Shire of Serpentine Jarrahdale Environmental Profile

Prepared for the Shire of Serpentine Jarrahdale

By Essential Environmental

June 2016

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1 INTRODUCTION

The Shire of Serpentine Jarrahdale (SJ Shire) has commenced preparation of a Local Planning Strategy. This Environmental Profile provides a summary of the natural environment of SJ Shire, highlighting issues associated with the environmental characteristics of the Shire in the context of future growth and development.

This report addresses the environmental context of SJ Shire only. It is recognised that this will need to be considered, together with economic and community (social) issues and opportunities, as part of the preparation of the local planning strategy.

1.1 The study area

SJ Shire is one of the largest local governments in the greater Perth metropolitan region with an area 905 km^2. It is situated approximately 45km south of the Perth CBD and 13km east of the Indian Ocean (Figure 1). SJ Shire is bound by the local governments of Wandering to the east, Murray to the south, Rockingham and Kwinana to the west and Armadale to the north. The Shire's populated places largely consists towns in a north south orientation of Byford, Mundijong (seat of government), Jarrahdale, and Serpentine.

The South Western Highway is the main road transport link that traverses the Shire in a north-south direction, passing though the Byford township. Albany Highway is adjacent on the eastern boundary and Kwinana Freeway runs parallel to the western boundary of SJ Shire. Tonkin Highway currently ends at Thomas Rd in Oakford though is planned to extend to Mundijong Rd.

1.2 Preparation of the report

Preparation of the Environmental Profile has included a review of available information relating to the natural environment, resources and environmental land use planning within SJ Shire. This is summarised in Section 2 and Appendix 1.

This report will be presented to key stakeholder groups through a series of workshops. The aim of the consultation is to identify any additional information with regards to the environment of SJ Shire which should be considered as part of the preparation of the local planning strategy.

1.3 Strategic guidance

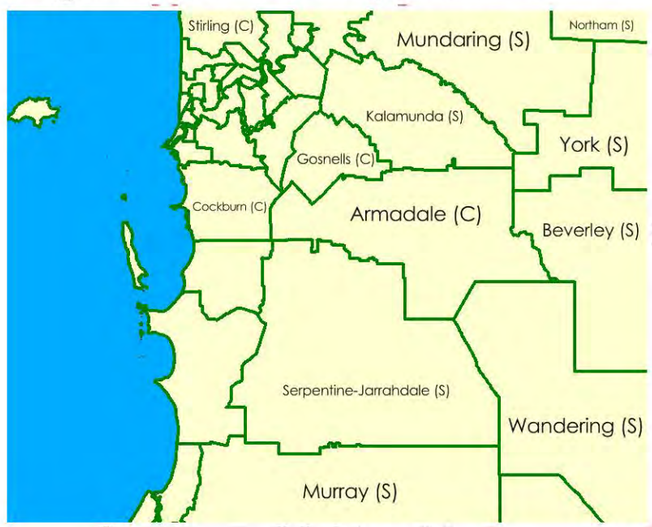
Strategic guidance is provided by a number of key documents at both local and State level. These include:

- Shire of Serpentine Jarrahdale Strategic Community Plan 2013 to 2022;
- Shire of Serpentine -Jarrahdale Rural Strategy 2013 Review (SJ Shire 2014);
- *Local Biodiversity Strategy for the Shire of Serpentine-Jarrahdale* (Ironbark Environmental, 2008);
- Draft Perth and Peel@3.5million: South Metropolitan Peel Framework (WAPC, 2015); and
- Draft Green Growth Plan for Perth and Peel @ 3.5 million (Government of WA, 2016).

These documents are described briefly below. Additional documents which have been considered as part of the preparation of this report are summarised in Appendix 1.

Shire of Serpentine Jarrahdale - Environmental Profile

Figure 1 - Study area



City of Armadale

Byford

Mundijong

Jarrahdale

Serpentine

Shire of Serpentine-Jarrahdale

City of Rockingham

Legend

- Local government boundary
- Populated places
- Road centerlines

Data source: SJ Shire, Landgate, MRWA. Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3

0 5.6 km

essential environmental

1.3.1 Strategic Community Plan 2013 to 2022

The Shire's Strategic Community Plan 2013 to 2022 is the key guiding document for the Shire. It outlines a Community Vision for

> *A sustainably developed Shire, where the community, local economy and natural environment are interconnected and thriving.*

Part of the vision statement highlights that in 2022, *"the area's distinct rural character will be intact, however the increasing number of residents who arrived over a decade will be suitably accommodated across a diverse range of village environments. Development across the Shire will be delivered in a sustainable manner. Regional planning will be supported by strategic alliances with key stakeholders.*

Water will be available through an integrated water cycle management program, waste will be at reduced levels through waste recovery and reuse initiatives. Local landscapes will be protected and enhanced, and Climate Change will be a very real focus for the Council; the community and local partners."

The Strategic Community Plan contains six vision categories; two of which are built environment and natural environment. The strategies and actions under these categories are summarised in Table 1.

Table 1: SCP actions relevant to the Environmental Profile

Category	Strategy	Action
Built environment	Urban Design with Rural Charm	Maintain the area's distinct rural character, create village environments and provide facilities that serve the community's needs, and encourage social interaction
		Provide appropriate amenities and accommodation for the Shire's growing population of youth and seniors.
		Interact with industry bodies to identify opportunities for the Shire.
	Appropriate Connecting Infrastructure	Plan and develop public transport networks link the community with the built and natural environment
		Ensure that planning for the bridge and road network incorporates community safety and emergency management.
		Enhance streetscapes and public places with vegetation that is natural to the area, sustainable (water wise) and cost effective.
Natural Environment	Responsible Resource Management	Conserve and recycle our water via an integrated water cycle management program.
		Reduce the creation of waste, facilitate waste recovery and reuse, and minimise the negative environmental impacts of waste disposal.
	Excellence in Environmental Management	Protect, restore and manage our landscapes and biodiversity.

Category	Strategy	Action
		Provide recreational, educational and economic access to natural assets without compromising their quality and integrity.
		Adapt to Climate Change by understanding the local environmental conditions.
	Environmentally Active Community	Support community groups (both new and existing), who are preserving and enhancing the natural environment.

These strategies and actions should guide preparation of the Local Planning Strategy.

1.3.2 Growth outlook

The Shire is projected to have a significant population increase of 128% over the next 20 years (ABS, 2014). Table 2 shows the population forecasts of the different settlement areas of SJ Shire, as shown in Figure 2.

Byford and Mundijong are predicted to have the greatest population growth with predicted increase of 103.6% and 667% respectively; this may be attributed to their location to the South Western Highway and proposed Tonkin Highway, practical topography and long term strategic planning.

Table 2: Population projections in settlement areas

Year	2016	2021	2026	2031	2036	Percentage increase
Byford	15,049	22,192	25,698	28,601	30,636	103.6%
Cardup	1,900	2,076	2,031	2,012	2,016	6.1%
Darling downs	3,010	3,816	4,227	4,317	4,323	43.6%
Hopeland - Keysbrook	558	597	632	659	683	22.4%
Jarrahdale	2,429	2,444	2,486	2,548	2,623	8.0%
Mundijong	2,316	5,187	8,887	13,050	17,769	667.2%
Oakford - Oldbury	676	724	1,314	2,050	2,677	296.0%
Serpentine	1,809	2,034	2,370	2,556	2,608	44.2%
Shire total	29,763	41,091	49,671	57,824	65,371	128.3%

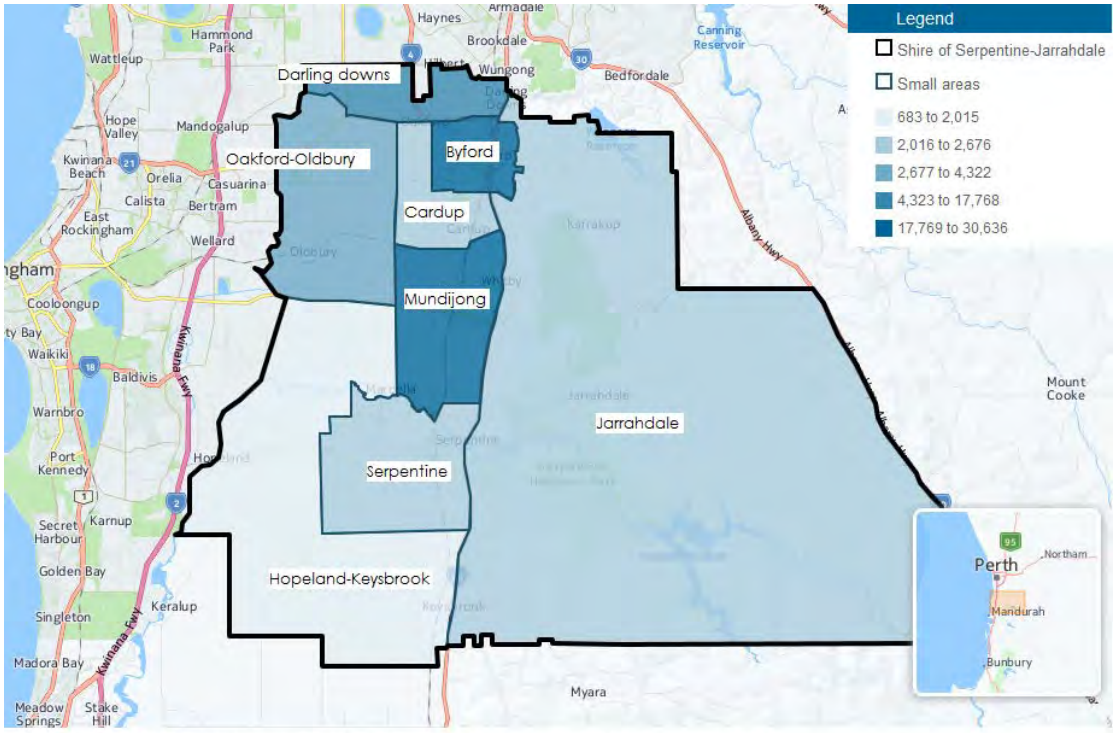


Figure 2: Settlement areas.

1.3.3 Shire of Serpentine -Jarrahdale Rural Strategy 2013 Review (August 2014)

The Rural Strategy has guided development in SJ Shire since 1994. The Strategy was updated in 2013 to incorporate minor modifications made in 2003 and 2006, as well as further modifications based on a review undertaken during 2011-2012.

The overall purpose of the Rural Strategy is to:

> *preserve and enhance the Shire's rural character and its role as an important economic contributor to the Shire and broader region.*

The Rural Strategy also contains a number of objectives under three themes as follows:

THEME: PROTECTION OF NATURAL ASSETS

- 01. Ensure that protection and enhancement of biodiversity assets in the Shire is considered early in the planning process.
- 02. Maintain and enhance the quality and quantity of remnant vegetation throughout the Shire.
- 03. Protect the integrity of Resource Enhancement and Conservation Category wetlands throughout the Shire from inappropriate land use.
- 04. Minimise offsite nutrient loading through appropriate land management and drainage considerations.
- 05. Recognise that a large proportion of the Shire's rural areas are classified as Multiple Use palusplain and that there may be opportunities for bona-fide rural activity within these areas.
- 06. Consider sustainable and efficient groundwater use, allocation and alternative water sources as an integral component of the planning process.

- 07. Prevent the worsening of land and water quality as a result of development, particularly on the palusplain

THEME: PROTECTION OF RURAL ATMOSPHERE

- 08. Maintain the 'nodal' pattern of urban development and urban villages in the Shire, interspersed with rural wedges. Specifically maintain a distinct 'rural wedge' between Serpentine and existing/ proposed urban areas to the north.
- 09. Facilitate an appropriate form of rural living development in appropriate locations in the Shire's rural areas.
- 10. Protect the landscape integrity of the scarp.
- 11. Recognise landscape as a legitimate issue for consideration within the planning and development process.
- 12. Subject to confirmation in the Urban Growth and Activity Centres strategies, limit the identification of new urban nodes within the Shire for the lifetime of this strategy.
- 13. Consolidate medium-long term urban growth within the already defined areas of Byford and Mundijong-Whitby.

THEME: FACILITATE PRODUCTIVE RURAL AREAS

- 14. Recognise the legitimacy of a broad economic base within the Shire's rural areas that does not focus solely on broad-acre agriculture.
- 15. Recognise and facilitate the on-going economic development of the Shire's rural industries/activities as a mechanism to meet the objectives of the 'natural assets' and 'rural atmosphere' objectives (identified above).
- 16. Promote agri- and rural-tourism within the Shire.
- 17. Recognise the importance of best practice environmentally managed extraction of Basic Raw Materials within the Shire.
- 18. Promote and encourage alternative agricultural land uses (provided they do not contribute to land degradation).

These objectives should guide preparation of the Local Planning Strategy.

1.3.4 Local Biodiversity Strategy for the Shire of Serpentine-Jarrahdale (Ironbark Environmental, 2008

The *Local Biodiversity Strategy for the Shire of Serpentine-Jarrahdale* (Ironbark Environmental, 2008) was adopted by the Serpentine Jarrahdale Council toward the end of 2008. It identifies 6333 ha of natural areas in the Shire. These are areas of bushland and vegetated wetlands and waterways on private lands and local reserves. 5986 hectares of these natural areas are on private lands, making the support of landowners critical to the implementation of the Strategy.

