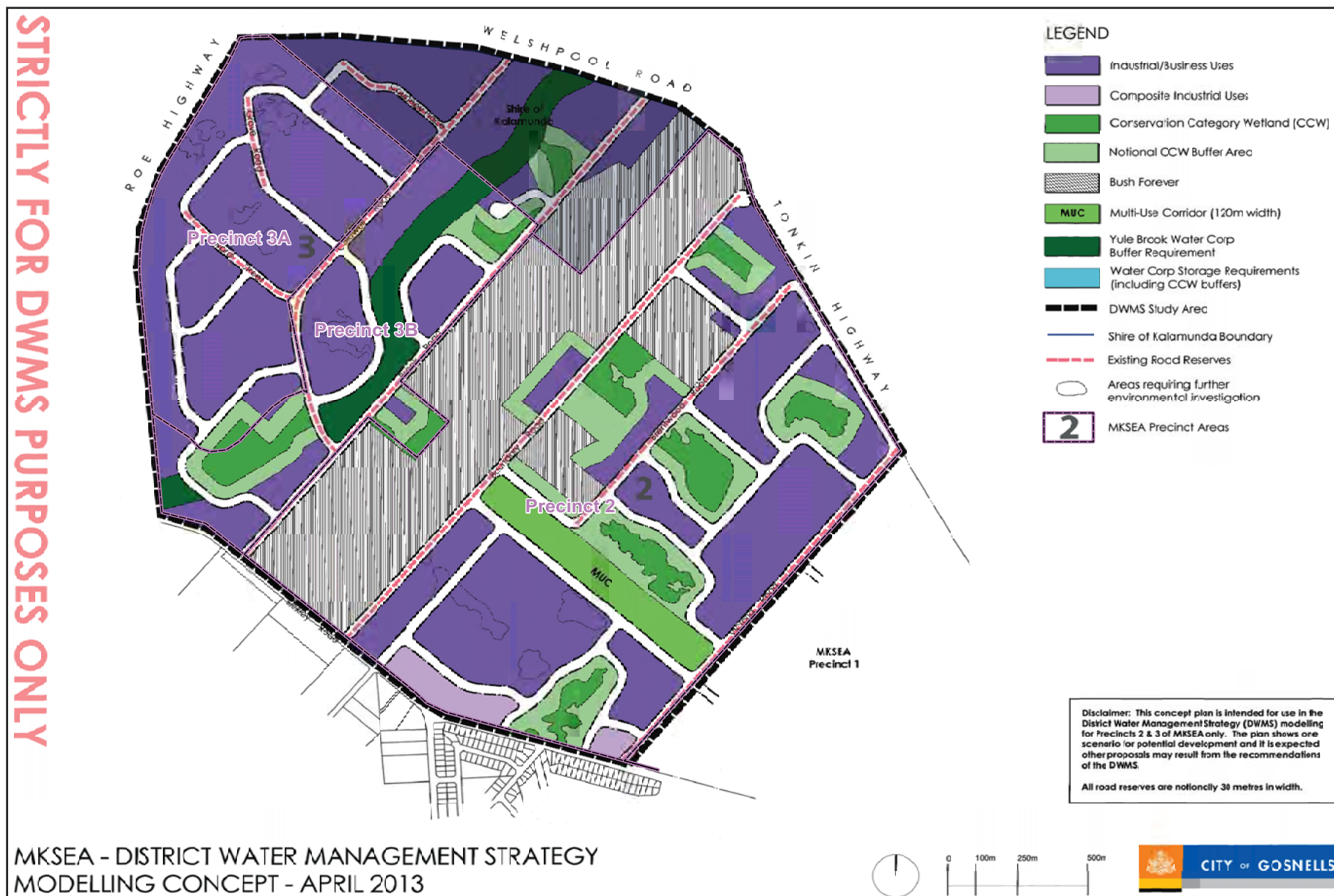


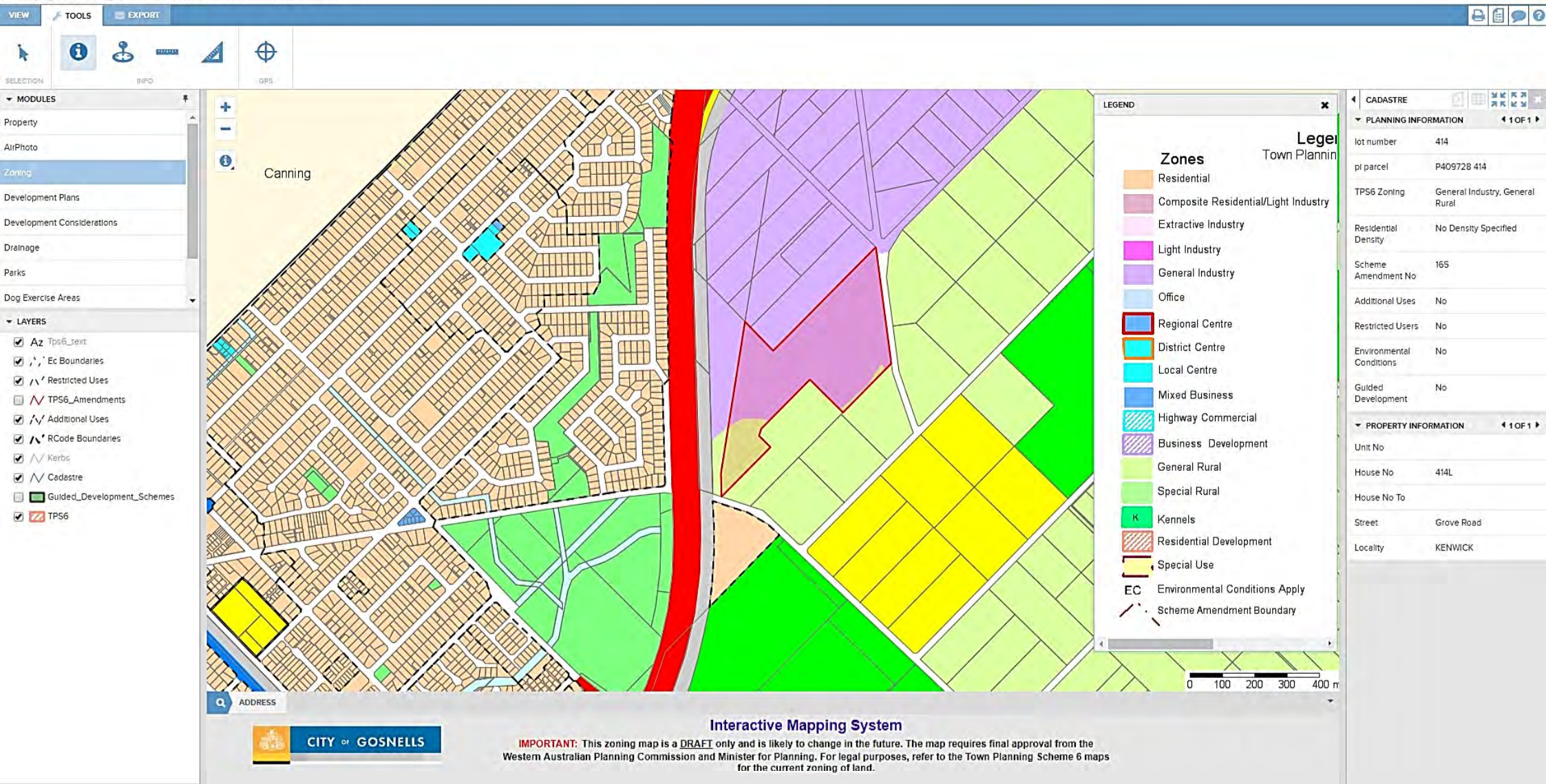
Western
Australian
Planning
Commission



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Appendix B

Relevant Bore Logs



PROJECT NUMBER: EP17-055(02)

CLIENT: Eastcourt

PROJECT NAME: Eastcourt Lot 2008 Grove Road

PROJECT LOCATION: Lot 2008 Grove Road, Kenwick

DATE INSTALLED: 11/07/2017

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Solid Flight Auger

LOGGED BY: PML & JRT

SURVEY SOURCE: MNG ref 100647

EASTING: 403176

NORTHING: 6457021

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 8.07 mAHD

ELEVATION (TOP OF CASING): 8.53 mAHD

ELEVATION (GROUNDWATER): 6.27 mAHD

CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT	WELL CONSTRUCTION
0	8		0.0m: SAND: light grey/grey, fine to medium grained.	Moist	Metal collar
			0.5m: SAND: light grey, fine to medium grained.	Moist	PVC stick-up Concrete
1	7				Back-fill
			1.5m: SAND: brown/orange, fine to medium grained, Water encountered at 1.8 mBGL.	Wet	Blank casing
2	6				Bentonite
3	5		3.0m: SAND: brown/yellow, fine to medium grained.	Wet	
4	4		4.0m: CLAY: brown/grey, fine grained.	Wet	Gravel
			4.3m: SAND: yellow, fine to medium grained.	Wet	Slotted casing
5	3				
6	2				
7	1		7.0m: SANDY CLAY: green/yellow, fine to medium grained.	Wet	Base cap

Total drilled depth: 7.5 mBGL

COMMENTS:

PROJECT NUMBER: EP17-055(02)

CLIENT: Eastcourt

DATE INSTALLED: 11/07/2017

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Solid Flight Auger

LOGGED BY: PML & JRT

PROJECT NAME: Eastcourt Lot 2008 Grove Road

PROJECT LOCATION: Lot 2008 Grove Road, Kenwick

SURVEY SOURCE: MNG ref 100647

EASTING: 403313

NORTHING: 6457121

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 8.25 mAHD

ELEVATION (TOP OF CASING): 8.54 mAHD

ELEVATION (GROUNDWATER): 6.58 mAHD

CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT	WELL CONSTRUCTION
0					Blank casing Metal collar
8			0.0m: SAND: white/grey, fine to medium grained.	Moist	PVC stickup Concrete
			0.5m: CLAY: brown/grey, fine grained.	Moist	
1			0.8m: CLAY: light brown/grey, fine grained, Water encountered at 1.7 mBGL.	Moist To Wet	Back-fill
7					
2					Bentonite
6			2.5m: CLAY: yellow/brown, fine grained.	Wet	
3					
5					
4			4.0m: CLAY: brown, fine grained.	Wet	Gravel Slotted casing
4					
5					
3					
6					Base cap
2					
7			7.0m: CLAY: blue/grey, fine grained.	Wet	
1					

Total drilled depth: 7.5 mBGL

COMMENTS:



Western Environmental
25 Prowse Street
West Perth, WA 6005
Telephone: 08 6162 8980

BOREHOLE NUMBER MW3

PAGE 1 OF 1

CLIENT <u>Public Transport Authority</u>	PROJECT NAME <u>Kenwick DSI</u>
PROJECT NUMBER <u>16.059</u>	PROJECT LOCATION <u>Kenwick</u>
DATE <u>10/10/16</u>	R.L. SURFACE _____ CASING HEIGHT _____
DRILLING CONTRACTOR <u>Strataprobe</u>	COORDINATES (MGA94 Zone 50) <u>403106.00 m E 6457303.00 m N</u>
METHOD / HOLE SIZE <u>Rotary Auger 0.008</u>	HOLE LOCATION <u>Lot 2008</u>
NOTES _____	LOGGED BY <u>BS</u> CHECKED BY <u>AV</u>

Depth (m)	RL (m)	Water	Well Diagram	Classification Symbol	Graphic Log	Material Description	Additional Observations	Samples
			Well Diagram Steel riser. Cement at surface. Bentonite seal. Gravel pack.			SAND, grey, fine to medium grained, moderately sorted with trace amounts of organic material SANDY CLAY, brown, fine grained, moderately sorted	Humic material throughout	
1						SANDY CLAY, pale yellowish brown, medium grained, moderately sorted	Saturated	MW3-1.0
2						SANDY CLAY, brown, medium grained, moderately sorted		MW3-2.0
3								MW3-3.0
4						SANDY CLAY, grey, fine to medium grained, moderately sorted		MW3-4.0
5						Borehole MW3 terminated at 5.5m		
6								

BOREHOLE / TEST PIT 16.059.GPJ GINT STD AUSTRALIA.GDT 13/12/16



Western Environmental
25 Prowse Street
West Perth, WA 6005
Telephone: 08 6162 8980

BOREHOLE NUMBER MW7

PAGE 1 OF 1

CLIENT <u>Public Transport Authority</u>	PROJECT NAME <u>Kenwick DSI</u>
PROJECT NUMBER <u>16.059</u>	PROJECT LOCATION <u>Kenwick</u>
DATE <u>10/10/16</u>	R.L. SURFACE _____ CASING HEIGHT _____
DRILLING CONTRACTOR <u>Strataprobe</u>	COORDINATES (MGA94 Zone 50) <u>403035.00 m E 6456787.00 m N</u>
METHOD / HOLE SIZE <u>Rotary Auger 0.008</u>	HOLE LOCATION <u>Lot 2008</u>
NOTES _____	LOGGED BY <u>BS</u> CHECKED BY <u>AV</u>

Depth (m)	RL (m)	Water	Well Diagram	Classification Symbol	Graphic Log	Material Description	Additional Observations	Samples
			Steel riser. Cement at surface. Sand backfill Bentonite seal. Gravel pack.					
1						SAND, pale grey, fine to medium grained, moderately sorted	Organic material at surface Humic material present	
2						SANDY CLAY, pale brownish grey, fine to coarse grained, poorly sorted		
3								
4								
5							Saturated	MW7-4.5, DUP01
								MW7-5.0
								MW7-5.5
6						Borehole MW7 terminated at 6m		MW7-6.0

BOREHOLE / TEST PIT 16.059.GPJ GINT STD AUSTRALIA.GDT 13/12/16

Appendix C

Geotechnical Investigation Report



GEOTECHNICAL INVESTIGATION REPORT

Proposed Industrial Development Lot 414 Grove Road, Kenwick



JDS171347
August 2017

INTEGRITY

We are open, honest, and consistent in our principles and conduct, so we're able to build trusted relationships with our clients and partners.

RESPECT

We treat everyone with respect and dignity and develop relationships founded on understanding and trust.

ACCOUNTABILITY

We always assume responsibility for our actions and make decisions in line with our economic, social, and ethical obligations.

EXCELLENCE

We pursue excellence in everything we do, challenging ourselves to look beyond the obvious and ensure ongoing improvement.

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Geotechnical Investigation Report

Lot 414 Grove Road, Kenwick

Prepared for:
Eastcourt Property Group
P O Box 456
Applecross WA 6953

Our ref: JDS171347-R01-Rev1

Prepared by:
JDSi Ground Engineering Pty Ltd
1 Nash Street
Perth WA 6000
10 August 2017

Document Authorisation

For and on behalf of JDSi Ground Engineering Pty Ltd



Neill Beattie
Principal Engineering Geologist

Quality information

Revision history

Revision	Description	Date	Author	Reviewer	Signatory
Rev0	Issued to Client	4/8/2017	NSB	RAM	NSB
Rev1	Issued to Client	10/8/2017	NSB	RAM	NSB

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Rev1	1	PDF	Eastcourt Property Group	10/8/2017
Rev1	1	PDF	JDSi Ground Engineering Report Library	10/8/2017

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IMPORTANT INFORMATION SHEETS

“Your Geotechnical Report”

FIGURES

Figure 1 – Site Investigation Layout

APPENDICES

Appendix A – Results of Investigations

1 Introduction

This report presents the results of a geotechnical investigation carried out by JDSi Ground Engineering Pty Ltd (JDSi) for Eastcourt Property Group (Eastcourt) at Lot 414 Grove Road, Kenwick ("the site"), a proposed industrial development, within Precinct 3A (Special Control Area SCA1), of the Maddington Kenwick Strategic Industrial Area.

This work was commissioned by Mr Tom Oosterhof on behalf of Eastcourt, via a confirmation email dated 12 July 2017.

This report, and the information presented herein, must be read in conjunction with JDSi's "Your Geotechnical Report" information sheets attached to this report.

2 Site Description

The site occupies an irregular shaped parcel of open pasture that covers an area of 15.4361ha at the southern end of Special Control Area SCA1, bounded in the east by Grove Road, in the west by Lot 413, in the north by Lots 12 and 14, and in the south by Precinct 3B.

3 Project Objectives

The objectives of the geotechnical study were to:

- ▶ Review relevant client supplied information and any relevant JDSi projects previously undertaken in the area;
- ▶ Carry out subsurface investigations to define subsurface conditions across the site;
- ▶ Assess soil permeability and provide comments on on-site stormwater disposal; and
- ▶ Provide comment on relevant construction considerations.

4 Available Information

4.1 Client Supplied Information

The following relevant information was provided by Eastcourt and reviewed by JDSi as part of this investigation:

- ▶ Douglas Partners (DP) Report: *'Factual Report on Geotechnical Investigations, Proposed Industrial Subdivision – Coldwell Road, Kenwick'*. Project 8886988.07, dated August 2016;
- ▶ Western Environmental Pty Ltd (WEPL) Report, *'Detailed Site Investigation for Potential Contamination'*, Report No. 16.059-DSI-V2, dated 25 January 2017;
- ▶ Drawing: *'Proposed Amendment to Town Planning Scheme No.6 MKSEA – Precinct 3A & 3B'*, dated 22 February 2016; and
- ▶ Drawing: *'Proposed Amendment to Precinct 3A & 3B Boundary'*, dated 20 January 2012.

Relevant information from the above has been incorporated in the findings of this investigation and referenced accordingly.

4.2 Published Information

The following published information has been used in the preparation of this report:

- ▶ 1:50,000 Environmental Geology Series map (Armadale) Geological Survey of WA; and
- ▶ Department of Water's online Perth Groundwater Atlas (<https://maps.water.wa.gov.au/>).

5 Investigation Fieldwork

Fieldwork was carried on 19 July 2017 in the full time presence of a Project Engineering Geologist from JDSi and comprised four hand auger boreholes, one Perth Sand Penetrometer (PSP) test, and three Dynamic Cone Penetrometer (DCP) tests, at selected locations across the site. Access to the site was from Grove Road, on the eastern site boundary. Access across the site was via existing tracks and across open paddock.

The investigation locations were measured during the fieldwork by hand-held GPS relative to Geocentric Datum of Australia (GDA94). Approximate investigation locations are shown on the Site Investigation Layout, **Figure 1**, attached to this report.

Each hand auger borehole was logged by the JDSi site representative in general accordance with the soil description guidance included in AS1726-2017 "Geotechnical Site Investigations". Geotechnical logs of the hand auger boreholes are attached as **Appendix A**.

PSP and DCP tests were carried out adjacent to the hand auger boreholes in general accordance with AS1289.6.3.3 (PSP) and AS1289.6.3.2 (DCP), except to a depth greater than required by the Standard. The results of the tests are presented in **Appendix A**, behind the hand auger borehole logs.

Surface elevations at investigations locations were not recorded.

5.1 Site Conditions

5.1.1 Existing Site Conditions

The site is generally flat lying with a gentle fall towards the south and southwest. Vegetation cover comprises grass, bushes and trees up to 15m in height. A large shed is present on the site, located adjacent to Grove Road on the eastern boundary of the site.

The ground surface comprises a layer of organic, Silty Sand topsoil. The 1:50,000 Environmental Geology map of the site indicates that the surface soils are associated with the Guildford Formation and comprise:

Sc – CLAYEY SAND, silty in part, pale grey to brown, medium to coarse grained, poorly sorted, sub-angular to sub-rounded, frequent heavy minerals, rare feldspar, of alluvial origin.

Geological mapping of the area by the Geological Survey of Western Australia indicates that the site is dominated by Quaternary Guildford Formation consisting of calcareous pale grey and brown silty and slightly sandy clay, overlain by a thin layer of Bassendean Sand. This is consistent with the findings of both the DP report and the WEPL report.

5.1.2 Published Groundwater Information

The site is included in the May 2003 (end of summer) and historic maximum groundwater information available on the Department of Water's online Perth Groundwater Atlas (<http://atlases.water.wa.gov.au/idelve/gwa/>). The May 2003 and historic maximum published groundwater contours indicates groundwater levels at the site can be expected to be at about RL 7.0m AHD to RL 10.0m AHD under most normal weather conditions. This is about 0.5m to 3m below current ground levels.

6 Results of Investigations

6.1 Subsurface Conditions

Hand Auger Investigations

Hand auger boreholes (HA1 to HA4) were advanced to depths of between 0.75m and 2.0m below ground level at the investigation locations shown on the Site Location Layout, attached as Figure 1. The hand auger boreholes were undertaken at locations selected on site by the JDSi site representative. The borehole records, showing detailed descriptions of the major strata encountered, in-situ test results and the depths at which disturbed samples were recovered, are presented in **Appendix A** along with explanatory notes.

Of the five hand auger boreholes, HA1 experienced hole collapse within sands below the water table, HA2 and HA3 experienced refusal at depths between 0.8m and 1.25m depth, and HA4 was progressed to the target depth of 2m.

The approximate locations of the hand auger boreholes, as recorded by hand held GPS, are summarised in Table 1.

Table 1. Summary of Hand Auger Borehole Locations

Hand Auger Borehole	Easting (m, WGS84)	Northing (m, WGS84)
HA1	403,479	6,457,449
HA2	403,418	6,457,124
HA3	403,320	6,457,219
HA4	403,074	6,456,964

The results of the hand auger boreholes indicate that the ground conditions across the site can be summarised as follows:

- ▶ Up to 0.1m of dark grey brown, fine to coarse grained, organic SAND / Silty SAND (Topsoil); overlying,
- ▶ Between 0.1m and 0.65m of grey, fine to coarse grained, SAND; overlying,
- ▶ Between 0.2m and 0.4m of medium to high plasticity, grey brown to orange brown, Sandy CLAY; overlying,
- ▶ In excess of 1.3m of low to medium plasticity, pale grey to off white, Sandy Clay with a trace of fine to medium grained calcareous gravel.

WEPL have completed a number of test holes along the western boundary of the site to a target depth of 1m. The near surface materials encountered generally comprised up to 0.5m of Topsoil and fine to medium grained SAND, overlying, brown, grey and orange grey Sandy Clay. The subsurface materials intersected by the WEPL test holes are consistent with the subsurface conditions intersected by the JDSi hand auger boreholes.

Perth Sand Penetrometer Testing

A Perth Sand Penetrometer test (PSP) was undertaken adjacent to HA1, as sand was encountered to a depth of 0.75m; the maximum depth of the hand auger borehole. The results of the PSP indicates that the sand is in a medium dense condition to approximately 0.6m depth and in a loose condition from 0.6m to the maximum depth investigated at 1.05m.

PSP testing was carried out in accordance with AS1289.6.3.3. The results of the PSP test is presented in the attachments following the test pit logs in **Appendix A**.

Dynamic Cone Penetrometer Testing

Dynamic cone penetrometer (DCP) testing was carried out adjacent to hand auger boreholes HA2 to HA4, as Sandy Clay was encountered at a maximum depth of 0.5m. DCP testing was carried out in accordance with AS1289.6.3.2 to a maximum depth of 1.2m. The results of DCP's are presented in the attachments following the test pit logs in **Appendix A**.

The results of the DCP's indicate that both the upper Sandy Clay layer and the underlying Sandy Clay with a trace of Gravel are generally in a Stiff to Very Stiff condition.

Groundwater

Groundwater was encountered between 0.75m and 0.9m depth in hand auger boreholes HA1, HA2 and HA4. Groundwater was not encountered in HA3, excavated to 0.8m depth. It should be noted that groundwater levels may vary over time in response to environmental factors, including rainfall, temperature, and other factors.

Groundwater monitoring wells constructed by WEPL adjacent to the western boundary of the site, and presented in the 2017 report as MW3 and MW7, indicate a groundwater level at between 1m and 2m below the ground surface in October 2016.

7 Assessment and Recommendations

7.1 Geotechnical Suitability

The aim of the current investigation is to assess the site for potential future development. Based on the results of the current investigation the following comments and recommendations are provided:

- ▶ The site is generally clear, lightly vegetated, level to very gently sloping, with subsurface soils in a generally undisturbed condition.
- ▶ Water was observed to pond locally on the site after periods of prolonged and/or heavy rain;
- ▶ The subsurface profile was found to comprise a thin layer of organic Sandy topsoil over fine to coarse grained Bassendean Sand, which in turn overlies low to high plasticity Sandy Clays of the Guildford Formation; and

- ▶ Any development on the site should be carried out in accordance with the following Australian Standard, as a minimum:
 - Standards Australia (2007) “Guidelines on Earthworks for Commercial and Residential Developments” Australian Standard AS3798 – 2007.

Based on the results of the investigation, the site is assessed as being geotechnically suitable for the proposed development following conventional site preparation and earthworks in accordance with relevant Australian Standards.

7.2 On Site Stormwater Disposal

Due to the presence of Guildford clays at shallow depths in the foundation, and the presence of a high water table, falling head permeability testing was not considered appropriate for this site and thus not undertaken. As such, the site is not considered conducive to the on-site disposal of stormwater.

8 References

The following published information sources have been reviewed by JDSi in compiling this report:

- ▶ Standards Australia (2011) “*Residential Slabs and Footings*” Australian Standard AS2870 – 2011
- ▶ Armadale (1986), Part sheets 2033 I and 2033 IV. (1:50,000 scale) Geological Series, Geological Survey of Western Australia.
- ▶ Standards Australia (1993) “*Geotechnical Site Investigations*” Australian Standard AS1726-2017.
- ▶ Water and Rivers Commission (1997) “Perth Groundwater Atlas”. Western Australia, Water and Rivers Commission.
- ▶ Standards Australia (2007) “*Guidelines on Earthworks for Commercial and Residential Developments*” Australian Standard AS3798 – 2007.



“Your Geotechnical Report”

1 Introduction

The information contained in this document is to inform JDSi's clients of the reasonable expectations of a geotechnical report and options to mitigate geotechnical risks and consequences. This information is provided to help clients understand where JDSi's responsibility as a geotechnical engineer, acting reasonably, begin and end. In doing so, it also highlights the responsibility of our client and third parties.

Please contact the JDSi Project Director should you not understand the report and the limitations of the information provided.

2 Collection and Interpretation of Data

Geotechnical investigations identify subsurface conditions only at the point of investigation. The material encountered during the investigation is recorded on logs and based on a visual assessment and (if undertaken) supported by laboratory test results. In the case of an Electric Friction Cone Penetrometer Test (CPT), the data recorded is a tip pressure and sleeve friction on a rod; from which ground conditions are inferred.

Actual conditions may differ from those encountered during the investigations and / or inferred a distance from the investigation stations. In addition, the actual interface between materials or units may be gradual or more abrupt than inferred from the results of the investigation.

A Chartered Geotechnical Engineer and / or Engineering Geologist should be retained through the various stages of the project to identify variances, conduct additional tests if required, and provide recommendations to address geotechnical / geological issues identified on site. The Chartered Geotechnical Engineer / Engineering Geologist should also review the actual conditions encountered to confirm that they are consistent with those inferred in this report.

3 Change in Subsurface Conditions

The geotechnical recommendations and parameters provided in this report are based on the ground conditions encountered at the time of the geotechnical investigation. Changes in the ground conditions can occur over time and include, but are not limited to, the following:

- ▶ Filling or excavation works (or other anthropologic events);
- ▶ Flooding;
- ▶ Groundwater fluctuations;
- ▶ Earthquakes or other such events;
- ▶ Works on neighbouring sites impacting on the subject site; and,
- ▶ Migration of pollutants from neighbouring properties.

JDSi should be consulted if there is any protracted delay in the issue of this report and the use of the recommendations provided.

It is important to note that where ground conditions have changed, additional geotechnical investigations and testing may be required to assess the impacts of the changed ground conditions.

4 Specificity of Report

This geotechnical report has been prepared for a specific project and design; therefore, it has been written to address specific geotechnical issues. In doing so, the following has been taken into account:

- ▶ The project objectives as described in the report;
- ▶ The client's budget and programme constraints;
- ▶ The specific site mentioned in the report; and,
- ▶ The nature and extent of the development at the site.

This report should not be used for any other purpose other than what has been specifically described and should not be relied upon if:

- ▶ The report was not written for you;
- ▶ The report was not written for your specific site;
- ▶ The report does not address your specific development;
- ▶ There is a significant delay between undertaking the report and developing the site; or,
- ▶ Significant changes to the site have occurred.

Where the information and recommendations contained within this report are being used by others, JDSi should be engaged during the design process to engage with the other members of the design team and review works being produced by the other design team members to confirm that it is consistent with the geotechnical report.

5 Environmental Issues

Unless specifically addressed in this report, environmental and contamination considerations are not included. The investigation methods required for environmental investigation often differ to those used for geotechnical investigations and the information contained within this report may not be appropriate for use by environmental engineering consultants and scientists.

This report was not prepared to address environmental issues and the client is responsible to ensure environmental considerations have been taken into account for the project. JDSi can provide information on environmental engineering consultants, should this be required.

6 Construction

The method of ground investigation used for geotechnical investigations limits JDSi's ability to know every detail about the ground conditions on site. JDSi use reasonable engineering judgement to form an assessment of the subsurface conditions at the site based on information obtained at specific locations.

Ground conditions may be encountered during construction that were not anticipated during the geotechnical investigation. Should this be the case, JDSi should be engaged to provide construction support as a means of mitigating the consequence of encountering unexpected ground conditions.

7 Responsibility of Others

JDSi has prepared this report for the use by our client. JDSi does not accept any responsibility from any third party, other than our client, who uses the information contained in this report. JDSi takes no responsibility for any damages suffered by any third party as a consequence of any decisions or action that have been made based on this report.

Further information regarding the responsibility of clients and other third parties should also be obtained from the following:

- ▶ “Guidelines for the Provision of Geotechnical Information in Construction”, published by the Institution of Engineers Australia;
- ▶ Australian Standard AS 2870 – 2011, Residential Slabs and Footings;
- ▶ Australian Standard, AS 5100 – 2004, Bridge Design Set; and,
- ▶ Any other Standard or Code of Practice applicable to the development.



Figures



PLAN
SCALE 1:5000

LEGEND

-  HAND AUGER LOCATIONS
-  APPROX SITE BOUNDARY



Appendix A – Results of Investigations

EXPLANATORY NOTES - SOIL DESCRIPTION

	FILL		SAND (SP OR SW)		CLAY (CL, CI OR CH)		COBBLES OR BOULDERS
	GRAVEL (GP OR GW)		SILT (ML OR MH)		ORGANIC SOILS (OL, OH OR PH)		

Combinations of these basic symbols can be used to indicate mixed materials (eg. Clayey Gravel)

GP	Poorly Graded Gravel	SM	Silty Sand	CH	High Plasticity Clay
GW	Well Graded Gravel	SC	Clayey Sand	OL	Organic Soils (LP)
GM	Silty Gravel	ML	Low Plasticity Silt	OH	Organic Soils (HP)
GC	Clayey Gravel	MH	High Plasticity Silt	PT	Peat
SP	Poorly Graded Sand	CL	Low Plasticity Clay	Describe	Cobbles and Boulders
SW	Well Graded Sand	CI	Medium Plasticity Clay	Fill	Fill

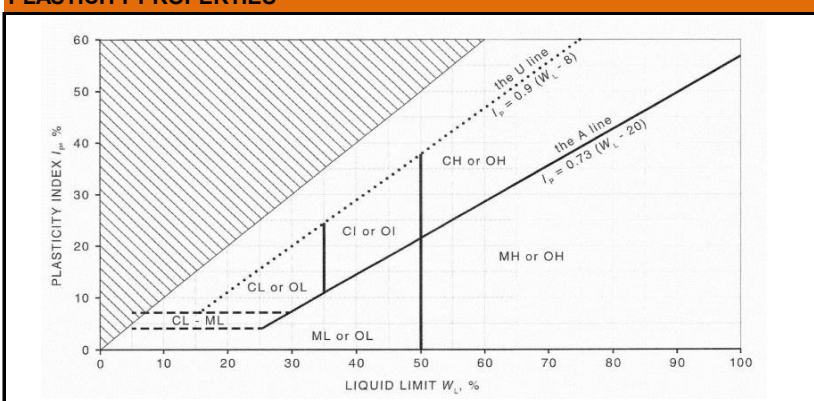
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726:2017, Section 6.2. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties if primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation.
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100mm	Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100mm	PSP blows per 300mm
VS	Very soft	0 to 12	0 to 2	<1	VL	Very Loose	<15	0 to 4	<1	0 to 2
S	Soft	12 to 25	2 to 4	<1	L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
F	Firm	25 to 50	4 to 8	1 to 2	MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
St	Stiff	50 to 100	8 to 15	3 to 4	D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VSt	Very Stiff	100 to 200	15 to 30	5 to 10	VD	Very Dense	>85	>50	>8	>15
H	Hard	>200	>30	>10	Note: PSP correlations only valid 450mm depth					

Consistency and density may also be inferred from excavation performance and material behaviour.

NON-CORED BOREHOLE NUMBER: HA1

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403479

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457449

BEARING:

CHECKED BY: RM

DRILLING					MATERIAL							
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA					0.0			SP	TOPSOIL / ORGANIC SILTY SAND: Fine to coarse grained, dark grey brown.	M	MD	
									SAND: Fine to coarse grained, sub-angular to sub-rounded, grey, trace of silt/clay.	M to W	L to MD	
									Hole Terminated at 0.75 m Collapse			
					1.0							
					1.5							
					2.0							
					2.5							

METHOD

AS - Auger Screwing
RR - Rock Roller
WB- Washbore
HA - Hand Auger
DPR Direct Push Probe

SUPPORT

C - Casing

PENETRATION

No Resistance

WATER

10 Oct., 73 Water Level on Date shown

water inflow

water outflow

SAMPLES & FIELD TESTS

U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE

D - Dry
M - Moist
W - Wet

CONSISTENCY / RELATIVE DENSITY

VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

NON-CORED BOREHOLE NUMBER: HA2

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403418

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457124

BEARING:

CHECKED BY: RM

DRILLING						MATERIAL						
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA				D	0.0				TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	L	Water perched above clay.
					0.10m				SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	W	L	
					0.30m			SP				
					0.5			CI	SANDY CLAY: Medium plasticity, pale yellow brown, fine to medium grained, sub-angular to sub-rounded sand.	M	F to St	
					0.60m 0.60m							
				D	1.0		CL		SANDY CLAY: Low plasticity, pale brown/off white, fine to coarse grained sand with some silt, trace of fine to medium grained, sub-angular gravels of cemented sand/limestone.	M	F to St	
					1.25m				Hole Terminated at 1.25 m Refusal			
					1.5							
					2.0							
					2.5							

METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe	PENETRATION No Resistance	SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test	CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System	CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
SUPPORT C - Casing	WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		MOISTURE D - Dry M - Moist W - Wet	

NON-CORED BOREHOLE NUMBER: HA3

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403320

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457219

BEARING:

CHECKED BY: RM

DRILLING						MATERIAL					
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m) Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA		Not Encountered			0.0			TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	L to MD	
					0.10m		SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	M	MD		
					0.20m		SANDY CLAY: Medium to high plasticity, grey brown, fine to coarse grained, sub-angular to sub-rounded sand.	M	F to St		
					0.60m						
					0.80m					SANDY CLAY: Low to medium plasticity, pale grey/off white, fine to coarse grained sand with some silt, with some fine to medium grained, sub-angular limestone gravels.	F to St
					1.0						
					1.5						
					2.0						
					2.5						
METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe SUPPORT C - Casing		PENETRATION No Resistance WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test		CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System MOISTURE D - Dry M - Moist W - Wet		CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense			

NON-CORED BOREHOLE NUMBER: HA4

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403074

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6456964

BEARING:

CHECKED BY: RM

DRILLING						MATERIAL					
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA					0.0			TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	MD	Grass at surface. Rootlets throughout.
					0.10m		SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	M	MD		
					0.5		0.50m	SANDY CLAY: Medium to high plasticity, grey brown, fine to coarse grained, sub-angular to sub-rounded sand.	M	F to St	
					1.0		0.70m	SANDY CLAY: Low to medium plasticity, pale grey/off white, fine to coarse grained sand with some fine to medium grained, sub-angular limestone gravels.	W	S to F	
					1.5		 Becoming off-white at 1.3m.				
					2.0		2.00m	Hole Terminated at 2.00 m Target depth			
					2.5						

METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe	PENETRATION No Resistance	SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test	CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System	CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
SUPPORT C - Casing	WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		MOISTURE D - Dry M - Moist W - Wet	

CLIENT: Eastcourt Property Group	DATE: 19/7/2017
PROJECT: Industrial Development	TESTED BY: JC
LOCATION: Lot 2008 Grove Road, Kenwick	HAMMER MASS: 9
SOIL TYPE: Silty CLAY	HAMMER DROP HEIGHT: 600mm

Test Location	HA1					
Test Depth mm	Blows/150mm					
0-150	SET					
150-300	3					
300-450	3					
450-600	2					
600-750	1					
750-900	1					
900-1050	2					
1050-1200						

CLIENT: Eastcourt Property Group	DATE: 19/7/2017
PROJECT: Industrial Development	TESTED BY: JC
LOCATION: Lot 2008 Grove Road, Kenwick	HAMMER MASS: 9
SOIL TYPE: Silty CLAY	HAMMER DROP HEIGHT: 510mm

Test Location	HA2	HA3	HA4			
Test Depth mm	Blows/100mm					
0-100	SET	SET	SET			
100-200	1	2	2			
200-300	2	2	2			
300-400	1	4	3			
400-500	3	4	4			
500-600	13	6	5			
600-700	9	7	5			
700-800	11	8	5			
800-900						

Appendix D

Surface Water Quality Monitoring Data



Table 15: Surface Water Quality results for the MKSEA: Field Parameters and Nutrients – 2009 monitoring.

Sample ID	Date	Field Parameters										Nutrients						
		Temp	pH	Electrical Conductivity	Dissolved Oxygen	Redox	TSS	TDS	BOD	COD	TN	NOx_N	NO2_N	Nitrate-NO3	TKN	TP	FRP	
	units	°C		mS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Marine trigger		-	8.0-8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LT Irrigation trigger		-	6.0-8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
M1	30-Jun-09	12.6	6.22	430	8.7	8.8	<1	280	7.0	<5	1.10	<0.760	<0.023	<0.74	0.32	0.02	<0.005	
M2	30-Jun-09	12.8	6.41	450	8.5	-1.0	<1	290	<5	10.0	1.10	0.85	<0.028	<0.82	0.29	0.02	<0.005	
SW1	30-Jun-09	16.2	6.68	1300	5.6	5.6	100	860	36.0	150.0	7.70	3.1	0.073	3	4.6	0.94	0.11	
SW2	30-Jun-09	Insufficient or no flow																
SW3	30-Jun-09	12.8	6.45	1300	5.8	5.8	3	820	8.0	120.0	3.10	1.3	0.048	1.3	1.8	0.28	0.18	
SW5	30-Jun-09	16.8	7.09	430	10.2	10.2	<1	280	8.0	570.0	2.60	1.2	0.032	1.1	1.4	0.04	<0.005	
SW6	30-Jun-09	Insufficient or no flow																
SW7	30-Jun-09	Insufficient or no flow																
M1	11-Aug-09	14.8	6.58	410	8.6	-	2	158	53.0	6.0	0.88	0.52	0.008	<0.52	0.36	0.01	<0.005	
M2	11-Aug-09	15	7.2	556	8.3	-	1	212	50.0	12.0	1.00	0.53	0.014	0.51957	0.48	<0.02	<0.005	
SW1	11-Aug-09	16	7.18	1448	9.1	-	40	578	20.0	650.0	4.30	1.6	0.028	1.5813	2.7	0.35	0.19	
SW2	11-Aug-09	Insufficient or no flow																
SW3	11-Aug-09	14.4	7.36	1900	6.7	-	22	770	20.0	450.0	3.60	0.22	0.019	0.2259	3.4	0.3	0.17	
SW5	11-Aug-09	17.5	7.99	502	10.7	-	<1	192	57.0	350.0	1.60	0.04	0.007	0.04518	1.5	0.03	<0.005	
SW6	11-Aug-09	16.4	7.3	1334	3.5	-	100	529	210.0	400.0	5.20	3.4	0.013	3.3885	1.9	0.17	0.025	
SW7	11-Aug-09	Insufficient or no flow																
M1	18-Aug-09	-	7.2	240	-	-	66	150	<5	100.0	1.50	0.47	0.015225	0.4518	1	0.06	<0.005	
M2	18-Aug-09	-	7	360	-	-	58	230	<5	300.0	1.80	0.58	0.01218	0.56475	1.2	0.08	0.005	
SW1	18-Aug-09	-	7	420	-	-	19	270	<5	500.0	3.10	0.37	0.009135	0.36144	2.8	0.53	0.32	
SW2	18-Aug-09	Insufficient or no flow																
SW3	18-Aug-09	-	7	560	-	-	60	360	<5	300.0	2.10	0.21	0.009135	0.20331	1.9	0.18	0.023	
SW5	18-Aug-09	-	7	170	-	-	7	110	<5	400.0	1.90	0.037	0.00609	0.02259	1.8	0.05	0.005	
SW6	18-Aug-09	-	7.3	440	-	-	27	280	7.0	300.0	3.30	0.9	0.015225	0.88101	2.4	0.63	0.51	
SW7	18-Aug-09	-	7.3	290	-	-	19	180	<5	400.0	1.90	0.05	0.009135	0.04518	1.9	0.06	0.008	
M1	11-Sep-09	15.8	7.98	399	8.0	-	8	150	<5	<5	0.71	0.56	<0.005	0.56475	0.15	0.01	<0.005	
M2	11-Sep-09	16.6	7.83	601	7.8	-	14	230	<5	<5	1.10	0.46	0.005	0.4518	0.68	0.05	<0.005	
SW1	11-Sep-09	16.1	7.7	1060	5.8	-	20	417	<5	100.0	3.20	0.25	0.006	0.24849	2.9	0.6	0.25	
SW2	11-Sep-09	16	7.81	742	5.7		11	288	<5	48.0	2.40	0.62	0.033	0.58734	1.8	0.09	0.01	
SW3	11-Sep-09	15	7.45	1050	7.2	-	30	417	<5	64.0	1.90	0.066	<0.005	0.06777	1.8	0.18	0.037	
SW5	11-Sep-09	17.2	7.81	408	8.5	-	6	154	<5	60.0	1.60	0.008	<0.005	<0.1	1.6	0.04	<0.005	
SW6	11-Sep-09	17	7.87	796	6.5	-	4	310	<5	36.0	2.30	0.77	<0.005	0.76806	1.6	0.27	0.15	
SW7	11-Sep-09	17.2	7.67	662	5.7	-	7	254	<5	68.0	1.90	0.014	<0.005	<0.1	1.9	0.07	<0.005	
M1	16-Sep-09	16.2	8	428	8.0		6	162	<5	52.0	1.10	-	<0.005	0.63252	1.1	0.01	<0.005	
M2	16-Sep-09	16.4	7.86	555	8.0	-	9	213	<5	60.0	1.00	-	0.005	0.54216	1	0.02	<0.005	
SW1	16-Sep-09	18.7	7.44	242	5.9	-	8	289	13.0	92.0	2.80	-	0.011	0.92619	2.8	0.3	0.14	
SW2	16-Sep-09	17.5	7.51	674	6.2	-	6	258	<5	120.0	2.50	-	0.033	0.51957	2.5	0.1	0.015	
SW3	16-Sep-09	20.1	7.9	1264	7.3	-	16	501	<5	340.0	2.20	-	0.006	0.11295	2.2	0.18	0.088	
SW5	16-Sep-09	22.4	8.31	428	7.7	-	5	162	18.0	300.0	2.10	-	<0.005	0.006777	2.1	0.07	<0.005	
SW6	16-Sep-09	16.8	7.81	1058	5.8	-	4	417	<5	240.0	4.00	-	0.007	2.430684	4	0.14	0.09	
SW7	16-Sep-09	18.2	7.37	785	4.5	-	23	305	13.0	350.0	2.70	-	<0.005	0.033885	2.7	0.08	<0.005	
M1	2-Nov-09	16.7	7.78	320	7.8	-8.0	<1	119	32.0	<5	0.63	0.36	<0.01	0.36144	0.27	0.5	<0.005	
M2	2-Nov-09	19.2	7.75	572	9.0	-30.1	5	219	28.0	<5	0.64	0.27	<0.01	0.27108	0.37	0.5	<0.005	
SW1	2-Nov-09	Insufficient or no flow																
SW2	2-Nov-09	Insufficient or no flow																
SW3	2-Nov-09	Insufficient or no flow																
SW5	2-Nov-09	Insufficient or no flow																
SW6	2-Nov-09	Insufficient or no flow																
SW7	2-Nov-09	Insufficient or no flow																
M1	19-Nov-09	17.7	7.45	246	7.4	-43.4	35		32.0	16.0	1.30	0.24	<0.005	0.24849	1.1	0.16	<0.005	
M2	19-Nov-09	18	7.45	282	5.2	-44.6	35		49.0	100.0	1.20	1.2	0.008	1.17468	<0.05	0.05	<0.005	
SW1	19-Nov-09	22.3	7.48	3640	4.9	-46.2	36		67.0	10000.0	3.20	0.54	0.089	0.4518	2.7	0.49	0.21	
SW2	19-Nov-09	Insufficient or no flow																
SW3	19-Nov-09	26.2	7.83	3480	7.3	-64.2	35		64.0	10000.0	3.00	1.2	0.026	1.17468	1.9	0.1	0.016	
SW4	19-Nov-09	-	-	-	-	-	14	-	59.0	300.0	2.30	0.51	0.007	0.49698	1.8	0.11	<0.005	
SW5	19-Nov-09	28	7.88	422	5.9	-67.8	-	-	-	-	-	-	-	-	-	-	-	
SW6	19-Nov-09	Insufficient or no flow																
SW7	19-Nov-09	Insufficient or no flow																

Table 16: Surface Water Quality for the MKSEA: Field Parameters and Nutrients – 2010 Monitoring.

Sample ID	Date	Field Parameters									Nutrients							
		Temp	pH	Electrical Conductivity	Dissolved Oxygen	Redox	TSS	TDS	BOD	COD	TN	NOx_N	NO2_N	Nitrate-NO3	TKN	TP	FRP	
	units	°C		mS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Marine trigger		-	8.0-8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LT Irrigation trigger		-	6.0-8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
M1	24-Jun-10	11.5	7.36	319	6.8	-15.4	<5	117	10	9	0.6	0.26	<0.01	0.26	0.3	0.01	<0.01	
M2	24-Jun-10	11.2	7.69	388	6.6	-35.5	<5	146	6	11	0.6	0.23	<0.01	0.23	0.4	0.02	<0.01	
SW1	24-Jun-10	Insufficient or no flow																
SW2	24-Jun-10	Insufficient or no flow																
SW3	24-Jun-10	11.8	7.79	1534	5.1	-42.3	<5	610	8	59	1.2	0.01	<0.01	0.01	1.2	0.19	0.12	
SW5	24-Jun-10	16.7	8.11	279	6.9	-61.2	<5	103	8	73	1.7	0.04	<0.01	0.04	1.7	0.1	0.02	
SW6	24-Jun-10	Insufficient or no flow																
SW7	24-Jun-10	Insufficient or no flow																
M1	9-Jul-10	12.2	7.06	185	10.1	99.5	25	120	12	13	0.6	0.24	<0.01	0.24	0.4	0.05	<0.01	
M2	9-Jul-10	12	7.13	199	6.9	119.0	16	129	23	16	0.7	0.22	<0.01	0.22	0.5	0.04	<0.01	
SW1	9-Jul-10	13.9	7.02	429	7.7	102.9	10	270	15	52	1.9	0.42	<0.01	0.42	1.5	0.25	0.24	
SW2	9-Jul-10	13.6	6.97	313	6.5	108.3	36	204	8	25	1.1	0.14	<0.01	0.14	1	0.13	0.04	
SW3	9-Jul-10	12	7.01	477	8.6	132.0	5	310	12	53	1.5	0.22	<0.01	0.22	1.3	0.12	0.09	
SW5	9-Jul-10	12.4	7	139	9.4	216.0	13	90	17	57	1.6	0.2	0.02	0.18	1.4	0.04	0.02	
SW6	9-Jul-10	13	6.81	36	9.8	141.0	5	23	12	<5	0.4	0.13	0.02	0.11	0.3	0.07	0.02	
SW7	9-Jul-10	Insufficient or no flow																
M1	13-Jul-10	11.5	7.43	460	6.9	-20.4	<5	181	2	22	1.1	0.83	<0.01	0.83	0.3	0.01	<0.01	
M2	13-Jul-10	12.3	8.13	386	6.4	-62.8	11	145	3	32	1.3	0.73	<0.01	0.73	0.6	0.03	<0.01	
SW1	13-Jul-10	13	7.57	950	3.8	-29.3	234	371	5	233	5	2.31	0.02	2.29	2.7	0.37	0.11	
SW2	13-Jul-10	12.5	7.82	690	5.4	-43.0	<5	265	5	49	2.2	0.74	0.03	0.71	1.5	0.1	0.02	
SW3	13-Jul-10	12.6	7.89	750	5.2	-47.6	20	290	<2	86	1.9	0.16	<0.01	0.16	1.7	0.18	0.1	
SW5	13-Jul-10	14.6	7.64	301	7.3	-32.7	<5	111	<2	83	1.5	0.03	<0.01	0.03	1.5	0.53	<0.01	
SW6	13-Jul-10	15.8	7.64	1279	0.7	-33.0	<5	500	3	186	2.4	1.54	0.02	1.52	0.9	0.07	0.02	
SW7	13-Jul-10	13	7.79	630	2.6	-42.3	<5	239	<2	88	1.6	0.01	<0.01	0.01	1.6	0.1	<0.01	
M1	12-Aug-10	12.8	6.86	330	6.8	-	11	123	<2	31	0.9	0.3	<0.01	0.3	0.6	0.04	<0.01	
M2	12-Aug-10	12.5	7.69	284	6.1	-	10	106	<2	20	0.7	0.3	<0.01	0.3	0.4	0.03	<0.01	
SW1	12-Aug-10	13.7	7.63	2400	4.9	-	10	811	<2	57	3.6	1.69	0.04	1.66	1.9	0.25	0.13	
SW2	12-Aug-10	Insufficient or no flow																
SW3	12-Aug-10	14.3	7.32	871	5.6	-	<5	337	<2	73	2	0.22	0.01	0.21	1.8	0.13	0.03	
SW5	12-Aug-10	15.3	8.33	325	6.6	-	5	121	<2	36	2.1	0.38	<0.01	0.38	1.7	0.11	0.02	
SW6	12-Aug-10	14.5	7.88	159	3.4	-	7	57	<2	16	0.8	0.28	<0.01	0.28	0.5	0.06	0.02	
SW7	12-Aug-10	Insufficient or no flow																
M1	1-Sep-10	14	8.32	460	6.7	-	<5	174	2	45	0.6	0.25	<0.01	0.25	0.4	<0.02	<0.01	
M2	1-Sep-10	14	8.14	572	7.8	-	<5	217	<2	48	0.5	0.22	<0.01	0.22	0.3	<0.01	<0.01	
SW1	1-Sep-10	16.1	8.04	3390	5.0	-	26	1390	6	115	3.3	1.36	0.04	1.32	1.9	0.2	0.1	
SW2	1-Sep-10	17.4	8.2	700	4.0	-	44	270	17	83	2.1	0.01	<0.01	0.01	2.1	0.23	0.01	
SW3	1-Sep-10	18.7	7.37	2815	2.5	-	6	1135	7	122	1.4	0.01	<0.01	0.01	1.4	0.14	0.15	
SW5	1-Sep-10	21.5	9.34	371	11.6	-	16	1.39	11	102	3	0.26	0.07	0.2	2.7	<0.05	0.04	
SW6	1-Sep-10	16.2	7.9	316	2.9	-	<5	117	7	77	0.9	0.04	<0.01	0.04	0.9	0.05	0.02	
SW7	1-Sep-10	Insufficient or no flow																
M1	23-Sep-10	13.4	7.85	6180	6.3	-	10	2360	-	-	0.8	0.19	<0.01	0.19	0.6	0.02	<0.01	
M2	23-Sep-10	13.4	7.33	8590	5.5	-	<5	334	-	-	0.4	0.04	<0.01	0.04	0.4	0.03	<0.01	
SW1	23-Sep-10	17.7	7.43	4110	4.3	-	14	170	-	-	2.2	0.03	<0.01	0.03	2.2	0.14	0.03	
SW2	23-Sep-10	Insufficient or no flow																
SW3	23-Sep-10	Insufficient or no flow																
SW5	23-Sep-10	Insufficient or no flow																
SW6	23-Sep-10	Insufficient or no flow																
SW7	23-Sep-10	Insufficient or no flow																
M1	14-Oct-10	17.9	8.1	956				374	-	-	0.8	0.038	0.024	0.014	0.76	0.02	<0.005	
M2	14-Oct-10	16.9	7.35	1850				745	-	-	0.83	0.034	<0.005	0.034	0.8	0.02	<0.005	
SW1	14-Oct-10	Insufficient or no flow																
SW2	14-Oct-10	Insufficient or no flow																
SW3	14-Oct-10	Insufficient or no flow																
SW5	14-Oct-10	Insufficient or no flow																
SW6	14-Oct-10	Insufficient or no flow																
SW7	14-Oct-10	Insufficient or no flow																

Appendix E

Groundwater Monitoring Data



Table 7
Groundwater Analytical Results - Physiochemical Parameters

			Field Parameters				Major Anions/Cations					
			pH	Electrical Conductivity	Redox	Dissolved Oxygen	Calcium	Potassium	Magnesium	Sodium	Chloride	Total Alkalinity (as CaCO ₃)
FWG			6.5-8.5 ¹	300-1,500 ²	NE	NE	NE	NE	NE	NE	NE	NE
LIWG			6.0-8.5	1,900-4,500 ³	NE	NE	NE	NE	NE	115 ⁴	175 ⁴	NE
NPGU			NE	NE	NE	NE	NE	NE	NE	NE	250	NE
Limits of Reporting (LOR)			-	-	-	-	0.1	0.1	0.1	0.1	5	5
Sample ID	Lab ID	Date Sampled	-	µs/cm	mV	ppm	mg/L					mg CaCO ₃ /L
MW1	16-08162-1	18/10/2016	6.58	385	14.6	12.7	18	3.1	6.3	55	69	82
MW2	16-08162-2	18/10/2016	7.04	620	-4.8	26.7	28	5.3	15	83	120	170
MW3	16-08162-3	18/10/2016	7.20	1,178	58.4	17.8	130	1.8	19	89	160	3,500
MW4	16-08162-4	18/10/2016	7.10	445	33.8	30.9	51	9.3	25	25	36	180
MW5	16-08162-5	18/10/2016	7.13	1,148	39.7	26.8	120	0.9	19	100	100	5,400
MW6	16-08162-6	18/10/2016	7.06	552	96.3	48.9	85	12	8.3	17	31	140
MW7	16-08162-7	18/10/2016	8.10	2,829	69.4	11.8	25	17	18	570	660	430

Notes:

NE = Regulatory guideline not established

¹ value derived from ANZECC (2000) - wetland ecosystems in South-west Australia

² value derived from ANZECC (2000) - lakes, reservoirs & wetland ecosystems in South-west Australia

³ value derived from ANZECC (2000) - for moderately tolerant crops

⁴ value derived from ANZECC (2000) - for sensitive crops

< Indicates sample results below the laboratory limit of reporting (LOR)

- Not Analysed

Regulatory Guidelines:

Guidelines are derived from DER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines*,

NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*,

NHMRC & NRMCC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).

shading indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).

shading indicates concentration exceeds the NPUG (Non-Potable Groundwater Use - Department of Health, 2014).

Table 8
Groundwater Analytical Results - Metals and Nutrients

			Dissolved Metals										Nutrients										
			Aluminium	Arsenic	Cadmium	Chromium (III)	Chromium (VI)	Copper	Iron	Lead	Mercury (Total)	Nickel	Zinc	Total Nitrogen	NOx (as N)	Nitrate-N	Nitrate (as NO ₃)	Nitrite-N	Nitrite (as NO ₂)	Ammonia (as NH ₃ -N)	Total Phosphorus	Filterable Reactive Phosphorus	Sulphate (as SO ₄)
FWG			0.055	0.024*	0.0002	NE	0.001	0.0014	0.3^	0.0034	0.00006	0.011	0.008	1 ¹	0.1 ²	NE	NE	NE	NE	0.9	0.1 ¹	NE	NE
LIWG			5	0.1	0.01	NE	NE	0.2	0.2^	2	0.002	0.2	2	5	NE	NE	NE	NE	NE	NE	0.05	NE	NE
NPGU			0.2	0.1	0.02	NE	0.5	20	0.3^	0.1	0.01	0.2	3	NE	NE	113	500	9	30	NE	NE	NE	1,000
Limits of Reporting (LOR)			0.01	0.001	0.0001	0.001	0.002	0.001	0.01	0.001	0.0001	0.001	0.005	0.2	0.01	0.01	-	0.01	-	0.02	0.01	0.01	1
Sample ID	Lab ID	Date Sampled	mg/L											mg/L									
MW1	16-08162-1	18/10/2016	0.57	<0.001	<0.0001	0.001	<0.002	0.003	0.18	0.002	<0.0001	0.001	0.22	2.9	0.05	0.05	0.22	<0.01	0.03	0.09	1.7	<0.01	43
MW2	16-08162-2	18/10/2016	0.16	0.001	<0.0001	0.003	<0.002	0.007	0.99	<0.001	0.0001	0.003	<0.005	6.6	0.17	0.17	0.75	<0.01	0.03	0.06	3.9	0.02	51
MW3	16-08162-3	18/10/2016	0.01	<0.001	<0.0001	<0.001	<0.002	0.003	0.02	<0.001	<0.0001	0.001	<0.005	0.9	0.34	0.34	1.51	<0.01	0.03	0.04	4.7	0.01	34
MW4	16-08162-4	18/10/2016	0.16	0.002	<0.0001	0.001	<0.002	0.004	0.06	<0.001	<0.0001	<0.001	<0.005	1.6	0.51	0.51	2.26	<0.01	0.03	0.03	0.62	<0.01	25
MW5	16-08162-5	18/10/2016	0.02	0.002	<0.0001	0.001	<0.002	0.003	<0.01	<0.001	<0.0001	0.001	<0.005	25	25	24.98	110.66	0.02	0.07	0.02	2.6	0.02	58
MW6	16-08162-6	18/10/2016	0.02	0.001	<0.0001	0.002	<0.002	0.009 [#]	0.05	0.001	<0.0001	0.002	0.008	32 [#]	18	17.99	79.70	0.01	0.03	0.05 [#]	5.06 [#]	<0.01	76
MW7	16-08162-7	18/10/2016	0.13	0.022	<0.0001	0.001	<0.002	0.004	0.08	<0.001	<0.0001	<0.001	<0.005	0.3	0.06	0.05	0.22	0.01	0.03	0.02	5	0.08	170

Notes:

NE = Regulatory guideline not established

¹ value derived from SRT (2008) Healthy Rivers Action Plan

² value derived from ANZECC (2000) - trigger values for slightly moderately disturbed wetland ecosystems

* indicates As(III) guideline value

^ indicates total value

[#] Indicates duplicate or triplicate sample result used instead of primary sample concentration

< Indicates sample results below the laboratory limit of reporting (LOR)

- Not Analysed

Regulatory Guidelines:

Guidelines are derived from DER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines*,

NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*,

NHMRC & NRMCC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).

shading indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).

shading indicates concentration exceeds the NPGU (Non-Potable Groundwater Use - Department of Health, 2014).

Table 9
Groundwater Analytical Results - Organochlorine and Organophosphorous Pesticides

			Organochlorine (OC) and Organophosphorus (OP) Pesticides																																		
			Aldrin	alpha-BHC	beta-BHC	delta-BHC	Bifenthrin	Bromophos Ethyl	Chlordane	Chlorothalonil	Chlorpyrifos	Diazinon	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulphate	Endrin	Ethion	Fenitrothion	Fipronil	Hexachlorobenzene (HCB)	Heptachlor Epoxide	Heptachlor	Lindane (gamma-BHC)	Malathion	Methoxychlor	pp-DDD	pp-DDE	op-DDT	pp-DDT	Oxychlordane	Parathion-ethyl	Parathion-methyl	Trifluralin	Vindozolin	Aldrin + Dieldrin	
FWG			NE	NE	NE	NE	NE	NE	0.03	NE	0.01	0.01	NE	0.03		NE	0.01	NE	0.2	NE	NE	NE	0.01	0.2	0.05	NE	NE	NE	0.006		NE	NE	NE	2.6	NE	NE	
LIWG			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		NE	NE	NE	NE	NE	NE	
NPGU			NE	NE	NE	NE	350	NE	20	500	100	40	NE	200		NE	NE	40	70	7	NE	3	NE	100	700	NE	NE	NE	90		NE	NE	7	900	NE	3	
			0.001	0.001	0.001	0.001	0.05	0.005	0.002	0.01	0.005	0.01	0.001	0.001	0.001	0.01	0.01	0.01	0.01	0.02	0.001	0.001	0.001	0.001	0.01	0.02	0.001	0.001	0.001	0.001	0.001	0.02	0.02	0.01	0.02	-	
Sample ID	Lab ID	Date Sampled	µg/L																																		
MW1	16-08162-1	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001
MW2	16-08162-2	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001
MW3	16-08162-3	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001
MW4	16-08162-4	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001
MW5	16-08162-5	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001	
MW6	16-08162-6	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	0.039 [#]	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	0.009 [#]	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	0.004 [#]
MW7	16-08162-7	18/10/2016	<0.001	<0.001	<0.001	<0.001	<0.05	<0.005	<0.002	<0.01	<0.005	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.01	<0.02	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.01	<0.02	<0.001	

Notes:
NE = Regulatory guideline not established
< Indicates sample results below the laboratory limit of reporting (LOR)
- Not Analysed
[#] Indicates duplicate or triplicate sample result used instead of primary sample concentration

Regulatory Guidelines:
Guidelines are derived from DER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines*,
NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*,
NHMRC & NRMCC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

	shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).
	shading indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).
	shading indicates concentration exceeds the NPGU (Non-Potable Groundwater Use - Department of Health, 2014).

Table 10
Groundwater Analytical Results - Hydrocarbons

			BTEXN					TRHs					PAHs																		
			Benzene	Toluene	Ethylbenzene	Xylenes (Total)	Naphthalene	C ₆ - C ₁₀	C ₆ - C ₁₀ less BTEX (F1)	>C ₁₀ - C ₁₆	>C ₁₀ -C ₁₆ less N (F2)	>C ₁₆ - C ₃₄ (F3)	>C ₃₄ - C ₄₀ (F4)	Naphthalene	2-Methylnaphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-c,d)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene	
FWG			0.95	NE	NE	0.2	0.016	NE	NE	NE	NE	NE	NE	16	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LIWG			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NPGU			0.001	0.025	0.003	0.02	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.1	NE	NE	NE	NE
Vapour Intrusion	HSL 'A' & 'B' - Sand (2 - <4m)		0.8	NL	NL	NL	NL	NE	1	NE	1	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	HSL 'C' - Sand (2 - <4m)		NL	NL	NL	NL	NL	NE	NL	NE	NL	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	HSL 'D' - Sand (2 - <4m)		5	NL	NL	NL	NL	NE	6	NE	NL	NE	NE	NL	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Limits of Reporting (LOR)			0.001	0.001	0.001	0.003	0.005	0.02	0.02	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sample ID	Lab ID	Date Sampled	mg/L											µg/L																	
MW1	16-08162-1	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW2	16-08162-2	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW3	16-08162-3	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW4	16-08162-4	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW5	16-08162-5	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW6	16-08162-6	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW7	16-08162-7	18/10/2016	<0.001	<0.001	<0.001	<0.003	<0.005	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Notes:
NE = Regulatory guideline not established
NL = Not Limiting
< Indicates sample results below the laboratory limit of reporting (LOR)
- Not Analysed

Regulatory Guidelines:
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NHMRC & NRMCMC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.
shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).
shading indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).
shading indicates concentration exceeds the NPUG (Non-Potable Groundwater Use - Department of Health, 2014).
shading indicates concentration exceeds the CRC CARE Health Screening Levels (HSL) for Vapour Intrusion (Sand - A-D)

Appendix F

Water Corporation Correspondence and Mapping



Aisha Chalmers

From: Gouraw Undale <Gouraw.Undale@watercorporation.com.au>
Sent: Thursday, 2 November 2017 2:16 PM
To: Amila Prasad
Cc: David Coremans; Rachel Evans; Kanex Kanagaratnam
Subject: Re: MKSEA Lot 2008 Modelling Assessment6
Attachments: Lot 2008 draiange plan - configurations (b).pdf

Follow Up Flag: FollowUp
Flag Status: Flagged

Hi Amila,

Thanks for your information.

I have included the attached system changes for Lot 2008 into the model (including changes to the storages in MKSEA 3A area) and assessed the model performance at a high level. The preliminary modelling results indicate that the proposed three storages (totalling 7000 m³) within the Lot 2008 seems to be reasonable to meet the storage requirements for this lot. However, as mentioned before, a detailed hydraulic analysis would be carried out to check the adequacy of the storages once the details of the Yule Brook main drain channel profile (cross-section, the width of the reserve, etc.) are confirmed with the Local Authorities.

In addition, a formal submission is required to be made to the DSB (Development Services Branch) prior to construction/connection which needs to meet the following conditions before a formal approval can be granted:

- Proposal must satisfy the Corporation's O&M and Engineering Standards requirements and other relevant guidelines
- Creation of living streams/multiple use corridor should be considered wherever possible.

Please feel free to contact me if you need any information.

Regards,

Gouraw Undale

Senior Planner

Drainage & Liveable Communities Metro

Asset Planning Group

Water Corporation

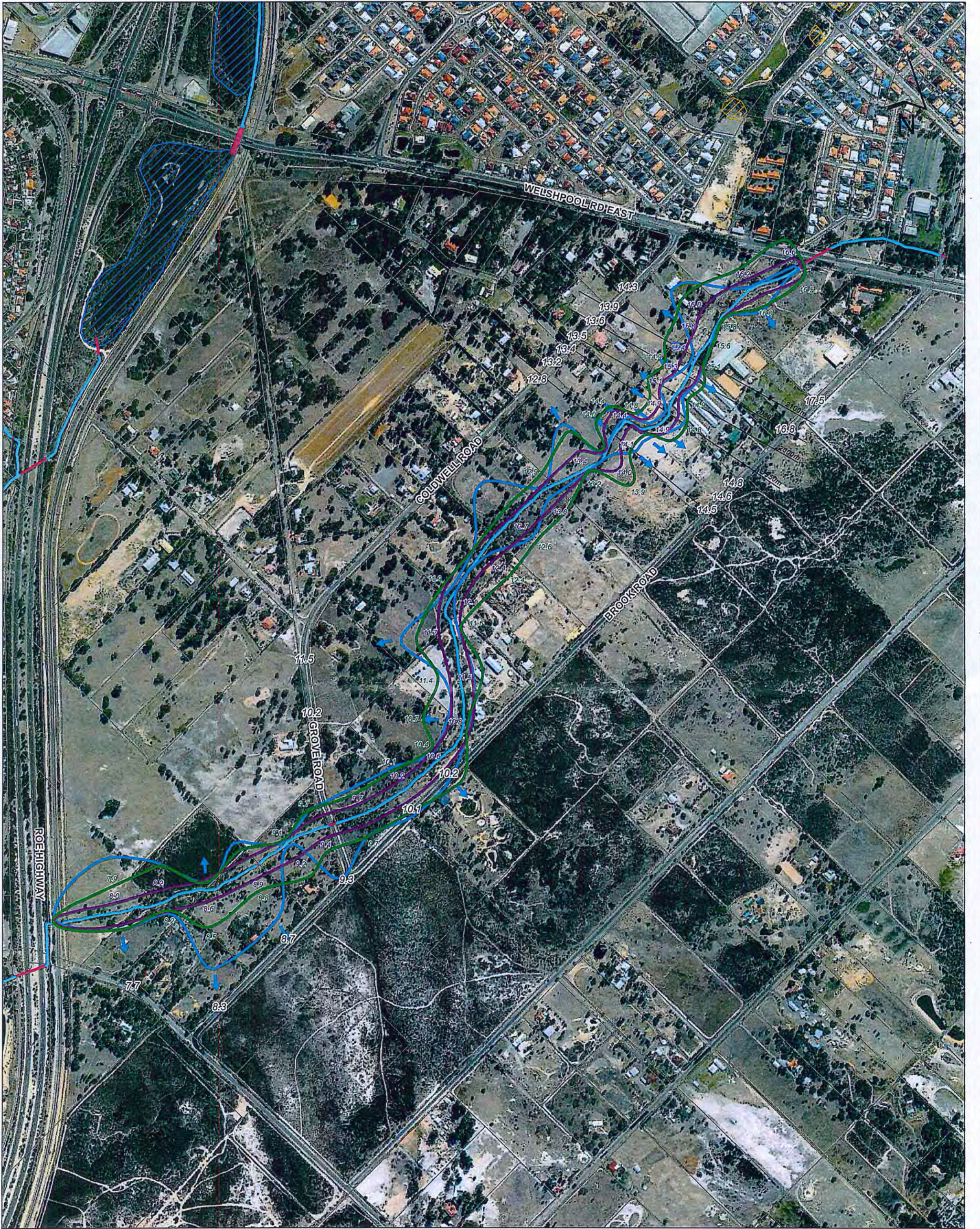
T: 9420 2060

www.watercorporation.com.au



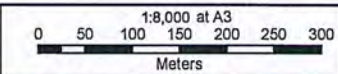
Please consider the environment before printing this email.

From: Amila Prasad [<mailto:Amila.Prasad@emergeassociates.com.au>]
Sent: Monday, 23 October 2017 2:46 PM
To: Gouraw Undale
Cc: Rachel Evans; David Coremans
Subject: RE: MKSEA Lot 2008 Modelling Assessment6



- LEGEND**
- Existing 100 yr ARI Floodplain
 - 100m Floodplain Option
 - 50m Floodplain Option
 - Open Drain
 - Piped Drain
 - 9.3 Existing Road Level (mAHD)
 - 8.6 100yr ARI Water Level for 50 Floodplain (mAHD)
 - 8.1 100yr ARI Water Level for 100 Floodplain (mAHD)

Coordinate System: ODA 1994 MGA Zone 50 Vertical Datum: AHD
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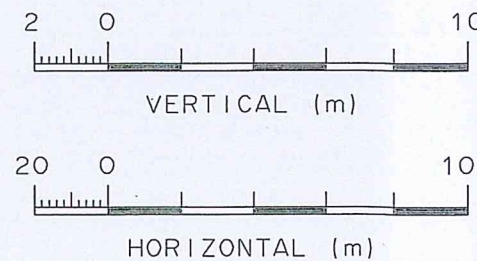
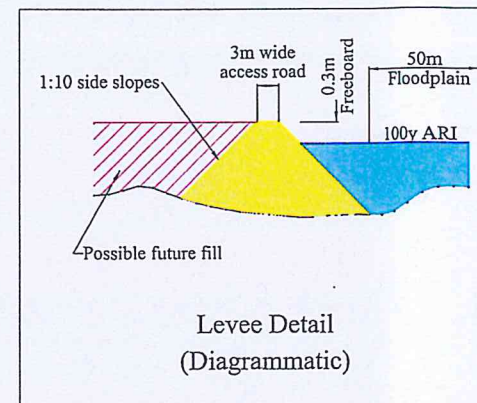
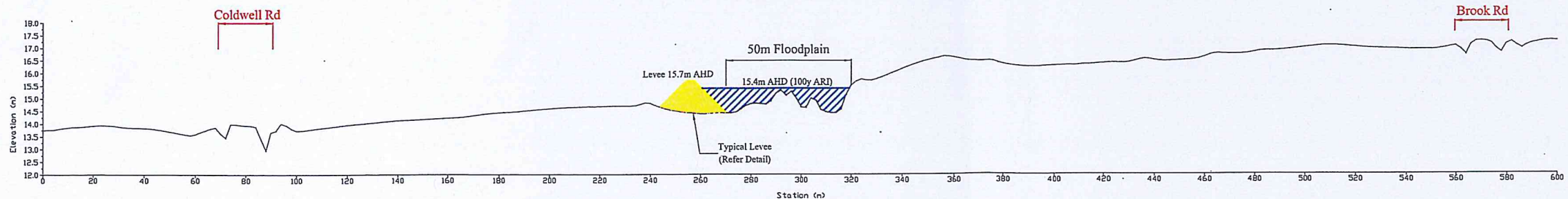
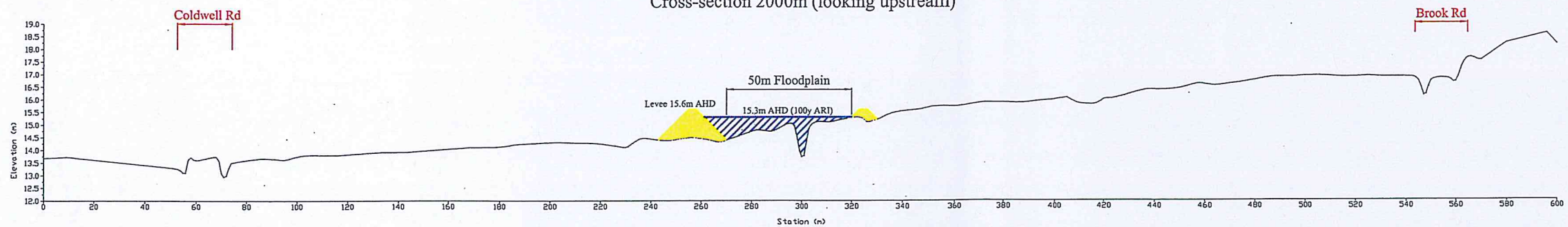
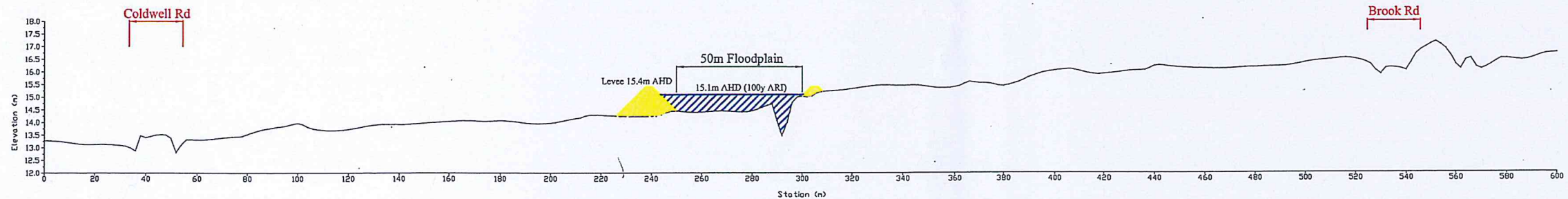
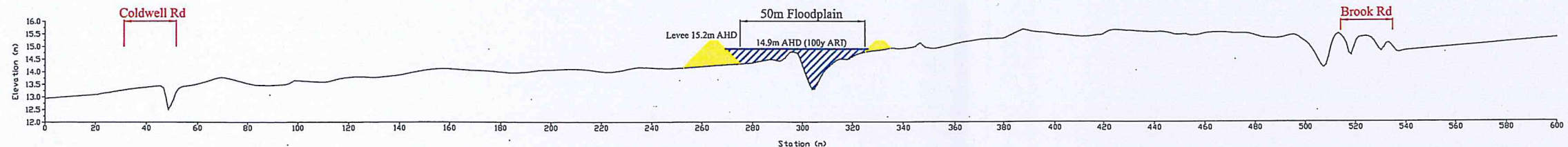
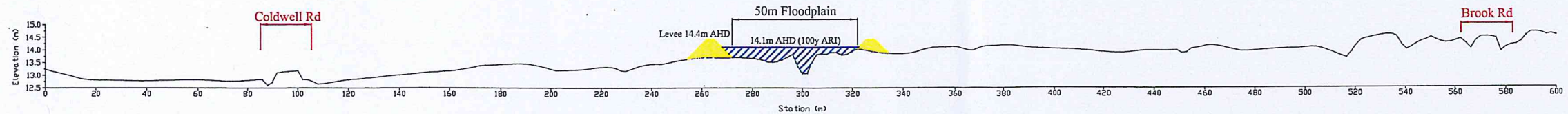
PROJECT No: XXXX
 GROUP: XXXX
 DOCUMENT: YuleBrook_CrossSection.mxd

AUTHOR: DEMPSTGO
 DATE: 19/02/2013



Yule Brook MD - MKSEA Area

Figure 1



YULE BROOK MAIN DRAIN - MKSEA AREA CROSS SECTIONS

Figure 1.1

DESIGN FILE: CRITICAL CROSS SECTIONS (A)

AUTHOR: DANIELMI



PROJECT No: TA-DP122

DATE: 21/11/2012

COORDINATE SYSTEM: MGA94 - Zone 50

Appendix G

Modelling Assumptions Report



Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick
Strategic Employment Area

Project No: EP17-055(03)

**Prepared for Grove Road Pty Ltd
June 2018**

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



Document Control

Doc name:		Modelling Assumptions Report Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area			
Doc no.:		EP17-055(13)--013 ASC			
Version	Date	Author		Reviewer	
1	November 2017	Aisha Chalmers	ASC	Rachel Evans	RLE
	Appendix for LWMS				
A	December 2017	Aisha Chalmers	ASC	Rachel Evans	RLE
	Appendix for LWMS				
B	December 2017	Aisha Chalmers	ASC	Rachel Evans	RLE
	Appendix for LWMS				

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Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



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Figure 1: Modelled Drainage Design

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



List of Abbreviations

Table A1: Abbreviations – General terms

General terms	
AHD	Australian height datum
ARI	Average recurrence interval
LWMS	Local water management strategy
MKSEA	Maddington Kenwick Strategic Employment Area

Table A2: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
m	Metre
mm	Millimetre
mm/hr	Millimetre per hour
m/s	Metres per seconds
m ³ /s	Cubic metres per second

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



1 Modelling Assumptions

In order to calculate the surface water runoff volumes and flows related to the Precinct 3A Structure Plan amendment in Maddington Kenwick Strategic Employment Area (MKSEA) development, XPSWMM hydrologic and hydraulic modelling software was used (Waterloo Hydrogeologic 2017).