SJ Shire adopted a *Biodiversity Incentives Strategy for Conservation on Private Property* in October 2010. The strategy provides for a range of mechanisms to assist with sound biodiversity management practices on private property including:

- Directing private property owners to grant funding;
- Zoning including conservation zoning and special purpose conservation living zoning with associated rate relief; and
- A stewardship healthy habitats program providing assessment and guidance on management.

1.3.5 Draft Perth and Peel@3.5million: South Metropolitan Peel Sub-regional Planning Framework

The draft framework considers where future homes and jobs will be located; what community and social infrastructure will be required; better integrated use of existing infrastructure; protection of important environmental assets and critical services; and staging and sequencing of future development.

The South Metropolitan Peel Sub-regional Planning Framework proposes that by 2050, SJ Shire will have a population of 113,058, which includes an additional 94,563 residents. It also identifies an urban infill dwelling target for SJ Shire of 1,365, which is anticipated to provide for 3,003 residents. Key areas of urban and industrial development identified in the draft South Metropolitan Peel Sub-regional Planning Framework are:

- Byford urban area;
- Mundijong-Whitby urban area;
- land to the south of Byford urban area (proposed urban expansion area);
- land to the north of Mundijong-Whitby urban area (proposed urban expansion area);
- land to the south of Mundijong-Whitby urban cell (proposed urban expansion area);
- Serpentine urban area;
- Jarrahdale townsite;
- West Mundijong Industrial Area; and
- Cardup Business Park.

A regional playing field is indicated in Cardup, on the east of the South-West Highway, with a cemetery, university and technical school indicated in the vicinity of Mundijong.

1.3.6 Draft Green Growth Plan for Perth and Peel @ 3.5 million

The Green Growth Plan outlines an environmental program for the protection of both Commonwealth matters of national environmental significance and State environmental values, in the context of a projected population growth to 3.5 million by 2050. It has considered the cumulative environmental impacts of growth to 3.5 million people and proposes a number of conservation outcomes and objectives that will be achieved over its 30 year lifespan, outlined in the Strategic Conservation Plan. Draft plan's Action Plans F and G set out conservation and environmental commitments to avoid environmental impacts on a site by site basis as development occurs over the coming decades.

The development actions or 'classes of action' which have been considered by the assessment, consistent with the South Metropolitan Peel Sub-regional Planning Framework (and other draft frameworks) are:

- Urban and industrial development;
- Rural residential development;
- Infrastructure development;
- Basic Raw Materials extraction; and
- Harvesting of pine plantations.

Where a development proposal falls within the definition of a 'class of action', the streamlined environmental approval processes detailed in Action Plans A to D will apply and referral under Part 9 of the EPBC Act will no longer be required and cannot occur. In order for an environmental approval to be granted, proponents will be required to meet the relevant conservation and environmental commitments set out in Action Plans F and G and contribute towards

implementation of the Conservation Program described in the Strategic Conservation Plan and Action Plan H.

The draft Green Growth Plan recognises that reducing nutrient inflow into the Swan Canning and Peel Harvey estuaries is essential to improving the long–term health of these systems. The draft plan commits to the introduction of targeted mandatory soil testing for agricultural properties of 40 hectares or greater in size in the Swan Canning and Peel Harvey coastal plain catchments, as well as long-term drainage intervention programs in both systems and a suite of other high priority measures to improve water quality.

2 EXISTING ENVIRONMENT

2.1 Climate

The climate in SJ Shire is typical of the south-west of Western Australia with hot dry summers and cool wet winters. The nearest Bureau of Meteorology (BoM) stations to SJ Shire with available climate data are located approximately seven kilometres north-east, and 18 kilometres west of Byford at Wungong Dam (Station No. 9044), and Medina Research Centre (Station No. 9194), respectively. Rainfall and temperature data collected at these stations are generally considered to reflect the climate of Serpentine-Jarrahdale.

Maximum temperatures at Medina Research Centre occur in summer and minimum temperatures occur in winter, with average temperatures peaking in February at approximately 32°C, and dropping to approximately 8°C in July-August (BoM, 2016)(Figure 3).

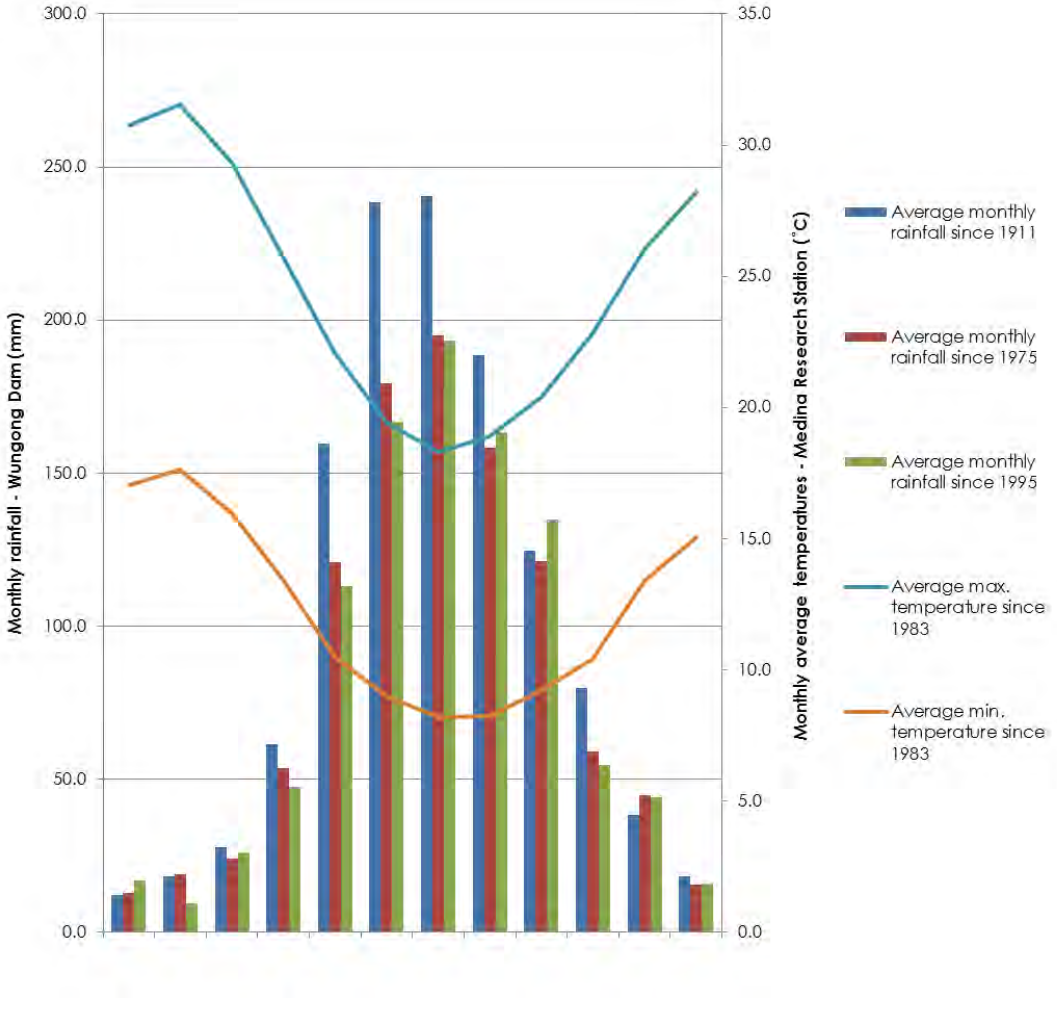


Figure 3: SJ Shire average monthly rainfall and temperature

As presented in Figure 3, the average annual rainfall recorded at Wungong Dam since 1911 is 1225 mm but has declined in recent years to an average of 1012 mm since 1975, and 998 mm since 1995. The minimum recorded annual rainfall occurred in 2010 at just 520 mm and the maximum was recorded in 1917 at 1958 mm. The average annual rainfall on the Swan Coastal Plain is generally less than that on the Darling Plateau, ranging from 800 to 1000 mm.

The majority of rainfall occurs in winter between May and September with the driest months being January and February. Whilst average annual rainfall has generally declined in recent years, it has actually increased in the late winter and autumn months of August and September. This may be indicative of changing rainfall patterns bringing more frequent intense rainfall events later in the year, with longer dry periods in between.

Wind data collected at Medina Research Centre shows that prevailing winds at the station are seasonally variable and exhibit diurnal variation caused by the regional weather patterns. Mean wind speeds are higher in late spring (November) in the morning (9am), and in early summer (December) in the afternoon (3pm), with mean monthly speeds ranging from 14 – 21 km/h at these times (BoM, 2016). Wind direction at Medina Research Centre is typically westerly-south-westerly in the morning (9am) and north-easterly direction in the afternoon (3pm). However, given that this weather station is located near to the coast and approximately 19 km west of Serpentine-Jarrahdale, it should be noted that the strength and direction of winds further inland at the Shire may not necessarily be reflected by these patterns.

2.1.1 Climate change

Reports from the International Panel on Climate Change (IPCC) provide limited detail on Australian climate change, particularly when it comes to regional climate change projections. Climate change in Australia (CSIRO, 2007, updated 2015) was developed by the Australian Greenhouse Office together with CSIRO and the Bureau of Meteorology. It is based upon international climate change research including conclusions from the IPCC's fifth assessment report. It also builds on a large body of climate research that has been undertaken for the Australian region in recent years.

The CSIRO has provided a number of projections based on the outputs of global climate models (named CMIP5) that estimate likely changes in regional climate for defined natural resource management clusters around 2030 (near future) and 2090 (late century). Regional clusters correspond to the broad-scale climate and biophysical regions of Australia. SJ Shire is located in the Western Australian Southern and South-Western Flatlands sub-cluster (Hope P. et al., 2015).

The CSIRO predicts that winter rainfall in the WA Southern and South-Western Flatlands sub-cluster will decline by up to approximately 15% in the near future (2030), and up to around 30% in the late century (2090) under an intermediate emissions scenario (RCP4.5). This projection increases to a 45% decline in rainfall under a high emission scenario (RCP8.5) (CSIRO, 2007). Temperature is predicted to increase by 0.5 to 1.2˚C by 2030 (CSIRO, 2007) (see Figure 4). This rise in temperature has the potential to impact on plants, animals and people, through increased heat stress and increased risk of bushfires.

It has also been reported that climate change is likely to result in lower spring and winter rainfall in WA's south west (the Southern and South-Western Flatlands sub-cluster), coupled with more intense rainfall events and longer periods of drought linked to reduced soil moisture and increased evaporation rates. This variability has the potential to result in localised flooding from stormwater during extreme events, which may become more frequent in the future. Furthermore, declining streamflows and superficial groundwater levels have been observed over the past ten years, most likely as a result of declining annual rainfall. Continuing reductions are likely to maintain this pattern and may have significant impacts on surface and groundwater availability for both human and environmental needs. As groundwater levels decrease, climate change may also increase the risk of acidification and heavy metal contamination resulting from the disturbance of acid-sulfate soils.

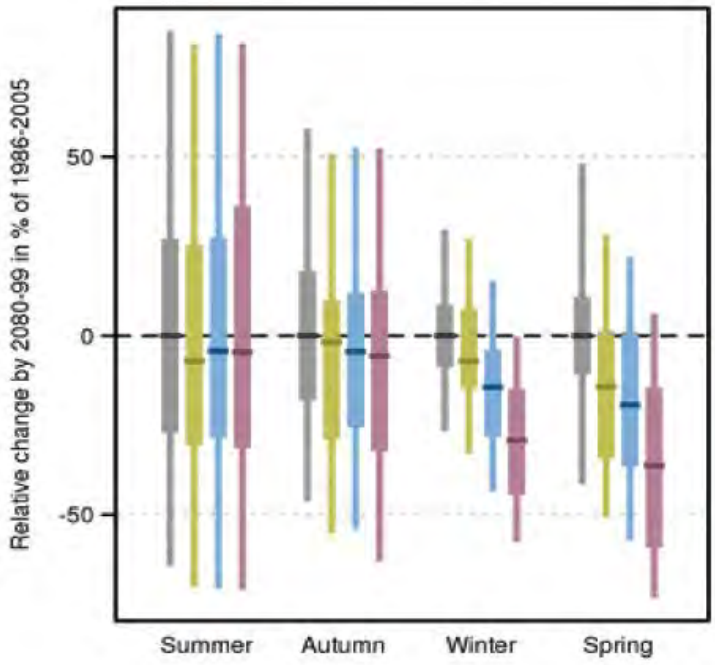


Figure 4: Projected seasonal rainfall changes for the Southern and South-Western Flatlands west sub-cluster for 2090. Rainfall anomalies are given in per cent with respect to the 1986–2005 mean under RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (purple). Natural variability is represented by the grey bar (Hope P. *et al*., 2015).

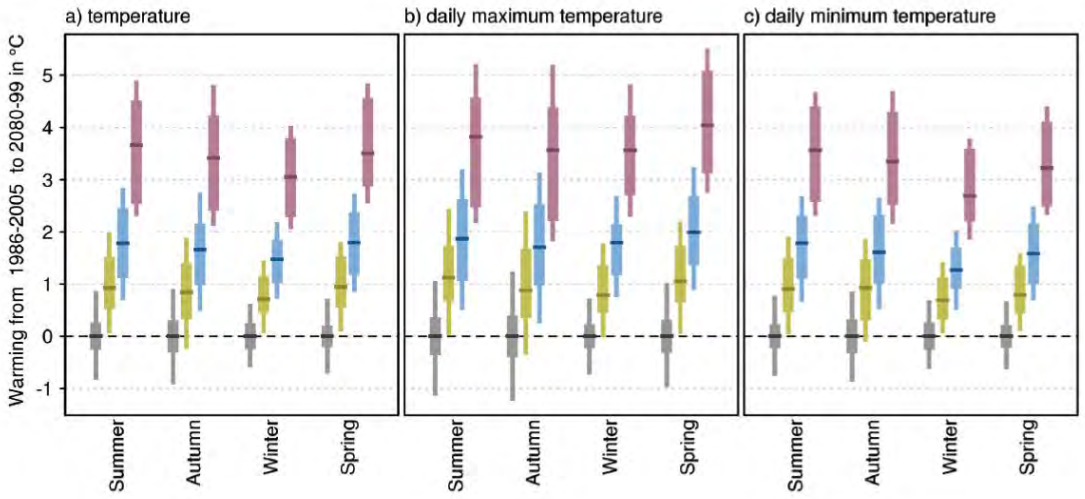


Figure 5: Projected seasonal surface air temperature changes for the Southern and South-Western Flatlands west sub-cluster to the mean (a), daily maximum (b) and daily minimum temperature (c). Temperature anomalies are given in °C relative to the 1986–2005 mean under RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (purple). Natural climate variability is represented by the grey bar (Hope P. et al., 2015).

2.1.2 Key considerations for strategic environmental planning

Key climate considerations for strategic planning are:

- **Temperature** – Increases in temperature are likely to result in increased needs for cooling and/or impacts on environmental and public health. Consideration should be given to heat island impacts and the need for green infrastructure to mitigate heat increases in "city" environments. Development should incorporate passive solar design and breezeways and provide shade in public and private places.
- **Rainfall change** – may result in localised flooding and pressure on stormwater systems, as well as pressure on available water sources.
- **Extreme weather** – may require improved emergency management responses and plans. Infrastructure to adequate to manage extreme weather conditions.

2.2 Air quality

Air quality in SJ Shire is generally good.

Dust from construction sites including residential subdivisions is an issue in some parts of SJ Shire. In some of the townsites, haze from wood heaters and photochemical smog may also be an issue which will need to be managed as the Shire's population increases.

The extraction of basic raw materials can result in air quality impacts such as dust, noise and light. Overspray of chemicals should also be considered in areas of intense agriculture, as well as odour from regional waste disposal sites, abattoirs, piggeries and animal feed lots.

2.2.1 Greenhouse gas emissions

SJ Shire is actively reducing its greenhouse gas emissions through the installation of renewable energy sources for powering Shire buildings. This includes the SJ Shire Administration Centre, Atwell Pavilion in Mundijong, Bruno Gianatti Hall in Jarrahdale, Byford Hall and the Serpentine Jarrahdale Community Recreation Centre, which also benefits from wind energy.

SJ Shire also works with the Cities of Armadale and Gosnells to deliver the Syt! (Switch your thinking) program. This program aims to develop partnerships with business, industry and residents, to encourage energy efficient, water-wise and waste reducing behaviour.

2.2.2 Key considerations for strategic environmental planning

Key air quality considerations for strategic planning are:

- **Dust** – from construction sites including residential subdivisions should be monitored and infringement notices issued where necessary, consistent with the Dust and Sand local law (2008).
- **Haze and smog** – may require monitoring and management as the population increases.
- **Odour** – from waste disposal sites, piggeries, abattoirs, animal feedlots and other intensive agricultural activities may require the establishment of suitable buffers.
- **Greenhous gas emissions** – which result from Shire operations may be reduced through increased use of renewable energy and implementation of actions to improve energy efficiency.

2.3 Land resources

2.3.1 Geography, topography and land forms

SJ Shire is unique in its topography and landform with two distinct halves. The western portion of SJ Shire comprises low flat topography, typical of the Swan Coastal Plain, whilst the eastern portion is characterised by undulating ridge peaks and troughs of the landform of the Darling Plateau. At the junction of the two landforms, known as the Darling Scarp, the topography is steep, with an average gradient of five percent.

The topographic features of the Darling Plateau and Darling Scarp allow for substantial water bodies to form, such as the Serpentine and Wungong Dam, and are an important catchment for surface water runoff. Figure 7 shows the topography of SJ Shire at 5m contours.

2.3.2 Geology and soils

Figure 7 presents mapping from Geoscience Australia's *Surface geology of Australia 1:1,000,000 scale, Western Australia* (Stewart et al. 2008). The soils of SJ Shire are reflective of the topography. The eastern Darling Scarp typically has a geology of gneiss, granite and shale with colluvium soils of gravel, clay-silt-sand, whilst the Swan Coastal Plain having the Guildford Formation of shallow sands over a basal conglomerate (typically clay). The lithographic description of soil types is provided in Table 3.

Table 3: Soils of SJ Shire (source: Stewart et al. 2008)

	Map symbol	Lithographic description
Darling Scarp	An	gneiss, granulite, migmatite
	Czl	Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite
	Ag	granite, granodiorite, tonalite, monzonite, diorite, syenite
	Nsca	shale, conglomerate, quartzite, sandstone,
	Qrc	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite
Swan Coastal Plain	Qag	Alluvial sand and clay with shallow-marine and estuarine lenses and local basal conglomerate
	Qdcb	Basal conglomerate overlain by dune quartz sand with heavy mineral concentrations
	Qt	Lacustrine or residual mud, clay, silt and sand, commonly gypsiferous and/or saline; playa, claypan, and swamp deposits; peat; peaty sand and clay; halitic and gypsiferous evaporites

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 6 - Topography

City of Armadale

City of Kwinana

City of Rockingham

Byford

Mundijong

Jarrahdale

Serpentine

Shire of Serpentine-Jarrahdale

Legend

- Local government boundary
- Populated places
- Road centerlines
- Topographic contours (5m)

Data source: SJ Shire, Landgate, MRWA. Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3

0 5.6 km

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2.3.3 Basic raw materials and minerals extraction

The Shire has significant resources of bauxite, mineral sands, sand, gravel, clay and hard rock. The bauxite and mineral sands industries impact on large areas and require intensive rehabilitation to stabilise the surface.

Regionally significant basic raw materials data was obtained from the Department of Mines and Petroleum. There are approximately 10 sites in SJ Shire, most identified for clay mining, with smaller areas identified for sand, aggregate and gravel (Figure 7). These sites are consistent with those identified in the South Metropolitan Peel Sub-regional Planning Framework.

2.3.4 Acid sulfate soils

Acid sulfate soils are soils and sediments that contain iron sulfides. They occur naturally in Western Australia and are harmless when left in a waterlogged, undisturbed environment. However, when exposed to air, through drainage or excavation, the iron sulfides in the soil react with oxygen and water to produce iron compounds and sulfuric acid. This acid can release other substances, including heavy metals, from the soil and into the surrounding environment and waterways (DEC, 2013b).

Much of Western Australia's acid sulfate soil material lies just below current water-tables. Continuing declines in annual rainfall, changes in land uses and increasing ground-water abstraction will lead to lower water-tables, resulting in possible widespread acid sulfate soil oxidation (DEC, 2013b).

The Western Australian Planning Commission has released the *Acid Sulfate Soils Planning Guidelines* (WAPC, 2008b) which outline a range of matters that need to be addressed at various stages of the planning process to ensure that the subdivision and development of land containing acid sulfate soils is planned and managed to avoid potential adverse effects on the natural and built environment.

Current information suggests the presence of soils with majority of moderate to low risk of acid sulphate soils occurring largely in the western portion of the Shire (see Figure 8).

2.3.5 Contaminated sites

Western Australia's contaminated sites legislation aims to protect people's health and save the environment from harm. Under the *Contaminated Sites Act 2003*, contaminated sites must be reported to the Department of Environment Regulation, investigated and, if necessary, cleaned up.

Land owners, occupiers and polluters are required to report all known or suspected contaminated sites to the Department of Environment Regulation. Reported sites are then classified, in consultation with the Department of Health, based on the risks posed to the community and environment.

Figure 8 provides a map of sites currently registered on the Department of Environment Regulation's database. There are 4 sites registered contaminated sites in the Shire, most of which are in relation to hydrocarbon contamination. Other sites reported to the Department of Environment Regulation, including sites awaiting classification are recorded separately by the Department of Environment Regulation and have not been mapped.

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 7 - Surface geology and basic raw materials

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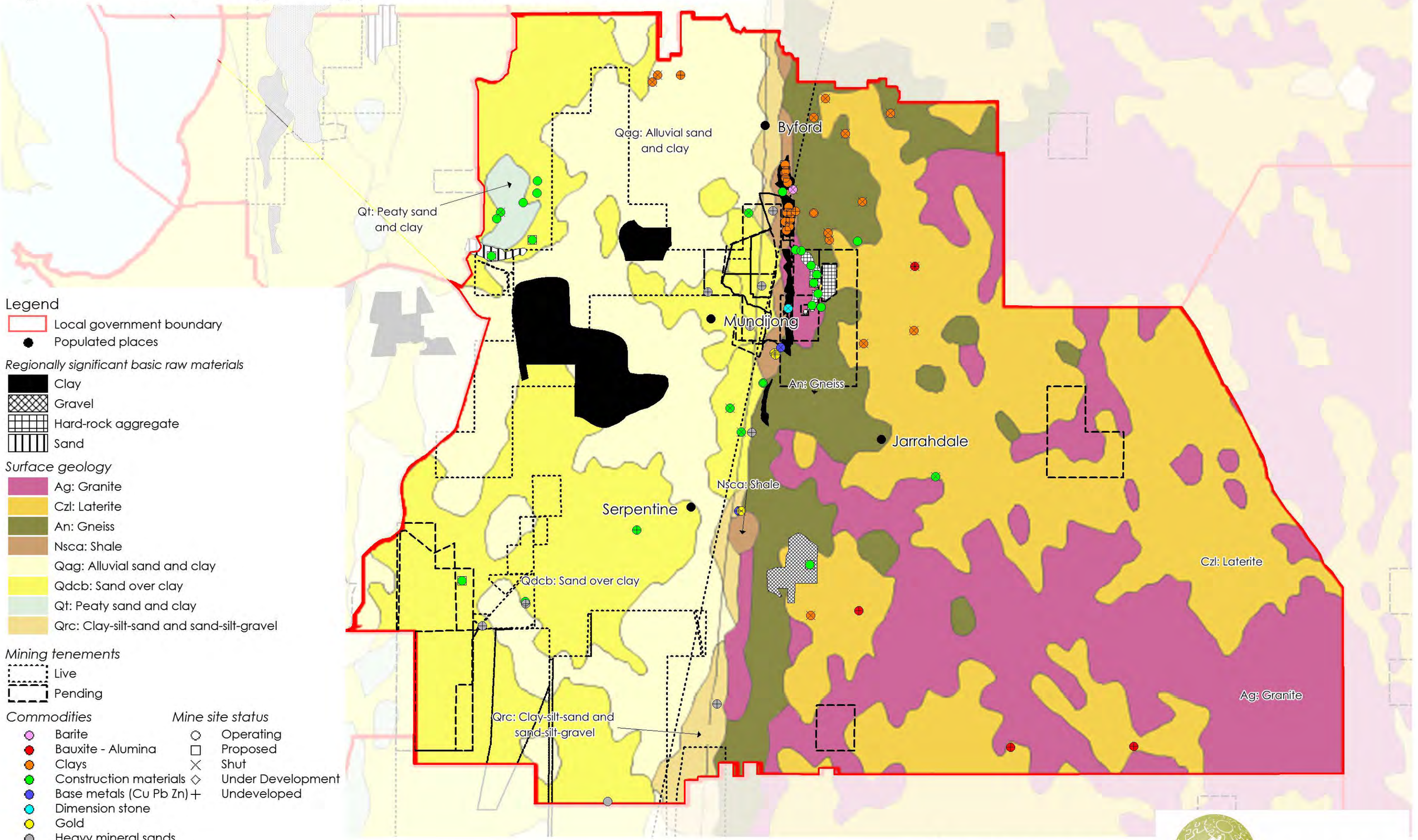


Legend

Local government boundary

Populated places

Regionally significant basic raw materials

- Clay
- Gravel
- Hard-rock aggregate
- Sand

Surface geology

- Ag: Granite
- Czl: Laterite
- An: Gneiss
- Nsca: Shale
- Qag: Alluvial sand and clay
- Qdcb: Sand over clay
- Qt: Peaty sand and clay
- Qrc: Clay-silt-sand and sand-silt-gravel

Mining tenements

- Live
- Pending

Commodities

- Barite
- Bauxite - Alumina
- Clays
- Construction materials
- Base metals (Cu Pb Zn)
- Dimension stone
- Gold
- Heavy mineral sands

Mine site status

- Operating
- Proposed
- Shut
- Under Development
- Undeveloped

Data source: DMP, Landgate Created by: RM Projection: MGA50: zone 50.