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

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

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

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given a length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node, a 'dummy intermediate' node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 100 year average recurrence interval (ARI) event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All virtual links are designed with a width of 5 m, roughness of 0.014 (Manning's n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



2 Post-development Model

The post-development model incorporates catchments associated with the development of Lot 414 Grove Road as shown in **Figure 1**. The modelling has not included areas within the 50 m Yule Brook buffer (discussed in Section 7 of the Lot 414 Grove Road Local Water Management Strategy (LWMS) (Emerge Associates 2017b)) as all development and proposed infrastructure is required to be located outside of this area.

2.1 Catchment hydrology

An “initial loss - continual loss” infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience on other projects in the area with similar site characteristics. **Table 1** gives the parameters used within the post-development model.

Table 1 Post-development parameters

Land type	Initial loss (mm)	Continual loss (mm/hr)	Roughness (Manning's n)
Road pavement	1	0.1	0.014
Road verge	12.5	1	0.02
Roof	1	0.1	0.014
Landscaped areas	20	2.5	0.02
Pavement / hardstand	1	0.1	0.014
Drainage reserve / buffer	20	2	0.05

The post-development catchment areas are based on the civil designs and earthworks strategy provided by the project team, provided in Appendix F of the LWMS (Emerge Associates 2017b). A summary of the post-development catchment details associated with the development are provided in **Figure 1**.

Table 2 Post-development catchment areas

Land type	Catchment area (ha)						
	EC1	EC2	EC3	EC4	GroveRd1	EC_Buffer1	EC_Buffer2
Road pavement	0	0	0	0	0.18	0	0
Road verge	0	0	0	0	0.18	0	0
Roof	3.03	0.69	1.07	1.28	0	0	0
Pavement / hardstand	2.73	0.62	0.96	1.15	0	0	0
Landscaped areas	0.30	0.07	0.11	0.13	0	0	0
Drainage reserves / buffers	0	0.37	0.19	0.26	0	0.91	0.65

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



The infiltration rates used were predominantly based upon the following assumptions:

- The developed area is assumed to be 50% roof, 50% pavement or handstand, and 5% landscaped areas. Landscaped areas will have high infiltration rates as it is likely that sand-based landscape mix or mulch will be used, and will infiltrate the first 20 mm of rainfall.
- Grove Road reserve contains 50% pervious verge and 50% impervious bitumen. The road verge area is similar in characteristics to landscaped areas except that it will also have some driveway crossovers. It is anticipated that the average initial loss in road verges will be lower than garden initial loss rates to account for the impervious portion of road verges.
- There will be no infiltration on roads, pavement and handstand. There will however be some minor absorption storage loss, this is accounted for in the initial and continuing loss values.
- Drainage reserves and buffers are assumed to be 100% pervious.

2.2 Hydraulics

Upstream runoff from the greater portion of Precinct 3A enters the development area at its northern boundary consistent with the flow rates given in *MKSEA Precinct 3A Outline Development Plan LWMS* (MKSEA LWMS) (Emerge Associates 2017a), and is conveyed to detention basin FSA A (shown in **Figure 1**).

Whilst detention basin FSA A detains runoff from upstream catchments, detention basins FSA B and FSA C only detain runoff from local catchments within the site. Detention basin FSA B has been modelled as an independent basin and discharges flows towards the Yule Brook. An arterial pipe between detention basins FSA A and FSA C has been modelled as a 900 mm diameter pipe in order to meet pre-development flow requirements (as discussed in the LWMS).

Detention basins have been modelled as square storage nodes with 1:6 side slopes of varying depths. Basins are provided with a low flow pipe and weir overflow in order to ensure pre-development peak flow rates for both the 10 year ARI and 100 year ARI event are achieved.

Details of hydraulic flow controlling structures and conveyance pipes are given in **Table 3**.

Table 3 Hydraulic flow controlling structure and conveyance pipe details

Storage & pipe reference	Upstream invert level (m AHD)	Downstream invert level (m AHD)	Length (m)	Details	Weir depth (m)	Maximum velocity (m/s)	Maximum flow (m ³ /s)
FSA A discharge to DN 900 pipe (FSA IL 8.40 m AHD)							
Low flow pipe (design for the first 15 mm event)	8.40	8.36	20.0	Single 300	n/a	1.6	0.1
Low flow pipe (design for the first 15 mm event)	8.70	8.69	20.0	Single 600	n/a	2.5	0.7

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



Table 3 Hydraulic flow controlling structure and conveyance pipe details (continued)

Storage & pipe reference	Upstream invert level (m AHD)	Downstream invert level (m AHD)	Length (m)	Details	Weir depth (m)	Maximum velocity (m/s)	Maximum flow (m³/s)
Top weir (design for the 10 & 100 year ARI event)	9.25	9.24	5.0	Broad crest weir	4.0	1.0	0.3
FSA C discharge to wetland 7635 (FSA IL 8.20 m AHD)							
Low flow pipe (design for the first 15 mm event)	8.20	8.16	20.0	Single 150	n/a	1.7	0.03
Top weir (design for the 10 & 100 year ARI event)	8.98	8.97	5.0	Broad crest weir	4.0	0.8	0.1
FSA B discharge to Yule Brook (FSA IL 7.00 m AHD)							
Low flow pipe (design for the first 15 mm event)	7.00	6.98	20.0	Single 150	n/a	1.7	0.03
Top weir (design for the 10 & 100 year ARI event)	7.95	7.94	5.0	Broad crest weir	4.0	0.10	0.01

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



3 References

3.1 General references

Emerge Associates 2017a, *Local Water Management Strategy MKSEA Precinct 3A Outline Development Plan*, report prepared on behalf of Linc Property Pty Ltd, Subiaco.

Emerge Associates 2017b, *Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area Local Water Management Strategy*, Perth.

3.2 Online references

Waterloo Hydrogeologic 2017, *Visual MODFLOW Classic*, viewed August 2017, <
<http://novamatrixgm.com/help/vmod/index.html>>.

Modelling Assumptions Report

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area



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Figures



Figure 1: Modelled Drainage Design

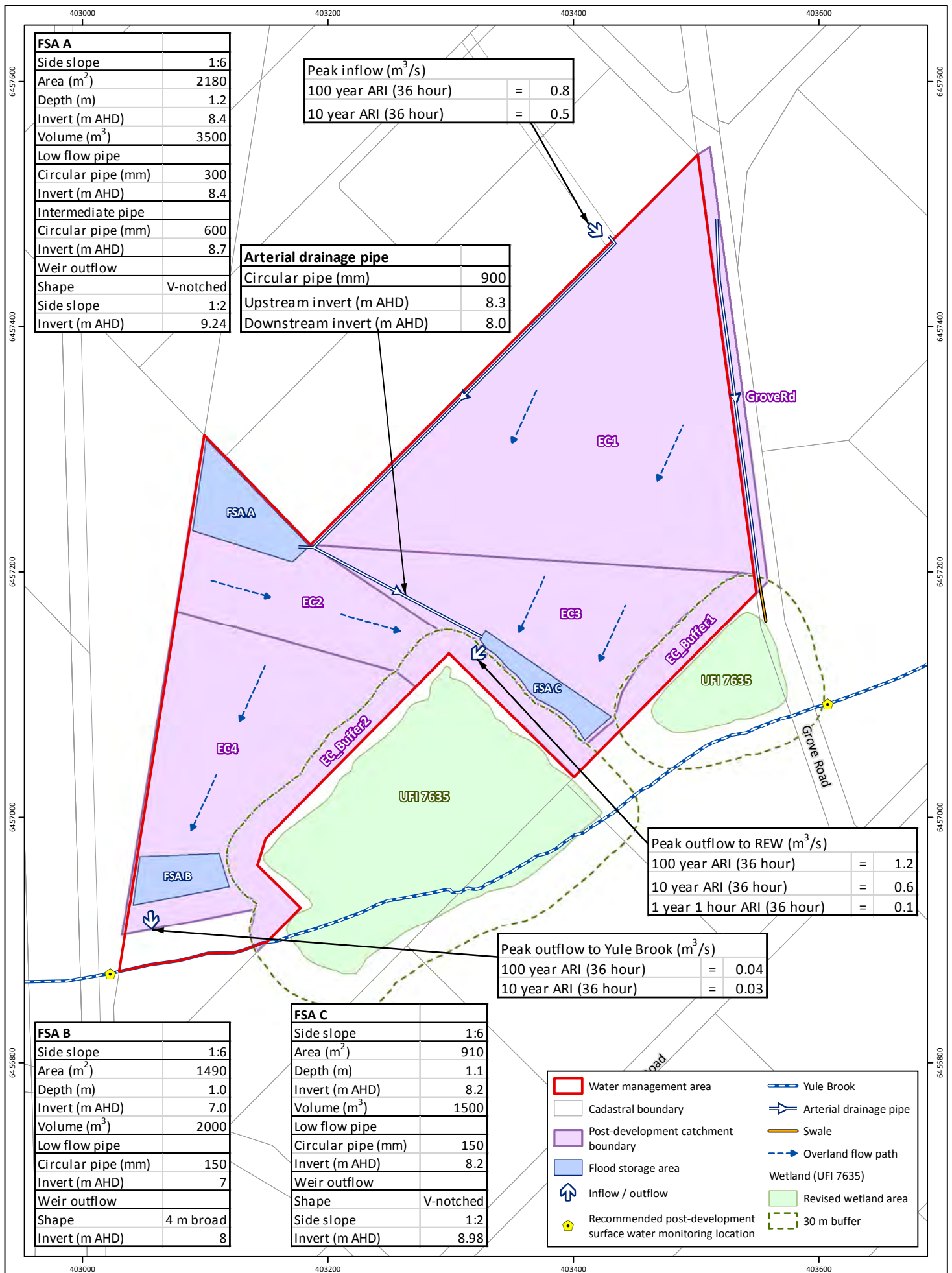


Figure 6: Stormwater Management Plan

Project: Modelling Assumptions Report
Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area

Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F09a
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



0 50 100
Metres
Scale: 1:4,000@A4
GDA 1994 MGA Zone 50



Appendix 3

Wetland and Wetland Buffer Assessment (PGV Environmental)

LOT 414 GROVE ROAD, KENWICK

WETLAND AND WETLAND BUFFER ASSESSMENT

Prepared for: Grove Road Pty Ltd

Report Date: 8 June 2018

Version: 6

Report No. 2017-319



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1 INTRODUCTION

1.1 Site Location

Lot 414 Grove Road, Kenwick (the site) is located in the City of Gosnells approximately 11km south-east of the Perth Central Business District (Figure 1). The site is bounded by Grove Road to the east, neighbouring rural properties to the north and south and a future railyard to the west (Figure 2).

1.2 Background

The site is within Precinct 3A of the Maddington-Kenwick Strategic Employment Area (MKSEA) and is currently zoned 'Industrial' under the Metropolitan Region Scheme (MRS). Most of the site is also zoned industrial under the City of Gosnells Town Planning Scheme No. 6 with a small area in the south-west corner zoned 'Rural'.

Lot 414 Grove Road is being added to the existing MKSEA Precinct 3A Structure Plan as an Amendment.

The whole of Lot 414 is mapped as wetland on the Department of Biodiversity Conservation and Attractions (DBCA, previously DPaW) wetland database. In addition, wetland UFI 7635 is mapped on the adjoining properties to the south with some overlap onto Lot 414. Wetland UFI 7635 has been identified as having environmental values, including the presence of a Threatened Ecological Community. As a result of the wetland's environmental significance the City of Gosnells' Local Planning Scheme No. 6 (LPS 6) requires the following to be undertaken as part of the LSP process:

Condition 6.10.3.1 *Investigations to determine the water balance and buffer requirements for occurrences of the Threatened Ecological Community and wetland identified as UFI 7635 in the Geomorphic Wetland Swan Coastal Plain dataset occurring adjacent to the Amendment area, prepared on advice by the Department of Parks and Wildlife and to the satisfaction of the Environmental Protection Authority; and*

Condition 6.10.3.2 *A boundary definition study for wetland UFI 7635 prepared on advice by and to the satisfaction of Department of Parks and Wildlife.*

This report was commissioned by Grove Road Pty Ltd, the owner of the site, to satisfy Conditions 6.10.3.1 and 6.10.3.2 of LPS 6 and has been prepared to accompany the LSP Amendment for Lot 414. The report pertains only to the portion of wetland UFI 7635 that affects the Lot 414 LSP.

2 RELEVANT POLICIES AND GUIDELINES

2.1 Evaluation of Specific Wetland Types on the Swan Coastal Plain

The draft document *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (DPaW, 2013) was developed by the Department of Parks and Wildlife's (DPaW's) Wetlands Section (now Department of Biodiversity Conservation and Attractions). The methodology integrates the previous systems of wetland assessment into a single and comprehensive wetland evaluation methodology and is in accordance with the *Framework for mapping, classification and evaluation of wetlands in Western Australia* (DEC, 2007a). The methodology applies scientific evaluation to wetland boundaries.

The level of significance and values of a wetland are attained through field assessment, with the information gathered used to assign an appropriate management category. This in turn provides guidance on the management and protection required for the wetland (WRC, 2001).

The information gathered during the field assessment is used to fill in a preliminary and a secondary evaluation questionnaire form. The wetland management categories are assigned based on the results of the preliminary and secondary evaluation.

2.2 Management Categories and Objectives for Wetlands

Management Categories and their objective are defined as outlined in Table 1 (DPaW, 2013).

Table 1: Wetland Management Categories and Objectives applied to the Swan Coastal Plain

Management Category	General description	Objectives
Conservation	Wetlands which support a high level of attributes and functions.	To preserve and protect their existing conservation values through various mechanisms including: - reservation in national parks, Crown reserves and state-owned land, - protection under Environmental Protection Policies, - wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement (Rehabilitation Potential)	Wetlands which may have been modified or degraded, but still support substantial attributes and functions.	To manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored or rehabilitated to Conservation category focusing on wetland functions, structure and biodiversity value.
Multiple Use	Wetlands with few remaining important attributes and functions.	The use, development and management of these wetlands should be considered in the context of ecologically sustainable development and best management practice catchment planning.

2.3 Determining Wetland Buffers

EPA Guidance Statement 33, *Environmental Guidance for Planning and Development*, states that wetlands that are to be protected require a minimum 50m buffer distance. This advice applies to Conservation Category wetlands as well as Resource Enhancement wetlands if they are to be retained in a development.

The Guidance Statement also states that an alternative to applying the minimum 50m setback is to undertake a site-specific buffer assessment. In determining a setback using site-specific studies the overall setback should be determined by:

- The wetland's values;
- The activities, land uses or development near the wetland, existing and proposed; and
- The threats posed by the adjacent activities, land uses or development.

3 WETLAND MAPPING

3.1 DPaW Geomorphic Wetland Mapping

The whole of Lot 414 Grove Road is mapped in the Department of Parks and Wildlife (DPaW) Geomorphic Wetlands on the Swan Coastal Plain database as wetland (Plate 1) (National Map, 2017).

Plate 1: Geomorphic Wetlands on the Swan Coastal Plain wetland map



Most of the site is mapped as a Multiple Use Palusplain (UFI 15254) (shown shaded in yellow on Plate 1). Multiple Use Palusplain (UFI 15254) is a large wetland that extends from near Albany Highway to the south-west of the site and extends to Welshpool Road to the north. The wetland adjoins other palusplain wetlands further north of Welshpool Road.

Resource Enhancement (RE) Palusplain (UFI 7635) (shown as light green on Plate 1) is mapped on two of the lots abutting Lot 414 to the south (Lot 4 Bickley Road) and south-east (Lot 8 Brook Road). The RE wetland extends onto a portion of Lot 414 in two areas; one to the west of Lot 4 and one long thin area at the north-eastern boundary with Lot 8.

Both wetlands mapped on the site are classified as Palusplain wetlands. A Palusplain is a seasonally inundated flat (Hill *et al.*, 1996). The wetlands on the site are part of the Keysbrook consanguineous wetland suite (National Map, 2017).

The portion of RE wetland 7635 on Lot 414 does not appear to have the wetland values that would define it as a Resource Enhancement wetland. Furthermore, the extent of the RE wetland on the

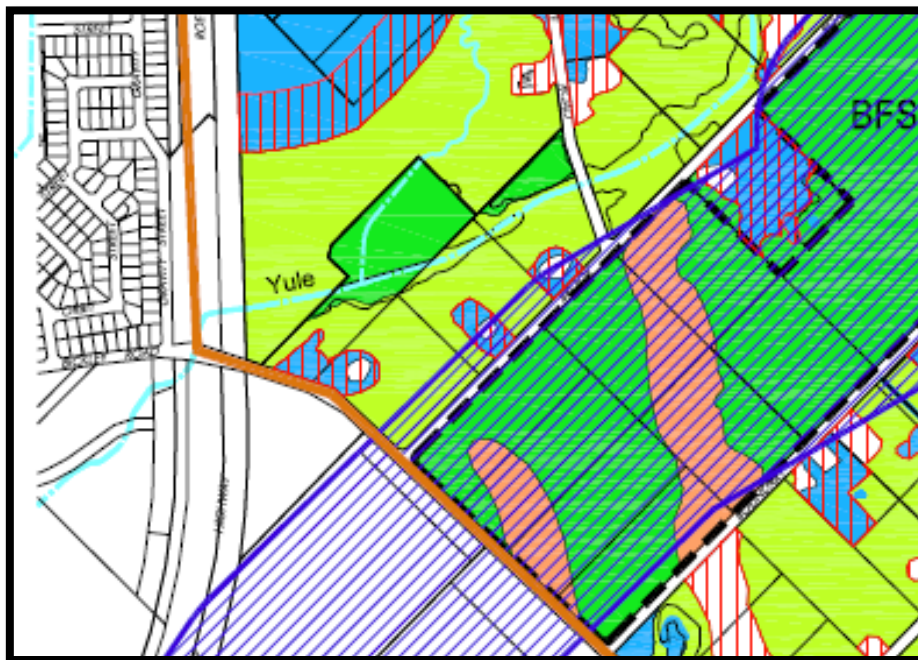
adjoining lots does not appear to have been drawn accurately. Therefore, this wetland assessment was undertaken to evaluate and, if required, propose a revised boundary for the wetland.

3.2 Tauss and Weston Wetland Mapping

The City of Gosnells commissioned a detailed study of the flora, vegetation and wetlands of the MKSEA area (Tauss and Weston, 2010).

Tauss and Weston (2010) undertook a Level 2 flora and vegetation survey of the MKSEA area and an evaluation of the DPaW wetland management categories. Tauss and Weston (2010) recommended that a large proportion of Palusplain 15254 (13362 in their report) should be upgraded from a Multiple Use (MU) wetland to a Resource Enhancement (RE) wetland. This recommendation affects most of the MU on Lot 414 apart from the north-west portion (Attachment 2).

Plate 2: Tauss and Weston (2010) Recommended Wetland Mapping



Tauss and Weston (2010) also recommend that Wetland UFI 7635 on the adjoining Lots to the south be upgraded to a Conservation category wetland based on the fact they were almost completely covered in native vegetation. The boundary of the recommended CCW for wetland UFI 7635 related to the cadastral boundary between Lot 414 and adjoining lots. No portion of the recommended CCW was located on Lot 414.

The recommendations in the Tauss and Weston (2010) report that are relevant to the site are:

1. The report states that the floodplain type of wetland that occurs on Lot 414 has not been built on and therefore retains its geomorphic integrity and hydrological function. Such palusplains are apparently scarce wetlands on the Pinjarra Plain. Tauss and Weston (2010) considered that these palusplain wetlands could actually be considered for upgrading to a Conservation category due to their rarity, representativeness and scientific importance, regardless of vegetation condition. This recommendation, based on geomorphic importance in the absence

of any vegetation appears to be an outcome of applying the V&C Semeniuk Research Group wetland questionnaire to the palusplain wetlands.

2. Tauss and Weston (2010) state that Lot 414 contains a small 'creek' that runs through Lot 414 and discharges into wetland UFI 7635 on the southern boundary of Lot 414 before flowing into Yule Brook. The report recommends that the creek on Lot 414 can be enhanced by avoiding further modification, controlling weeds, and revegetation. The report asserts that enhancement will improve water quality and recharge the floodplain adjacent to Yule Brook.

4 WETLAND DESCRIPTIONS

4.1 Wetland Boundary

Wetland UFI 7635 is currently mapped predominantly on the adjacent Lots 4 and 8, outside the ownership of Grove Road Pty Ltd (Figure 3). The wetland mapping extends slightly onto the southern boundary of Lot 414 Grove Road. Wetland 15254 is mapped over the remainder of Lot 414.

4.2 Topography

The wetland areas are predominantly low lying and flat. The elevation of the wetlands varies between approximately 7m Australian Height Datum (AHD). The topography of Lot 414 ranges from around 7-10m AHD and slopes gradually up to the northern corner near Grove Road.

Some micro-topographical changes occur on site due to man-made drainage features and compaction due to tracks.

4.3 Hydrology

The Perth Groundwater Map shows the top of the groundwater table on Lot 414 at 5m to 7mAHD which is approximately 1.8 to 3.3m below the ground surface. The groundwater level in wetland UFI 7635 ranges from 5.5 – 6m AHD. Groundwater is generally flowing to the south-west (DoW, 2017a). The groundwater around the wetland has geological formations that have been grouped into three distinct aquifers:

- Superficial Swan Aquifer;
- Leederville Aquifer; and
- Yarragadee North (DoW, 2017b)

A section of Yule Brook runs through wetland UFI 7635 on the adjoining properties and passes through the southwestern corner of Lot 414.

The 'creek' described by Tauss and Weston (2010) is an extension of agricultural drains that occur to the north of the property. As such, the 'creek' is more like an informal drain that connects the northern agricultural drains with the property south of Lot 414 via a series of sinuous depressions up to 10m wide. The depressions fill up with water following large rainfall events but are rarely fully connected at the surface, except in years of high rainfall such as in 1981 (Plate 3).

In 1981 the Bureau of Meteorology (BOM) recorded May rainfall of 177.8mm at the nearby Gosnells weather station, which is 73mm greater than the long term monthly average (BOM, 2017).

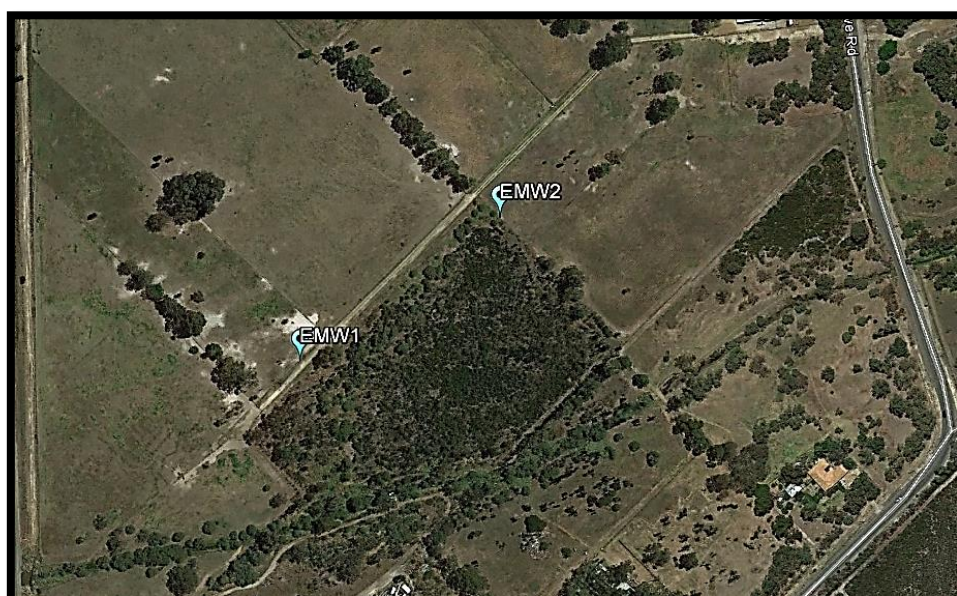
Plate 3: Historical Aerial Photography from August 1981



There is a very shallow surface channel connection point for the outlet of the informal drain into the north-east corner of Lot 4. It is likely that in low to average rainfall years water from the informal drain seeps into the wetland on Lot 4 predominantly by sub-surface flow. The informal drain runs through Lot 4 and eventually connects to Yule Brook within Lot 4.

Groundwater monitoring in the wetland on Lot 414 has been undertaken in 2017 on the boundary of the lot (Plate 4).

Plate 4: Piezometer Locations



Recorded groundwater depth was 0.97m (EMW1) and 0.61m (EMW2) below ground level in July 2017. Groundwater rose in August by approximately 0.5m and was 0.48m (EMW1) and 0.58m (EMW2) below ground level.

A Local Water Management Strategy (LWMS) has been prepared for Lot 414 by Emerge Associates (2017). The LWMS included a wetland water balance model for the whole site and also included wetland UFI 7635.

The box model approach to the water balance study was confirmed as appropriate by DBCA officers at a meeting on 13 July 2017. The model demonstrates that the water balance in wetland UFI 7635 is determined by seven key factors which are shown diagrammatically in Appendix 1 and summarised in Table 3.

Table 3: Summary of Wetland UFI 7635 Water Balance Model

Factor	Flows
Inflows	
Precipitation	Determined by annual weather conditions
Surface Inflows from upstream catchments via the 'informal drain'	Modelled and confirmed as: - 1 year 1 hr ARI = 0.1m³/s - 10 year ARI = 0.6m³/s - 100 year ARI = 1.2m³/s
Yule Brook	Seasonal flow rates in Yule Brook, upstream and downstream of the wetland
Groundwater conditions	Pre-development conditions include: - Winter levels (Sept 2017) between 7.6 – 8.2m AHD along the northern boundary of Lot 4 - Summer levels (July 2017) between 7.1 – 7.6m AHD - Seasonal variability of approximately 500mm - Localised groundwater mounding identified at the surface water inflow point to the wetland.
Outflows	
Evaporation	Determined by seasonal temperatures and meteorological conditions
Transpiration	Transpiration by vegetation in wetland and grasses in the paddocks of Lot 414
Surface outflows	Discharges to Yule Brook from the wetland by natural flow in Lot 4.

4.4 Geology and Soils

4.4.1 Geology

The site is mapped as part of the Pinjarra Plain System on the eastern side of the Swan Coastal Plain. The Pinjarra Plain System consists of a broad low relief plain west of the foothills, comprising predominantly Pleistocene fluvial sediments and some Holocene alluvium associated with major current drainage systems (Bolland, 1998). The major soils are naturally poorly drained and many swamps occur (DAFWA, 2017).

4.4.2 Soils

The soils on Lot 414 have been mapped and described by the Department of Primary Industries and Regional Development (DPIRD) as shown in Figure 3 and outlined below:

- Pinjarra, Phase Gf4 (213Pj_Gf4) which are imperfectly drained, level to very gently inclined alluvial fans with variable imperfectly drained soils with layers of sand, sandy loam, clay, grit and weathered granitic detritus, mapped over the intact wetland part of the site;
- Pinjarra EnvGeol Ms4 Phase (213PjSWMs4) which are sandy silt soils that are light yellow brown, blocky, mottled, some fine to medium-grained sand, soft when moist with variable clay content. These soils are associated with Yule Brook;
- Pinjarra EnvGeol Sc Phase (213Pj_Sc) which is Clayey Sand, silty in part, pale grey to brown, medium to coarse-grained, poorly sorted, subangular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin. These soils are in the northern part of the site; and
- Pinjarra, Phase Gf3 (213Pj_Gf3) which are poorly drained level to very gently sloping plain with mottled yellow earths with loamy topsoil (DPIRD, 2017).

The soil type in wetland UFI 7635 within Lots 4 and 8 is all mapped as Pinjarra Phase Gf4 soil type (DPIRD, 2017).

4.4.3 Soil Disturbance

Some soil has been pushed up/deposited along the northern, western and eastern boundaries of the wetland (Plate 5 to 7) within the adjoining Lot 4.

Plate 5: Mounds of soil on northern boundary



Plate 6: Pile of soil on western boundary



Plate 7: Mounded soil on eastern boundary



A limestone track exists within Lot 414 on the north-western boundary of Lot 4 (Plate 8). The track is slightly raised and forms a barrier to any surface water draining off that portion of Lot 414 into the wetland on Lot 4. One piped culvert occurs under the limestone track on the southern boundary of Lot 414 that directs any temporary ponding of surface water on Lot 414 caused by the raised track into the wetland (Plate 9). Surface water would have run-off into Lot 4 prior to the limestone track being constructed.

Plate 8: Compacted track around the boundary of the wetland.



Plate 9: Pipe culvert under limestone track



4.5 Wetland Database Search

Table 2 shows the results of the desktop wetland database search for significant wetlands.

Table 2: Wetland Database Search Results

Item	Response
Ramsar List of Wetlands of International Importance	Wetland 7635 is not a Ramsar listed wetland (RAMSAR, 2017)
A Directory of Important Wetlands in Australia	Wetland 7635 is not listed as an Important Wetland in Australia (Environment Australia, 2001).
Register of the National Estate	NA – This register was closed in 2007 and all references to the Register of the National Estate were removed from the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) on 19 February 2012.
Conservation Reserves for Western Australia The Darling System–System 6	Wetland 7635 is on the Perth Swan Coastal Plain and therefore comes under Bush Forever which supersedes the System 6 study in the Perth Metropolitan Region.
Environmental Significance of Wetlands in the Perth to Bunbury Region	Wetland 7635 is not listed in the Environmental Significance of Wetlands in the Perth to Bunbury Region report. (LeProvost, Semeniuk & Chalmer, 1987)
A Systematic Overview of the Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton–Walpole Region	Wetland 7635 does not fall within the area described (Pen, 1997)
Bush Forever	Wetland 7635 is not part of a Bush Forever site (Government of Western Australia, 2000)
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	No longer a relevant Policy since November 2016.

4.6 Heritage

The Department of Aboriginal Affairs Aboriginal Heritage Inquiry System (DAA, 2017) was used to determine if there are any Aboriginal heritage sites recorded on the site. There have been three large scale surveys that include the site (Appendix 2). There were four Heritage Places recorded in the search area of the Aboriginal Inquiry System report. Place 4340 is to the north of the lot, Place 122 is 'Stored Data / Not a Site' as the place has been assessed as not meeting Section 5 of the *Aboriginal Heritage Act 1972*. The database did not show any listed sites in the wetland areas (Appendix 2).

There were two 'Other Heritage Places' that are 'Lodged' as information has been received in relation to the place, but an assessment has not been completed to determine if it meets Section 5. Place 24785 is an Artefacts / Scatter, Arch Deposit located around Yule Brook in the south-western part of the site. Place 3312 is mapped over the southern part of Lot 414 and is an Artefacts / Scatter, Camp, however the location of the place is not accurate and the place is mapped over a large area.

A search of the National (DotEE, 2017) and State (Heritage Council of WA, 2017) registers of historical sites also indicated that there are no heritage sites in or near the wetlands.

4.7 Vegetation

4.7.1 Vegetation Types

Lot 414

All of Lot 414 has been cleared for horse paddocks and no intact native vegetation remains.

All the trees within the paddocks in the western part of the site are planted trees not native to the site and are primarily River Red Gum (*Eucalyptus camaldulensis*). The eastern part of the site near the horse stables and Grove Road contain scattered young Marri (*Corymbia calophylla*) trees over a pasture understorey.

A short section of Yule Brook passes through the southwestern corner of the site. The brook in this area contains native vegetation in and on the banks of the brook, including Flooded Gum (*Eucalyptus rudis*) and Paperbark (*Melaleuca raphiophylla*) with some Bulrush (*Typha orientalis*) also present. The brook is not fenced off from the adjoining paddocks on both sides and is traversed by horses at one section when the creekline is dry.

Lot 4 Bickley Road and Lot 8 Brook Road

The vegetation on Lot 4 to the south of Lot 414 consists of a variety of wetland vegetation types including Flooded Gum trees (*Eucalyptus rudis*), Paperbark (*Melaleuca raphiophylla*), *Melaleuca viminea*, *Callitris pyramidalis* (formerly *Actinostrobus pyramidalis*), and heath plants such as *Hypocalymma angustifolium*. Tauss and Weston (2010) mapped two vegetation types on Lot 4 as follows:

- *Acacia saligna* – *Actinostrobus pyramidalis* – *Melaleuca viminea* closed scrub (ST6)
- *Melaleuca raphiophylla* – *Eucalyptus rudis* – *Actinostrobus pyramidalis* low open forest to low open woodland.

Most of the vegetation on Lot 4 and 8 is mapped by the Department of Biodiversity Conservation and Attractions (DBCA) as the Muchea Limestone Threatened Ecological Community (TEC). The boundary of the TEC coincides with the ST6 vegetation type of Tauss and Weston.

The vegetation on Lot 8 was mapped by Tauss and Weston as:

- *Acacia lasiocarpa* – *Actinostrobus pyramidalis* mid-dense heath and open, species-rich rushes, sedges and herbs (SL3).

4.7.2 Vegetation Condition

The vegetation condition over the site was assessed using the condition scale adopted in Bush Forever (Table 4).

Table 4: Vegetation Condition Rating Scale.

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Condition	Description
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Source: Government of Western Australia, 2000.

No native vegetation occurs on Lot 414 apart from some isolated Marri trees and a short section of riparian vegetation along the south-west portion of Yule Brook. As a result, the portion of the Lot 414 adjoining the wetland on Lots 4 and 8 is Completely Degraded.

Tauss and Weston (2010) mapped the vegetation on Lots 4 and 8 in Good to Very Good condition. The wetland contains a number of aggressive weeds including Arum Lily (*Zantedeschia aethiopica*), Watsonia (*Watsonia meriana* var. *bulbillifera*), Kikuyu (*Cenchrus clandestinus*), Lovegrass (*Eragrostis curvula*) and Patterson's Curse (*Echium plantagineum*). A section of Lovegrass on Lot 8 is in Completely Degraded condition.

4.8 Flora

Tauss and Weston (2010) recorded a number of conservation significant species in their study of the MKSEA area. The locations for each species are not publicly available, however would not be located on Lot 414 due to the absence of native understorey vegetation.

A number of the Conservation Significant species identified were associated with areas of Muchea Limestone which is recorded as occurring on Lot 4. The quadrat sampled by Tauss and Weston on Lot 4 contained the Priority 4 species *Grevillea thelemanniana*. The description of the site also states that most of the other flora is regionally significant.

4.9 Fauna

Lot 414 has very little ecological value for native fauna due to the absence of intact native vegetation. The scattered Marri trees in the eastern part of the lot and the non-native planted River Red Gums in the paddocks and along fence lines have some value as bird habitat. The waterlogged parts of the site at the end of the diffuse informal drain have some value as habitat for wading birds.

The native vegetation on the adjoining lots to the south have a range of ecological value for reptiles, birds, frogs and small mammals such as Bandicoots.

4.10 Wetland Environmental Values

As part of a wetland assessment, an understanding of the wetland environmental values is required to determine the appropriate protection and management priorities for the wetland.

The wetland values of the Multiple Use Wetland on Lot 414 are limited to providing overland flow to the wetland in Lots 4 and 8 and some foraging value wading birds in waterlogged areas.

The vegetation in the wetland UFI 7635 on Lots 4 and 8 ranges from Good to Very Good condition with a patch on Lot 8 being Completely Degraded. The mapped boundary of wetland UFI 7635 on Lot 414 has all been cleared and therefore is Completely Degraded. The wetland vegetation on Lots 4 and 8 has been impacted by weeds such as *Watsonia* which occurs in dense patches within the wetland. Some clearing for fire breaks has occurred around the inside perimeter of Lots 4 and 8 as well as some other areas cleared within the wetlands on those lots.

Tauss and Weston (2010) identified one Priority flora and a number of regionally significant flora in the wetland on the lots to the south of Lot 414. The fauna habitat values of the vegetated part of the wetland on Lots 4 and 8 is Good Fauna Habitat in the dense vegetation and has some linkage through Yule Brook riparian vegetation to other areas.

The ecological values of wetland UFI 7635 on Lots 4 and 8 are:

- TEC Vegetation 'Mucnea Limestone';
- Regionally Conservation Significant Flora; and
- Good Fauna habitat.

These wetland values do not occur on Lot 414.

5 WETLAND BOUNDARY ASSESSMENT

5.1 Wetland Boundary

The *Protocol for Proposing Modifications to the Geomorphic Wetlands Swan Coastal Plain Dataset* (DEC, 2007b) states wetland values or area can change, either through natural or anthropogenic processes and in such a large dataset some inaccuracies may occur. The mapped boundary for Wetland 7635 was identified by PGV Environmental by site inspection and a review of aerial photography as being slightly inaccurate. Therefore, a wetland boundary assessment was undertaken by Dr Paul van der Moezel and Jackie Cabot from PGV Environmental on 29 September 2016. The assessment was generally in alignment with DPaW's *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (2013).

The assessment included walking the boundary between areas containing dense native wetland vegetation and areas with no native vegetation. The co-ordinates of the boundary were recorded at approximately 20m intervals using a hand-held GPS with an accuracy of about 3m. There was generally a sharp delineation between the densely vegetated areas and those areas devoid of any native vegetation.

No holes were required to be excavated across the wetland boundary as the assessment was one to determine wetland categories rather than a wetland/dryland boundary.

The results of the site assessment are shown in Figure 3 and Appendix 3.

Native wetland vegetation was recorded on Lots 4 and 8. No native wetland vegetation was recorded on Lot 414. The native vegetation on Lot 4 did not extend up to the fence line. The closest the native vegetation was to the fence line on Lot 4 was about 5m (Plate 10) and the cleared areas extended up to 15m away (Plate 11).

Plate 10: Vegetation on Lot 4 closest to Lot 414



Plate 11: Vegetation on Lot 4 up to 15m from Lot 414



The areas on Lot 4 that did not contain native vegetation mostly contained Kikuyu Grass (*Cenchrus clandestina*), Veldtgrass (*Ehrharta calycina*), Watsonia (*Watsonia bulbifera*), Lovegrass (*Eragrostis curvula*) and other weed species.

Lot 8 Brook Road contained a southern area of dense Lovegrass, Lotus and Capeweed (*Arctotheca calendula*) and did not contain any native vegetation (Plate 12). The northern part of Lot 8 contained dense native vegetation within 3m of the fence line with Lot 414 including *Eucalyptus rudis*, *Melaleuca viminea*, *Acacia saligna*, *Viminaria juncea* and *Callitris pyramidalis* (Plate 13).

Plate 12: Lovegrass on 8 Brook Road



Plate 13: Native vegetation on Lot 8 Brook Road (to the left)



5.2 Hydrology

The groundwater hydrology along the boundary of the native vegetation and the cleared areas was not investigated as it was considered any differences in the depth to groundwater would be very small. The area either side of the vegetation/cleared area boundary was considered to be wetland.

5.3 Hydric Soils

The soils along the boundary of the native vegetation and the cleared areas was heavy with a dark organic clayey soil typical of wetland soils. The soils either side of the vegetation/cleared area boundary was considered to be wetland soils.

5.4 Wetland Function Area

The WAPC (2005) guideline states that the wetland function area (WFA) is:

... the area which needs to be protected to ensure the important functions and values of the wetland can be maintained.

Based on this definition, the WFA of the subject wetland is defined as the area delineated on Figure 2. The function area of the Conservation Category Wetland is selected as that part of the wetland that is vegetated and functions ecologically as a wetland.

6 WETLAND MANAGEMENT CATEGORY ASSESSMENT

A secondary evaluation of the wetland characteristics was undertaken as required by *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (DPaW, 2013). The results are provided in Appendix 4.

The evaluation was undertaken on the whole of Lot 414 and the portion of Lots 4 and 8 that did not contain any native vegetation. The evaluation methodology was applied to the wetland using the criteria assessed by PGV Environmental and also by using an elevated geomorphological rating for the palusplain as suggested by Tauss and Weston (2010). Application of the criteria in the Secondary Evaluation results in a Multiple Use Category for all wetland areas on Lot 414 and the completely cleared areas on the adjacent lots using both the PGV Environmental ranking and the elevated Tauss and Weston geomorphological rating.

The presence of the Threatened Ecological Community, as determined by Tauss and Weston (2010) on most of Lot 4 and 8 automatically gives a Conservation Category rating to the vegetated parts of those lots (Figure 3).

7 WETLAND BUFFER ASSESSMENT

7.1 Role of the Buffer

Wetland buffers are defined as the transition zone between the wetland and the surrounding land use. Buffers are measured from the wetland boundary, which in this case will be the Wetland Function Area as shown in Figure 3.

The role of the wetland buffer is to maintain the ecological processes, values and functions of the wetland and to protect the wetland from potential adverse impacts (EPA 2008). Buffers can help protect people from potential nuisance and disease-carrying insects including midges and mosquitoes.

7.2 Wetland Values Requiring Protection

The EPA's ultimate objective for Resource Enhancement wetlands is to manage, restore and protect towards improving their conservation value. The EPA's objective for Conservation Category wetlands is to preserve and protect the existing conservation values through various mechanisms including reservation and protection.

Table 5 summarises the values of wetland UFI 7635 that need to be protected. In summary, the wetland values are very high although they are currently impacted by some altered soil profiles and localised changes in topography, a compacted firebreak around the perimeter of the Wetland Function Areas and high weed infestation within the native vegetation.

Table 5: Summary of Wetland UFI 7635 Values

Environmental Factor	Environmental Value
Geomorphology	Limestone substrate associated with Muchea Limestone TEC
Hydrology	Wetland associated with the Yule Brook floodplain
Flora	Potentially contains regionally significant flora species
Vegetation	Good to Very Good vegetation quality.
Ecological Community	Muchea Limestone TEC present.
Fringing Habitat	There is no native vegetation fringing the wetland on Lot 414
Fauna	Wetland provides habitat for birds, reptiles and amphibians. Likely presence of Southern Brown Bandicoot

7.3 Threats to the Wetland

7.3.1 Ownership

The Wetland Function areas are owned by separate parties to the proposed Industrial Development on Lot 414. The separate lots have firebreaks between the wetland vegetation and the fence. The varied ownership means that no commitments to revegetation of the firebreak or works within the wetland can be made by Grove Road Pty Ltd. The width of the separation distance on Lot 414 therefore will have no bearing on how the adjoining landowners might manage, or not manage the portion of the MU wetland that lies between the boundary fence and the CC wetland boundary.

7.3.2 Hydrology

Groundwater from Lot 414 flows in a south-westerly direction towards the wetland on Lots 4 and 8.

Industrial development has the potential to alter the surface flows and groundwater levels in the wetland due to the likely filling of the land to obtain sufficient clearance to groundwater, and the concentration of stormwater discharge to the soils as a result of the large area of roofing and hardstand that is associated with industrial development.

Development on Lot 414 also has the potential to affect the flow rates of surface and shallow sub-surface water into the wetland on Lot 4 if stormwater basins and outlets are not designed to maintain pre-development levels.

The health of the wetland vegetation on Lots 4 and 8 is sensitive to water levels. The vegetation type in the wetland can tolerate shallow inundation. Groundwater levels on the edge of the vegetated area have been measured at between approximately 1 and 0.5m below ground level in July and August 2017, respectively.

The LWMS prepared for Lot 414 contains several stormwater and groundwater management criteria which will ensure the water balance of wetland UFI 7635 is maintained post-development. The key management criteria relevant to the wetland are:

- **SW1** Maintain pre-development peak flow rates leaving Lot 414 (up to the 100 year ARI event which has been modelled at 1.2m³/s)
- **SW2** Surface flows will be appropriately treated prior to discharge from Lot 414
- **GW2** Inverts of flood detention structures to be set at or above MGL or the underlying clay layer
- **GW3** Maintain groundwater quality leaving Lot 414

The LWMS includes a Flood Storage Area located close to the north-east corner of Lot 4 (Appendix 5). Overflow from the storage area will maintain the ecological water requirements of the wetland UFI 7635 in Lot 4. The distance of the overflow outlet from the corner of Lot 4 will not impact on the flow rate into the wetland on Lot 4.

Some localised mounding may occur beneath the flood storage area, however this is considered by Emerge Associates to be generally consistent with the existing conditions as demonstrated by the groundwater monitoring results.

The portion of Yule Brook that runs through Lot 4 controls the peak water levels on Lot 4 by providing a natural outlet in major flow events, effectively capping the maximum level of water in the wetland.

7.3.3 Water Quality

Industrial development has the potential to add nutrients and contaminants to the groundwater due to activities on the industrial sites and off roads.

The LWMS requires the appropriate treatment or disposal of industrial wastewater and the treatment of stormwater runoff.

Removal of horses from the site will reduce the nutrient loading from horse dung into the soils and groundwater adjacent to wetland UFI 7635.

7.3.4 Direct Impacts

Industrial development will increase vehicle movement on Lot 414 and day time usage of the industrial area. However, the development will not have any public roads as such and will have most of the

access restricted to hard stand areas and the front of any buildings that are highly likely to be constructed adjacent to Grove Road.

The wetland vegetation on the adjoining lots is located on private land and does not have any appeal for public recreation or for off-road vehicle use. The wetland will continue to be fenced from the future development.

The potential for direct impacts on the wetland vegetation from the industrial development is considered negligible.

7.3.5 Weeds

The wetland currently contains an abundance of weeds including dense patches of Arum Lily (*Zantedeschia aethiopica*), Watsonia (*Watsonia meriana* var. *bulbillifera*), Kikuyu (*Cenchrus clandestinus*), Lovegrass (*Eragrostis curvula*) and Patterson's Curse (*Echium plantagineum*) and a variety of other species.

The eastern part of Lot 414 adjacent to Lot 8 contains abundant Cape Weed (*Arctotheca calendula*) and Patterson's Curse. The paddocks adjacent to the wetland may be the source of some of the weeds in the wetland but not all, especially Arum Lily and Watsonia which do not occur in the paddocks.

Industrial development of Lot 414 would reduce the potential source of weeds into the wetland with development on the cleared paddocks.

The dryland species that would be used in landscaping on the elevated lots are unlikely to survive the wetland conditions in the wetland.

If the buffer is revegetated with a low shrubland vegetation type or mix of shrubland and sedgeland that would reduce the potential source of weeds into the wetland. The width of the buffer in that case is not related to the potential impact of weeds on the wetland.

If the buffer were to remain unvegetated, the potential weed threat could be managed by a regular mowing regime.

7.3.6 Fire

The cleared paddocks are currently rated as a Moderate fire hazard level. It is possible that in its current condition a fire could spread across the paddock with a northerly wind blowing. The Interim Recovery Plan for Muchea Limestone indicates that hotter, more frequent fires are a threatening process to the TEC.

Industrial development of Lot 414 would remove the potential for wildfire from Lot 414 to burn the wetland vegetation in Lots 4 and 8.

An unvegetated buffer would need to be mowed on a regular basis to reduce the fire risk spreading from the development to the wetland.

There is also the threat of fire spreading from the wetland to the industrial development. The vegetation in the wetland is rated as Scrub which has an Extreme fire hazard rating. The cleared paddock adjacent to the wetland is likely to be rated as Moderate hazard because it is a Low hazard within 100m of vegetation classified as an extreme hazard (the wetland vegetation).

7.3.7 Feral Animals

The wetland vegetation is highly likely to already be home to an abundance of rabbits. Feral cats and foxes are also likely to hide in the densely vegetated area.

Industrial development may increase the number of cats and foxes attracted to an increased number of rubbish bins around buildings.

The setback distance would not have any impact on cats, foxes or rabbits impacting on the wetland as these animals can roam over large distances.

7.4 Separation Distance

EPA Guidance Statement 33 states that wetlands that are to be protected require a minimum 50m buffer distance. This advice applies to Conservation Category wetlands as well as Resource Enhancement wetlands if they are to be retained in a development. There is no scientific rationale to justify why 50m is the minimum setback distance.

The Guidance Statement also says that an alternative to applying the minimum 50m setback is to undertake a site-specific buffer assessment. In determining a setback using site-specific studies the overall setback should be determined by:

- The wetland's values;
- The activities, land uses or development near the wetland, existing and proposed; and
- The threats posed by the adjacent activities, land uses or development.

7.5 Recommended Separation Distance

The analysis of the environmental values of the wetland on the lots to the south of Lot 414 and the potential threats from industrial development demonstrates that a 30m buffer would be acceptable to the boundary of wetland UFI 7635.

The 30m buffer is supported by a Risk Assessment provided in Section 7.6.

The 30m buffer result is largely an outcome of the following features of the site:

- the completely cleared nature of the areas adjacent to the wetland do not provide any environmental function for the wetland and, with respect to fire, actually increases the risk to the wetland the larger the setback is; and
- any revegetation of the buffer would be with wetland species similar to the existing wetland and not dryland species that would increase the environmental value of the wetland and its surrounds.

PGV Environmental recommends a wetland buffer of 30m to be revegetated with a low shrubland and/or sedgeland vegetation structure. The impact of a fully revegetated buffer with dense shrub and tree species would increase the fire risk to the wetland vegetation, one of the key threatening processes to the Mueha Limestone TEC. High intensity fires could decrease the diversity of the vegetation and also increase weed infestation (Burrows, 2009). Low, vegetated buffers may increase the risk of fire slightly, however is likely to be of lower intensity and therefore not result in catastrophic consequences compared to a completely vegetated buffer.

7.6 Risk Assessment

A risk assessment of a 20m, 30m and 50m wetland buffer has been undertaken consistent with Australian Standard AS4360 (Table 6). The results are shown in Table 7

Table 6: Risk Assessment Matrix

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequences	Insignificant (1)	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
	Minor (2)	Acceptable	Acceptable	Acceptable	Moderate	Moderate
	Moderate (3)	Acceptable	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

Inherent risk to the Wetland Function Area assumes all controls typical to industrial developments such as Urban Water Management Plans, Acid Sulphate Soils investigation and management, Dewatering management plans are prepared and implemented in accordance with best practice. The inherent risk only takes into account no separation to the wetland and the residual risk is determined with a separation distance of 50m and 30m from the development (Table 6).

Table 7: Risk Analysis

Inherent Risk - Development with no separation distance					Residual Risk	Development and 20m separation distance	Development and 30m separation distance	Development and 50m separation distance						
Factor	Potential Impact	Residual Risk			Residual Risk	Residual Risk			Residual Risk			Residual Risk		
		Likelihood	Likelihood	Likelihood		Likelihood	Consequence	Significance	Likelihood	Consequence	Significance	Likelihood	Consequence	Significance
Ownership	No management able to be undertaken in Wetland Function Area or cleared firebreak due to ownership by others	E	1	Acceptable	No risk controls possible and setback does not impact on the inherent risk.	E	1	Acceptable	E	1	Acceptable	E	1	Acceptable
Hydrology	Potential increase in groundwater levels due to mounding at edge of wetland at infiltration points	A	5	Moderate	Maximum water levels in wetland governed by Yule Brook outlet, and not determined by the size of the buffer.	A	3	Acceptable	A	3	Acceptable	A	3	Acceptable
	Potential alteration of water source into north-east part of Lot 4	D	3	High	Stormwater Management Plan requires location of Flood Storage Basin in close proximity to the NE corner of Lot 4 with overflow to maintain pre-development flow rate of 1.2m³/s (100 year ARI).	E	1	Acceptable	A	3	Acceptable	A	3	Acceptable
Water Quality	Potential contamination of groundwater from industrial development.	B	3	Moderate	Stormwater management system designed according to Better Urban Water Management and protected by separation distance	A	3	Acceptable	A	3	Acceptable	A	3	Acceptable

Inherent Risk - Development with no separation distance					Residual Risk	Development and 20m separation distance			Development and 30m separation distance			Development and 50m separation distance		
Factor	Potential Impact	Residual Risk			Residual Risk	Residual Risk			Residual Risk			Residual Risk		
		Likelihood	Likelihood	Likelihood		Likelihood	Consequence	Significance	Likelihood	Consequence	Significance	Likelihood	Consequence	Significance
Direct Impacts	Increased human usage in the wetland causing degradation of the vegetation	B	3	Moderate	Access controlled by additional fencing to separation zone. Access not impacted by separation distance.	A	3	Acceptable	A	3	Acceptable	A	3	Acceptable
Weeds	Hardstand to boundary of the wetland would decrease the number of weeds compared to the current grazed paddocks.	C	3	Moderate	Buffer area will be revegetated to reduce weed source or mowed regularly as a managed buffer.	C	3	Moderate	B	2	Acceptable	B	2	Acceptable
Fire	Reduction in threat to wetland by developing on cleared paddocks.	B	4	Moderate	50m revegetated buffer has a higher fire intensity risk (in some potential fire situations) to the wetland compared to a 20 and 30m revegetated buffer.	B	3	Moderate	B	3	Moderate	B	4	Moderate
Feral Animals	Potential increase in predators (foxes and cats) which would impact on native fauna	C	3	Moderate	Control on rubbish storage within development site, separation distance has no impact on feral animals entering the wetland	C	3	Moderate	C	3	Moderate	C	3	Moderate

Not all potential threats require a buffer to the wetland. Some threats are actually reduced by a smaller buffer. The outcome is similar for a 30m buffer and a 50m buffer.

The use of a buffer to the wetland decreases the risk of:

- Potential increases to groundwater in the wetland due to water mounding from compaction or runoff from the development;
- Impacts due to changed run-off from Lot 4;
- Point source changes in groundwater quality due to separation distance;
- Direct impacts by human usage; and
- Potential weed vectors from developed areas.

The risk assessment compares the use of a 20m, 30m and 50m buffer. Most of the risks were mitigated to the same level by all three buffer widths.

However, the 20m buffer had a higher risk to the wetland from weeds spreading from the development site due to the closer proximity of the development compared to 30m and 50m.

A revegetated buffer arguably might increase the risk of fire spreading from the buffer to the wetland compared to the current grazed paddocks. In addition, a larger buffer was considered to have a greater risk of higher intensity fire to the wetland vegetation on adjoining properties when the behaviour of fire was considered. There are two phases of growth common to most bushfires. The Equilibrium Phase where the Rate of Spread (ROS) is in a quasi-steady state where the forward spread reaches an equilibrium with the available fuel, dead fuel moisture content and the mean wind speed (Gould *et al.*, 2003). Calculating bushfire movement for the purposes of predicting spread and directing firefighting efforts uses data from the fire in this phase. However, like a car, the initial phase of a bushfire behaves differently. A car does not reach its speed limit instantly, but accelerates to the speed limit, and so does a fire (McAlpine, 1988).

There are several factors that may impact on the acceleration (or transition) phase of a fire between ignition and equilibrium which can include fuel type and moisture content, wind speed, area of ignition and also can be impacted by type of ignition such as the use of accelerants. The time and the distance travelled by the fire from during the transition phase can be short (Gould *et al.*, 2018). Generally lighter winds can result in a fire achieving equilibrium over a much smaller distance than in strong wind conditions (Couch, 2018).

A larger buffer can allow the bushfire to develop through more of the acceleration phase and also develop a larger front, which results in an increased intensity and larger line of impact when it reaches the wetland. This then results in more of the vegetation being impacted by a fire that reaches its peak intensity. As stated in the report high intensity fires are one of the known risk factors to the TEC vegetation within the wetland. Therefore, the risk assessment concluded that a smaller vegetated buffer can have a reduced risk of the severity of impact of fire.

7.7 Buffer Treatment

A Wetland Buffer Management Plan is recommended to be prepared as a condition of a Development Application or subdivision. The following points will need to be considered in determining an appropriate treatment of the buffer:

1. The wetland 7635 on Lots 4 and 8 is owned by other private landowners. Therefore, management of the wetland such as weeding and rehabilitation is outside the control of the owner of Lot 414;
2. The wetland within Lots 4 and 8 have firebreaks around the lot boundaries as per the requirements under the *Bushfires Act 1954*. The landowners are required to maintain these firebreaks by notice from the City of Gosnells at a minimum width of 3m with 4m clearance for fire vehicle access and failure to do so is an offence under the Act. The boundary of the wetland on those lots therefore should always be measured from the vegetation inside the firebreak;
3. The wetland buffer on Lot 414 will also be required to maintain a cleared firebreak adjacent to the wetland on the adjoining properties. The slightly raised limestone-based track along the north-west boundary of the wetland and Lot 4 provides this function. A formal firebreak does not occur along the eastern boundaries of the wetland abutting Lot 8 as these areas are kept low by horse grazing. The two combined firebreaks either side of the property boundary will maintain a 6-8m cleared zone, preventing any native vegetation from forming in this area between the vegetated part of the wetland and the re-vegetated wetland buffer;
4. The industrial development will remain a private development on a single title and not a subdivision into multiple privately-owned lots. As a result, all roads will be internal private roads rather than Council infrastructure. A public road interface with the wetland buffer therefore is not required; and
5. The wetland buffer will remain privately owned. An easement may be required for regional drainage works. Therefore, management of the buffer is likely to be more regular and controlled under private ownership compared to management by a local authority.

Re-vegetated Buffer

The buffer should be planted with a mix of low shrubs and sedges/rushes to meet the low shrubland vegetation type required to maintain a low fire hazard rating. The density of shrubs needs to be less than 30% to meet the shrubland classification. Typical species that could be planted in the buffer include:

Low Shrubs

- *Hypocalymma angustifolium*
- *Melaleuca lateritia*
- *Pericalymma ellipticum*
- *Dasypogon bromeliifolius*

Sedges/Rushes

- *Juncus pallidus*

- *Lepidosperma longitudinale*
- *Dielsia stenostachya*

Managed Buffer

An alternative to revegetating the buffer could be to retain the existing site conditions (paddock of grasses and herbs) and to mow regularly to reduce any seed set from the weeds that could further disperse into the adjoining wetland.

Stormwater Drainage

The LWMS prepared for the industrial development of Lot 414 includes a Flood Storage Area located close to the north-east corner of Lot 4 (Appendix 5). Overflow from the storage area will maintain the ecological water requirements of wetland UFI 7635 in Lot 4. The overflow does not need to be directed into Lot 4 by man-made structures provided the outlet from the flood storage area is designed appropriately. Revegetation in the portion of the buffer where the overflow will go should be planted with species more tolerant of inundation.

8 SUMMARY AND CONCLUSIONS

This wetland and wetland buffer assessment concludes the following:

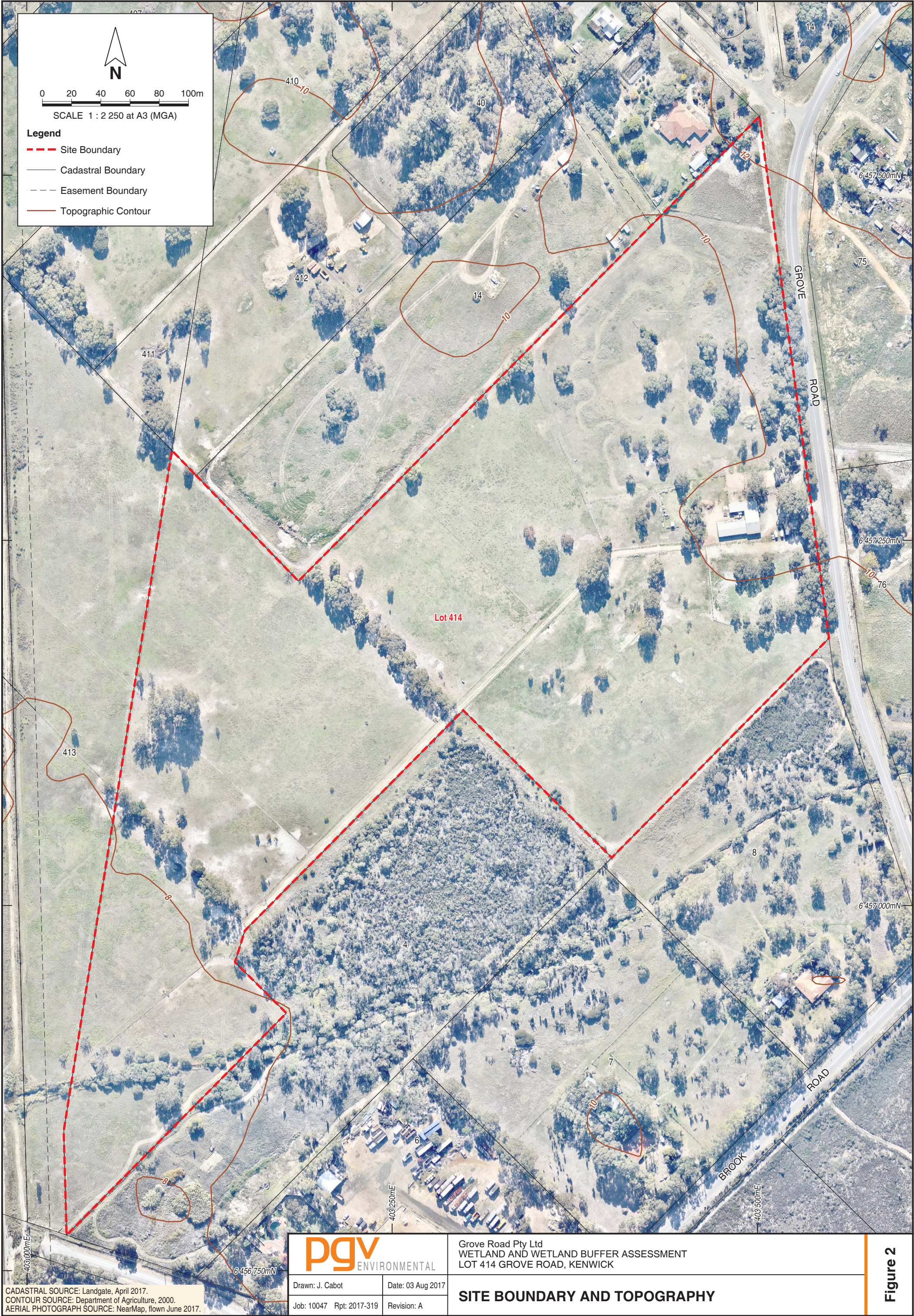
1. The wetland on Lot 414 is completely cleared of native vegetation and does not have any flora or vegetation values and has limited fauna values;
2. An evaluation of the cleared wetland on Lot 414 results in a management category of Multiple Use;
3. The boundary of wetland UFI 7635 was found to be inaccurate. Based on the location of native vegetation, the boundary would be more accurately mapped as being 3m to 15m into the adjoining Lots 4 Bickley Road and Lot 8 Brook Road and not on Lot 414 ;
4. The vegetated parts of Lot 4 and 8 are rated as Conservation Category primarily due to the presence of the Muchea Limestone Threatened Ecological Community;
5. The weed infested area on the southern half of Lot 8 is considered a Multiple Use wetland management category, thereby separating two CCW portions of the wetland on Lots 4 and 8;
6. In accordance with EPA Guidance Statement 33 a site-specific buffer assessment was undertaken to determine a suitable setback distance, rather than apply the default 50m distance;
7. The site-specific buffer assessment demonstrated through a Risk Assessment approach that a 30m buffer mitigated all the identified risks to the wetland and a 50m buffer did not provide any additional protection but instead had a slightly higher risk of increased impact by fire that could negatively impact on the wetland vegetation on the adjoining lots;
8. The recommended setback to development as assessed through risk assessment is a 30m buffer vegetated with low shrubs and sedges; and
9. The threats to the wetland by industrial development of Lot 414 can all be managed to have no impact on wetland UFI 7635 with a 30m buffer to the development.

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FIGURES



CADASTRAL SOURCE: Landgate, April 2017.
CONTOUR SOURCE: Department of Agriculture, 2000.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown June 2017.

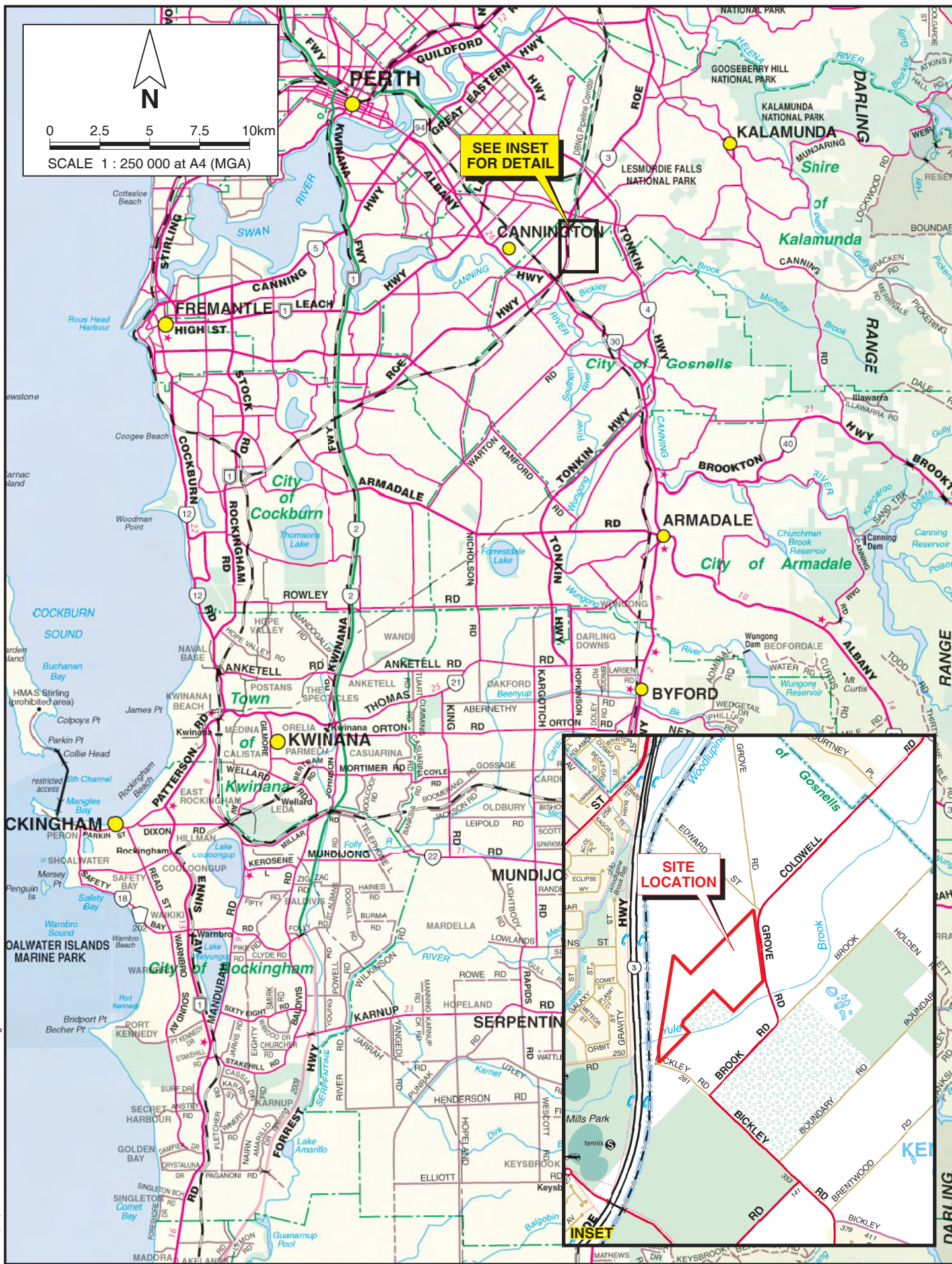
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Drawn: J. Cabot	Date: 03 Aug 2017
Job: 10047 Rpt: 2017-319	Revision: A

Grove Road Pty Ltd
WETLAND AND WETLAND BUFFER ASSESSMENT
LOT 414 GROVE ROAD, KENWICK

SITE BOUNDARY AND TOPOGRAPHY

Figure 2





pgv ENVIRONMENTAL

Grove Road Pty Ltd
WETLAND AND WETLAND BUFFER ASSESSMENT
LOT 414 GROVE ROAD, KENWICK

Drawn: J. Cabot	Date: 03 Aug 2017
Job: 10047 Rpt: 2017-319	Revision: A

SITE LOCATION

Figure 1

APPENDIX 1

Wetland Water Balance Model (Emerge Associates, 2017)

Local Water Management Strategy

Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area

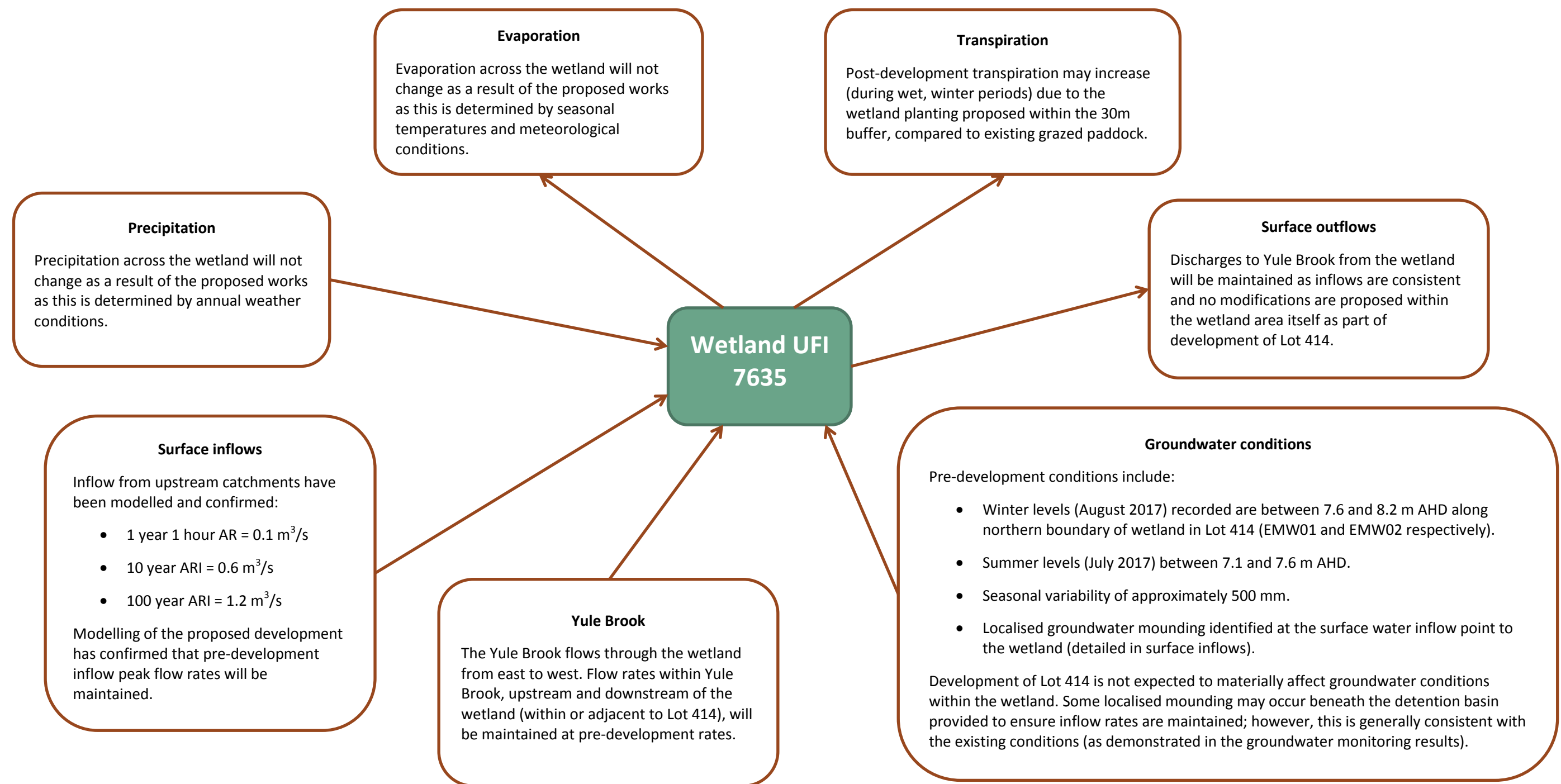


Plate 2 Pre-to-post development comparison water balance for wetland 7635 (as impacted by works proposed in Lot 414 Grove Road only)

Note: This wetland water balance has been prepared in response to Condition 6.10.3.1 of LPS6 - amendment 165 (CoG 2016). A high level, qualitative assessment has been carried out following discussions with Jennifer Higbid of DBCA on 13th July 2017 and confirmation that a box model approach will be sufficient to satisfy DBCA. Detailed modelling of groundwater conditions and transpiration characteristics of the wetland have not been carried out as works proposed are not within the wetland area. Based on the qualitative assessment of the WMA the proposed development is not expected to detrimentally impact the wetland from a hydrological perspective.

APPENDIX 2

Aboriginal Heritage Inquiry System Reports



Search Criteria

No Registered Aboriginal Sites in Custom search area - Polygon - 115.97178460649°E, 32.0214518323958°S (GDA94) : 115.97178460649°E, 32.0135557825081°S (GDA94) : 115.980024352584°E, 32.0135557825081°S (GDA94) : 115.980024352584°E, 32.0214518323958°S (GDA94) : 115.97178460649°E, 32.0214518323958°S (GDA94)

Disclaimer

The Aboriginal Heritage Act 1972 preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Aboriginal Affairs by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at heritageenquiries@daa.wa.gov.au and we will make every effort to rectify it as soon as possible.

South West Settlement ILUA Disclaimer

Your heritage enquiry is on land within or adjacent to the following Indigenous Land Use Agreement(s): Whadjuk People ILUA.

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The ILUAs bind the parties (including 'the State', which encompasses all State Government Departments and certain State Government agencies) to enter into a Noongar Standard Heritage Agreement (NSHA) when conducting Aboriginal Heritage Surveys in the ILUA areas, unless they have an existing heritage agreement. It is also intended that other State agencies and instrumentalities enter into the NSHA when conducting Aboriginal Heritage Surveys in the ILUA areas. It is recommended a NSHA is entered into, and an 'Activity Notice' issued under the NSHA, if there is a risk that an activity will 'impact' (i.e. by excavating, damaging, destroying or altering in any way) an Aboriginal heritage site. The Aboriginal Heritage Due Diligence Guidelines, which are referenced by the NSHA, provide guidance on how to assess the potential risk to Aboriginal heritage.

Likewise, from 8 June 2015 the Department of Mines and Petroleum (DMP) in granting Mineral, Petroleum and related Access Authority tenures within the South West Settlement ILUA areas, will place a condition on these tenures requiring a heritage agreement or a NSHA before any rights can be exercised.

If you are a State Government Department, Agency or Instrumentality, or have a heritage condition placed on your mineral or petroleum title by DMP, you should seek advice as to the requirement to use the NSHA for your proposed activity. The full ILUA documents, maps of the ILUA areas and the NSHA template can be found at <https://www.dpc.wa.gov.au/lantu/Claims/Pages/SouthWestSettlement.aspx>.

Further advice can also be sought from the Department of Aboriginal Affairs (DAA) at heritageenquiries@daa.wa.gov.au.

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Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Search Criteria

4 Other Heritage Places in Custom search area - Polygon - 115.970261111757°E, 32.0209606233532°S (GDA94) : 115.970261111757°E, 32.0130281420383°S (GDA94) : 115.980689540407°E, 32.0130281420383°S (GDA94) : 115.980689540407°E, 32.0209606233532°S (GDA94) : 115.970261111757°E, 32.0209606233532°S (GDA94)

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Aboriginal Heritage Inquiry System

List of Other Heritage Places

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Aboriginal Affairs to the place.

Status:

- Registered Site: The place has been assessed as meeting Section 5 of the Aboriginal Heritage Act 1972.
- Other Heritage Place which includes:
 - Stored Data / Not a Site: The place has been assessed as not meeting Section 5 of the Aboriginal Heritage Act 1972.
 - Lodged: Information has been received in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of the Aboriginal Heritage Act 1972.

Access and Restrictions:

- File Restricted = No: Availability of information that the Department of Aboriginal Affairs holds in relation to the place is not restricted in any way.
- File Restricted = Yes: Some of the information that the Department of Aboriginal Affairs holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Aboriginal Affairs receives written approval from the informants who provided the information. To request access please contact heritageenquiries@daa.wa.gov.au.
- Boundary Restricted = No: Place location is shown as accurately as the information lodged with the Registrar allows.
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact DAA.
- Restrictions:
 - No Restrictions: Anyone can view the information.
 - Male Access Only: Only males can view restricted information.
 - Female Access Only: Only females can view restricted information.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

Aboriginal Heritage Inquiry System

List of Other Heritage Places

ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
122	YULE BROOK FARM	No	No	No Gender Restrictions	Stored Data / Not a Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	403053mE 6457085mN Zone 50 [Unreliable]	S02969
3312	WATTLE GROVE, PERTH.	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter, Camp	*Registered Knowledge Holder names available from DAA	403639mE 6456649mN Zone 50 [Unreliable]	S00208
4340	EDWARD/GROVE STREETS	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	403339mE 6457599mN Zone 50 [Unreliable]	S00750
24785	Yule Brook Farm 02	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter, Arch Deposit	*Registered Knowledge Holder names available from DAA	403088mE 6456869mN Zone 50 [Reliable]	



Search Criteria

6 Heritage Surveys containing 6 Survey Areas in Custom search area - Polygon - 115.968930736086°E, 32.0212153246766°S (GDA94) : 115.968930736086°E, 32.0122275782549°S (GDA94) : 115.980775371096°E, 32.0122275782549°S (GDA94) : 115.980775371096°E, 32.0212153246766°S (GDA94) : 115.968930736086°E, 32.0212153246766°S (GDA94)

Disclaimer

Heritage Surveys have been mapped using information from the reports and / or other relevant data sources. Heritage Surveys consisting of small discrete areas may not be visible except at large scales. Reports shown may not be held at DAA. Please consult report holder for more information. Refer to www.daa.wa.gov.au/heritage for information on requesting reports held by DAA.