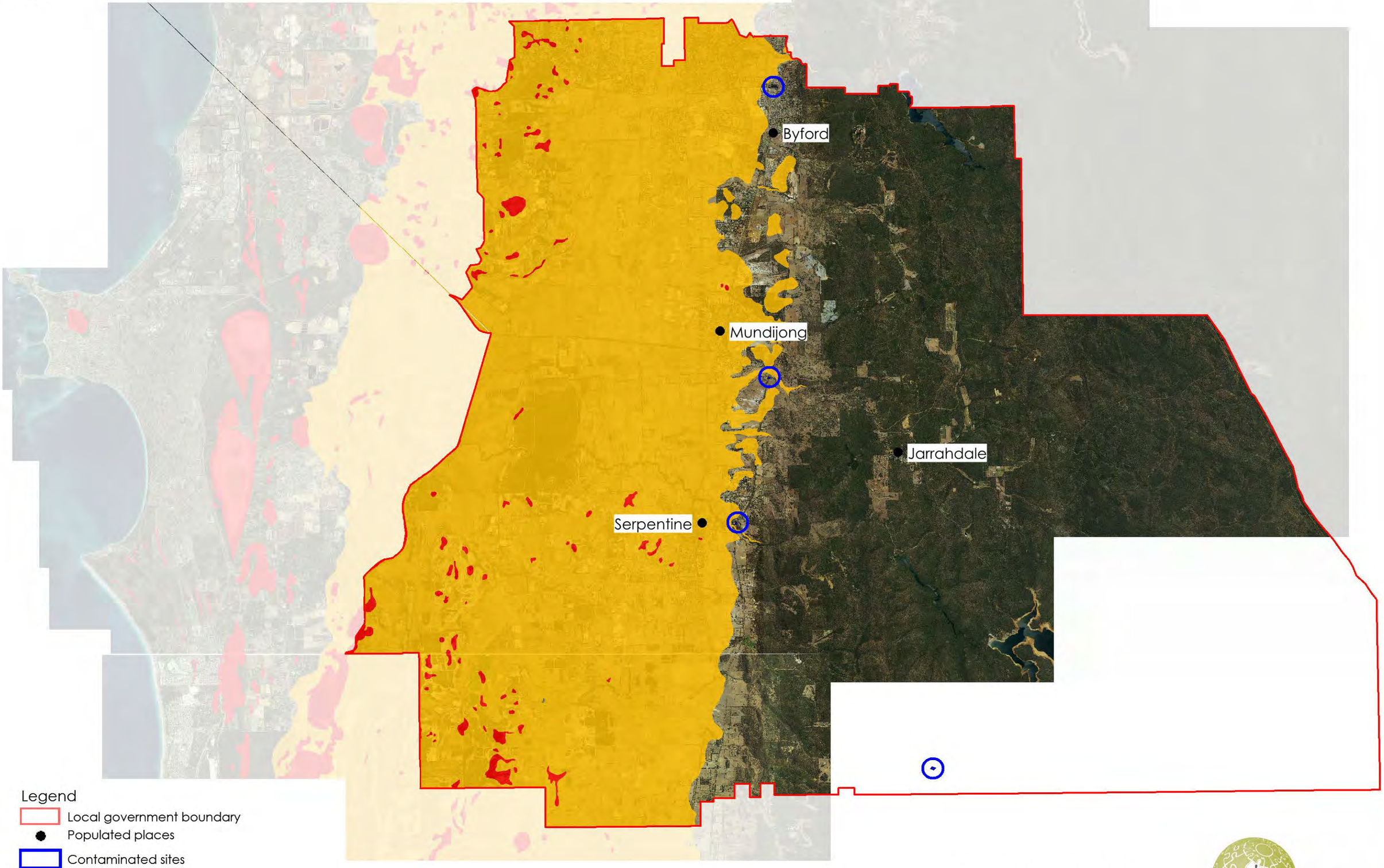
Scale 1: 140,000 at A3

0 5.6 km

essential environmental

OCM 18 December 2017

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 8 - Acid sulfate soil risk and contaminated sites



Legend

- Local government boundary
- Populated places
- Contaminated sites

Acid sulfate soil risk

- High to moderate risk within 3m of surface
- Moderate to low risk within 3m of surface

Data source: SJ Shire DEC, Landgate Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3

0 5.6 km

essential environmental

2.3.6 Land capability

The Department of Agriculture and Food has undertaken an assessment of soil degradation hazard of the soils of Western Australia. With regards to SJ Shire, it is recognised that the Swan Coastal Plain portion generally has a high risk of phosphorus export, wind erosion, subsurface acidification and water logging. Areas of the Darling Plateau associated with the Serpentine River and Dam, as well as the Darling Scarp, are also associated with a high risk of water erosion and phosphorus export (Plates 1 to 6).

The Department of Agriculture and Food has also assessed the capability of the soils to sustain annual horticulture, dryland cropping, grazing, perennial horticulture and vines. This mapping suggests that the majority of the Swan Coastal Plain has a low capability for agriculture. This is likely to be associated with the high risk of nutrient export and associated risk of water logging of the palusplain. Some of the land on the Darling Plateau has a higher capability for agriculture; however, this is likely to require access to water for irrigation, which may be limited by the fractured rock aquifer.

It should be noted that the mapping replicated below provides a board indication only. It is recognised that advances in agricultural techniques have resulted in better understandings of how agriculture can be practiced so as to not impact on the land, soil and water.

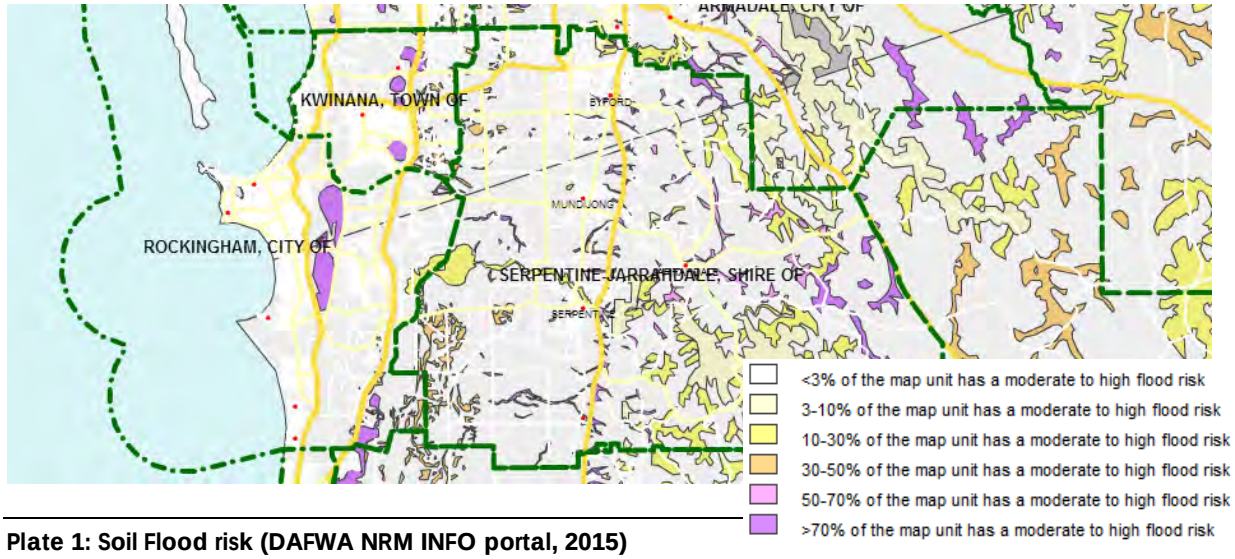


Plate 1: Soil Flood risk (DAFWA NRM INFO portal, 2015)

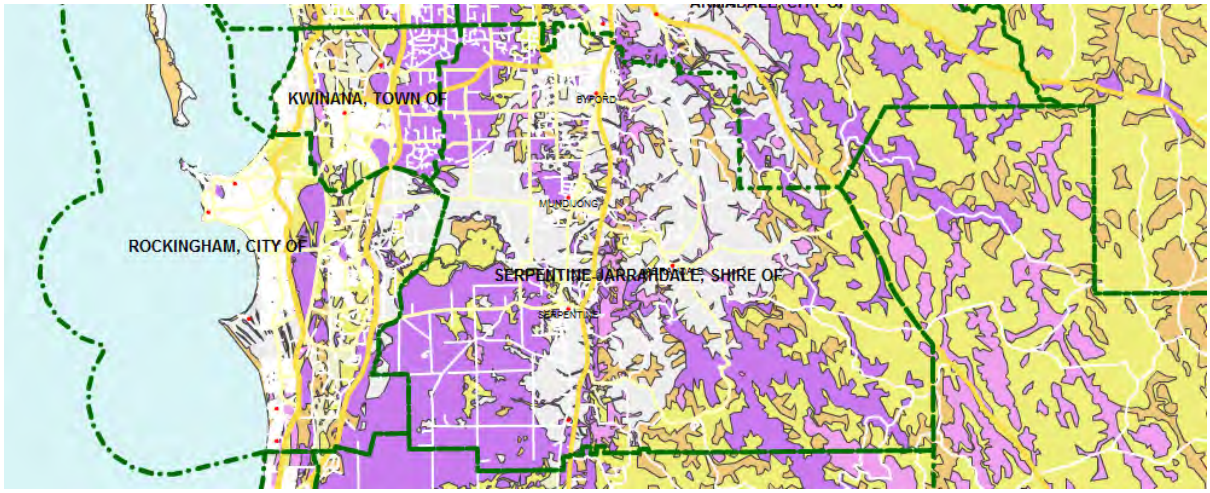


Plate 2: Soil Phosphorous export risk (DAFWA NRM INFO portal, 2015)

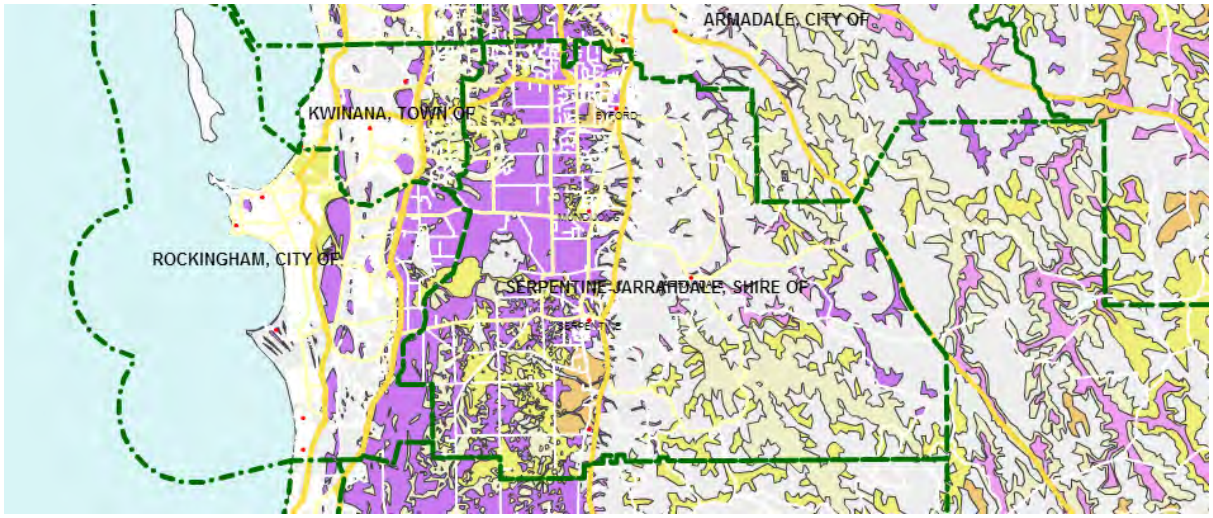


Plate 3: Soil Waterlogging risk (DAFWA NRM INFO portal, 2015)

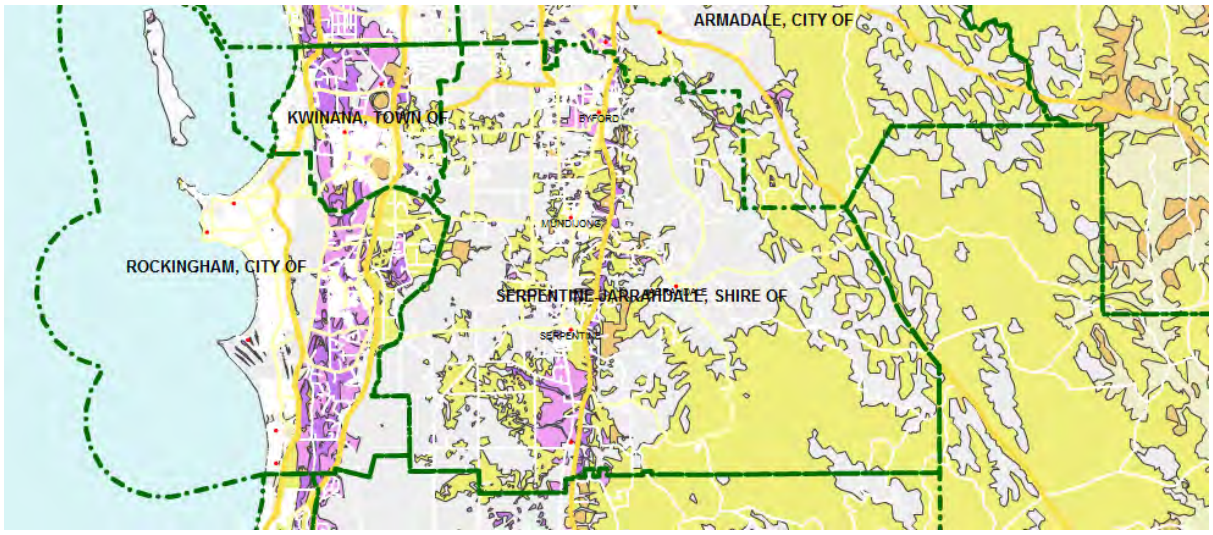


Plate 4: Soil Subsurface acidification risk (DAFWA NRM INFO portal, 2015)