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Access

Some reports are restricted.

Spatial Accuracy

The following legend strictly applies to the spatial accuracy of heritage survey boundaries as captured by DAA.

Very Good	Boundaries captured from surveyed titles, GPS (2001 onwards) submitted maps georeferenced to within 20m accuracy.
Good / Moderate	Boundaries captured from GPS (pre 2001) submitted maps georeferenced to within 250m accuracy.
Unreliable	Boundaries captured from submitted maps georeferenced to an accuracy exceeding 250m.
Indeterminate	Surveys submitted with insufficient information to allow boundary capture.

Aboriginal Heritage Inquiry System

List of Heritage Surveys

Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
21817	Ballaruk (traditional owners) Aboriginal site recording project	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
21818	Ballaruk (traditional owners of Whadjuk territorial boundaries the lands of the Ballaruk Peoples) Aboriginal site recording project : additional material	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
22955	Results of an Aboriginal cultural heritage survey of the Yule brook flow reduction dam site, Kenwick	Gifford, Peter.	1	Archaeological & Ethnographic	The survey area comprises two paddocks on the edge of the railway line, adjacent to Roe Highway. The area is bisected by Yule Brook.	Good	Field and Desktop
102670	Preliminary Report on the Survey of Aboriginal Areas of Significance in the Perth Metropolitan & Murray River Regions July 1985.	O'Connor, R	1	Ethnographic	Perth Metropolitan & Murray River Regions. A roughly triangular region, with Yanchep National Park as the Northern point, Gidgegannup as the Eastern point and Pinjarra as the Southern point.	Indeterminate	Field and Desktop
103564	An Archaeological Survey Project: The Perth Area, Western Australia. Apr 1972.	University of Western Australia.	1	Archaeological	The Perth Area. 103 site locations in 67 site groups were investigated.	Indeterminate	Field and Desktop
105660	Report on a survey for Aboriginal Sites on the Roe Highway Welshpool Road to South Street section	O'Connor, R	1	Archaeological	Roe Highway, Welshpool Road to South Street Section. The proposed development involves 15.5km of roadworks within the MRD road reserve varying between 70 and 300m in width for the proposed Roe Highway (12km) between Welshpool Road, East Cannington, and South Street Leeming. Plus the Wimbeldon Street Deviation (3.5km), Beckenham as shown in Fig. 1	Unreliable	Field and Desktop

APPENDIX 3

Wetland Boundary Co-ordinates and Vegetation Description

Lot 414 Grove Road - Wetland UFI 7635 vegetation boundary

Point	Easting	Northing	Native Vegetation at boundary
1	403182	6456935	<i>Hypocalymma angustifolium</i> , no trees
2	403169	6456949	<i>Eucalyptus rudis</i> , <i>Callitris pyramidalis</i>
3	403147	6456968	<i>Eucalyptus rudis</i> on corner
4	403157	6456980	<i>Eucalyptus camaldulensis</i> , <i>Callitris pyramidalis</i> , <i>Melaleuca raphiophylla</i>
5	403174	6456995	<i>Eucalyptus camaldulensis</i> , <i>Callitris pyramidalis</i> , High weed coverage
6	403191	6457007	<i>Callitris</i> , <i>Melaleuca viminea</i> , <i>Watsonia bulbiferous</i>
7	403206	6457018	<i>Melaleuca viminea</i> , <i>Watsonia</i> , <i>Callitris pyramidalis</i>
8	403211	6457013	<i>Melaleuca viminea</i> , <i>Melaleuca raphiophylla</i>
9	403217	6457037	<i>Melaleuca viminea</i> , <i>Callitris pyramidalis</i>
10	403221	6457045	<i>Melaleuca viminea</i> , <i>Callitris</i> , <i>Astartea affinis</i>
11	403235	6457058	<i>Melaleuca viminea</i>
12	403244	6457062	<i>Melaleuca viminea</i> , <i>Callitris pyramidalis</i> , Kikuyu
13	403260	6457082	<i>Melaleuca raphiophylla</i>
14	403268	6457093	one <i>Melaleuca raphiophylla</i>
15	403281	6457111	<i>Melaleuca raphiophylla</i>
16	403297	6457124	<i>Melaleuca raphiophylla</i> on corner
17	403304	6457112	<i>Melaleuca raphiophylla</i> , <i>Callitris pyramidalis</i>
18	403313	6457109	<i>Callitris pyramidalis</i>
19	403332	6457097	<i>Melaleuca raphiophylla</i> , <i>Callitris pyramidalis</i> ,
20	403342	6457078	<i>Melaleuca viminea</i> , <i>Callitris pyramidalis</i>
21	403366	6457060	<i>Corymbia calophylla</i> , <i>Hypocalymma angustifolium</i>
22	403384	6457039	<i>Melaleuca viminea</i> , <i>Callitris pyramidalis</i>
23	403397	6457030	<i>Callitris pyramidalis</i>

APPENDIX 4

Secondary Evaluation Wetland Assessment

The Secondary evaluation criteria have been addressed as PGV Environmental would recommend. The second score (T&W Score) is evaluated on the values that the Tauss and Weston report have attributed to the wetland.

Attachment 1: Secondary evaluation criteria.

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
Geomorphology					
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H	H	
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H	H	
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H	H	
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H	H	
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: - < 25% altered - 25-75% altered - > 75% altered.	H I L	H I L	There is evidence of soil disturbance and compacted tracks modifying the geomorphology – greater than 75% of the wetland when tracks are included – The Tauss and Weston report does not acknowledge these changes
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H	H	
7		The wetland is the best example of its type in its consanguineous suite.	H	H	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
Wetland processes					
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H I L	H I L	The Tuass and Weston report indicates that the wetland geomorphology is intact however there are drainage lines through the wetland.
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H	H	
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	H I L	H I L	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H	H	
Linkages					
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H	H	
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	H I L	H I L	
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I	I	
Habitats					
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H	H	
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H	H	
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H	H	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained. The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated. The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	H I L	H I L	
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H	H	
Flora					
20	<i>Representativeness</i>	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state. The wetland supports a reduced diversity of native flora due to human induced disturbances. The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	H I L	H I L	
21		The wetland is identified in a vegetation complex (Hedde et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	H I	H I	
22	<i>Naturalness</i>	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	H I L	H I L	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
23		The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	H I L	H I L	
24	Scarcity	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	H	H	
25		The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	I	I	
26		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H	H	
27		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	I	I	
Fauna					
28	Representativeness	The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages. The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	H I	H I	
29		The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna. The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	H I	H I	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
30	Naturalness	The wetland’s current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type. The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	H I	H I	The Wetland Area is disturbed by tracks and livestock and is likely to be impacted by domestic predation and feral species.
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L	L	
32	Scarcity	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	H	H	
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H	H	
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H	H	
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I	I	
Cultural					
36	Representativeness	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H	H	
37	Representativeness	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I	I	

Attributes/ functions/ values	General criteria	Criteria	PGV Score	T&W Score	Reason
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H	H	
39		The wetland is important to the local community either nationally or state wide for its natural values.	H	H	
40		The wetland is or has the potential to be a site for public or private based recreation.	I	I	
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	I L	I L	
Scientific and educational					
42	Representativeness	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	H I	H I	
43		The wetland supports known scientific, geoheritage or geoconservation values.	H	H	
44	Representativeness	The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L	L	

Attachment 2: Tallies for the Secondary Evaluation.

PGV Environmental tally for the secondary evaluation.

Attributes/functions/values	Scores		
	High	Intermediate	Low
Geomorphology	3	0	1
Wetland processes	0	1	3
Linkages	0	0	1
Habitats	0	0	1
Flora	1	0	3
Fauna	0	0	1
Cultural	0	0	0
Scientific and educational	0	0	1
Total score	4	1	11
Defining attributes/functions/values	Geomorphology		
Applicable management category	Multiple Use		

Tally for the secondary evaluation including values suggested in Tauss and Weston Report

Attributes/functions/values	Scores		
	High	Intermediate	Low
Geomorphology	6	0	0
Wetland processes	0	2	2
Linkages	0	0	1
Habitats	1	0	3
Flora	0	0	1
Fauna	0	0	0
Cultural	0	0	1
Scientific and educational	0	1	0
Total score	7	3	8
Defining attributes/functions/values	Geomorphology		
Applicable management category	Multiple Use		

APPENDIX 5

Stormwater Management Plan

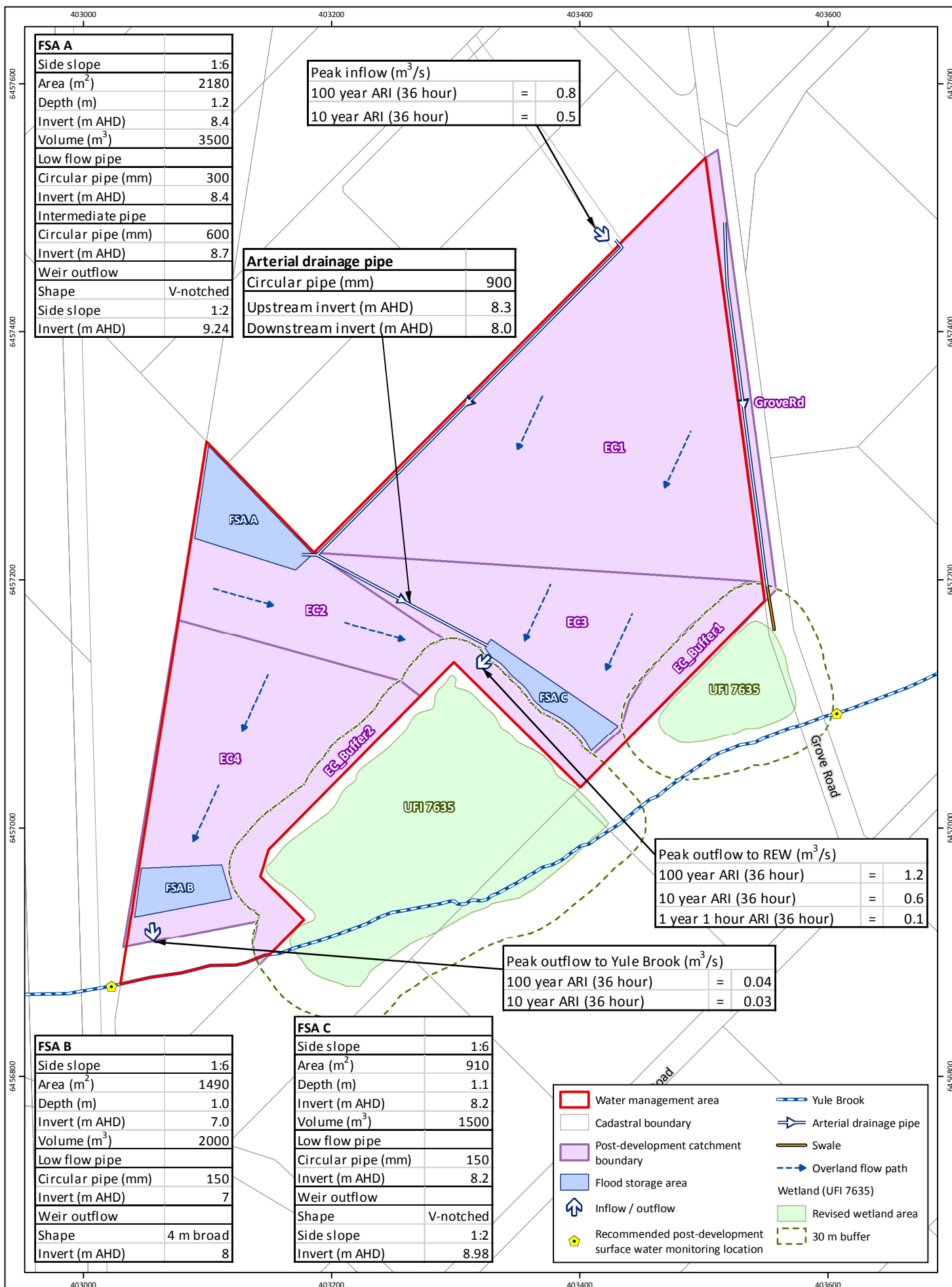


Figure 6: Stormwater Management Plan

Project: Modelling Assumptions Report
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area
Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F09a
Drawn: KNM
Date: 08/12/2017
Checked: ASC
Approved: RLE
Date: 08/12/2017



0 50 100
 Metres
Scale: 1:4,000@A4
 GDA 1994 MGA Zone 50

emerge
 ASSOCIATES

Appendix 4

Bushfire Management Plan (Bushfire Prone Planning)



Bushfire Management Plan

(Local Structure Planning)

Lot 414 Grove Road, Kenwick

City of Gosnells

Project Number: 170447

Assessment Date: 3 August 2017

Report Date: 6 September 2017

Document Control

Version	Version Details	Date Submitted
1.0	Original Document	8-Sep-17
1.1	Amendments to project proposal and purpose	8-Jun-18
		-

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Document Compliance Statement

This Bushfire Management Plan (the Plan) meets the content requirements of *State Planning Policy No. 3.7: Planning in Bushfire Prone Areas* (SPP 3.7, December 2015) and the associated *Guidelines for Planning in Bushfire Prone Areas* (WAPC 2017 v1.2 - the 'Guidelines').

BMP Template v7.0

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Disclaimer

The measures contained in this report are considered to be minimum standards and they do not guarantee that a building will not be damaged in a bushfire. This is substantially due to the unpredictable nature and behaviour of fire and extreme weather conditions. Additionally, the correct implementation of required bushfire management measures will depend, among other things, on the actions of the landowners or occupiers over which Bushfire Prone Planning has no control.

All surveys, forecasts, projections and recommendations made in this report associated with the project are made in good faith based on information available to Bushfire Prone Planning at the time.

All maps included herein are indicative in nature and are not to be used for accurate calculations.

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Executive Summary

This Bushfire Management Plan (the Plan) has been prepared to support a proposed amendment to the existing MKSEA Precinct 3A Structure Plan. The purpose of the proposed amendment is to include Lot 414 Grove Road, Kenwick in the Structure Plan area. The development site is proposed to be several industrial warehouse styled developments managed as an englobo development.

The development site of approximately 15.4361 ha is within a designated bushfire prone area and the Proposal requires the application of *State Planning Policy No. 3.7: Planning in Bushfire Prone Areas* (SPP 3.7). The assessed bushfire risk is considered to be manageable and will be achieved by the identified stakeholders implementing and maintaining the bushfire risk management measures that are presented in this Plan.

Assessment of the planned location, vegetation and consideration of planned infrastructure indicates that compliance is able to be achieved against all applicable bushfire related legislation, policy, standards and guidelines, including the Bushfire Protection Criteria.

The proposed development will be able to achieve a BAL rating of BAL-29 or lower based on the existing location of the buildings and offsite vegetation. The proposed development will encompass multiple industrial warehouses that are not required to be constructed to AS3959-2009 construction standards.

There is currently two way access available for the development site provided by the existing public road Grove Road. The private driveway access and internal road layout will be designed and constructed to comply with the requirements of the Guidelines including width, passing bays, all weather surface and turn arounds areas appropriate for a 3.4 fire appliance.

There is an identified wetland adjacent to the development site that will require a revegetated buffer within the development site to be maintained. The separation distance from the wetland and the buffer will be incorporated into the BAL separation distances.

Depending on the future land use of the development any future operators that have a 'high risk' land use may be required to have a risk management plan that addresses the impact of a bushfire on the development.

1 The Proposal

1.1 Details

Preparation of the Bushfire Management Plan	
BPP commissioned by:	Eastcourt Property Group- Tom Oostehof
Purpose:	To accompany a planning application
For Submission to:	City of Gosnells
Proposal Details	
Landowner / Proponent:	Eastcourt Property Group
Site Address:	Lot No. 414 Grove Road, Kenwick
Local Government:	City of Gosnells
Site Area:	154,361m ²
Planning Stage:	Structure plan
Project Type:	Strategic planning proposal
Overview of Proposal:	
The development proposal is for a private industrial estate to be managed as an englobo development. This report is to support a proposed amendment to the existing MKSEA Precinct 3A Structure Plan.	

1.2 Existing Documentation Relevant to the Construction of this Plan

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

Existing Relevant Reports or Plans		
Existing Document	Copy Provided by Client	Title
Structure Plan	N/A	
Environmental Report	Yes	
Landscaping (Revegetation) Plan	Yes	Resource Enhancement Wetland 7635 plan
Bushfire Risk Assessments	N/A	

Referenced Documents – Relevance and Impact on the Bushfire Management Plan

Resource Enhancement Wetland 7635 plan- PGV

Figure 1.1
Proposed Development

Lot 414 Grove Road
Kenwick

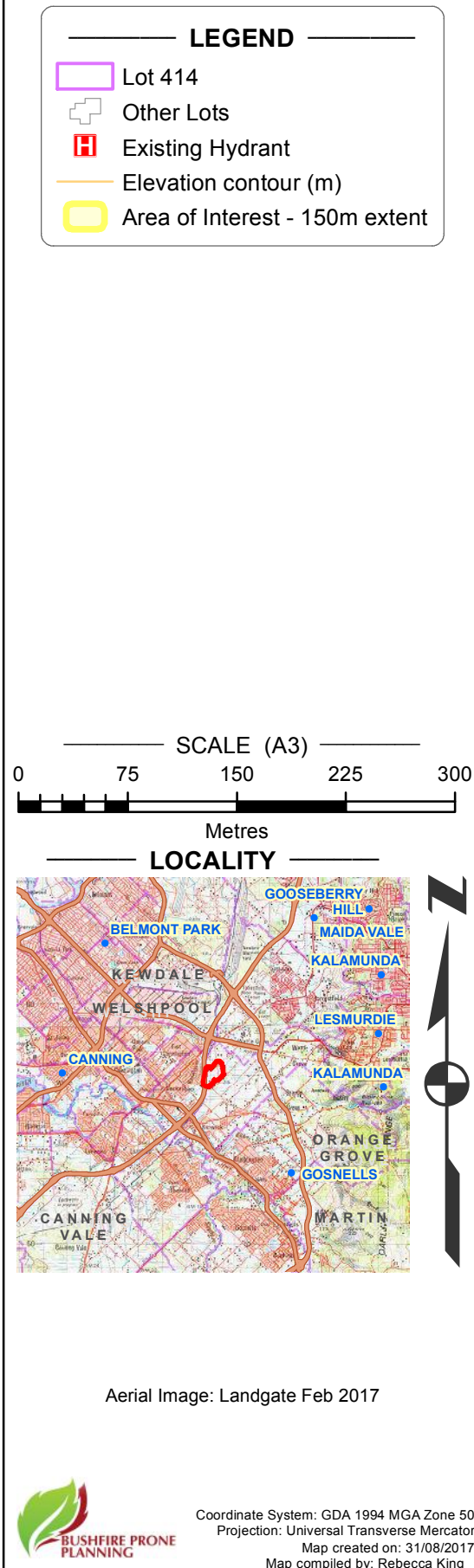




Figure 1.2: Map of Bushfire Prone Areas for the subject site and surrounds (SLIP Landgate- September 2017)

2 Bushfire Impact Assessment

2.1 Assessment Summary

Table 2.1.1: Summary BAL results

BAL Results – Summary of Assessment (detail of assessment and determination is presented in the following sections of this report)		
Lot	BAL Status (Indicative or Determined)	Bushfire Attack Level
414	Indicative Only	BAL-12.5

Indicative BAL for Lot 414 is for the whole lot and depending on the final design and development onsite will be guide the final BAL rating for any future development.

2.2 Assessment Input

2.2.1 Fire Danger Index (FDI) Applied

AS 3959-2009 specifies the fire danger index values to apply for different regions as per Table 2.1. The values used in the model calculations are for the Forest Fire Danger Index (FFDI) and for which equivalent representative values of the Grassland Fire Danger Index (GFDI) are applied as per Appendix B. The values can be refined if appropriately justified.

Table 2.2.1: Applied FDI Value

Applied FDI Value		
Vegetation Area	Determined as per AS 3959 - 2009 Table 2.1	Value Applied
All Areas (1-11)	80	80

2.2.2 Existing Vegetation Identification and Classification

Vegetation identification and classification has been conducted in accordance with AS 3959-2009 s2.2.3 and the Visual Guide for Bushfire Risk Assessment in WA (DoP February 2016).

When more than one vegetation type is present, each type is identified separately with the worst-case scenario being applied as the classification. The predominant vegetation is not necessarily the worst-case scenario.

The vegetation structure has been assessed as it will be in its mature state (rather than what might be observed on the day).

Areas of modified vegetation are assessed as they will be in their natural unmodified state (unless maintained in a permanently low threat, minimal fuel condition, satisfying AS 3959 s2.2.3.2-f).

Vegetation destroyed or damaged by a bushfire or other natural disaster has been assessed on its revegetated mature state.

When there is a significant change in ground slope under vegetation that will impact a site, the vegetation will be identified as a separate area to enable correct assessment (and construction of the BAL contour map if included in the Plan).

Table 2.2.2: Vegetation identification and classification.

All Vegetation Within 100 metres of the Proposed Development			
Vegetation Area	Identified Types ¹ or Description if 'Excluded'	Applied Classification ²	Effective Slope Under Classified Vegetation (degrees)
1	Offsite Low Open Forest A-04	Class A Forest	0
2	Onsite Open Tussock G-23	Class G Grassland	0
3	Offsite Open Heath C-11	Class C Shrubland	0
4	Offsite Open Tussock G-23	Class G Grassland	0
5	Offsite Open Tussock G-23	Class G Grassland	0
6	Offsite Low Open Forest A-04	Class A Forest	0
7	Offsite Woodland B-05	Class B Woodland	0
8	Offsite Open Tussock G-23	Class G Grassland	0
9	Offsite Woodland B-05	Class B Woodland	0
10	Offsite Woodland B-05	Class B Woodland	0
11	Offsite Open Tussock G-23	Class G Grassland	0

Representative photos of each vegetation area, descriptions and classification justification, are presented on the following pages. The areas of classified vegetation are defined and the photo locations identified on the topography and classified vegetation map, Figure 2.1.1.

Note¹: As per AS 3959-2009 Table 2.3 and Figures 2.3 and 2.4 a-g.

Note²: As per AS 3959-2009 Table 2.3.

2.2.3 Vegetation Excluded from Classification

The vegetation associated with the Roe Highway verge and railway reserve has been excluded due to the narrow nature of the vegetation strips and are excluded under AS3959-2009 s2.2.3.2 (d) and the vegetation will not increase the bushfire behaviour if a fire occurs in the area.

There are several areas surrounding residential and shed areas that have been excluded as low threat areas under AS3959-2009 s2.2.3.2(f).

Vegetation Area 1

Classification Applied: Class A Forest

Classification Justification: offsite low open forest, tea tree, eucalypt, acacia scrub, wetland conservation area, tree height ~8m, grass on outer edges with moderate weed invasion



Photo ID: 1a



Photo ID: 1b

Vegetation Area 2

Classification Applied: Class G Grassland

Classification Justification: onsite grassland, paddocks, sporadic trees <10%, horse paddocks



Photo ID: 2a



Photo ID: 2b

Vegetation Area 2

Classification Applied: Class G Grassland

Classification Justification: sporadic trees and wind breaks within horse paddocks



Photo ID: 2c

Vegetation Area 3

Classification Applied: Class C Shrubland

Classification Justification: offsite shrubland, weed species, open tussock, bamboo, shrubs >2m tall, previously cleared site



Photo ID: 3a



Photo ID: 3b

Vegetation Area 4

Classification Applied: Class G Grassland

Classification Justification: offsite grassland, eucalypt trees <10% coverage



Photo ID: 4a

Vegetation Area 5

Classification Applied: Class G Grassland

Classification Justification: offsite grassland, unmanaged paddocks



Photo ID: 5a

Vegetation Area 6

Classification Applied: Class A Forest

Classification Justification: offsite low open forest, tea tree, callitris, acacia scrub, tree height ~6m, note short cropped grassland in foreground onsite



Photo ID: 6a

Vegetation Area 7

Classification Applied: Class G Grassland

Classification Justification: offsite woodland, eucalypts, shrub and grass understorey



Photo ID: 7a

Vegetation Area 8

Classification Applied: Class G Grassland

Classification Justification: offsite grassland, unmanaged paddocks



Photo ID: 8a



Photo ID: 8b

Vegetation Area 9

Classification Applied: Class B Woodland

Classification Justification: onsite woodland, creek line, paperbark, grass understorey, note onsite grassland in foreground of Photo 9b



Photo ID: 9a



Photo ID: 9b

Vegetation Area 10

Classification Applied: Class B Woodland

Classification Justification: offsite woodland, paperbark, Marri, minor understorey, mulched areas



Photo ID: 10a

Vegetation Area 11

Classification Applied: Class G Grassland

Classification Justification: offsite grassland, unmanaged paddocks, tree coverage <10%, partly cleared



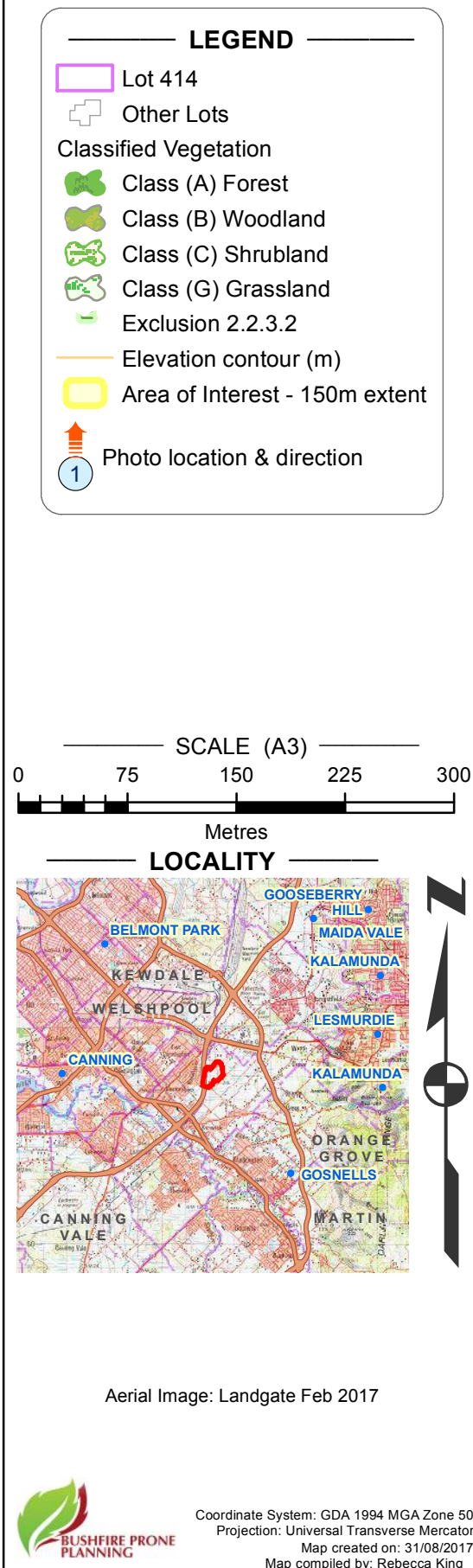
Photo ID: 11a



Photo ID: 11b

Figure 2.1
Topography &
Classified Vegetation

Lot 414 Grove Road
Kenwick



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

2.2.4 Future Planned On-site Vegetation Changes

In assessing vegetation for bushfire threat, consideration must be given to possible future vegetation changes likely on the site that is being assessed, particularly those that would have the potential to increase the bushfire risk.

This may be due to growth of existing vegetation or growth of planned landscape plantings, including future roadside or water course re-vegetation.

There must be careful consideration of the creation of vegetation corridors where they join offsite vegetation and may provide a route for fire to enter an area of future development.

There is a wetland area associated with Lot 4 (260) Bickley Road that will require a revegetated buffer within the development site. The environmental buffer will be based on the recommendations from the Environmental Report from PGV and guided by Parks & Wildlife requirements/conditions.

This buffer will need to be retained and will affect the BAL ratings of any future development onsite depending on the classification of any vegetation. Further information is provided in Section 3 of this plan on environmental factors affecting this development site.

A drainage basin is planned to be incorporated into the site with all surface water to be directed to an area in the south west corner near Bickley Road with the grassland and woodland to be maintained potentially.

2.2.5 Effective Slope and Site Slope

Effective Slope: Is the ground slope under the classified vegetation and is determined for each area of classified vegetation. It is the measured or assessed slope which will most significantly influence the bushfire behaviour in that vegetation. When there is a significant change in ground slope under vegetation that will cause a change in fire behaviour, that area of vegetation will be identified separately enable correct assessment and the construction of the BAL contour map if required.

Site Slope: Is the slope along the ground by line of sight between the site or building and the area of classified vegetation to which the assessment applies. AS 3959-2009 Method 1 assumes that site slope is the same as the effective slope while Method 2 allows input of the actual slope.

Table 2.2.3: Effective slope and site slope values applied.

Effective Slope and Site Slope Assessed Values			
Values to Apply Using Method 1 (AS 3959-2009)			
Vegetation Area	Vegetation Classification	Effective Slope (degrees)	Effective Slope Range (degrees)
1 & 6	Class A Forest	0	upslope or flat
2, 4, 5, 8, 11	Class G Grassland	0	upslope or flat
7, 9, 10	Class B Woodland	0	upslope or flat
3	Class C Shrubland	0	upslope or flat

2.2.6 Vegetation Separation Distance

Separation Distance: Is the distance from the site or building to the area of classified vegetation and is measured in the horizontal plane.

Measured Separation Distance (m): Will apply when the actual location of a 'site' (building, envelope or lot) has been defined (refer to the site plan), and the separation distance can be measured. In this situation, a BAL rating for the 'site' can be determined.

Derived Separation Distance (range of m): Will apply when the actual location of a 'site' (building, envelope or lot) has not been defined and therefore an actual separation distance cannot be measured. Instead the separation distance is a derived range in metres away from an area of classified vegetation that corresponds to each BAL rating. These separation distance ranges are also used to create a BAL contour map if required as part of the assessment.

The derived separation distance ranges corresponding to each BAL Rating are determined by:

- Method 1 - taken from AS 3959-2009 Table 2.4.3 as determined by the vegetation classification and effective slope.
- Method 2 – calculations as per AS 3959-2009 Appendix B applying the assessed site data.

Development and Change of Land Use Applications: For these proposals, building locations typically exist or are known and the vegetation separation distances can be measured and the BAL rating determined.

Table 2.2.4: Vegetation separation distances corresponding to BAL ratings - derived from site data.

Derived Separation Distance Range							
Vegetation Area	Vegetation Classification	BAL Assessment Method Applied	BAL Rating and Corresponding Separation Distance Range (metres)				
			BAL-FZ	BAL-40	BAL-29	BAL-19	BAL12.5
1 & 6	Class A Forest	Method 1	<16	16-<21	21-<31	31-<42	42-<100
2, 4, 5, 8, 11	Class G Grassland	Method 1	<6	6-<8	8-<12	12-<17	17-<100
7, 9, 10	Class B Woodland	Method 1	<10	10-<14	14-<20	20-<29	29-<100
3	Class C Shrubland	Method 1	<7	7-<9	9-<13	13-<19	19-<100

Important: The vegetation separation distances stated in this table are applied to construct the BAL contours that are presented on Figure 2.3.1

2.3 Assessment Output

2.3.1 Bushfire Attack Level – Indicative BAL's Mapped as Contours

Note: The derived vegetation separation distances that have been applied in creating the BAL contours on Figure 2.3.1 are explained and stated in Section 2.2.6 'Vegetation Separation Distance'.

BAL Contour Map Interpretation

The contour map will present different coloured contour intervals constructed around the classified bushfire prone vegetation. These represent the different Bushfire Attack Levels (BAL's) that exist as the distance increases away from the classified vegetation. Each BAL represents a set range of radiant heat flux (refer to Appendix 2) that can be generated by the bushfire in that vegetation. The width of each shaded contour interval (i.e. the applicable vegetation separation distances corresponding to a BAL rating) will vary and is determined by consideration of variables including vegetation type, fuel structure, ground slope, climatic conditions. They are unique to a site and can vary across a site.

Planning Applications

BAL contour mapping is primarily a planning tool that can give an overview as to the suitability of a site for development with respect to the extent to which bushfire is a potential threat to future buildings and persons on the subject land.

The mapping considers the development site (i.e. all existing or proposed lots) and does not consider the bushfire risk at an individual lot level or over different development time frames. Rather it is assessing the situation that will exist when the entire development has been completed, including any vegetation management that would reasonably be expected to take place as part of establishing buildings on the lots. On this basis, it helps decision makers determine the suitability of the proposed development for planning approval.

Building Applications and BAL Certificates

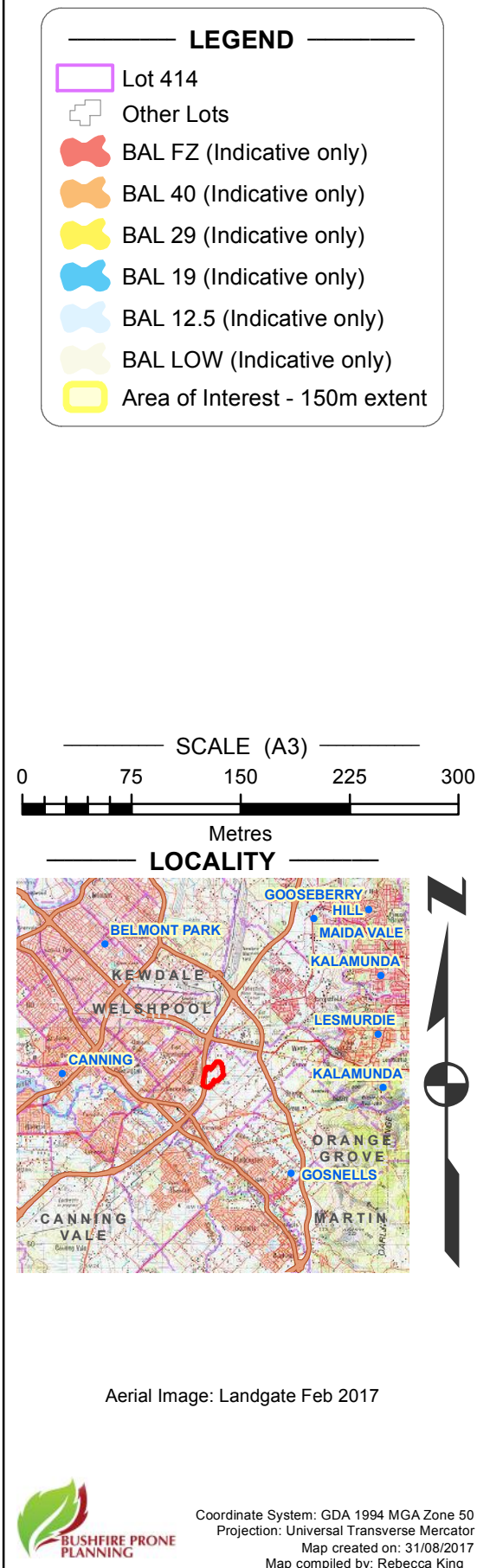
Building approval (and the issue of a building permit) requires that a BAL rating is determined for an actual building and not just a lot or a building envelope (i.e. an 'area'). Determination of this BAL rating must consider the actual location of a building within an individual lot and its separation distance from any classified vegetation at the actual time of applying for building approval. It is a site-specific assessment based on the buildings design and location at a given point in time.

The specific assessment (BAL report and BAL certificate) required for a building application cannot necessarily be derived from an assessment that is primarily designed to inform planning decisions. As a result, there are limitations to obtaining a single BAL rating for a future building of unknown location, from a BAL contour map assessment.

Nonetheless, there are limited specific situations where the required building application information (i.e. a BAL Certificate) might be obtained from a BAL contour map assessment.

Figure 2.2
BAL Contour Map

Lot 414 Grove Road
Kenwick



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2.3.2 Indicative/Determined Bushfire Attack Levels from BAL Contour Map

Deriving BAL Ratings from the BAL Contour Map

Indicative BAL Ratings: If the assessed BAL for a lot or building envelope (the 'area') is stated as being 'indicative', it is because that 'area' is impacted by more than one BAL contour interval and/or classifiable vegetation remains on the lot, or on adjacent lots, that can influence a future building's BAL rating (and this vegetation may have been omitted from being contoured for planning purposes e.g. Grassland or when the assumption is made that all onsite vegetation can be removed and/or modified).

In this report, the indicative BAL is presented as either the highest BAL impacting the 'area' or as a range of achievable BAL's within the 'area' – whichever is the most appropriate.

The BAL rating that will apply to any future building within that 'area' will be dependent on:

1. vegetation management onsite; and/or
2. vegetation remaining on adjacent lots; and/or
3. the actual location of the future building within that 'area'.

A BAL Certificate cannot be provided for future buildings within an 'area' with an indicative BAL until the location of any future building has been determined. A report confirming the location and BAL rating will be required and submitted with the BAL certificate.

Determined BAL Ratings: If the assessed BAL for a Lot or building envelope (the 'area') or existing building, is stated as being 'determined' it is because that 'area' or building is impacted by a single BAL contour interval. This has been determined by offsite classified vegetation, and no classifiable vegetation currently exists on the lot or on adjacent lots (i.e. it has been cleared to a minimal fuel, low bushfire threat state).

As a result, a determined BAL can be provided in this limited situation because:

1. No classified vegetation is required to be removed or modified to achieve the determined BAL, either within the lot or on adjacent lots (or if vegetation is excluded from classification, it is reasonable to assume it will be maintained in this state into the future); and
2. A future building can be located anywhere within the 'area' and be subject to the determined BAL rating; and
3. The degree of certainty is more than sufficient to allow for any small discrepancy that might occur in the mapping of the BAL contours.

A BAL Certificate (referring to the BAL Contour Map assessment) can be provided for a future building on those 'areas' assessed as having a determined BAL as long as the assessment is still valid and there is no requirement to reassess the vegetation and update the contour map (this is a dependant on the time that has passed since the original assessment). A BAL Certificate will only remain valid for one year.

The indicative BAL ratings for Lot 414 Grove Road are BAL-29 or lower and is dependent on the location of any future building to be located within the lot. At later planning stages, the actual location and type of development will be decided and this will guide the actual BAL rating. With the BAL contour map associated within this plan the onsite infrastructure can be located appropriately to reduce the impact of any bushfires in the area.

3 Environmental Considerations

Protection

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

“Clearing of native vegetation in Western Australia requires a clearing permit under Part V, Division 2 of the Environmental Protection Act 1986 unless clearing is for an exempt purpose. Exemptions from requiring a clearing permit are contained in Schedule 6 of the Act or are prescribed in the Environmental Protection Regulations” (‘Guidelines’ s2.3).

Existing conservation areas that are potentially affected by the development proposal are required to be identified. This may result in vegetation removal/modification prohibition or limitations. These areas include National Parks; Nature Reserves; Wetlands and Bush Forever sites.

The Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), administered by the Australian government Department of Environment, provides a national scheme of environment and heritage protection and biodiversity conservation. The objectives of the of the EPBC Act include the protection of the environment with respect to matters of national environmental significance and conservation of Australian biodiversity.

Nationally threatened species and ecological communities are a specific matter of significance. Areas of vegetation can be classified as a Threatened Ecological Community (TEC) under the EPBC Act and consequently have removal restrictions imposed.

Development Design

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

3.1 Native Vegetation – Modification and Clearing

Table 3.1.1: Existing or potential vegetation modification and clearing restrictions.

Identified Existing or Potential Restrictions	
For the proposed development site, have any existing vegetation modification or clearing restrictions been identified?	Yes
Type of existing restriction:	Conservation Category Wetlands and Buffer
For the proposed development site, have any areas of native vegetation been identified as species that might result in the classification of the area as a Threatened Ecological Community (TEC)?	No
Potential TEC species identified:	N/A
Other identified conservation issue to be considered:	N/A

Table 3.1.2: Design solutions to reduce the extent of native vegetation removal.

Bushfire Management Design Solutions		
Options to Minimise Removal of Native Vegetation	Adopted in the Proposal	Identified as an Option
Reduction of lot yield	No	N/A
Cluster development	No	N/A
Construct building to a higher standard as per BCA and AS 3959-2009	No	N/A
Modify the development location	No	N/A

The existing vegetation onsite is comprised mostly of grass paddocks with scattered trees and minor native paperbark wetlands that has been highly modified associated with the Yule Brook drainage in the south of the site.

Impact on Adjoining Land

Is this planning proposal able to implement the required bushfire measures within the boundaries of the land being developed so as not to impact on the bushfire and environmental management of neighbouring reserves, properties or conservation covenants?	Yes
---	-----

3.2 Re-vegetation/Landscape Plans

Riparian Vegetation Maintenance and Re-vegetation

Where, as part of the Proposal, revegetation of riparian zones and wetland or foreshore buffers is necessary for their protection or management, this bushfire management plan assesses the ability and practicality of maintaining vegetation separation distances corresponding to determined BAL's.

Is the maintenance and/or re-vegetation of riparian zones and/or wetland or foreshore buffers a part of this Proposal?	Yes
Can the required BAL separation distance be maintained into the future?	Yes

Due to the presence of a 'Resource Enhancement Wetland' on adjacent land a 30m buffer from an updated mapped wetland area, see Figure 3.2.1 (PGV plan), will be revegetated to be maintained within Lot 414 as Class D Scrub. This revegetation will be maintained and has been utilised in the proposed BAL contour map and therefore impact of the future BAL rating of any development onsite.

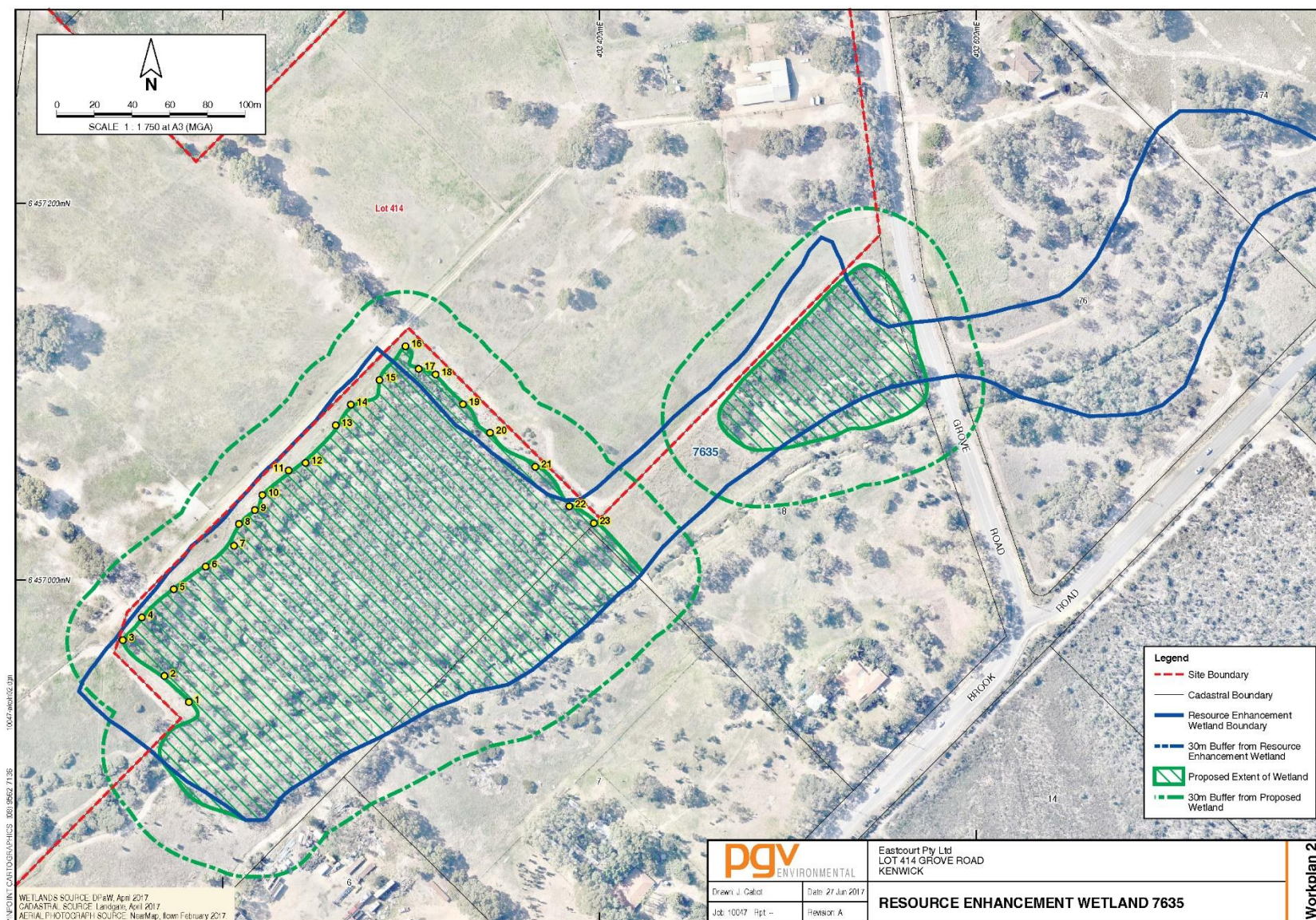


Figure 3.1: Resource Enhancement Wetland plan (PGV Environmental- Aug 2017)

4 Identification of Bushfire Hazard Issues

Bushfire hazard issues arising from the site assessment and proposed development plans can consist of onsite and offsite vegetation to be retained, onsite development, vehicular access and access to an appropriate emergency water source for emergency services.

Bushfire hazard issues associated with this development include the environmental buffers to the wetlands offsite that will require revegetation. To address these issues the following Section 5 will mitigate the bushfire hazard to a manageable level to allow the development to not be affected by extreme bushfire impacts.

5 Assessment Against the Bushfire Protection Criteria

5.1 Summary of the Assessment Outcomes

Summarised Outcome of the Assessment Against the Bushfire Protection Criteria (BPC)				
Element for which one or more applicable ‘acceptable solutions’ are provided	Basis for the Proposals Assessment by the Decision Maker			
	How the Intent of the Element is Achieved (or will be achieved at future planning stages)			Minor or Unavoidable Development
	Compliance with the Acceptable Solutions (currently or at future planning stages)		Performance Based Assessment	
	Complies with all applicable ‘acceptable solutions’	One or more applicable ‘acceptable solutions’ are not <u>fully</u> met. A <u>variation</u> of the solution is provided and justified.	Alternative solution/s are developed and presented in the BMP	the required statements are presented in the BMP
Location	✓			N/A
Siting and Design of Development	✓			
Vehicular Access	✓			
Water	✓			
Notes:				

5.2 The Elements of the Criteria – Compliance with the Required Outcomes and the Acceptable Solutions

Bushfire Protection Criteria - Element 1- Location

Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

Performance Principle P1 (to be complied with to meet the intent and used to develop alternative solutions): The intent may be achieved where the strategic planning proposal, subdivision or development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low **OR** a BAL-29 or below applies **AND** the risk can be managed. For unavoidable development in areas where BAL-40 or BAL-FZ applies, demonstrating that the risk can be managed to the satisfaction of DFES and the decision-maker.

Acceptable Solution	Further Explanation	Compliance	Assessment Statements (and any required action)
A1.1 Development Location - The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low; OR Be subject to BAL-29 or below;	Land is most suitable for land use intensification where hazard levels are low. Where there is an extreme bushfire hazard level or requirements for use of BAL-40 or BAL-FZ construction standards, the land is not considered suitable for development unless it meets the definition of minor or unavoidable development.	Will Fully Comply with the Acceptable Solution	The proposed development will achieve the intent of Element 1 by complying with the requirements of the acceptable solution. These are complied with by: - The proposed development being subject to BAL-29 or below (the highest indicative BAL is BAL-12.5). This is achieved by implementing the bushfire risk management measures of positioning, design and/or onsite vegetation modification as identified within this Plan; and - The bushfire risk being additionally managed by the existence and/or future implementation of bushfire risk management measures that include the requirements for vehicular access, firefighting water and the ongoing maintenance of all measures as identified within this Plan.

Bushfire Protection Criteria - Element 2 - Siting and Design of Development

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

Performance Principle P2 (to be complied with to meet the intent and used to develop alternative solutions): The intent may be achieved where the siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire risk that applies to the site. That it incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS3959 if appropriate.

Acceptable Solution	Further Explanation	Compliance	Assessment Statements (and any required action)
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 29 kW/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/s will be managed in a low-fuel state on an ongoing basis, in perpetuity. Management: The APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones' ('Guidelines' Appendix 4, Element 2 Schedule 1). Refer to Appendix 1 of this Report/Plan.	The APZ is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level by reducing fuel loads (predominantly combustible vegetation). The required width of the APZ varies with the vegetation impacting the site and ground slopes. The APZ is to include a defendable space (minimum 3m width) – an area adjoining the asset in which vegetation is kept to an absolute minimum and free from combustible items and obstructions – to facilitate firefighting operations. Where the loss of vegetation is not acceptable or causes conflict with landscape and environmental objectives, then the development may need to be modified.	Will Fully Comply with the Acceptable Solution	The proposed development will achieve the intent of Element 2 by complying with the requirements of the acceptable solution. These are complied with by: - Being able to establish the required size APZ fully within the lot boundaries that will result in the required construction standard not exceeding that corresponding to BAL-29. - These APZ dimensions are set out in Section 5.4.1 'Siting and Design of Development'.

Bushfire Protection Criteria - Element 3 - Vehicular Access

Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.

Performance Principle P3 (to be complied with to meet the intent and used to develop alternative solutions): The intent may be achieved where 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.

Acceptable Solution	Further Explanation	Compliance	Assessment Statements (and any required action)
A3.1 Two access routes Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents and the public at all times and under all weather conditions.	This is to apply to access routes leading into a subdivision as well as those within a subdivision. All access should accommodate type 3.4 fire appliances (4WD 7t chassis). Two-way access should be provided as a public road, however, where a public road cannot be provided (and this will need to be demonstrated by the proponent providing justification), an emergency access way may be considered.	Fully Complies with the Acceptable Solution	The proposed development will achieve the intent of Element 3 by complying with the requirements of the acceptable solution. These are complied with by: - Groves Road, is a sealed public road, providing safe vehicular access (and egress) under all weather conditions, including a bushfire event; and - Groves Road providing a choice of two different access routes and egress destinations.

Bushfire Protection Criteria - Element 3 - Vehicular Access (continued)

Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.

Performance Principle P3 (to be complied with to meet the intent and used to develop alternative solutions): The intent may be achieved where 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.

Acceptable Solution	Further Explanation	Compliance	Assessment Statements (and any required action)
A3.2 Public Road Minimum trafficable surface of 6m. Constructed to meet the technical requirements stated in Appendix 4.	In special circumstances, where ≤ 8 lots serviced, a minimum 4m trafficable surface for a maximum of 90 might be approved.	Fully Complies with the Acceptable Solution	Groves Road is an existing public road compliant with the technical requirements of the Guidelines.
A3.3 Cul-de-sacs - (includes dead-end roads). A maximum length of 200m with a 17.5m turnaround. 600m length if cul-de-sacs services ≤ 8 lots and is joined to another cul-de-sac by an emergency access way of < 600 m). Constructed to meet the technical requirements stated in Appendix 4.	Should be avoided in bushfire prone areas as they do not provide access/egress in different directions. Where no alternative exists this will need to be demonstrated by the proponent including if the lot layout already exists. Cul-de-sac is to connect to a public road.	N/A	
A3.4 Battle-axe Maximum length 600m, minimum width 6m, passing bays @ 200m, turnaround area @ 500m and at house site. Constructed to a minimum of private driveway standards. Constructed to meet the technical requirements stated in Appendix 4.	Should be avoided in bushfire prone areas If no alternative exists this will need to be demonstrated by the proponent.	N/A	

Bushfire Protection Criteria - Element 3 - Vehicular Access (continued)

Acceptable Solutions	Further Explanation	Compliance	Assessment Statements (and any required action)
A3.5 Private Driveways Are required where a house is >50m from a public road. Passing bays @ 200m, turnaround area @ 500m and within 50m of house. Bridges/culverts to support 15t. All weather surface. Constructed to meet the technical requirements stated in Appendix 4.		Will Fully Comply with the Acceptable Solution	The private driveway access to any future development may be >50m in length and will therefore be compliant with the technical requirements including width, trafficable surface, passing bays and turn around areas.
A3.6 Emergency Access Way Provided as a right of way or public access easement in gross (maximum length of 600m) to ensure accessibility to the public and fire services in emergencies. It should comply with minimum standards for a public road and be signposted. Constructed to meet the technical requirements stated in Appendix 4.	An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists, this will need to be demonstrated by the proponent. It is to be provided as an alternative link to a public road during emergencies.	N/A	
A3.7 Fire Service Access Routes - (perimeter roads) Provided as rights of way or public access easements in gross; all weather surface and allow for two-way traffic; dead-end roads not permitted; turnarounds every 500m; less than 600m to a public road and be signposted. Constructed to meet the technical requirements stated in Appendix 4.	Fire service access routes should be established to separate bushfire prone areas from developed areas and to provide access within and around the edge of the subdivisions and related development. To be used during bushfire suppression operations and prevention work.	N/A	
A3.8 Firebreak Width Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level prescribed in the local firebreak notice issued by the local government.		Will Fully Comply with the Acceptable Solution	The lot will comply with the requirements of the local government annual firebreak notice issued under s33 of the Bush Fires Act 1954.

Bushfire Protection Criteria - Element 4 – Water

Intent: To ensure water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

Performance Principal P4 (to be complied with to meet the intent and used to develop alternative solutions): The intent may be achieved where the subdivision, development or land use is provided with a permanent and secure supply that is sufficient for firefighting purposes.

Acceptable Solution	Further Explanation	Compliance	Assessment Statements (and any required action)
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 DFES. Constructed to meet the technical requirements stated in Appendix 5.	The Water Corporations 'No 63 Water Reticulation Standard' is deemed to be the baseline criterion for developments and should be applied unless local water supply authorities' conditions apply. Additionally, any local government variation must be met (s8.4).	Fully Complies with the Acceptable Solution	A reticulated water supply is available to the subject site and two hydrants are located on Groves Road within 100m of any future development onsite.
A4.2 Non-Reticulated Areas Water tanks for firefighting purposes with a hydrant or standpipe are provided. Minimum of 50,000l/tank; minimum 1 tank/25 lots (or part thereof); house ≤2km from a tank; 20min turnaround time for 2.4 appliance; hardstand area suitable for 3.4 appliance within 3m of tank Must meet the technical requirements stated in Appendix 5. Any local government variation must also be met (s8.4).	The specification of the requirements for the proposal being assessed will be set by the water supply authority and DFES. A procedure must be in place to ensure that water tanks are maintained at or above the designated capacity at all times, including home tanks on single lots. This could be in the form of an agreement with the local government and the fire service. Water tanks and associated facilities are vested in the relevant local government	N/A	
A4.3 Non-reticulated Areas (Individual Lots) Single lots above 500 m ² need a dedicated static water supply on the lot that has the effective capacity of 10,000 litres. Must meet the technical requirements stated in Appendix 5.	A4.3 is only for use if creating one additional lot and cannot be applied cumulatively.	N/A	

5.3 Local Government Variations to the Bushfire Protection Criteria

Local governments may apply specific acceptable solutions or technical requirements that vary from those specified in the Guidelines. When applicable, the Proposal will be assessed against these variations and the changed technical requirements of the acceptable solutions associated with each 'Element' will apply.

Are there any endorsed local variations to the acceptable solutions of the Bushfire Protection Criteria elements that are to apply to this Proposal?	No
Are there any endorsed local variations to the technical requirements of the Bushfire Protection Criteria acceptable solutions that are to apply to this Proposal?	No

5.4 Additional Assessment Information

5.4.1 Siting and Design of Development

The development site is assumed to be maintained as low threat vegetation and excluded as per AS3959-2009 s2.2.3.2 excluding the revegetation buffer that is to occur as a 30m buffer to the remapped wetland on adjacent land. For any future development, the separation distances required to maintain the APZ and BAL-29 or lower rating is shown in Table 5.4.1 below.

Table 5.4.1: Ongoing maintenance of the separation area from any future building works to the classified vegetation (refer to Figure 2.2.3 for vegetation area details)

Vegetation Area	Vegetation Classification	Effective Slope	BAL Separation Distance (m)		
			BAL-29	BAL-19	BAL12.5
1 & 6	Class A Forest	0	21-<31	31-<42	42-<100
2, 4, 5, 8, 11	Class G Grassland	0	8-<12	12-<17	17-<100
7, 9, 10	Class B Woodland	0	14-<20	20-<29	29-<100
3	Class C Shrubland	0	9-<13	13-<19	19-<100
Revegetation buffer	Class D Scrub	0	13-<19	19-<27	27-<100

6 Responsibilities for Implementation and Management of the Required Bushfire Measures

6.1 Implementation Responsibilities Established by the BMP

Table 6.1.1: Developer BMP implementation responsibilities.

DEVELOPER			
No.	Implementation Action	Timing	Subdivision Clearance
1	Install the private driveways to the standards stated in the BMP.	To support the creation of titles	☐
2	Planning approval may be conditioned with the requirement to make appropriate notifications (on the certificates of title and the deposited plan), of the existence of this Bushfire Management Plan. The WAPC may condition a subdivision application approval with a requirement for the landowner / proponent to place a notification onto the certificate(s) of title and a notice of the notification onto the diagram or plan of survey (deposited plan). This will be done pursuant to Section 165 of the Planning and Development Act 2005 ('Hazard etc. affecting land, notating titles as to:') and applies to lots with a determined BAL rating of BAL-12.5 or above. The notification will be required to state: <i>'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land'.</i>	To support the creation of titles	☐
3	Establish the Asset Protection Zone (APZ) within the lot to the dimensions and standard stated in the BMP.	To support the creation of titles	☐
4	Depending on the future land use, future operators may need to prepare a risk management plan that provides bushfire risk management measures to address: - The increased risk of bushfire ignition; and/or - The existence of flammable onsite hazards. Currently unknown specific content (e.g. key persons) is to be added to the plan prior to occupancy of the building.	To support the development application.	☐
5	The entity responsible for having the BMP prepared should ensure that anyone listed as having responsibility under the Plan has endorsed it and is provided with a copy for their information. This	Post planning approval and prior	☐

	includes the landowners/proponents (including future landowners where the Plan was prepared as part of a subdivision approval), local government and any other authorities or referral agencies ('Guidelines' s4.6.3).	to development occupation	
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Table 6.1.2: Landowner BMP implementation responsibilities.

LANDOWNER		
No.	Implementation Action	Timing
1	Inform any builders of proposed structures on the Lot of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to the determined BAL rating.	Prior to any building work
2	Establish the Asset Protection Zone (APZ) to the dimensions and standard stated in the BMP.	Prior to occupancy

Table 6.1.3: Landowner BMP implementation responsibilities.

BUILDER		
No.	Implementation Action	Timing
1	Be aware of the existence of any BMP that refers to the subject Site.	Prior to any building work
2	The builder (generally named on the building permit) is responsible for ensuring that the building or incidental structure to which a building permit applies will be compliant on completion with the bushfire provisions of the Building Code of Australia (BCA) as it applies in WA.	Prior to any building work

6.2 Management Responsibilities Established by the BMP

Table 6.2.1: Landowner/Occupier management responsibilities.

LANDOWNER/OCCUPIER		
No.	Management Action	Timing
1	Maintain the Asset Protection Zone (APZ) to the dimensions and standard stated in the BMP.	Ongoing
2	Comply with City of Gosnells Annual Firebreak Notice issued under s33 of the Bush Fires Act 1954.	Ongoing
3	Maintain vehicular access routes within the lot to the required surface condition and clearances as stated in the BMP.	Ongoing
4	Ensure that any builders (of future structures on the Lot) are aware of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to the determined BAL rating.	Ongoing
457	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: (a) the requirements of the WA Building Act 2011 and the bushfire provisions of the Building Code of Australia (BCA); and (b) with any identified additional requirements established by this BMP or the relevant local government. Refer to Section 7.7 'Building Construction Standards'	Ongoing
6	Updating the Bushfire Management Plan may be required to ensure that the bushfire risk management measures remain effective. Bushfire plans do not expire and should be a 'living document'. Updating is required in certain circumstances, including (but not limited to) if site conditions change, if further details are required at subsequent stages of the planning process or to reflect new technologies or methodologies in best practice bushfire risk management ('Guidelines' s4.6.4 and s4.6.5).	Ongoing

Table 6.2.2: Local Government management responsibilities

LOCAL GOVERNMENT		
No.	Management Action	Timing
1	Monitor landowner compliance with the annual firebreak notice.	Ongoing
2	Develop and maintain district bushfire fighting services and facilities.	Ongoing
3	The adjoining reserve to be managed in accordance with the written agreement, to ensure the vegetation remains as low threat vegetation, in accordance with AS3959-2009.	Ongoing
4	Where control of an area of vegetated land is vested in the control of the local government and that area of land has influenced the assessed BAL rating/s of the site/s – and the BAL rating has been correctly assessed - there is an obligation to consider the impact of any changes to future vegetation management and/or revegetation plans with respect to that area.	Ongoing

Appendix 1 – Onsite Vegetation Management Responsibilities

Explaining Asset Protection Zones (APZ)

Description: An APZ is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level (by reducing fuel loads). The width of the required APZ varies with slope and vegetation. For planning applications, the minimum sized acceptable APZ is that which is of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL-29). It will be site specific.

(For subdivision planning, hazard separation in the form of using subdivision design elements or excluded and low threat vegetation adjacent to the lot may be used to reduce the dimensions of the APZ within the lot).

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

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

Native Vegetation: APZ's can adversely affect the retention of native vegetation. Where the loss of vegetation is not acceptable or causes conflict with landscape or environmental objectives, such as waterway foreshore areas and wetland buffers, reducing lot yield may be necessary to minimise the removal and modification of remnant vegetation.

Responsibility: It is the responsibility of the landowner/proponent to maintain their APZ in accordance with the 'Guidelines' Appendix 4 Schedule 1 'Standards for Asset Protection Zones' (WAPC 2017). It is likely that this requirement is also contained in the firebreak notice issued by the relevant local government under s33 of the Bushfire Act 1954 along with any additional requirements.

Source: Guidelines for Planning in Bushfire Prone Areas (WAPC 2017 v1.2) Appendix 4 Element 2

Standards for Asset Protection Zones

(‘Guidelines’ WAPC 2017 v1.2 Appendix 4 Schedule 1)

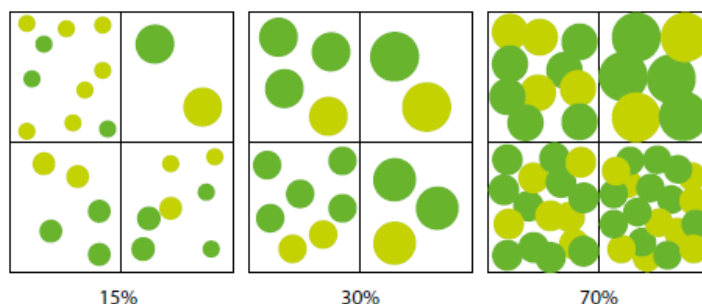
Fences: within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

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

Fine Fuel Load: combustible dead vegetation matter less than 6 mm in thickness reduced to and maintained at an average of two tonnes per hectare. The visual guide below shows a fuel load that equates to approximately 2t/ha (source: Shire of Augusta Margaret River’s Firebreak and Fuel Reduction Hazard Notice).



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



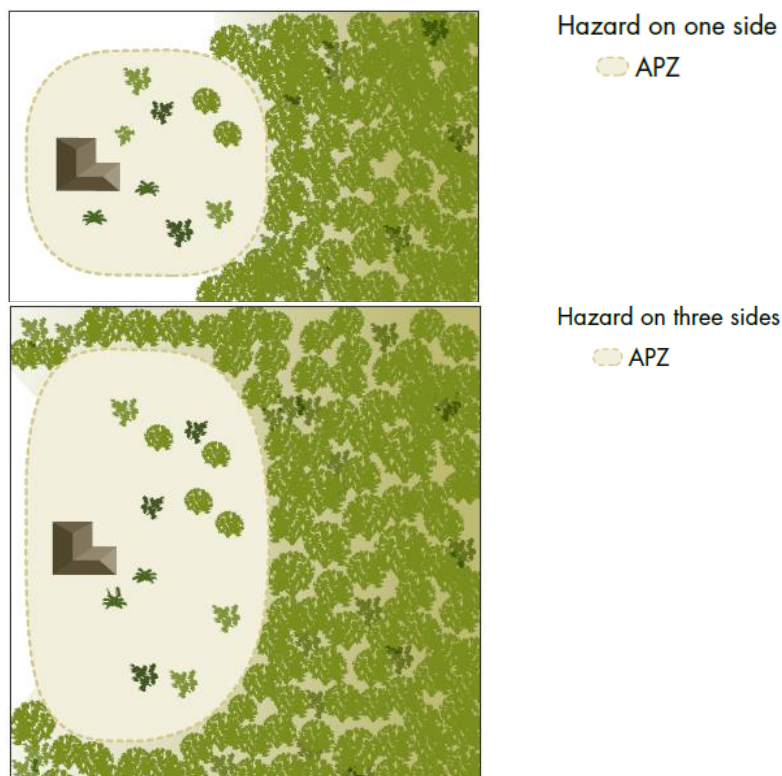
Shrubs (0.5 metres to 5 metres in height): should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m² in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres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

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

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

Note that individual local governments may set their APZ standards with differing requirements compared to the standard set in the ‘Guidelines’. These will be contained in their annual firebreak notice issued under s33 of the Bush Fires Act 1954 and are to be complied with.

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



Additional DFES Guidance

- Store firewood at least 20 metres away from the building.
- Keep gutters free of leaves and other combustible material.
- Roof mounted evaporative coolers to be fitted with ember screens.
- Gas cylinders to vent away from a building and be tethered to prevent falling over.
- Driveways and access ways must allow for safe passage of a fire appliance to all buildings on the land.
- Land owners/occupiers must maintain compliance with the local government's annual firebreak notice issued under s33 of the Bush Fires Act 1954.

Regardless of whether an Asset Protection Zone exists in accordance with the acceptable solutions and is appropriately maintained, it should be noted that fire fighters are not obliged to protect an asset if they think the separation distance between the dwelling and vegetation is unsafe.

Appendix 2 – Technical Requirements - Vehicular Access

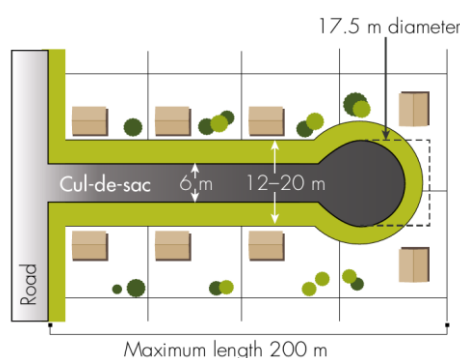
Vehicular Access – Technical Requirements of Acceptable Solutions - Part 1

Source: *Guidelines for Planning in Bushfire Prone Areas WAPC 2015*

Acceptable Solution 3.3 Cul-de-sacs (including a dead-end road)

Their use in bushfire prone areas should be avoided. Where no alternative exists then the following requirements are to be achieved:

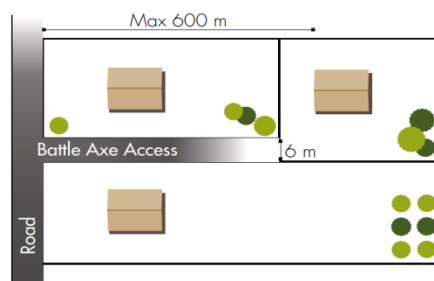
- Maximum length is 200m. If public emergency access is provided between cul-de-sac heads (as a right of way or public access easement in gross), the maximum length can be increased to 600m provided no more than 8 lots are serviced and the emergency access way is less than 600m in length;
- Turnaround area requirements, including a minimum 17.5m diameter head to allow type 3.4 fire appliances to turn around safely;
- The cul-de-sac connects to a public road that allows for travel in two directions; and
- Meet the additional design requirements set out in Part 2 of this appendix.



Acceptable Solution 3.4 Battle-axe

Their use in bushfire prone areas should be avoided. Where no alternative exists then the following requirements are to be achieved:

- Maximum length 600m and minimum width 6m; and
- Comply with minimum standards for private driveways.



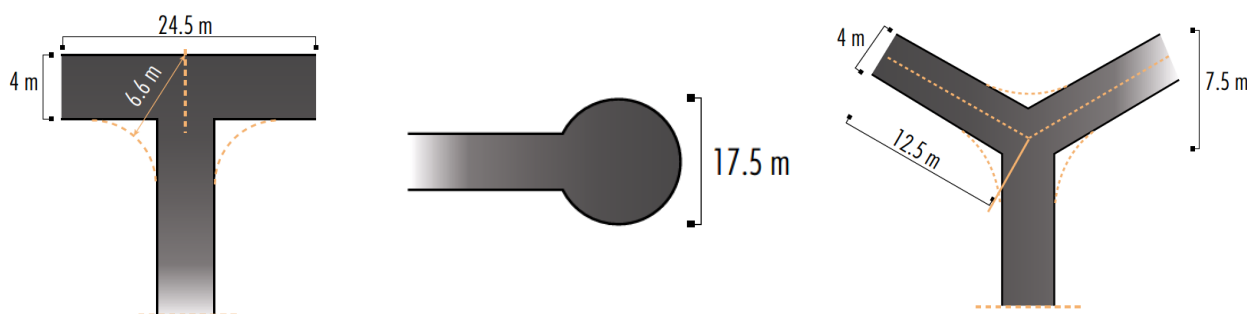
Acceptable Solution 3.5 Private Driveways

The following requirements are to be achieved:

- The design requirements set out in Part 2 of this appendix; and

Where the house site is more than 50 metres from a public road:

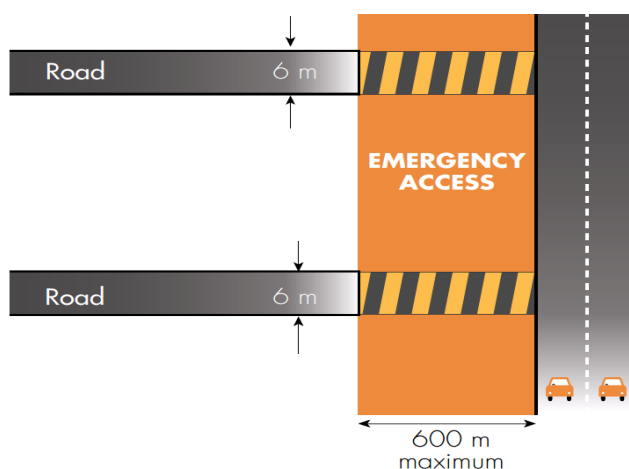
- Passing bays every 200 metres with a minimum length of 20 metres and a minimum width of two metres (ie combined width of the passing bay and constructed private driveway to be a minimum six metres);
- Turn-around areas every 500 metres and within 50 metres of a house, designed to accommodate type 3.4 fire appliances to turn around safely (ie kerb to kerb 17.5 metres);
- Any bridges or culverts are able to support a minimum weight capacity of 15 tonnes; and
- All weather surface (i.e. compacted gravel, limestone or sealed).



Acceptable Solution 3.6 Emergency Access Way

An access way that does not provide through access to a public road is to be avoided bushfire prone areas. Where no alternative exists, an emergency access way is to be provided as an alternative link to a public road during emergencies. The following requirements are to be achieved:

- No further than 600 metres from a public road;
- Must be signposted including where they ajoin public roads;
- Provided as a right of way or public access easement in gross;
- Where gates are used they must not be locked and they must be a minimum width of 3.6 metres with design and construction approved by local government (refer to the example in this appendix); and
- Meet the additional design requirements set out in Part 2 of this appendix.



Acceptable Solution 3.7 Fire Service Access Routes (Perimeter Roads)

Are to be established to provide access within and around the edge of subdivision and related development and to provide direct access to bushfire prone areas for firefighters and link between public road networks for firefighting purposes. Fire service access is used during bushfire suppression activities but can also be used for fire prevention work. The following requirements are to be achieved:

- No further than 600 metres from a public road (driveways may be used as part of the designated fire service access;
- Dead end roads not permitted;
- Allow for two-way traffic (i.e. two 3.4 fire appliances);
- Provide turn-around areas designed to accommodate 3.4 fire appliances and to enable them to turn around safely every 500m (i.e. kerb to kerb 17.5 metres);
- All weather surface (i.e. compacted gravel, limestone or sealed) and have erosion control measures in place;
- Must be adequately sign posted;
- Where gates are used they must be a minimum width of 3.6 metres with design and construction approved by local government (refer to the example in this appendix) and may be locked (use a common key system);
- Meet the additional design requirements set out in Part 2 of this appendix;
- Provided as right of ways or public access easements in gross; and
- Management and access arrangements to be documented and in place.

A3.8 Firebreak Width

Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three meters or to the level as prescribed in the local firebreak notice issued by the local government.

Vehicular Access - Technical Requirements of Acceptable Solutions - Part 2

Source: *Guidelines for Planning in Bushfire Prone Areas WAPC 2015*

Technical Component	Vehicular Access Types				
	Public Roads	Cul-de-sacs	Private Driveways	Emergency Access Ways	Fire Service Access Routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	4.5	4.5	4.5	4.5
Maximum grade <50 metres	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum cross-fall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5
* A six metre trafficable surface does not necessarily mean paving width. It could, for example, include four metres of paving and one metre of constructed road shoulders. In special circumstances, where 8 lots or less are being serviced, a public road with a minimum trafficable surface of four metres for a maximum distance of ninety metres may be provided subject to the approval of both the local government and DFES.					

Appendix 5

Traffic Summary (Cardno)

Technical Memorandum

Title	Transport Summary Lot 414, Grove Road, Kenwick		
Client	Grove Road Pty Ltd Aft the Grove Trust	Project No	CW1018300
Date	8 June 2018	Status	Rev C
Author	Arun Mohan	Discipline	Traffic and Transport
Reviewer	Andreas Wang	Office	Perth

1 Introduction

Cardno was commissioned by Grove Road Pty Ltd Aft the Grove Road Trust to prepare a high-level transport summary in support of a proposed amendment to the existing MKSEA Precinct 3A Structure Plan. The purpose of the proposed amendment is to include Lot 414 Grove Road, Kenwick in the Structure Plan area. The geographic area the subject of this report, and the subject of the proposed Amendment, may be described interchangeably as 'Lot 414', 'the site', or the 'amendment area'.

The report specifically focuses on the following aspects:

- > Existing situation;
- > Proposed Precinct 3A Structure Plan Amendment;
- > Trip generation and distribution on immediate local network;
- > Proposed internal and external transport networks; and
- > Integration with surrounding land uses and transport networks.

2 Existing Situation

The Site is located to the south of Welshpool Road East and is bounded by Bickley Road to the south and Grove Road to the east as shown in **Figure 1** and currently consists of vacant land.

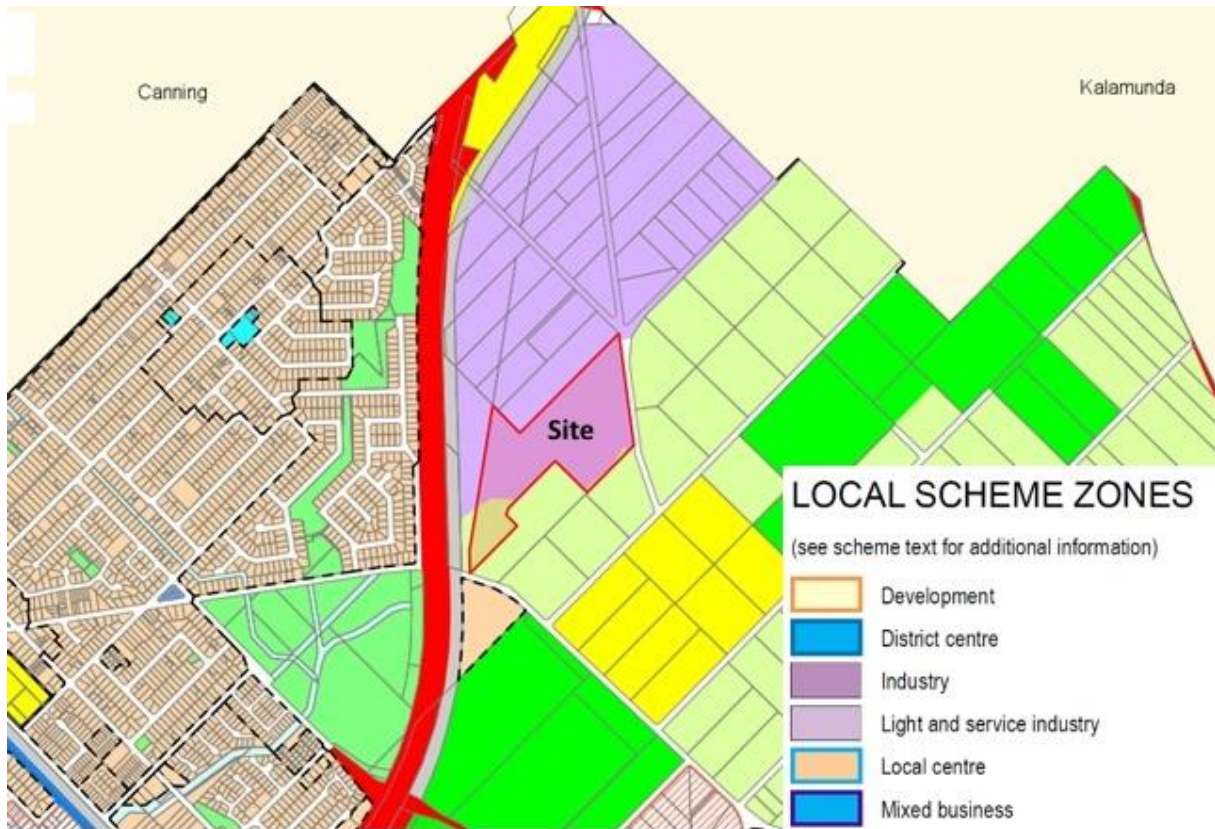
Figure 1 Lot 414 Site Location



Source: Nearmap (2017)

The majority of the site is currently zoned as “Industrial” as per the City of Gosnells *Town Planning Scheme No. 6* as shown **Figure 2**. The south western edge of the site is currently zoned as development.