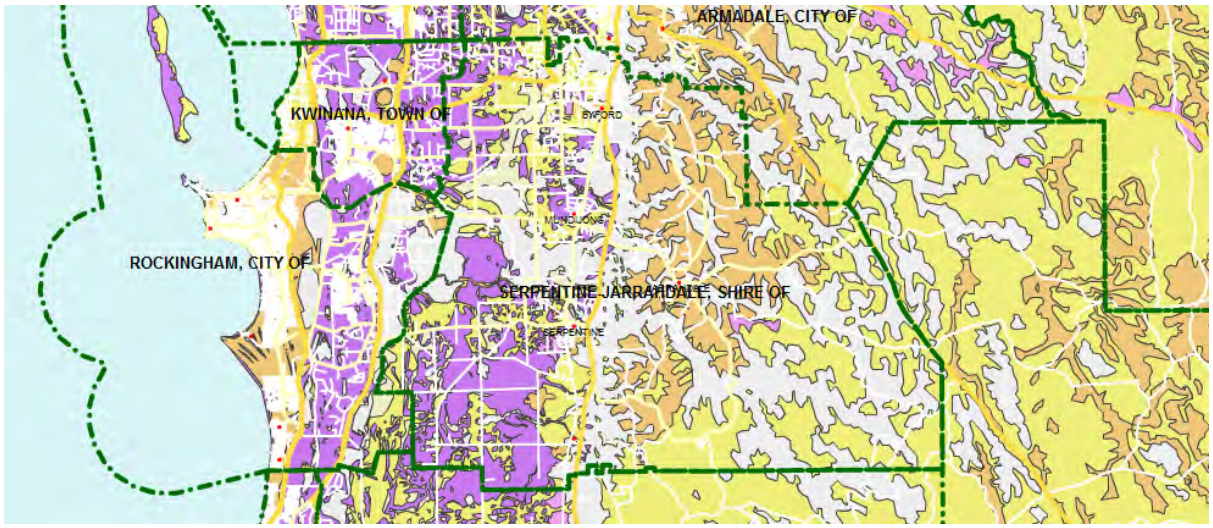


Plate 5: Soil Wind erosion risk (DAFWA NRM INFO portal, 2015)

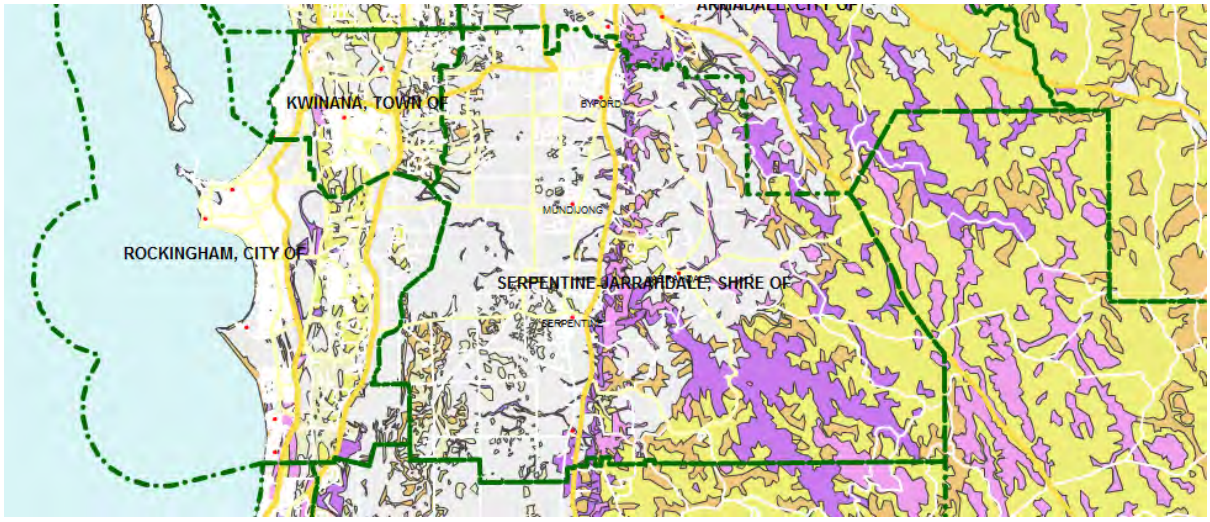


Plate 6: Soil Water erosion risk (DAFWA NRM INFO portal, 2015)

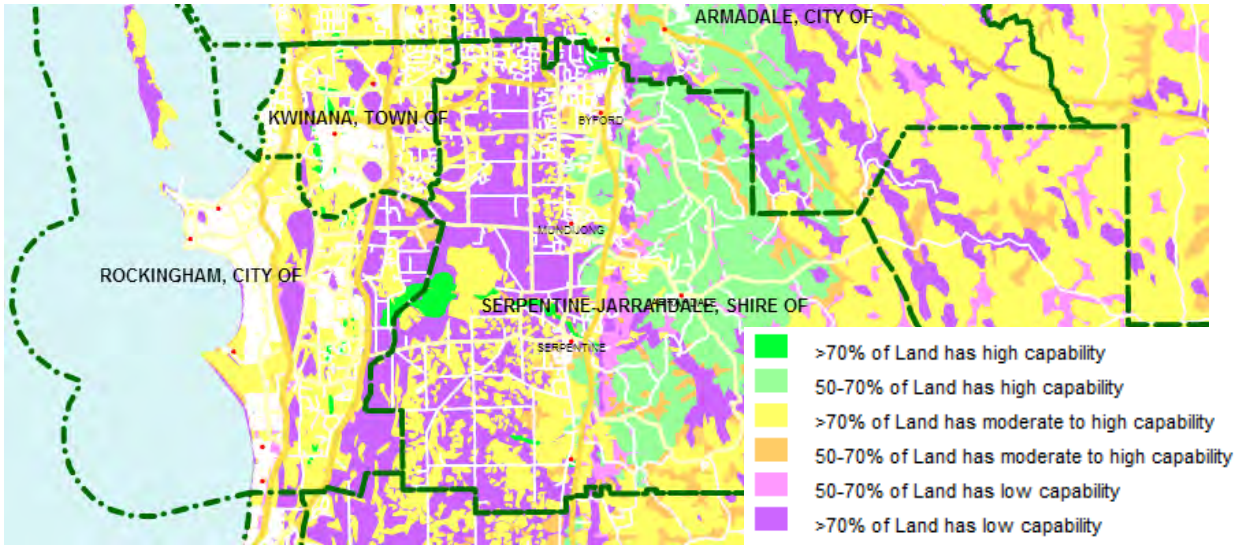


Plate 7: Soil capability for annual horticulture (DAFWA NRM INFO portal, 2015)

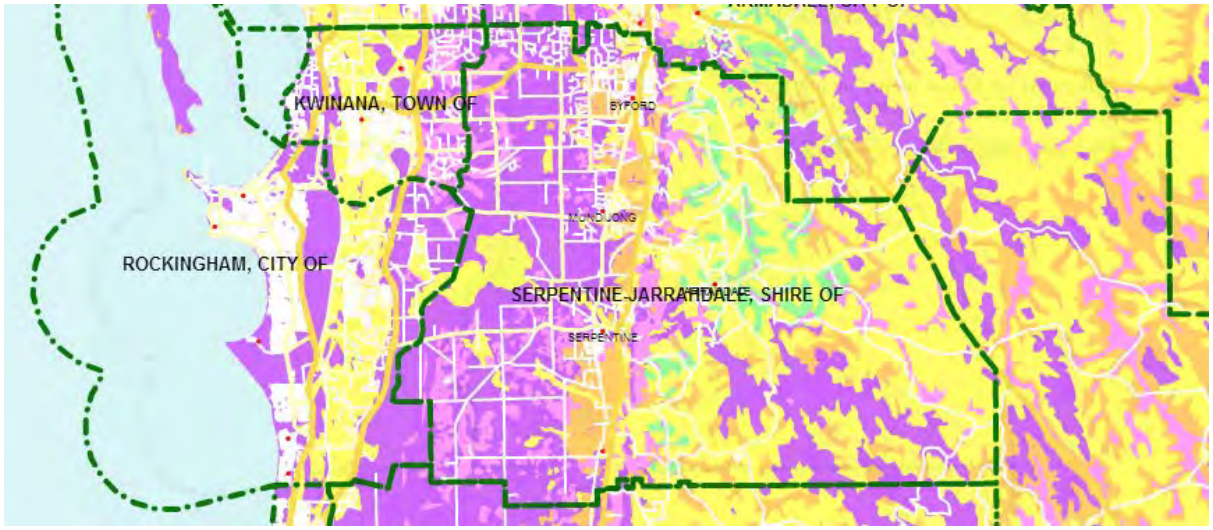


Plate 8: Soil capability for Dryland cropping (DAFWA NRM INFO portal, 2015)

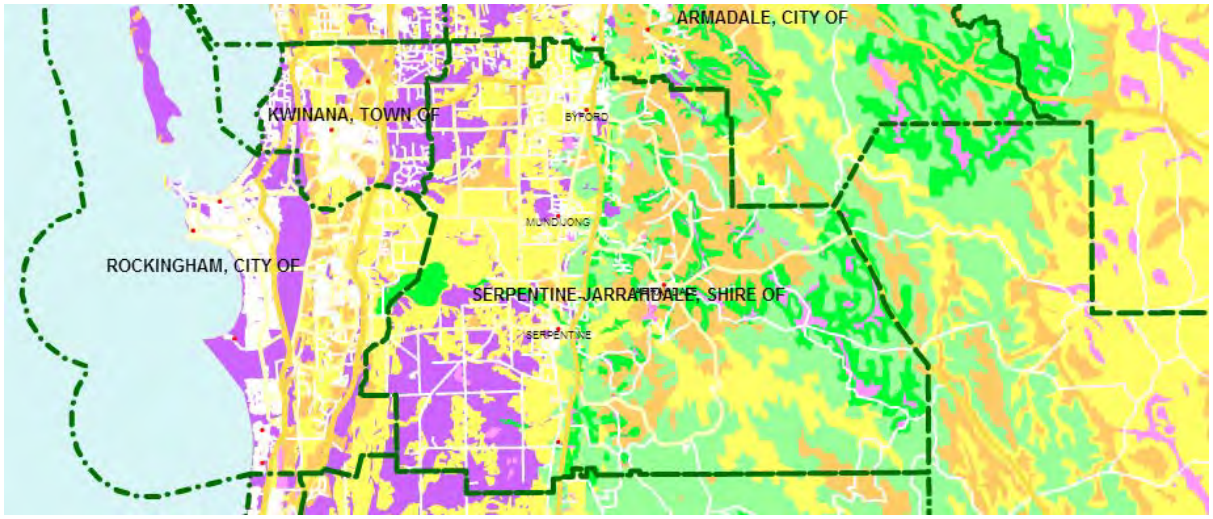


Plate 9: Soil capability for Grazing (DAFWA NRM INFO portal, 2015)

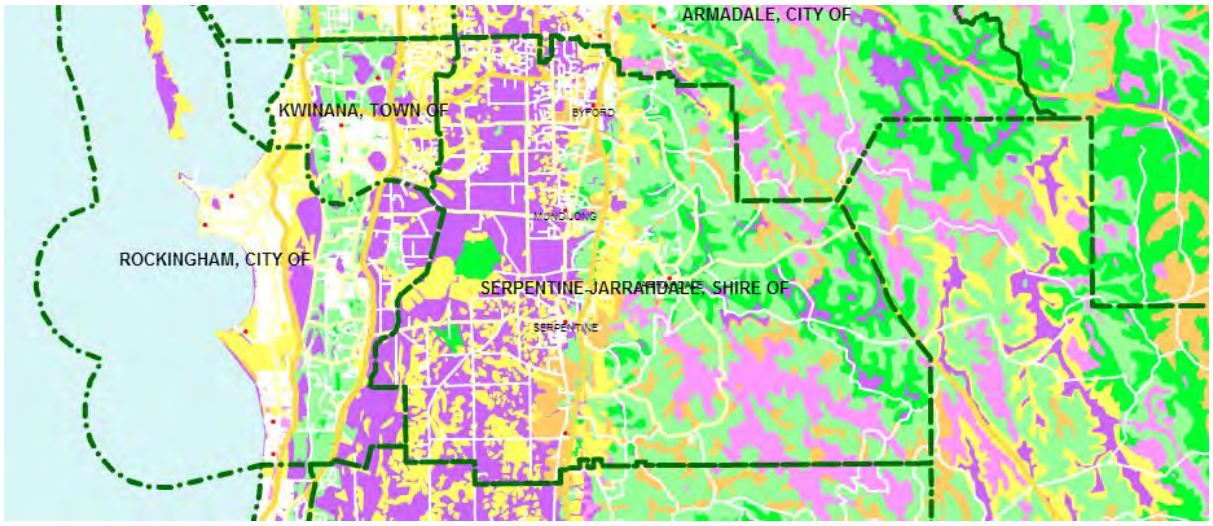


Plate 10: Soil capability for Perennial horticulture (DAFWA NRM INFO portal, 2015)