Figure 2 City of Gosnells Town Planning Scheme No.6 – Zoning Map



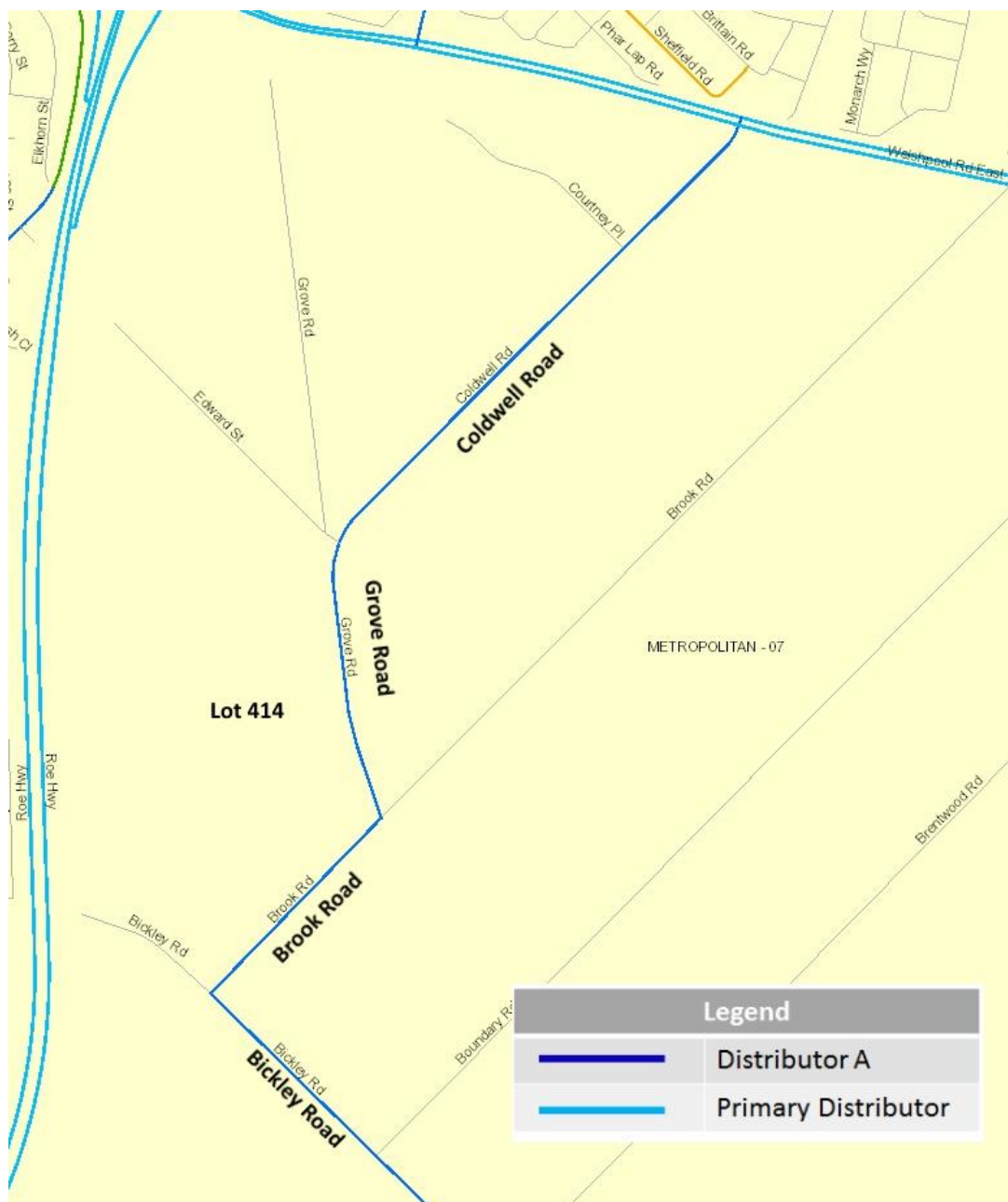
Source: City of Gosnells Town Planning Scheme No. 6 (2017)

2.1 Road Network

The existing road network is described below:

- > **Coldwell Road** is classified as a Distributor B under the Main Roads Functional Hierarchy and is located to the northern boundary of the Site. The road has a posted speed limit of 60km/h.
- > **Brook Road** is classified as a Distributor B under the Main Roads Functional Hierarchy and is located to the east of the site. The road has a posted speed limit of 60km/h.
- > **Bickley Road (west of Brook Road)** is classified as a Distributor B under the Main Roads Functional Hierarchy and is located to the south of the site. Bickley Road consists of one lane in each direction. The road had a posted speed limit of 60km/h.

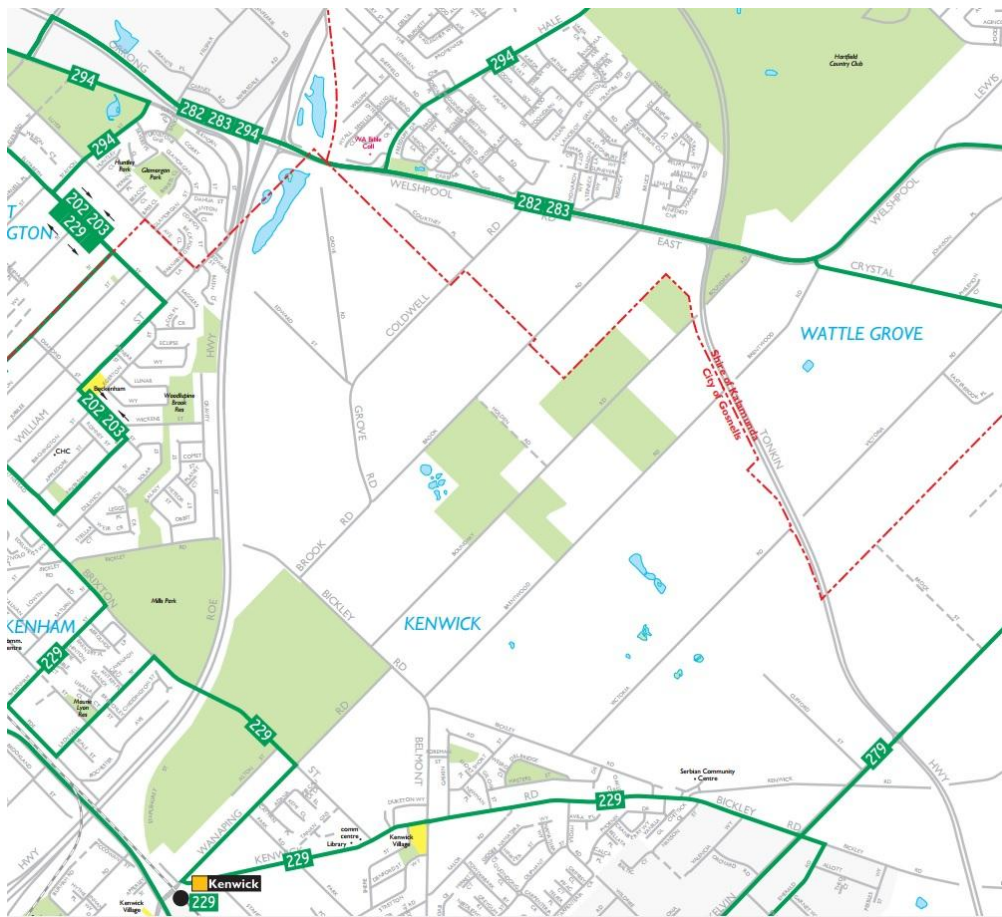
Figure 3 Road Hierarchy



2.2 Existing Public Transport Services

As shown in **Figure 4**, the amendment area is not serviced by any existing Public Transport services. However, bus routes 282 and 283 run along the Welshpool Road East, while bus route 229 runs along Kenwick Road to the South of the study area.

Figure 4 Existing PT Services Adjacent to Amendment Area



Source: Transperth (2017)

2.3 Existing Pedestrian/Cycle Network Facilities

A 2.0m wide pedestrian footpath is currently provided on the northern side of Coldwell Road (between Welshpool Road and Courtney Place). No other pedestrian or cycle facilities are currently provided within the amendment area.

2.4 Existing Restricted Access Vehicle (RAV) Network

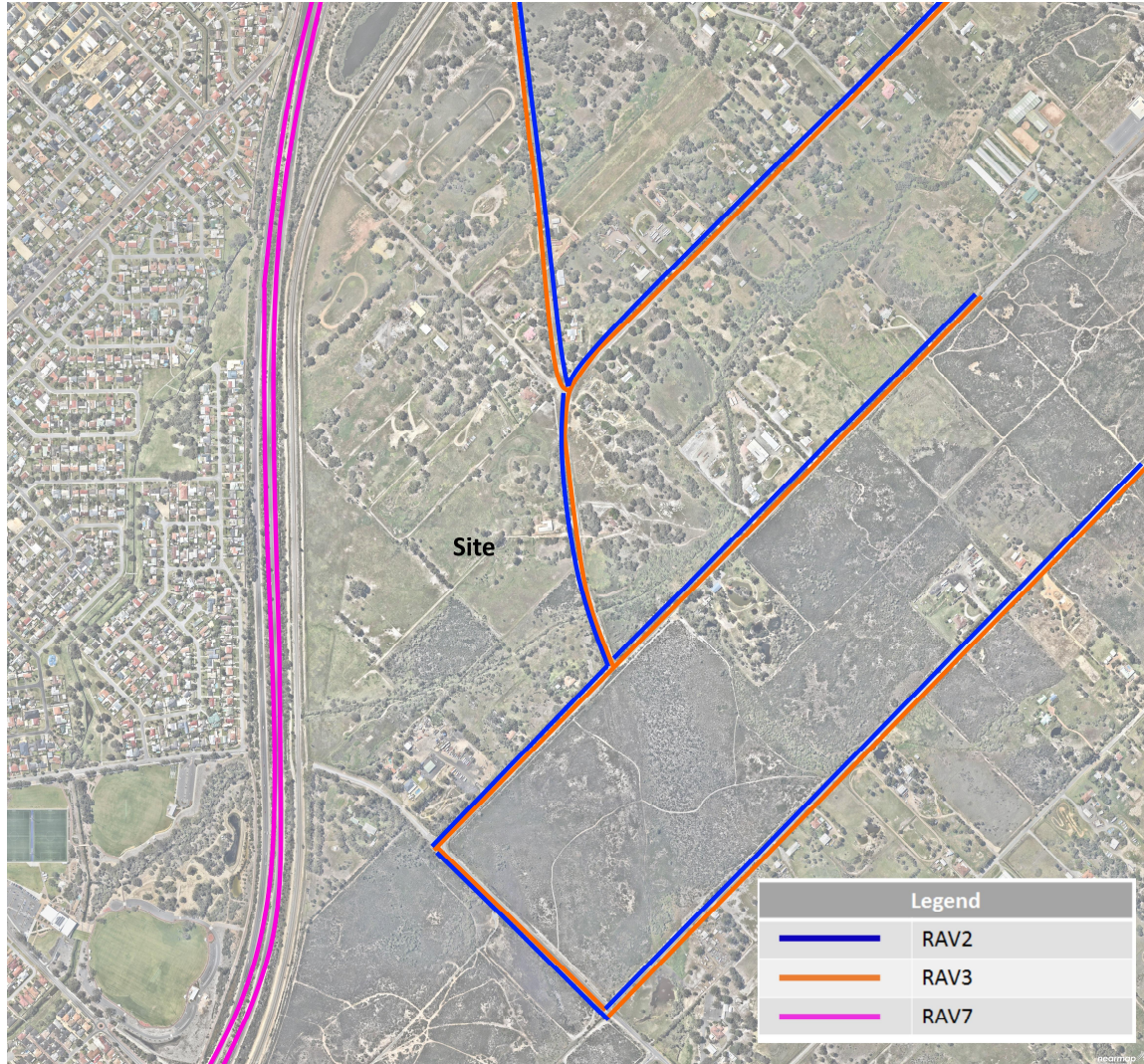
Currently only RAV2 and RAV3 vehicles have access to the internal roads of Coldwell Road, Brook Road and Bickley Road.

While RAV4 vehicles are permitted on Welshpool Road East, these vehicles are currently not permitted on roads within the amendment area.

It is noted that RAV7 vehicles are currently only permitted on Roe Highway and therefore currently do not have access to the amendment area.

Figure 5 shows the RAV network around Lot 414, Grove Road.

Figure 5 Restricted Access Vehicle (RAV) Network



Source: MRWA RAV Network

3 Proposed Precinct 3A Structure Plan Amendment

An indicative Development Concept Plan for the amendment area is shown in **Figure 6**.

Figure 6 Development Concept Plan



Source: CLE Lot414 Development Concept Plan (plan no: 2290-25B-01)

3.1 Proposed Development Land Uses

The land use of the amendment area is industrial and is summarised in **Table 1**. Upon full development of the amendment area, it is expected to generate 60 employment opportunities.

Table 1 Proposed amendment area Land uses

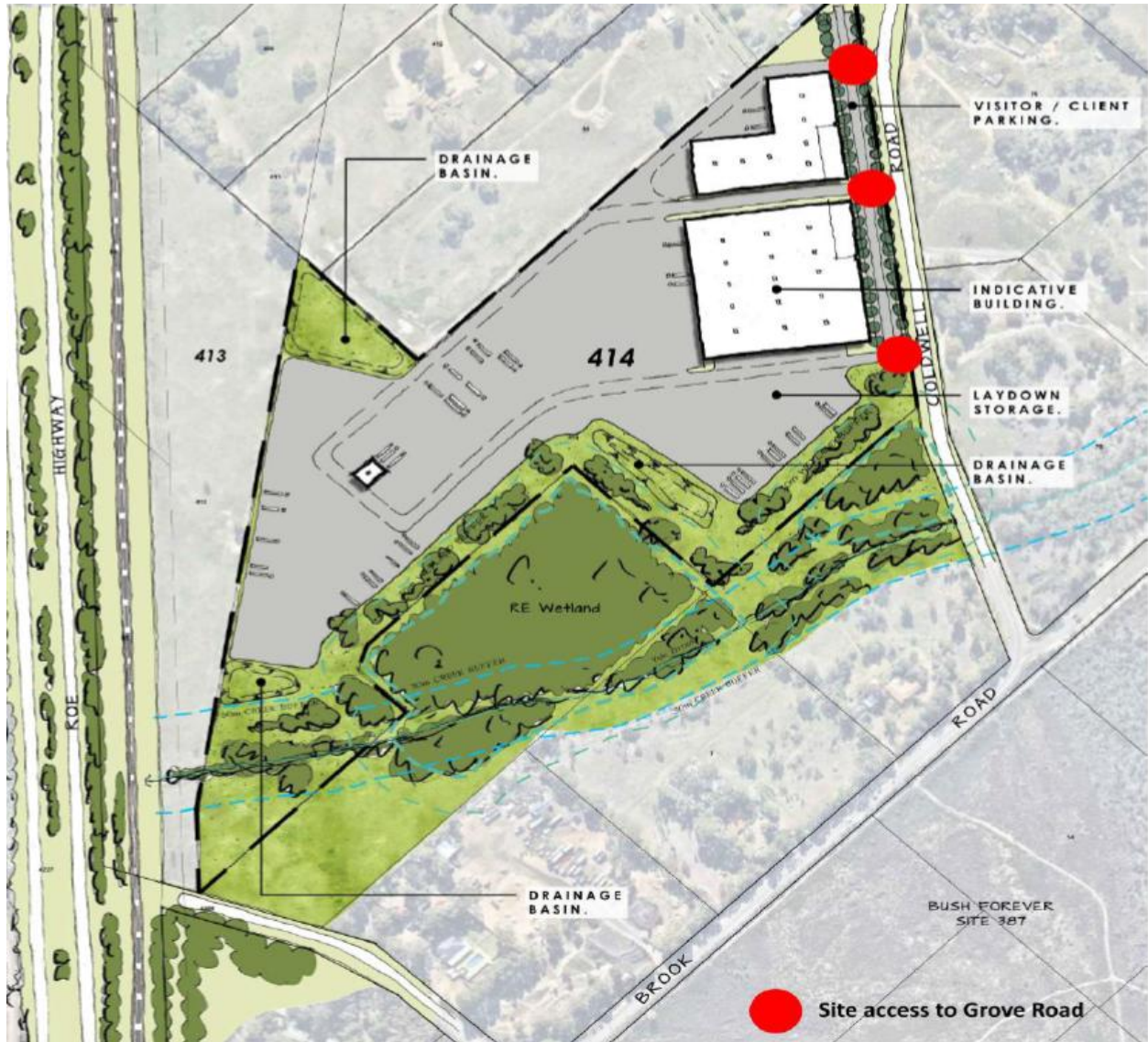
Land Use	Area
Warehouse	20,000 m ²
Office	800 m ²

4 Proposed Internal and External Networks

4.1 Access Arrangements

The access to the Site is shown in **Figure 7**. The development plan shows there are to be three access points to the Site via Grove Road.

Figure 7 Access Arrangements



Source: CLE Lot414 Development Concept Plan (plan no: 2290-25B-01)

5 Trip Generation and Distribution

Consistent with trip generation and distribution assumptions adopted from the MKSEA Precinct 3A Structure Plan Transport Assessment (Cardno, 2017), the trip generation volumes (based on the proposed land uses for the amendment area) are summarised in **Table 2**, while the assumed trip distribution is shown in **Figure 8**.

Table 2 Trip Generation

Peak Period	In (Trips)	Out (Trips)
AM	42	20
PM	18	38

Figure 8 Trip Distribution



6 Integration with Surrounding Land uses

All land is zoned as Industrial in the MRS and in the Precinct 3A structure plan. Therefore the Precinct 3A Structure Plan Amendment will be consistent with the surrounding sites once these are developed.

7 Conclusions

The proposed Precinct 3A Structure Plan Amendment is consistent with the City of Gosnells Town Planning Scheme No 6 and the trip generation from Lot 414, Grove Road will have minimal impact on the immediate local road network as it is consistent with the City's intention for the Site.

Appendix 6

Engineering Infrastructure Servicing Report (TABEC)

**LOT 414 GROVE ROAD
INFRASTRUCTURE SERVICING REPORT**

Eastcourt Property Group

February 2017

CLIENT: EASTCOURT PROPERTY GROUP**PROJECT: LOT 414 GROVE ROAD, KENWICK****TITLE: INFRASTRUCTURE SERVICING REPORT**

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
DRAFT	29 September 17	Chris Clay	Chris Bitmead	Chris Bitmead
0	8 November 17	Chris Clay	Barry Smith	Barry Smith
1	17 November 17	Chris Clay	Barry Smith	Barry Smith
2	8 December 17	Chris Clay	Barry Smith	Barry Smith
3	1 February 2018	Chris Clay	Barry Smith	Barry Smith
4	13 February	Chris Clay	Barry Smith	Barry Smith

Note:

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APPENDICES

<i>APPENDIX A</i>	<i>SITE FEATURE SURVEY</i>
<i>APPENDIX B</i>	<i>GEOTECHNICAL INVESTIGATION REPORT</i>
<i>APPENDIX C</i>	<i>STORMWATER DRAINAGE PLAN</i>

1 INTRODUCTION

TABEC Pty Ltd has prepared the following servicing report for Grove Road Pty Ltd to summarise the results of a preliminary engineering assessment for the proposed industrial development of Lot 414 Grove Road, Kenwick (formerly lot 2008). The 15.4ha development site falls within Precinct 3A of the Maddington Kenwick Strategic Employment Area (MKSEA).

The report provides engineering advice on the capability and future infrastructure requirements of the site to support the proposed industrial development and the civil engineering influences on the development plan form. In particular we have considered earthworks, roads, drainage, wastewater, water, gas, power and communication servicing requirements to support development.

The report provides servicing advice on the development of a single lot with the intention of building multiple warehouses for varied commercial or light industrial use at a later stage. Thus, the report will provide commentary on how the servicing proposed will provide for the future development.

The site investigation and servicing recommendations are primarily based on preliminary advice from the City of Gosnells, Water Corporation and various relevant service authorities. The information provided within this report is current as of November 2017 and is subject to change in the event that development of the lots surrounding the site occurs.

The site is identified by the red boundary on Figure 1 presented below:

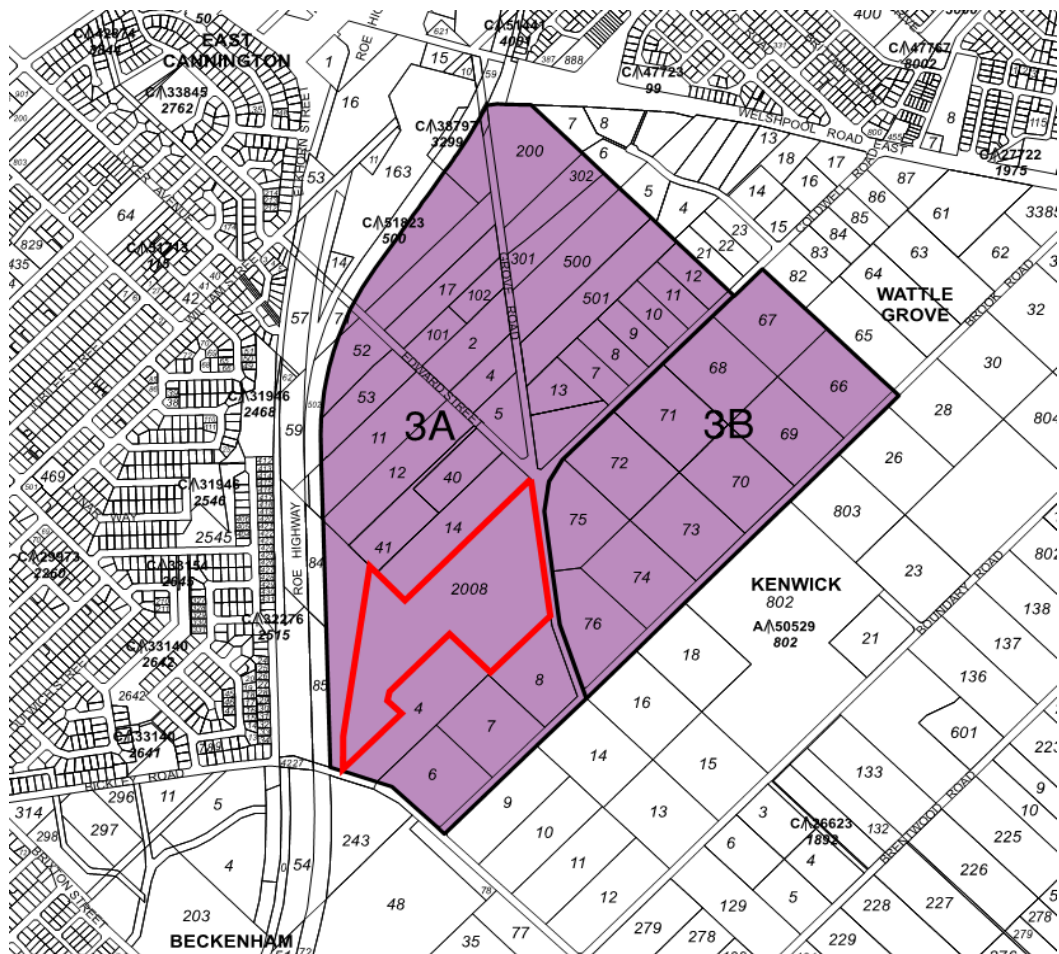


Figure 1 – MKSEA Precinct 3 (WAPC)

2 THE STUDY AREA

2.1 Site Description

Lot 414 Grove Road is situated approximately 17 km to the south-east of Perth within the MKSEA Precinct 3. The development site spans an area of 15.4ha with 360m of direct frontage to Grove Road, located within the City of Gosnells. The site is zoned mostly General Industry with a small area in the south west corner zoned General Rural and typically surrounded by general rural residential properties similar to the subject property.

There is an existing drainage swale which traverses approximately 330m through the middle of the site from north to south, discharging into the Yule Brook Main Drain. The Yule Brook intersects the south west corner of the site and runs for approximately 120m before entering the Public Transport Authority site. The site is classified as Multiple Use Wetland with the southern border abutting a landholding consisting of Resource Enhancement Wetland for which appropriate buffers and treatments will be applied.

2.2 Landform / Topography

Survey information provided by MNG indicates that the existing surface levels grade steadily at about 0.6% across the site from approximately 12.0m AHD at the north eastern corner to 7.0m AHD in the south western corner. The overall topography is relatively flat, as the 5m vertical difference across the site is experienced over a distance of 860m with no significant high or low areas other than in the open drains.

Figure 2 below illustrates the existing terrain and vegetation of the site. The feature survey plan provided by MNG can be referred to in further detail within Appendix A.



Figure 2 – Development Site Aerial image

The site is mostly cleared with a grassed surface. Trees are scattered around the existing farm sheds, in two tree lines and amongst dense vegetation surrounding the Yule Brook watercourse. The existing drainage swale possesses numerous bends to create a highly varied footprint ranging from 0.3m to 0.6m in depth with an average of about 10m wide. The Yule Brook Main Drain is clearly defined, surrounded by vegetation, and at an average depth of 1m and a width of about 10m with an average floodplain width of 50m.

2.3 Ground Conditions

JDSi completed a preliminary geotechnical investigation for the subject site in August 2017, with their report found in Appendix B. The 1:50,000 Environmental Geology map indicates the surface soils are associated with the Guildford Formation and comprise of:

Sc – CLAYEY SAND, silty in part, pale grey to brown, medium to coarse grained, poorly sorted, sub-angular to sub-rounded, frequent heavy minerals, rare feldspar, of alluvial origin.

Test pits undertaken by JDSi across the site generally show the following:

- Sand/Silty Sand (Topsoil) – Up to 0.1m of dark grey brown, fine to coarse grained; overlying,
- Sand – between 0.1m and 0.65m of grey, fine coarse grained; overlying,
- Sandy Clay – between 0.2m and 0.4m of medium to high plasticity, grey brown to orange brown; overlying,
- Sandy Clay – in excess of 1.3m of low to medium plasticity, pale grey to off white with trace of fine to medium grained calcareous gravel.

Permeability testing conducted by Douglas Partners in August 2016 as part of the MKSEA Precinct 3A structure plan for in-situ Silty Sand and Clayey Sand achieved on average 11.5m/day and 1.5m/day respectively.

The Geotechnical Investigation determined that the site is suitable for industrial development.

2.4 Groundwater

A desktop review of the Perth Groundwater Atlas reveals the historical maximum groundwater levels range from RL10.0m AHD in the north east to RL 7.0m AHD in the south west. The presence of groundwater at and near the surface will require imported fill to raise the development levels. Dewatering may be required when installing underground infrastructure. Further detail is provided within the Local Water Management Strategy prepared by Emerge Associates for Lot 414 Grove Road, Kenwick.

2.5 Acid Sulfate Soils

A desktop review of the Swan Coastal Plain Acid Sulfate Soils (ASS) Risk Map designates the site location as having “moderate to low ASS disturbance risk” (within 3m from surface) as illustrated in Figure 3. The ASS mapping indicates “high to moderate disturbance risk” along the Yule-Brook watercourse which will remain untouched as part of this development.

Groundwater Salinity	1500-3000 mg/L
Surface Geology Type	Guildford Clay: alluvium (clay, loam, sand and gravel)Qpg
Iron Staining Risk	Low risk
Garden Bore Suitability	Unsuitable
Acid Sulfate Class	Moderate to low risk
Public Drinking Water Source Areas (PDWSA)	N/A

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



Figure 3 – Perth Groundwater Atlas (DoW)

3 SITE WORKS AND EARTHWORKS

Site works for land development generally comprises the clearing, demolition, stripping, proof rolling and earthworks. The minimal vegetation spread throughout the site, existing fencing and the shed structure will require minor clearing and demolition respectively. A nominal 100mm of topsoil will be stripped before proof roll compaction and spread across areas not requiring structural fill or screened and blended with imported fill. Earthworks will consist of an import fill exercise to meet drainage and groundwater clearance requirements and tie into surrounding constraints. The feature survey identified several structures for demolition including the shed and several fences, with clearing of existing vegetation throughout the site to accommodate the imported fill.

Finalisation of the drainage strategy and the development plan, and a better understanding of the building envelopes, proposed use and loadings will assist in determining the development levels.

4 ROADS

The site is accessible via Grove Road, sharing a 360m boundary of direct frontage and a single crossover. Grove Road maintains a road reserve width of 20m. Grove Road asphalt seal is 7.4m wide without kerbing and unsealed shoulders ranging from 1 – 2m in width. Grove Road is line marked to separate the 3.7m wide lanes and is signposted at 60kph. Drainage swales either side of Grove Road capture the stormwater runoff.

Grove Road pavement appears to be in satisfactory condition and will be retained within the 20m wide existing road reserve. The western side will be kerbed for installation of a pit and pipe network by the proponent. Proposed crossovers to the development site will be sealed and kerbed.



Figure 4 – Existing Grove Road (Google)

5 STORMWATER DRAINAGE

5.1 Existing Drainage Network

There is currently no pit and pipe system present within the development site or Grove Road. Surface runoff collects in the open drain central to the site running from north to south which outlets into the Yule Brook water course. Roadside swales along Grove Road collect runoff from the crowned road and discharge into Yule Brook.

5.2 Stormwater Quantity Management

The Local Water Management Strategy prepared by Emerge Associates provides further insight into the site stormwater management and the effect of the development on the greater catchment area. The Stormwater Management Plan, located in Appendix C, was produced in consultation with TABEC and provides earthworks and drainage preliminary design. This plan, in conjunction with the LWMS, aims to facilitate drainage for the development of lot 414 Grove Road and the upstream catchment of Precinct 3A.

The drainage strategy utilises three basins, each with a different purpose but all eventually outlet into the Yule Brook. Drainage basin EC FSA A is sized to capture and detain the flow received from the neighbouring upstream development via a DN900 pipe. Runoff from the eastern and central portion of the site is directed toward basin EC FSA C which discharges into the wetland via the existing outlet. EC FSA B receives runoff from the western portion of the site before discharging directly into the Yule Brook.

Stormwater runoff on the west side of Grove Road will be formalised with the installation of a pit and pipe network to capture and convey the runoff before discharging into the existing road side swale.

Due to clayey soils it is expected that infiltration will be limited, with the focus aimed towards storage and compensation of the post development flow to control flow into Yule Brook. The depth of imported fill proposed across the development avoids the need for subsoil drainage.

5.3 Stormwater Quality Management

The key objectives for water quality management are to maintain surface and groundwater quality at pre-development levels and maintain the quality of water leaving the development area. Stormwater runoff quality should be managed through on-site treatment of runoff as well as non-structural measures to reduce applied nutrient loads.

To achieve these objectives, the water quality of stormwater runoff originating from the proposed development will be directed via a pipe network or overland flow path into vegetated detention basins underlain with high PRI media for treatment.

6 WASTEWATER

The site is located within the Water Corporation's Wattle Grove District for which currently no wastewater infrastructure is present. However, Water Corporation's planning allows for an extension of the DN750 sewer main from west of Roe Highway to the south of the site to collect flows from the MKSEA area. This will then ultimately discharge into an existing sewer downstream on Bickley Road.

As the above planning is a long term proposal, it is suggested that the development utilise Aerobic Treatment Units (ATUs) for onsite management of wastewater in line with the Department of Health regulations, until reticulated sewerage becomes available.

7 WATER SUPPLY

There is existing Water Corporation water infrastructure surrounding the proposed development site on Grove Road, with the existing farm shed connected with a water meter just south of the existing crossover. The DN150 main is PVC and capable of servicing the proposed development.

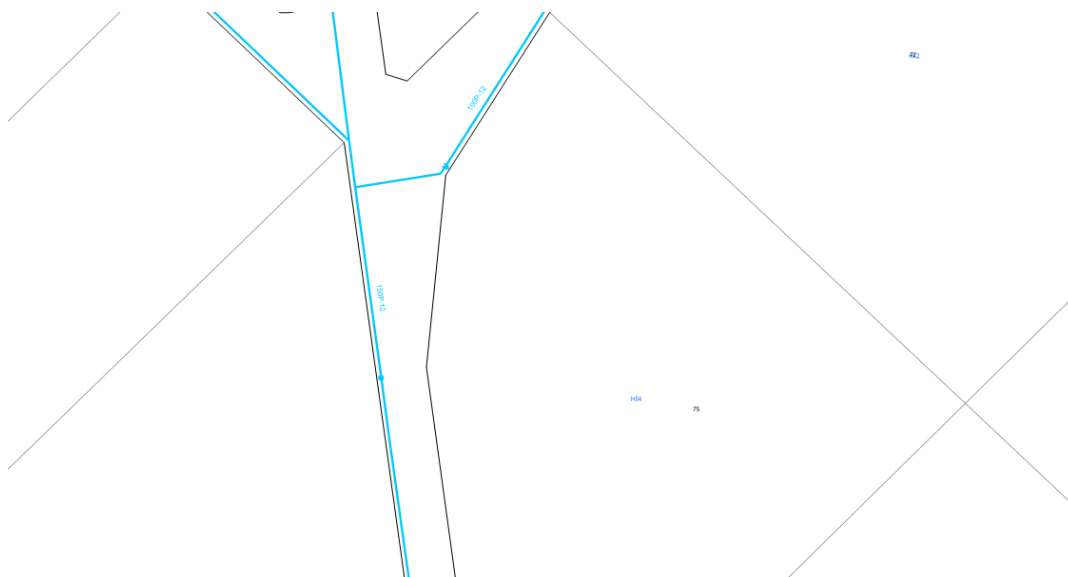


Figure 5 - Existing Water Infrastructure (Water Corporation)

8 GAS SUPPLY

A gas supply is not intended to be provided for the new development. However, if necessary, further investigations will be undertaken to determine if a gas supply is readily available and/or required.

9 POWER SUPPLY

High voltage power is present in overhead power lines on the eastern side of Grove Road which services existing dwellings direct from the overhead lines. The HV power will be more than sufficient to supply power to the proposed development. Given the small level of design required it would be recommended to deal direct with Western Power with no need for third party design.

There are no street lights existing in Grove Road, but due to the increased traffic volume and introduction of crossovers, streetlights may be required within the immediate vicinity for the development access/egress locations. The increased traffic may also trigger the requirement for a streetlight at the intersection of Coldwell Road and Grove Road.

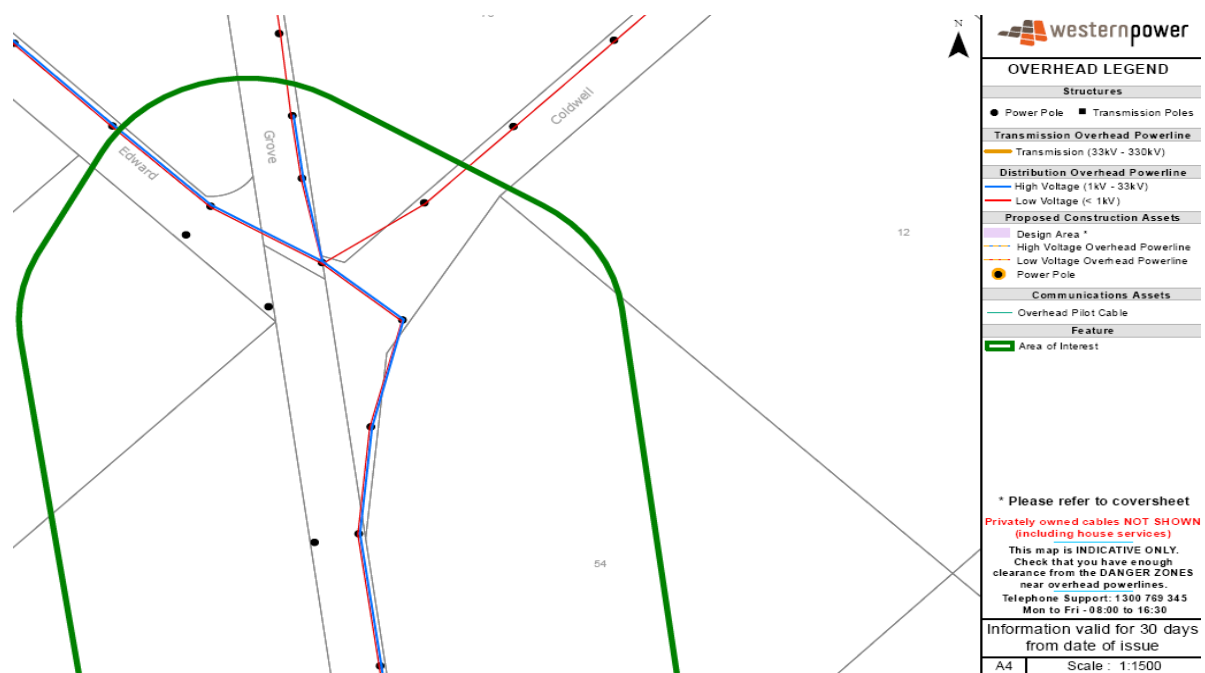


Figure 6 – Existing Overhead Power (Western Power)

10 TELECOMMUNICATIONS

Existing Telstra infrastructure can be found both north and south of Grove Road with Lot 414 serviced by a P50 and type 3 pit with two available connections. The Type 3 pit is capable of being extended further north with another length of P50 to service the northern portion of the proposed development.

Additionally, the development is within NBN Co's footprint and will be serviced in the future under the Greenfield rollout scheme.