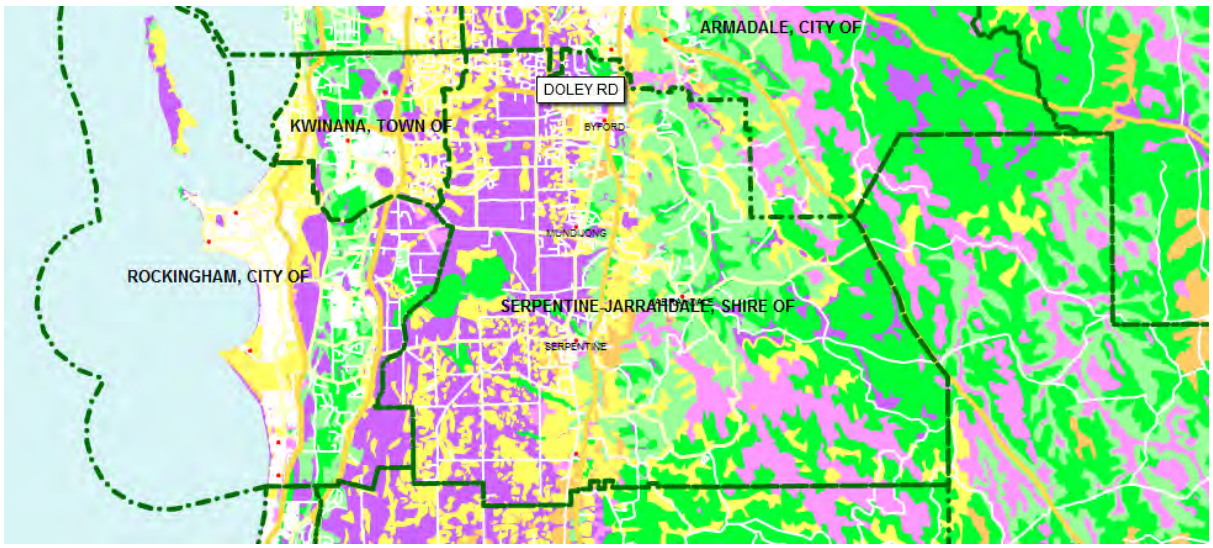


Plate 11: Soil capability for Vines (DAFWA NRM INFO portal, 2015)

2.3.7 Key considerations for strategic environmental planning

Key land resource considerations for strategic planning are:

- **Priority agricultural land** – the Shire's Rural Strategy proposes and Agricultural Protection Policy area which aims to retain and maintain the productive capability of land for agricultural enterprises, amongst other objectives. Consideration should be given to the identification of priority agricultural land in the local planning strategy, consistent with *State Planning Policy 2.5: Land use planning in Rural areas* (2012).
- **Minerals and basic raw materials extraction** – clearing of the land for resource extraction results in a loss of biodiversity and can lead to erosion. Mining activities also impact on the visual landscape of the Shire and can result in off-site impacts on nearly land uses including dust, noise and light. Appropriate guidance should be provided for rehabilitation and mine closure planning.
- **Nutrient risk -** As a result of the historic agricultural landuse of the western portion of SJ Shire and the presence of saturated clays with the affinity to absorb nutrients, the soils of SJ Shire are typically high in legacy nutrients. The movement of groundwater via sub-soil drainage or similar can transport the nutrients to a receiving water body more rapidly than what would occur naturally. This is particularly important in the Peel Harvey catchment, which has been identified at significant risk of eutrophication.
- **Erosion –** Clearing for agricultural and urban uses, particularly along the Darling Scarp can lead to erosion and loss of sediments to receiving waterbodies. Erosion may occur as a result of either water or wind.
- **Waterlogging** – development in areas of seasonally waterlogged soils must be constructed to withstand these conditions. This has traditionally required the use of fill; however, declining access to said fill is likely to lead to the use of alternative construction techniques and footings.
- **Soil health** – Vegetation retention assists in the maintenance of soil health. Soils on the Darling Scarp also have better nutrient and water retentive properties and are generally associate with higher agricultural productivity.
- **Acid sulphate soils** - Declining soil and land quality can occur as a result of development where acid sulphate soils are disturbed. This leads to the release of acid and heavy metals which can cause significant harm to the environment and infrastructure. Appropriate management of acid sulphate soils, particularly in areas of medium and high risk where changes in groundwater are likely or mining is proposed, is required, consistent with current best practice.
- **Contaminated sites** - Consideration should be given to the remediation of contaminated sites as part of any future development. Landfill sites are a current and ongoing source of pollution of soil and water. There is a large regional facility at Cardup, and a decommissioned Shire landfill on Watkins Road. Unsewered residential and industrial areas also have the potential to lead to contamination of land and groundwater and alternative treatment units should be used in areas of high environmental risk.

2.4 Water resources

2.4.1 Surface water – waterways, wetlands and flooding

The most notable waterway within SJ Shire is the Serpentine River, which forms part of the Serpentine Dams (Serpentine Reservoir and Serpentine Pipehead Dam). The Serpentine River traverses the Shire south-east flowing through the western boundary of the Shire. The Serpentine main dam's capacity of 137.7 million kilolitres, makes it one of the biggest dams supplying the Perth metropolitan area (Water Corporation, 2009).

Several brooks pass through the southern Hopeland-Keysbrook area such as the Karnet and Dirk Brook and similarly in the north with Cardup Brook and Berriga Main Drain. Further to this, a large portion of the Wungong Reservoir resides in the north-eastern corner of the Shire, with a large amount of the Reservoir's catchment within the Shire's boundaries.

The Department of Water's Water Catchment Hierarchy (Figure 9) shows the majority of SJ Shire lies within the Peel Estuary – Serpentine River catchment. This catchment drains into the RAMSAR listed Peel-Yalgorup System which is protected as a Matter of National Environmental Significance under the *Environment Protection Biodiversity Conservation Act 1999*. The Serpentine catchment provides around 15% of the annual surface inflow to the Peel-Harvey system.

100 year ARI Floodway mapping shows extensive floodway of the Birriga Main Drain which connects to the Serpentine River, which similarly experiences flooding in a 100 year ARI event as shown in Figure 9.

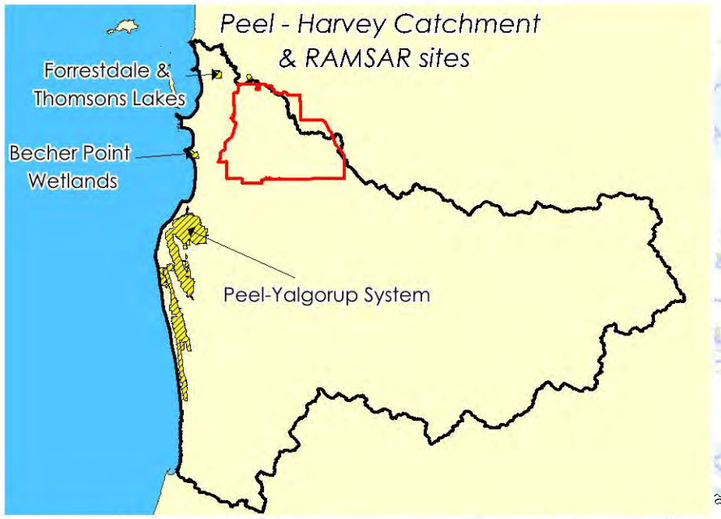
A number of conservation category wetlands are located within SJ Shire (Figure 9). The draft Green Growth Plan for Perth and Peel recommends that a new wetland buffer policy will be developed and implemented through the land use planning processes applied to the classes of action to protect Conservation Category Wetlands.

The western portion of the Shire, coinciding with the Swan Coastal Plain is largely categorised as Multiple Use Wetland. This is largely attributed to the geological system of the Guildford Formation, typically sand over clay, which is seasonally waterlogged flat land. In the case of Multiple Use wetlands, the Environmental Protection Authority (EPA) urges that all reasonable measures are taken to retain the wetlands hydrological functions (including on-site water infiltration and flood detention) and, where possible, other wetland functions (SJ Shire, 2008). However, the majority of the wetlands on the Swan Coastal Plain have been modified as a result of agricultural practices.

The natural hydrology of most of the Swan Coastal Plain portion of SJ Shire is to be inundated in winter. This has led to the construction of a number of drains across the landscape to facilitate agricultural activities, increasing the risk of transportation of sedimentation and nutrients to the estuary. In areas of Byford and Mundijong, these drains have been converted into urban waterways which are incorporated into areas of public open space known as multiple use corridors. The Shire requires urban drains to be constructed in accordance with department of Water Policy which aims to minimise nutrient and sediment transport.

Shire of Serpentine Jarrahdale - Environmental Profile

Figure 9 - Surface water



Wungong Reservoir
Byford
Beenyup Brook
Birriga Main Drain
Cardup Brook
Manjedal Brook
Mundijong
Manjedal Brook
Birriga Main Drain
Wungong Brook
Jarrahdale
Serpentine River
Serpentine
Karnet Brook
Serpentine Pipehead Dam
Serpentine Reservoir
Dirk Brook

Legend

- Local government boundary
- Populated places
- Rivers

100 year ARI Floodway

- Flood Fringe
- Floodway
- Floodplain

Geomorphic wetlands

- Conservation catergory
- Resource enhancement
- Multiple use

Data source: SJ Shire DoW, Landgate Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3

0 5.6 km

essential environmental

2.4.2 Groundwater – resources, availability and use

The most significant groundwater resources underlie the Swan Coastal Plain portion of SJ Shire. This includes the superficial aquifer, which is unconfined and recharged by rainfall, and the deeper, confined aquifers of the Leederville and Yarragadee. Groundwater is generally within 3 m of the surface in areas of sand (Figure 10). Groundwater quality is generally good but information on groundwater quality is limited.

The nature of the geology of the Darling Plateau is such that groundwater is located in fractured rock aquifers and so the groundwater resource is not considered to be reliable or readily available for abstraction.

Jandakot groundwater mound

The Jandakot groundwater mound extends into a small area in the north west of SJ Shire and is currently identified in the Metropolitan Region Scheme and Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 as a Water catchment (Figure 10). The mound area is currently reserved for Parks and Recreation or zoned for Rural Groundwater Protection. Land located within Rural groundwater protection zoning is required to be used and developed in accordance with the provisions of State Planning Policy No. 2.3 Jandakot Groundwater Protection Policy.

The area of the Jandakot groundwater mound located within SJ Shire is divided into sections which are classified as Priority 1 and Priority 2 underground water pollution control areas (UWPCA). P1 areas correspond with TPS No. 2 Water catchment, and Parks and recreation zoning, while P2 areas correspond with Rural groundwater protection zoning.