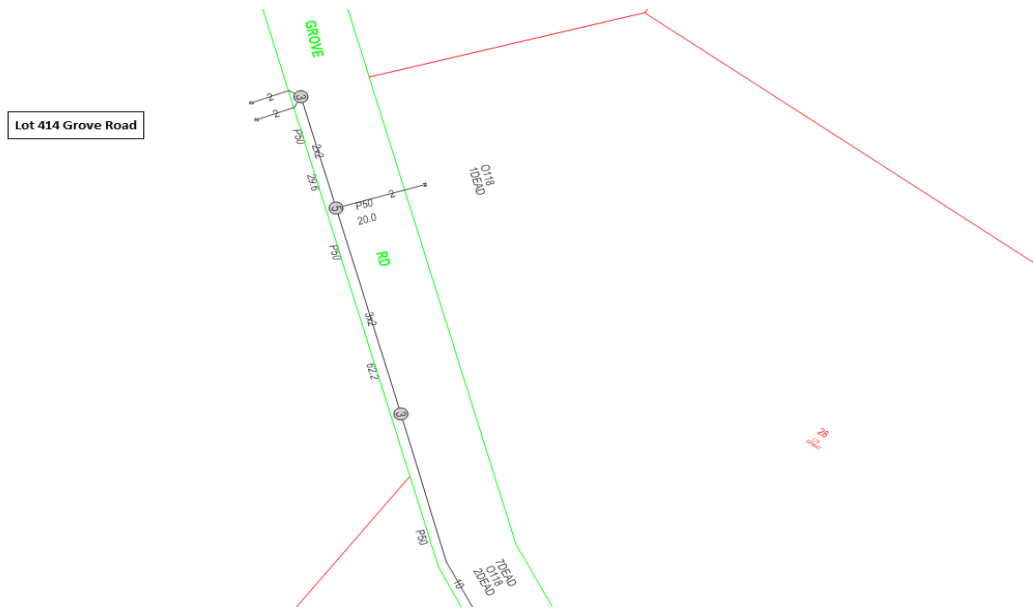


Figure 7 - Existing Telecommunications Services (Telstra)

11 CONCLUSION

Lot 414 Grove Road is situated within the extensively planned Maddington Kenwick Strategic Employment Area and has infrastructure readily available to service the proposed development.

From an engineering perspective, the site is suitable for immediate commercial and industrial development.

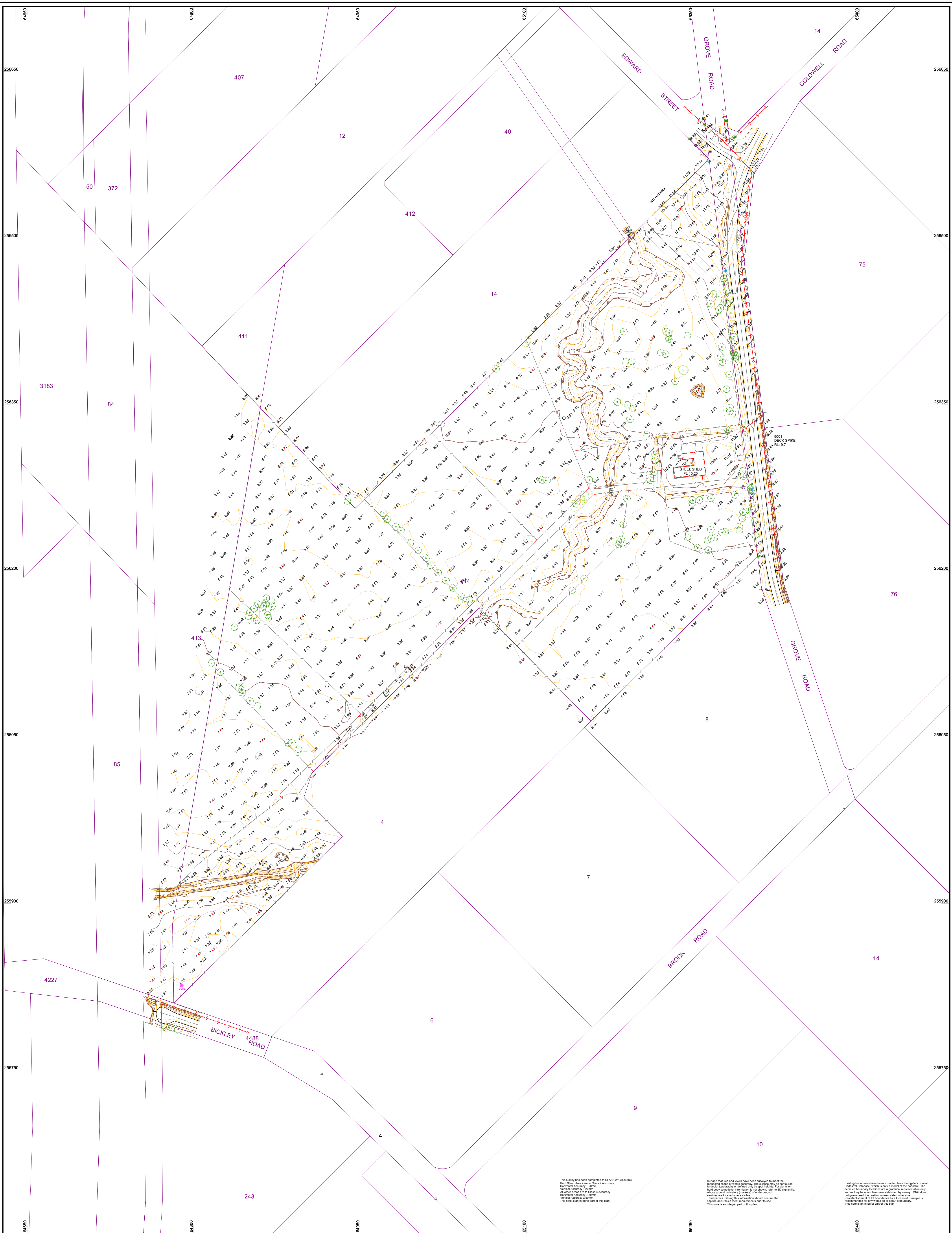
12 REFERENCES

- Western Australian Planning Commission, October 2016, Maddington Kenwick Strategic Employment Area Precincts 3A & 3B – Metropolitan Region Scheme Amendment 1302/57.
- JDSi, August 2017, Geotechnical Investigation Report Proposed Industrial Development Lot 414 Grove Road, Kenwick, JDS171347.
- Google Maps, July 2017, Streetview - Grove Road, Kenwick.
- Water Corporation, February 2017, Underground Asset Details (DBYD) - Grove Road, Kenwick.
- Western Power, July 2017, Underground Asset Details (DBYD) - Grove Road, Kenwick.
- Telstra, July 2017, Underground Asset Details (DBYD) - Grove Road, Kenwick.

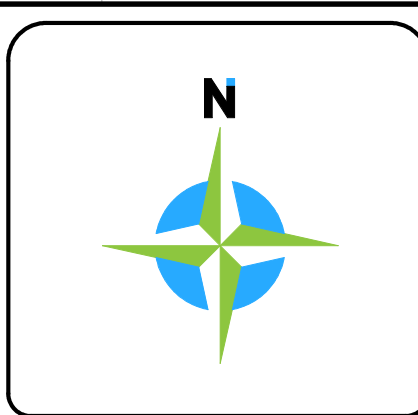
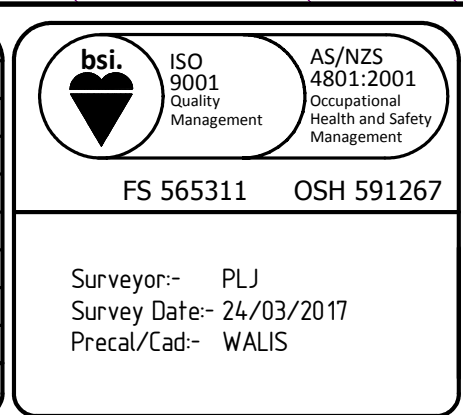
APPENDIX A SITE FEATURE SURVEY

Lot 414 Grove Road, Kenwick

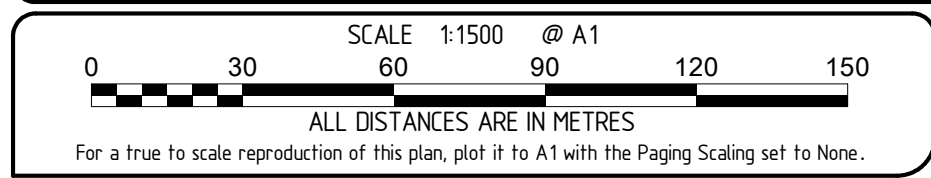
MNG Survey (March 2017)



A	Initial Issue	GBH	31/03/2017	CAY
Rev.	Description	Drawn	Date	Checked



LOT 2008 GROVE ROAD KENWICK DETAIL SURVEY	
CLIENT: <i>EASTCORP PROPERTY GROUP</i>	The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plan currency by contacting the Schuller Nolan Group.



The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.



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Project Mngnr.	Charles Younge	Datum	PCG94 / AHD
100647 - DE - 001 - A Job Plan Number Type Number Revision			

APPENDIX B GEOTECHNICAL SITE INVESTIGATION REPORT

Lot 414 Grove Road, Kenwick

JDSi (August 2017)

GEOTECHNICAL INVESTIGATION REPORT

Proposed Industrial Development Lot 414 Grove Road, Kenwick



JDS171347
August 2017

INTEGRITY

We are open, honest, and consistent in our principles and conduct, so we're able to build trusted relationships with our clients and partners.

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ACCOUNTABILITY

We always assume responsibility for our actions and make decisions in line with our economic, social, and ethical obligations.

EXCELLENCE

We pursue excellence in everything we do, challenging ourselves to look beyond the obvious and ensure ongoing improvement.

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Geotechnical Investigation Report

Lot 414 Grove Road, Kenwick

Prepared for:
Eastcourt Property Group
P O Box 456
Applecross WA 6953

Our ref: JDS171347-R01-Rev1

Prepared by:
JDSi Ground Engineering Pty Ltd
1 Nash Street
Perth WA 6000
10 August 2017

Document Authorisation

For and on behalf of JDSi Ground Engineering Pty Ltd



Neill Beattie
Principal Engineering Geologist

Quality information

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Rev1	1	PDF	Eastcourt Property Group	10/8/2017
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IMPORTANT INFORMATION SHEETS

“Your Geotechnical Report”

FIGURES

Figure 1 – Site Investigation Layout

APPENDICES

Appendix A – Results of Investigations

1 Introduction

This report presents the results of a geotechnical investigation carried out by JDSi Ground Engineering Pty Ltd (JDSi) for Eastcourt Property Group (Eastcourt) at Lot 414 Grove Road, Kenwick ("the site"), a proposed industrial development, within Precinct 3A (Special Control Area SCA1), of the Maddington Kenwick Strategic Industrial Area.

This work was commissioned by Mr Tom Oosterhof on behalf of Eastcourt, via a confirmation email dated 12 July 2017.

This report, and the information presented herein, must be read in conjunction with JDSi's "Your Geotechnical Report" information sheets attached to this report.

2 Site Description

The site occupies an irregular shaped parcel of open pasture that covers an area of 15.4361ha at the southern end of Special Control Area SCA1, bounded in the east by Grove Road, in the west by Lot 413, in the north by Lots 12 and 14, and in the south by Precinct 3B.

3 Project Objectives

The objectives of the geotechnical study were to:

- ▶ Review relevant client supplied information and any relevant JDSi projects previously undertaken in the area;
- ▶ Carry out subsurface investigations to define subsurface conditions across the site;
- ▶ Assess soil permeability and provide comments on on-site stormwater disposal; and
- ▶ Provide comment on relevant construction considerations.

4 Available Information

4.1 Client Supplied Information

The following relevant information was provided by Eastcourt and reviewed by JDSi as part of this investigation:

- ▶ Douglas Partners (DP) Report: *'Factual Report on Geotechnical Investigations, Proposed Industrial Subdivision – Coldwell Road, Kenwick'*. Project 8886988.07, dated August 2016;
- ▶ Western Environmental Pty Ltd (WEPL) Report, *'Detailed Site Investigation for Potential Contamination'*, Report No. 16.059-DSI-V2, dated 25 January 2017;
- ▶ Drawing: *'Proposed Amendment to Town Planning Scheme No.6 MKSEA – Precinct 3A & 3B'*, dated 22 February 2016; and
- ▶ Drawing: *'Proposed Amendment to Precinct 3A & 3B Boundary'*, dated 20 January 2012.

Relevant information from the above has been incorporated in the findings of this investigation and referenced accordingly.

4.2 Published Information

The following published information has been used in the preparation of this report:

- ▶ 1:50,000 Environmental Geology Series map (Armada) Geological Survey of WA; and
- ▶ Department of Water's online Perth Groundwater Atlas (<https://maps.water.wa.gov.au/>).

5 Investigation Fieldwork

Fieldwork was carried on 19 July 2017 in the full time presence of a Project Engineering Geologist from JDSi and comprised four hand auger boreholes, one Perth Sand Penetrometer (PSP) test, and three Dynamic Cone Penetrometer (DCP) tests, at selected locations across the site. Access to the site was from Grove Road, on the eastern site boundary. Access across the site was via existing tracks and across open paddock.

The investigation locations were measured during the fieldwork by hand-held GPS relative to Geocentric Datum of Australia (GDA94). Approximate investigation locations are shown on the Site Investigation Layout, **Figure 1**, attached to this report.

Each hand auger borehole was logged by the JDSi site representative in general accordance with the soil description guidance included in AS1726-2017 "Geotechnical Site Investigations". Geotechnical logs of the hand auger boreholes are attached as **Appendix A**.

PSP and DCP tests were carried out adjacent to the hand auger boreholes in general accordance with AS1289.6.3.3 (PSP) and AS1289.6.3.2 (DCP), except to a depth greater than required by the Standard. The results of the tests are presented in **Appendix A**, behind the hand auger borehole logs.

Surface elevations at investigations locations were not recorded.

5.1 Site Conditions

5.1.1 Existing Site Conditions

The site is generally flat lying with a gentle fall towards the south and southwest. Vegetation cover comprises grass, bushes and trees up to 15m in height. A large shed is present on the site, located adjacent to Grove Road on the eastern boundary of the site.

The ground surface comprises a layer of organic, Silty Sand topsoil. The 1:50,000 Environmental Geology map of the site indicates that the surface soils are associated with the Guildford Formation and comprise:

Sc – CLAYEY SAND, silty in part, pale grey to brown, medium to coarse grained, poorly sorted, sub-angular to sub-rounded, frequent heavy minerals, rare feldspar, of alluvial origin.

Geological mapping of the area by the Geological Survey of Western Australia indicates that the site is dominated by Quaternary Guildford Formation consisting of calcareous pale grey and brown silty and slightly sandy clay, overlain by a thin layer of Bassendean Sand. This is consistent with the findings of both the DP report and the WEPL report.

5.1.2 Published Groundwater Information

The site is included in the May 2003 (end of summer) and historic maximum groundwater information available on the Department of Water's online Perth Groundwater Atlas (<http://atlases.water.wa.gov.au/idelve/gwa/>). The May 2003 and historic maximum published groundwater contours indicates groundwater levels at the site can be expected to be at about RL 7.0m AHD to RL 10.0m AHD under most normal weather conditions. This is about 0.5m to 3m below current ground levels.

6 Results of Investigations

6.1 Subsurface Conditions

Hand Auger Investigations

Hand auger boreholes (HA1 to HA4) were advanced to depths of between 0.75m and 2.0m below ground level at the investigation locations shown on the Site Location Layout, attached as Figure 1. The hand auger boreholes were undertaken at locations selected on site by the JDSi site representative. The borehole records, showing detailed descriptions of the major strata encountered, in-situ test results and the depths at which disturbed samples were recovered, are presented in **Appendix A** along with explanatory notes.

Of the five hand auger boreholes, HA1 experienced hole collapse within sands below the water table, HA2 and HA3 experienced refusal at depths between 0.8m and 1.25m depth, and HA4 was progressed to the target depth of 2m.

The approximate locations of the hand auger boreholes, as recorded by hand held GPS, are summarised in Table 1.

Table 1. Summary of Hand Auger Borehole Locations

Hand Auger Borehole	Easting (m, WGS84)	Northing (m, WGS84)
HA1	403,479	6,457,449
HA2	403,418	6,457,124
HA3	403,320	6,457,219
HA4	403,074	6,456,964

The results of the hand auger boreholes indicate that the ground conditions across the site can be summarised as follows:

- ▶ Up to 0.1m of dark grey brown, fine to coarse grained, organic SAND / Silty SAND (Topsoil); overlying,
- ▶ Between 0.1m and 0.65m of grey, fine to coarse grained, SAND; overlying,
- ▶ Between 0.2m and 0.4m of medium to high plasticity, grey brown to orange brown, Sandy CLAY; overlying,
- ▶ In excess of 1.3m of low to medium plasticity, pale grey to off white, Sandy Clay with a trace of fine to medium grained calcareous gravel.

WEPL have completed a number of test holes along the western boundary of the site to a target depth of 1m. The near surface materials encountered generally comprised up to 0.5m of Topsoil and fine to medium grained SAND, overlying, brown, grey and orange grey Sandy Clay. The subsurface materials intersected by the WEPL test holes are consistent with the subsurface conditions intersected by the JDSi hand auger boreholes.

Perth Sand Penetrometer Testing

A Perth Sand Penetrometer test (PSP) was undertaken adjacent to HA1, as sand was encountered to a depth of 0.75m; the maximum depth of the hand auger borehole. The results of the PSP indicates that the sand is in a medium dense condition to approximately 0.6m depth and in a loose condition from 0.6m to the maximum depth investigated at 1.05m.

PSP testing was carried out in accordance with AS1289.6.3.3. The results of the PSP test is presented in the attachments following the test pit logs in **Appendix A**.

Dynamic Cone Penetrometer Testing

Dynamic cone penetrometer (DCP) testing was carried out adjacent to hand auger boreholes HA2 to HA4, as Sandy Clay was encountered at a maximum depth of 0.5m. DCP testing was carried out in accordance with AS1289.6.3.2 to a maximum depth of 1.2m. The results of DCP's are presented in the attachments following the test pit logs in **Appendix A**.

The results of the DCP's indicate that both the upper Sandy Clay layer and the underlying Sandy Clay with a trace of Gravel are generally in a Stiff to Very Stiff condition.

Groundwater

Groundwater was encountered between 0.75m and 0.9m depth in hand auger boreholes HA1, HA2 and HA4. Groundwater was not encountered in HA3, excavated to 0.8m depth. It should be noted that groundwater levels may vary over time in response to environmental factors, including rainfall, temperature, and other factors.

Groundwater monitoring wells constructed by WEPL adjacent to the western boundary of the site, and presented in the 2017 report as MW3 and MW7, indicate a groundwater level at between 1m and 2m below the ground surface in October 2016.

7 Assessment and Recommendations

7.1 Geotechnical Suitability

The aim of the current investigation is to assess the site for potential future development. Based on the results of the current investigation the following comments and recommendations are provided:

- ▶ The site is generally clear, lightly vegetated, level to very gently sloping, with subsurface soils in a generally undisturbed condition.
- ▶ Water was observed to pond locally on the site after periods of prolonged and/or heavy rain;
- ▶ The subsurface profile was found to comprise a thin layer of organic Sandy topsoil over fine to coarse grained Bassendean Sand, which in turn overlies low to high plasticity Sandy Clays of the Guildford Formation; and

- ▶ Any development on the site should be carried out in accordance with the following Australian Standard, as a minimum:
 - Standards Australia (2007) “Guidelines on Earthworks for Commercial and Residential Developments” Australian Standard AS3798 – 2007.

Based on the results of the investigation, the site is assessed as being geotechnically suitable for the proposed development following conventional site preparation and earthworks in accordance with relevant Australian Standards.

7.2 On Site Stormwater Disposal

Due to the presence of Guildford clays at shallow depths in the foundation, and the presence of a high water table, falling head permeability testing was not considered appropriate for this site and thus not undertaken. As such, the site is not considered conducive to the on-site disposal of stormwater.

8 References

The following published information sources have been reviewed by JDSi in compiling this report:

- ▶ Standards Australia (2011) “*Residential Slabs and Footings*” Australian Standard AS2870 – 2011
- ▶ Armadale (1986), Part sheets 2033 I and 2033 IV. (1:50,000 scale) Geological Series, Geological Survey of Western Australia.
- ▶ Standards Australia (1993) “*Geotechnical Site Investigations*” Australian Standard AS1726-2017.
- ▶ Water and Rivers Commission (1997) “Perth Groundwater Atlas”. Western Australia, Water and Rivers Commission.
- ▶ Standards Australia (2007) “*Guidelines on Earthworks for Commercial and Residential Developments*” Australian Standard AS3798 – 2007.



“Your Geotechnical Report”

1 Introduction

The information contained in this document is to inform JDSi's clients of the reasonable expectations of a geotechnical report and options to mitigate geotechnical risks and consequences. This information is provided to help clients understand where JDSi's responsibility as a geotechnical engineer, acting reasonably, begin and end. In doing so, it also highlights the responsibility of our client and third parties.

Please contact the JDSi Project Director should you not understand the report and the limitations of the information provided.

2 Collection and Interpretation of Data

Geotechnical investigations identify subsurface conditions only at the point of investigation. The material encountered during the investigation is recorded on logs and based on a visual assessment and (if undertaken) supported by laboratory test results. In the case of an Electric Friction Cone Penetrometer Test (CPT), the data recorded is a tip pressure and sleeve friction on a rod; from which ground conditions are inferred.

Actual conditions may differ from those encountered during the investigations and / or inferred a distance from the investigation stations. In addition, the actual interface between materials or units may be gradual or more abrupt than inferred from the results of the investigation.

A Chartered Geotechnical Engineer and / or Engineering Geologist should be retained through the various stages of the project to identify variances, conduct additional tests if required, and provide recommendations to address geotechnical / geological issues identified on site. The Chartered Geotechnical Engineer / Engineering Geologist should also review the actual conditions encountered to confirm that they are consistent with those inferred in this report.

3 Change in Subsurface Conditions

The geotechnical recommendations and parameters provided in this report are based on the ground conditions encountered at the time of the geotechnical investigation. Changes in the ground conditions can occur over time and include, but are not limited to, the following:

- ▶ Filling or excavation works (or other anthropologic events);
- ▶ Flooding;
- ▶ Groundwater fluctuations;
- ▶ Earthquakes or other such events;
- ▶ Works on neighbouring sites impacting on the subject site; and,
- ▶ Migration of pollutants from neighbouring properties.

JDSi should be consulted if there is any protracted delay in the issue of this report and the use of the recommendations provided.

It is important to note that where ground conditions have changed, additional geotechnical investigations and testing may be required to assess the impacts of the changed ground conditions.

4 Specificity of Report

This geotechnical report has been prepared for a specific project and design; therefore, it has been written to address specific geotechnical issues. In doing so, the following has been taken into account:

- ▶ The project objectives as described in the report;
- ▶ The client's budget and programme constraints;
- ▶ The specific site mentioned in the report; and,
- ▶ The nature and extent of the development at the site.

This report should not be used for any other purpose other than what has been specifically described and should not be relied upon if:

- ▶ The report was not written for you;
- ▶ The report was not written for your specific site;
- ▶ The report does not address your specific development;
- ▶ There is a significant delay between undertaking the report and developing the site; or,
- ▶ Significant changes to the site have occurred.

Where the information and recommendations contained within this report are being used by others, JDSi should be engaged during the design process to engage with the other members of the design team and review works being produced by the other design team members to confirm that it is consistent with the geotechnical report.

5 Environmental Issues

Unless specifically addressed in this report, environmental and contamination considerations are not included. The investigation methods required for environmental investigation often differ to those used for geotechnical investigations and the information contained within this report may not be appropriate for use by environmental engineering consultants and scientists.

This report was not prepared to address environmental issues and the client is responsible to ensure environmental considerations have been taken into account for the project. JDSi can provide information on environmental engineering consultants, should this be required.

6 Construction

The method of ground investigation used for geotechnical investigations limits JDSi's ability to know every detail about the ground conditions on site. JDSi use reasonable engineering judgement to form an assessment of the subsurface conditions at the site based on information obtained at specific locations.

Ground conditions may be encountered during construction that were not anticipated during the geotechnical investigation. Should this be the case, JDSi should be engaged to provide construction support as a means of mitigating the consequence of encountering unexpected ground conditions.

7 Responsibility of Others

JDSi has prepared this report for the use by our client. JDSi does not accept any responsibility from any third party, other than our client, who uses the information contained in this report. JDSi takes no responsibility for any damages suffered by any third party as a consequence of any decisions or action that have been made based on this report.

Further information regarding the responsibility of clients and other third parties should also be obtained from the following:

- ▶ “Guidelines for the Provision of Geotechnical Information in Construction”, published by the Institution of Engineers Australia;
- ▶ Australian Standard AS 2870 – 2011, Residential Slabs and Footings;
- ▶ Australian Standard, AS 5100 – 2004, Bridge Design Set; and,
- ▶ Any other Standard or Code of Practice applicable to the development.



Figures



PLAN
SCALE 1:5000

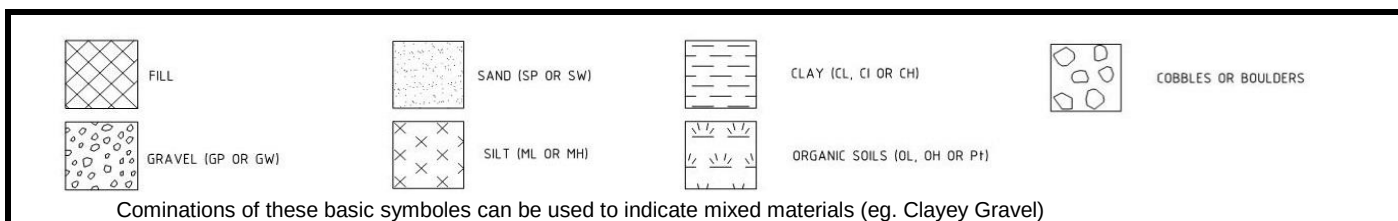
LEGEND

-  HAND AUGER LOCATIONS
-  APPROX SITE BOUNDARY



Appendix A – Results of Investigations

EXPLANATORY NOTES - SOIL DESCRIPTION



GP	Poorly Graded Gravel	SM	Silty Sand	CH	High Plasticity Clay
GW	Well Graded Gravel	SC	Clayey Sand	OL	Organic Soils (LP)
GM	Silty Gravel	ML	Low Plasticity Silt	OH	Organic Soils (HP)
GC	Clayey Gravel	MH	High Plasticity Silt	PT	Peat
SP	Poorly Graded Sand	CL	Low Plasticity Clay	Describe	Cobbles and Boulders
SW	Well Graded Sand	CI	Medium Plasticity Clay	Fill	Fill

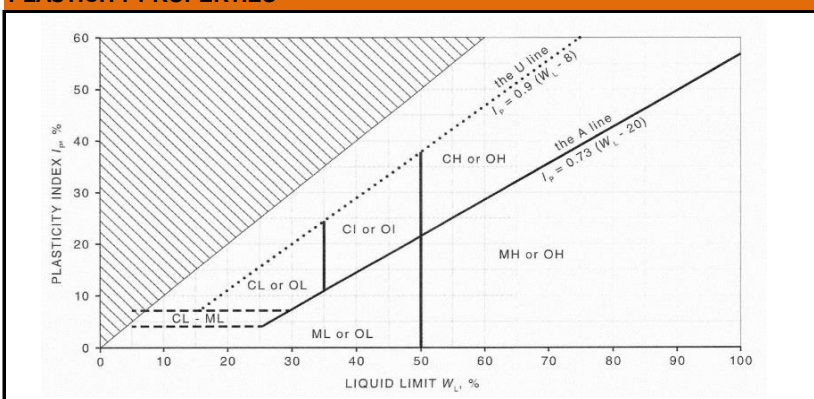
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726:2017, Section 6.2. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties if primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation.
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100mm	Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100mm	PSP blows per 300mm
VS	Very soft	0 to 12	0 to 2	<1	VL	Very Loose	<15	0 to 4	<1	0 to 2
S	Soft	12 to 25	2 to 4	<1	L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
F	Firm	25 to 50	4 to 8	1 to 2	MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
St	Stiff	50 to 100	8 to 15	3 to 4	D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VSt	Very Stiff	100 to 200	15 to 30	5 to 10	VD	Very Dense	>85	>50	>8	>15
H	Hard	>200	>30	>10	Note: PSP correlations only valid 450mm depth					

Consistency and density may also be inferred from excavation performance and material behaviour.

NON-CORED BOREHOLE NUMBER: HA1

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403479

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457449

BEARING:

CHECKED BY: RM

DRILLING					MATERIAL							
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA					0.0			SP	TOPSOIL / ORGANIC SILTY SAND: Fine to coarse grained, dark grey brown.	M	MD	
					0.10m				SAND: Fine to coarse grained, sub-angular to sub-rounded, grey, trace of silt/clay.	M to W	L to MD	
					0.75m				Hole Terminated at 0.75 m Collapse			
					1.0							
					1.5							
					2.0							
					2.5							

METHOD

AS - Auger Screwing
RR - Rock Roller
WB- Washbore
HA - Hand Auger
DPR Direct Push Probe

SUPPORT

C - Casing

PENETRATION

No Resistance

WATER

10 Oct., 73 Water Level on Date shown

water inflow

water outflow

SAMPLES & FIELD TESTS

U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE

D - Dry
M - Moist
W - Wet

CONSISTENCY / RELATIVE DENSITY

VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

NON-CORED BOREHOLE NUMBER: HA2

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403418

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457124

BEARING:

CHECKED BY: RM

DRILLING						MATERIAL						
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA				D	0.0				TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	L	Water perched above clay.
					0.10m				SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	W	L	
					0.30m			SP				
					0.5			CI	SANDY CLAY: Medium plasticity, pale yellow brown, fine to medium grained, sub-angular to sub-rounded sand.	M	F to St	
				D	0.60m			0.60m	SANDY CLAY: Low plasticity, pale brown/off white, fine to coarse grained sand with some silt, trace of fine to medium grained, sub-angular gravels of cemented sand/limestone.			
				D	1.0		CL			M	F to St	
					1.25m				Hole Terminated at 1.25 m Refusal			
					1.5							
					2.0							
					2.5							

METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe	PENETRATION No Resistance	SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test	CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System	CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
SUPPORT C - Casing	WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		MOISTURE D - Dry M - Moist W - Wet	

NON-CORED BOREHOLE NUMBER: HA3

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403320

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6457219

BEARING:

CHECKED BY: RM

DRILLING					MATERIAL							
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA		Not Encountered			0.0				TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	L to MD	
					0.10m	SP		SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	M	MD		
					0.20m			SANDY CLAY: Medium to high plasticity, grey brown, fine to coarse grained, sub-angular to sub-rounded sand.				
						CI			M	F to St		
					0.60m			SANDY CLAY: Low to medium plasticity, pale grey/off white, fine to coarse grained sand with some silt, with some fine to medium grained, sub-angular limestone gravels.		F to St		
					0.80m			Hole Terminated at 0.80 m Refusal				
					1.0							
					1.5							
					2.0							
					2.5							

METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe	PENETRATION No Resistance	SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test	CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System	CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
SUPPORT C - Casing	WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		MOISTURE D - Dry M - Moist W - Wet	

NON-CORED BOREHOLE NUMBER: HA4

PAGE: 1 OF 1

PROJECT NUMBER: JDS171347

PROJECT NAME: PRELIMINARY GEOTECHNICAL INVESTIGATION

PROJECT LOCATION: LOT 2008, GROVE ROAD, KENWICK



DATUM: GDA Zone 50

DRILL MODEL AND MOUNTING: HAND AUGER

DATE STARTED: 19/07/2017

ELEVATION:

HOLE DIAMETER (mm): 80 mm

DATE COMPLETED: 19/07/2017

EASTING (m): 403074

INCLINATION: -90

LOGGED BY: JC

NORTHING (m): 6456964

BEARING:

CHECKED BY: RM

DRILLING						MATERIAL						
METHOD	PENETRATION	SUPPORT	WATER	SAMPLES & FIELD TESTS	DEPTH (m)	Elevation (m AHD)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Name, Plasticity or Particle Characteristic, Colour, Secondary Soil Components, Minor Components and Origin	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
HA					0.0			0.10m	TOPSOIL / ORGANIC SAND: Fine to coarse grained, dark grey brown, trace of silt.	M	MD	Grass at surface. Rootlets throughout.
									SAND: Fine to coarse grained, sub-angular to sub-rounded, grey.	M	MD	
					0.5			0.50m	SANDY CLAY: Medium to high plasticity, grey brown, fine to coarse grained, sub-angular to sub-rounded sand.	M	F to St	
								0.70m	SANDY CLAY: Low to medium plasticity, pale grey/off white, fine to coarse grained sand with some fine to medium grained, sub-angular limestone gravels.			
					1.0				 Becoming off-white at 1.3m.	W	S to F	
					2.0			2.00m	Hole Terminated at 2.00 m Target depth			
					2.5							

METHOD AS - Auger Screwing RR - Rock Roller WB- Washbore HA - Hand Auger DPP Direct Push Probe	PENETRATION No Resistance	SAMPLES & FIELD TESTS U - Undisturbed Sample D - Disturbed Sample SPT - Standard Penetration Test	CLASSIFICATION SYMBOLS & SOIL DESCRIPTION Based on Unified Classification System	CONSISTENCY/ RELATIVE DENSITY VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard Fr - Friable VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
SUPPORT C - Casing	WATER 10 Oct., 73 Water Level on Date shown water inflow water outflow		MOISTURE D - Dry M - Moist W - Wet	

CLIENT: Eastcourt Property Group	DATE: 19/7/2017
PROJECT: Industrial Development	TESTED BY: JC
LOCATION: Lot 2008 Grove Road, Kenwick	HAMMER MASS: 9
SOIL TYPE: Silty CLAY	HAMMER DROP HEIGHT: 600mm

Test Location	HA1					
Test Depth mm	Blows/150mm					
0-150	SET					
150-300	3					
300-450	3					
450-600	2					
600-750	1					
750-900	1					
900-1050	2					
1050-1200						

CLIENT: Eastcourt Property Group	DATE: 19/7/2017
PROJECT: Industrial Development	TESTED BY: JC
LOCATION: Lot 2008 Grove Road, Kenwick	HAMMER MASS: 9
SOIL TYPE: Silty CLAY	HAMMER DROP HEIGHT: 510mm

Test Location	HA2	HA3	HA4			
Test Depth mm	Blows/100mm					
0-100	SET	SET	SET			
100-200	1	2	2			
200-300	2	2	2			
300-400	1	4	3			
400-500	3	4	4			
500-600	13	6	5			
600-700	9	7	5			
700-800	11	8	5			
800-900						

APPENDIX C STORMWATER MANAGEMENT PLAN

Lot 414 Grove Road, Kenwick

EMERGE (February 2018)

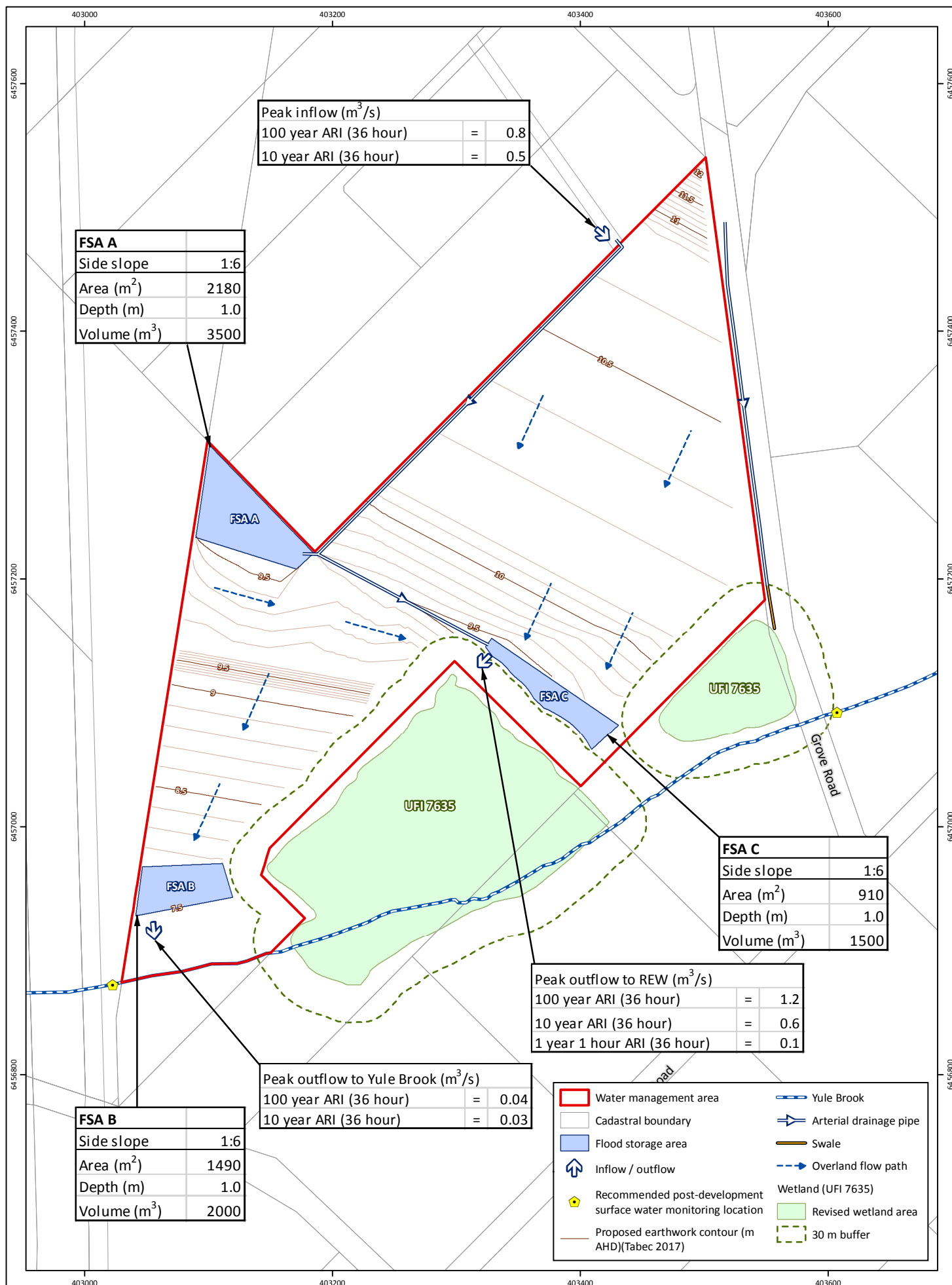


Figure 6: Stormwater Management Plan

Project: Local Water Management Strategy
 Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area

Client: Grove Road Pty Ltd

Plan Number: EP17-055(01)--F08c
Drawn: KNM
Date: 07/02/2018
Checked: RLE
Approved: DPC
Date: 07/02/2018



0 50 100
 Metres
Scale: 1:4,000@A4
 GDA 1994 MGA Zone 50