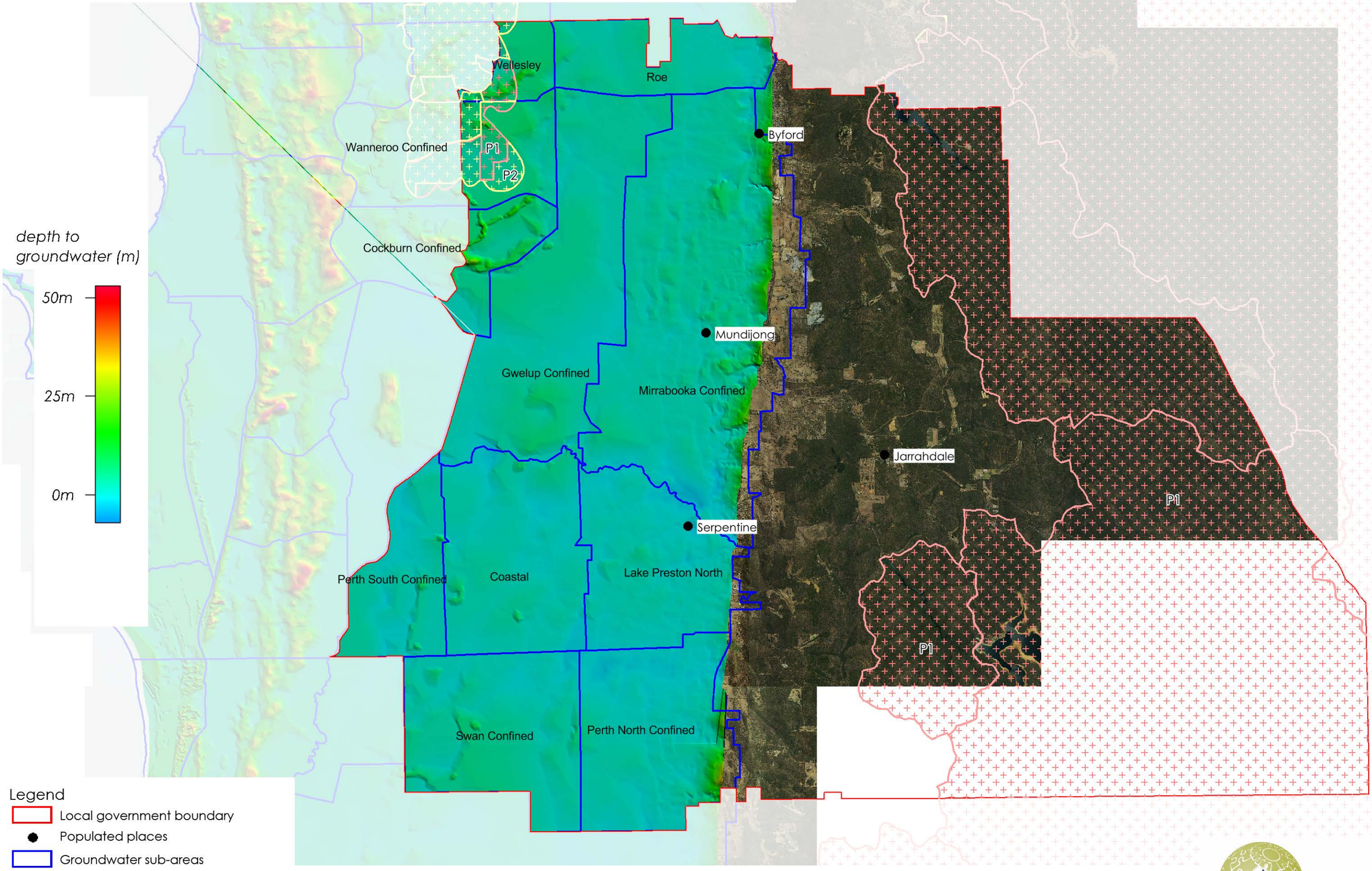
Two wellhead protection zones with a radius of 300 m have also been identified around existing or proposed bores for public water supply abstraction within this area (WAPC, 2014). Wellhead protection zones are specific protection zones defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities.

Priority 1 (P1) classification areas are managed to ensure that there is no degradation of the drinking water source by preventing the development of potentially harmful activities in these areas, and is principally managed on the basis of risk avoidance. Priority 2 (P2) classification areas are managed to ensure that there is no increased risk of water source contamination/ pollution, and is principally managed on the basis of risk minimisation.

The major compatible land uses in P1 areas are national and regional parks and nature reserves, pastoral agriculture, apiaries, forestry and plantations, residential buildings with conditions, community education centres and research facilities, mining and extraction facilities with conditions, and drinking water treatment plants.

In addition to the land uses compatible with P1 areas, intensive agriculture, some animal establishment, major transport infrastructure, wineries, and some commercial activity may be undertaken in P2 areas. Further guidance on compatible land uses within P1 and P2 areas is provided in WQPN 25 – Land use compatibility in Public Drinking Water Source Protection Areas (draft for comment, DoW, 2015).

Shire of Serpentine Jarrahdale - Environmental Profile
Figure10- Groundwater



Data source: SJ Shire DoW. UWA, Landgate. Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3
0 5.6 km

essential environmental

Groundwater availability

Table 4 provides information on the committed allocation and remaining volume of groundwater resources within SJ Shire (data requested from DoW 1st April 2016). Subareas not included in the table as they are generally a n on-allocated drinking water source includ Byford 2: Perth - Cattamarra Coal Measures, Serpentine 1: Perth - Cattamarra Coal Measures, Jandakot Mound 1 & 2: Perth – Leederville, all subareas: Yarragadee North.

Table 4: Groundwater resource and allocation limits (source: DoW, April 2016)

Management Subarea	Resource	Allocation Limit	Allocated Volume	Committed Volume	Remaining Volume	% Allocated and Committed	Additional Requested
Byford 2	Perth - Leederville.	1,350,000	786,897	0	**563,103**	**58.29%**	112,130
Byford 2	Perth - Superficial Swan	8,077,900	464,505	0	**7,613,395**	**5.75%**	11,500
Byford 3	Perth - Cattamarra Coal Measures.	1,130,000	736,914	365,001	**28,085**	**97.51%**	27,750
Byford 3	Perth - Leederville.	2,270,000	2,034,100	0	**235,900**	**89.61%**	296,060
Byford 3	Perth - Superficial Swan	13,291,660	1,059,537	205,000	**12,027,123**	**9.51%**	510,340
Jandakot Mound 1	Perth - Superficial Swan	3,980,000	3,593,660	189,500	**196,840**	**95.05%**	64,245
Jandakot Mound 2	Perth - Superficial Swan	1,761,500	1,517,244	296,026	**-51,770**	**102.94%**	35,773
Keysbrook 1	Perth - Leederville.	750,000	503,390	400,000	**-153,390**	**120.45%**	0
Keysbrook 1	Perth - Superficial Swan	2,000,000	1,659,906	0	**340,094**	**83.00%**	745,000
Keysbrook 2	Combined - Fractured Rock West - Fractured Rock	9,500	15,000	0	**-5,500**	**157.89%**	0
Keysbrook 2	Perth - Cattamarra Coal Measures.	0	8,250	0	**-8,250**	**0.00%**	428,700
Keysbrook 2	Perth - Leederville.	860,000	533,149	0	**326,851**	**61.99%**	311,500
Keysbrook 2	Perth - Superficial Swan	2,596,200	328,370	0	**2,267,830**	**12.65%**	0
Serpentine 1	Perth - Leederville.	450,000	579,895	0	**-129,895**	**128.87%**	0
Serpentine 1	Perth - Superficial Swan	1,359,500	173,800	0	**1,185,700**	**12.78%**	0
Serpentine 2	Perth - Leederville.	920,000	783,625	129,000	**7,375**	**99.20%**	0
Serpentine 2	Perth - Superficial Swan	2,749,500	1,447,410	0	**1,302,090**	**52.64%**	499,500
Serpentine 3	Combined - Fractured Rock West - Fractured Rock	8,500	2,150	0	**6,350**	**25.29%**	1,150

Management Subarea	Resource	Allocation Limit	Allocated Volume	Committed Volume	Remaining Volume	% Allocated and Committed	Additional Requested
Serpentine 3	Perth - Cattamarra Coal Measures.	390,000	442,680	0	**-52,680**	**113.51%**	0
Serpentine 3	Perth - Leederville.	790,000	791,579	0	**-1,579**	**100.20%**	40,100
Serpentine 3	Perth - Superficial Swan	2,356,000	415,963	0	**1,940,037**	**17.66%**	0

Current levels of allocation of the superficial suggests that groundwater is likely to be available to provide a source of irrigation for future development including areas of regional and local public open space. It is likely that fit-for-purpose water could also be provided to industrial areas to reduce the use of potable (Scheme) water.

Groundwater is also likely to be available for irrigated agriculture or horticulture on the Swan Coastal Plain, provided that risks of nutrient export and waterlogging are able to be adequately addressed. Water availability for agriculture on the Darling Scarp is dependent on the site specific characteristics and testing is usually required to demonstrate that an appropriate source is available.

2.4.3 Key strategic environmental planning issues for consideration

Key water resource considerations for strategic planning, consistent with *State Planning Policy 2.9: Water Resources* and SJ Shire *Local Planning Policy No 6 Water Sensitive Design* are:

- **Climate change** – is resulting in declining levels in superficial groundwater systems. This, coupled with increased abstraction from superficial systems may impact on the health of groundwater dependent ecosystems. Strategies should aim to restore local hydrological conditions where possible, through design of integrated water cycle systems and solutions.
- **Altered hydrology** – filling of the land has resulted in a loss of wetlands and the installation of drains has significantly altered the hydrology of the landscape. This results in a loss of environmental values. Consideration must be given to the natural water cycle as part of any future development in order to re-establish lost values and design systems to cope with soil waterlogging and minimise nutrient and sediment export.
- **Eutrophication** - Over 90% of the Shire is in the Peel Harvey catchment, and the estuary's ecosystem is under pressure from eutrophication. Many land uses contribute nutrients to the estuary and impact on the Serpentine River and other waterways, including the artificial drains. As intensive and residential land use grows, there is a risk of increasing nutrient export. The Shire currently stipulates a high standard of water sensitive urban design in areas of new development, with particular focus on treatment of sub-soil drainage. This practice should be maintained through all new development. The Shire also has a policy requiring revegetation, including streamlining, as a condition of subdivision approvals. The potential to ameliorate export will depend on planting quality and compliance.
- **Groundwater availability** – although allocation currently remains in most parts of the superficial aquifer, declining rainfall may result in reduced recharge and consequently availability in the future.
- **Shallow groundwater** – conventional building practices are designed for sandy sites with good separation to groundwater. Alternative building practices including appropriate

footings which do not require the use of fill should be encouraged across the Swan Coastal Plain. Infrastructure should be designed in meet appropriate standards.

- **Flooding from stormwater** - Adequately manage the risk of flooding in urban areas through application of *State Planning Policy 2.9: Water Resources.* SJ Shire may also need to review existing townsite drainage systems and ensure appropriate levels of service will be maintained as development occurs and water quality of stormwater is addressed.
- **Water use efficiency-** Although it is recognised that SJ Shire is a Waterwise Council, these principles should also be adopted for the irrigation of public open spaces.
- **Water reuse** – Due to the availability of groundwater, it is considered that water recycling and reuse to provide fit-for-purpose sources of water may not be considered cost-effective. However, consideration should be given to the establishment of decentralised systems which optimise (re)use of the total water cycle.
- **Declining soil health** – Clearing of land for agriculture and/or development may result in threats to water quality, including exposure of acid sulphate soils, sediment and nutrient export and chemical pollutants.
- **Contamination of water resources** - Landfill sites are a potential source of pollutants to ground and surface waters, and must be carefully designed, managed and monitored to avoid impacts. The use of clean fill in wetland areas is also a threat, reducing the area of wetland ecosystems and changing the hydrology.

2.5 Biodiversity

SJ Shire is located within the Kwongan ecoregion of the South West Australian Floristic Region, and is one of the world's 25 biodiversity hotspots. The Shire is part of two of Western Australia's bioregions; the Northern Jarrah Forest subregion (JAF01), which includes the plateau and Darling Scarp in the east of the Shire, and the flat low lying Swan Coastal Plain subregion (SWA02) in the west of the Shire.

The Northern Jarrah Forrest Bioregion is characterised by tall, open jarrah-marri forests on laterite gravels over clayey soils with bullich and blackbutt in the valleys, and grades into wandoo woodlands in the east with powder bark on breakaways. There are extensive but localised sand sheets with Banksia low woodlands. Heath (including species such as grevillea, hakeas, rock sheoak and Darling Range Ghost Gum) is found on granite rocks and as a common understorey of forests and woodlands in the north and east (CALM, 2002).

The Swan Coastal Plan Bioregion includes urban developments associated with the city of Perth, and is dominated by woodlands of Banksia and tuart on sandy soils, sheoak on outwash plains and paperbark in swampy areas.

Remnant vegetation

Natural areas and associated biodiversity in SJ Shire have been significantly impacted since European settlement particularly as a result of clearing for agriculture on the coastal plain and foothills, and logging, bauxite mining and dieback on the plateau. However, the plateau area within SJ Shire retains much of the original vegetation structure in comparison to the coastal plain. This has resulted in a significant reduction of local native animal and birdlife, the deterioration of bushland and wetlands, and has contributed to the pollution of downstream waterways including the Peel-Harvey estuary. There is only 12.4% or 4,503 ha of the original 36,338 ha of vegetation west of the Scarp remaining (Table 5). In contrast, 91% of the native vegetation of the hills forest (Darling Plateau) remains (Ironbark Environmental, 2008).

Table 5: Native vegetation of the Swan Coastal Plain & Foothills portion of SJ Shire (Source: Ironbark Environmental, 2008)

Native vegetation	Area remaining
Pre-European	**40,466 ha**
Total native vegetation protected	2,431 ha - (6 % of pre-European native vegetation protected)
Total Local natural areas (LNA)	2,073 ha
Total native vegetation remaining	4,503 ha - (12% of pre-European native vegetation retained)

Overall, of the original 89,977 hectares of native vegetation in SJ Shire, 48,130 hectares or 54% remains. Of this only 8,266 ha, less than ten percent of the original extent, is currently protected in nature reserves, national parks or through Bush Forever (Ironbark Environmental, 2008). Management of local reserves is undertaken by the Shire, consistent with its series of management plans for specific natural reserves. Where no management plan has been prepared, management is guided by the Shire's generic management plan for local reserves.

Table 6: Native vegetation in the Shire of Serpentine-Jarrahdale (Source: Ironbark Environmental, 2008)

Native vegetation	Area remaining
Pre-European	**89,977ha**
Total native vegetation protected *(Bush Forever, DEC estate, including Regional Parks, excluding State Forest)*	8,266 ha
State Forest	35,343 ha
Total not protected (excl. State Forest) *(These are referred to as Local Natural Areas)*	4,521 ha
Total native vegetation remaining *(Includes protected, State Forest and non-protected)*	48,130 ha (54% of original vegetation remaining)

One of the key commitments of the Draft *Strategic Conservation Plan for the Perth and Peel Regions* (Government of WA, 2015) is the expansion of the conservation reserve system and the establishment of 170,000 hectares of additional conservation reserves across the Perth and Peel regions. This is proposed to occur in two phases (Figure 11):

Phase 1 Initial Package of additional conservation reserves includes three isolated areas within SJ Shire:

- Jandakot Regional Park (approx. 694ha) located in the north-west corner of SJ Shire, overlaying a Bush Forever site;
- Wungong Regional Park (182ha) to the east; and
- a small area of approx. 51ha, overlaying Bush Forever site No:74 – Rapids Roads Bushland located in the central south of the Shire, west of Serpentine.

Phase 2 contains a number of smaller areas. These areas tend to overlay Local Natural Areas, including a large portion within the DPaW Conservation area south of Jarrahdale, Bush Forever sites, such as Henderson Road Bushland (approx.140ha) and Yangedi Swamp (approx. 448ha), and further area of the Wungong Regional Park (approx. 328ha).

The area of remnant native vegetation within SJ Shire has been estimated for each vegetation complex, presented in Table 7. The State Government's Bush Forever aims for the protection of at least 10% of the original extent of each vegetation complex. Within SJ Shire, the majority of vegetation on the Swan Coastal Plain is currently under-represented in conservation reserves.

Table 7: Remnant vegetation within vegetation complexes of the Shire of Serpentine-Jarrahdale (Source: Ironbark Environmental, 2008)

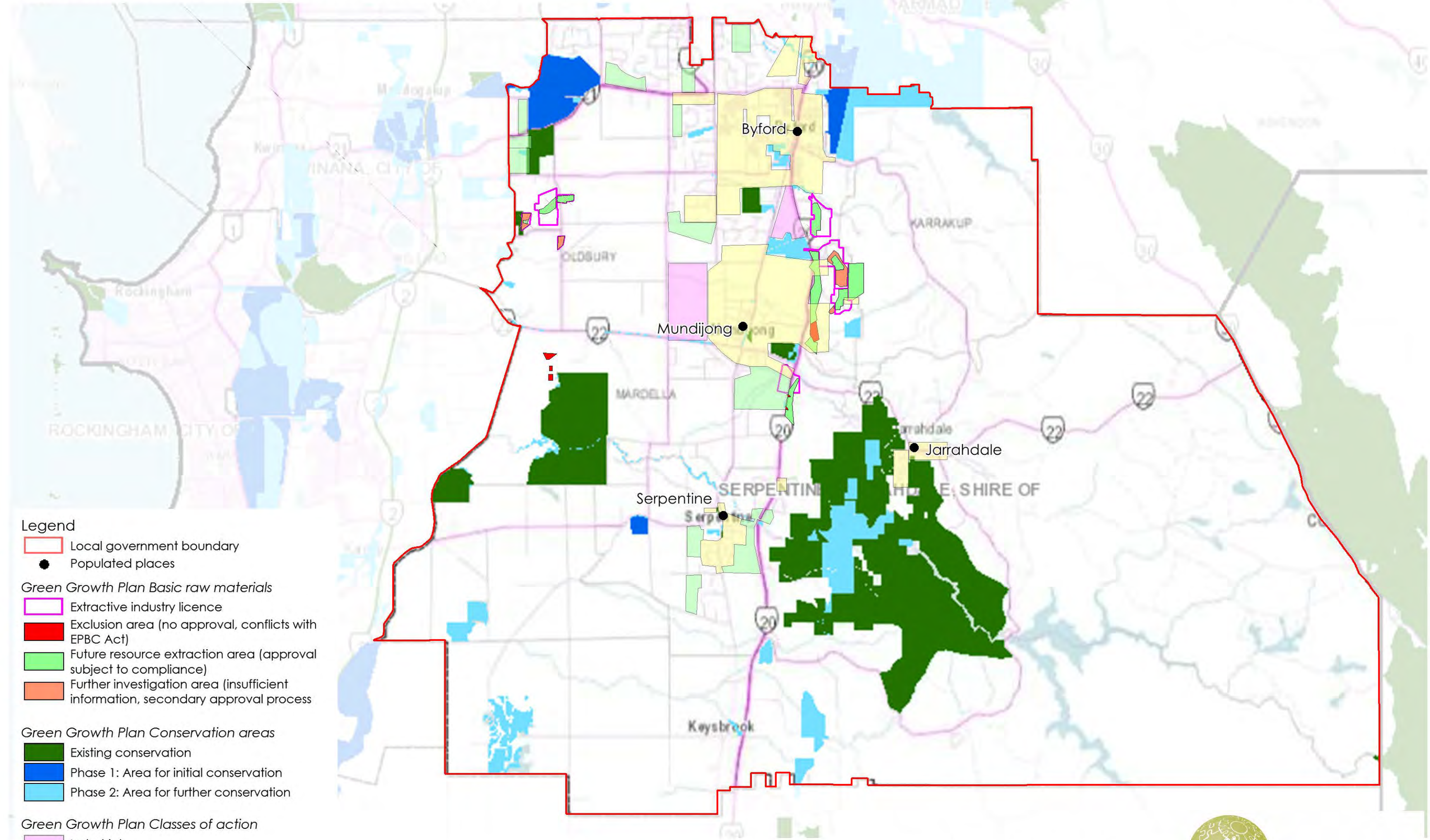
Vegetation complex	Original extent (ha)	Current extent -2006 (ha) (%)	Extent currently protected – (ha) & (%) of original extent	Representational Target (ha)
SWAN COASTAL PLAIN				
Bassendean Central & South Complex	9854	2707 (27%)	1666 (17%)	266
Beermullah Complex	3691	40 (1%)	14 (< 1%)	20

Vegetation complex	Original extent (ha)	Current extent -2006 (ha) (%)	Extent currently protected – (ha) & (%) of original extent	Representational Target (ha)
Dardanup Complex	1113	148 (13%)	135 (12%)	12
Guildford Complex	13244	611 (5%)	347 (3%)	96
Serpentine River Complex	783	51 (7%)	17 (2%)	8
Southern River Complex	7653	680 (9%)	107 (1%)	172
FOOTHILLS				
Forrestfield	4128	266 (6%)	145 (4%)	101
DARLING SCARP				
Darling Scarp Complex	4175	2100 (50%)	812 (21%)	583
DARLING PLATEAU				
Cooke Complex	914	900 (99%)	0 (0%)	0
Dwellingup 1 Complex	11030	10,536 (96%)	1420 (13%)	47
Dwellingup 2 Complex	11398	10,676 (94%)	1226 (11%)	122
Goonaping Complex	304	283 (93%)	0 (0%)	16
Helena 1 Complex	599	592 (99%)	591 (99%)	1
Murray 1 Complex	8530	6996 (82%)	1150 (13%)	133
Swamp Complex	1797	1670 (93%)	0 (0%)	15
Yarragil 1 Complex	4734	4224 (89%)	576 (12%)	66
Yarragil 2 Complex	6030	5694 (94%)	0 (0%)	32
Total	**89 977**			**432**

2.5.1 Regionally and locally significant areas

The majority of the eastern half of the Shire of Serpentine Jarrahdale comprises the 9,998 ha Jarrahdale State Forrest (Figure 12). Serpentine National Park is located directly west of the Jarrahdale State Forest, near the south and centre of the Shire. It is approximately 4.9 ha in area and the Serpentine River and its tributaries flow through and drain much of the Park. The Serpentine Falls waterfall is a key feature of the Park and lies within an incised valley at the base of the Darling Scarp, on the Park's western edge. Serpentine National Park is characterised by its diverse vegetation structure, ranging from jarrah-marri forest to wandoo woodlands, scarp heath lands and specialised granite outcrop communities. These forests are managed by the Department of Parks and Wildlife and vested with the Conservation Commission of Western Australia.

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 11- draft Green Growth Plan



Legend

- Local government boundary
- Populated places

Green Growth Plan Basic raw materials

- Extractive industry licence
- Exclusion area (no approval, conflicts with EPBC Act)
- Future resource extraction area (approval subject to compliance)
- Further investigation area (insufficient information, secondary approval process

Green Growth Plan Conservation areas

- Existing conservation
- Phase 1: Area for initial conservation
- Phase 2: Area for further conservation

Green Growth Plan Classes of action

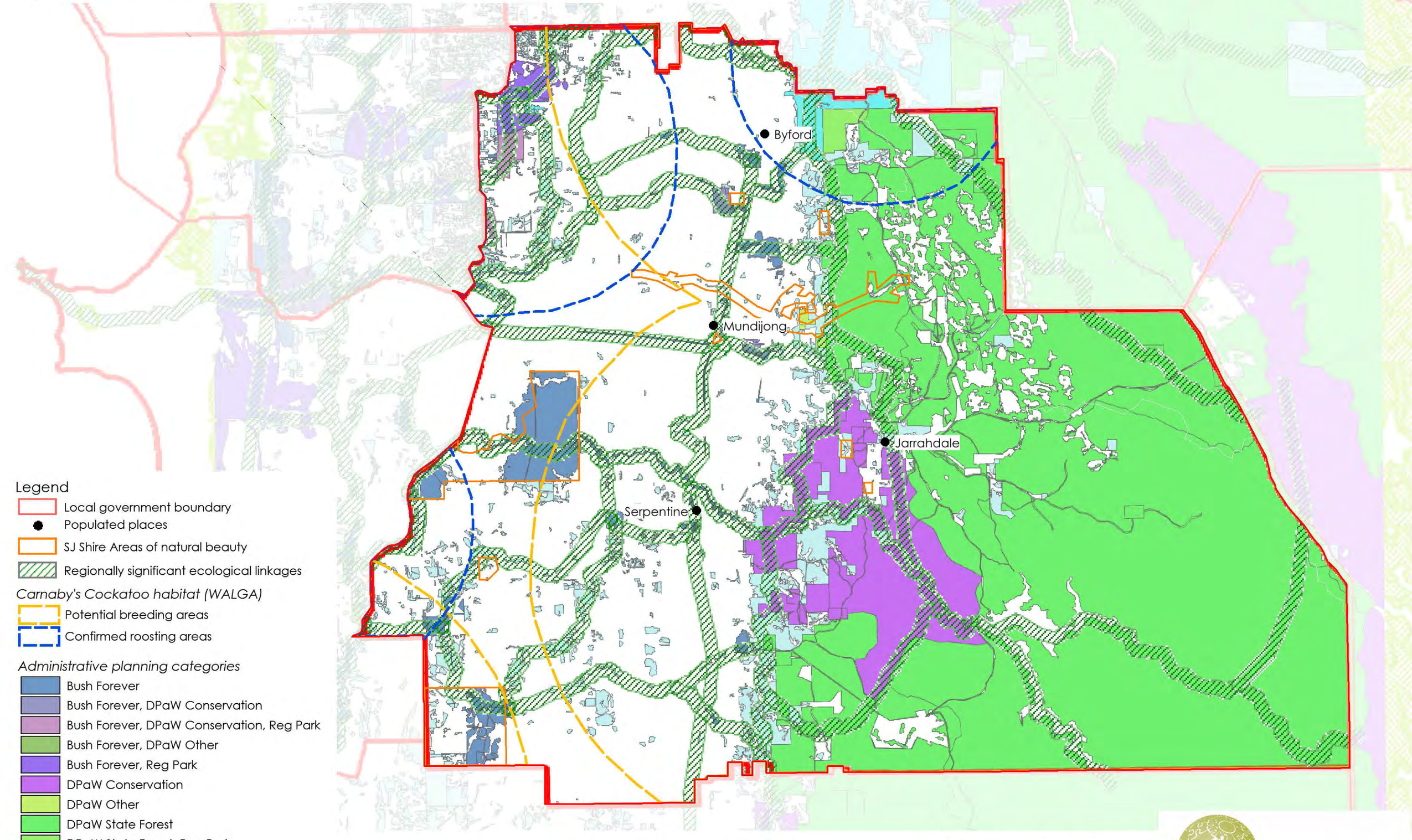
- Industrial
- Rural
- Urban

Data source: SJ Shire, DoP, Landgate Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3
0 5.6 km

essential environmental

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 12 - Biodiversity



Legend

- Local government boundary
- Populated places
- SJ Shire Areas of natural beauty
- Regionally significant ecological linkages

Carnaby's Cockatoo habitat (WALGA)

- Potential breeding areas
- Confirmed roosting areas

Administrative planning categories

- Bush Forever
- Bush Forever, DPaW Conservation
- Bush Forever, DPaW Conservation, Reg Park
- Bush Forever, DPaW Other
- Bush Forever, Reg Park
- DPaW Conservation
- DPaW Other
- DPaW State Forest
- DPaW State Forest, Reg Park
- Local Natural Area
- Regional Park

Data source: SJ Shire, WALGA, DPaW, DoP, DEC, Landgate Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3

0 5.6 km

essential environmental

Bush forever sites

State Planning Policy No. 2.8: Bushland Policy for the Perth Metropolitan Region (2010) identifies areas of regionally significant bushland along with Threatened Ecological Communities (TECs) and Declared Rare (Threatened) and Priority flora for protection.

Bush Forever aims to protect at least 10% of each of the 26 original vegetation complexes within the Swan Coastal Plain section of metropolitan Perth, and to conserve TECs. There are 30 Bush Forever sites in the Shire of Serpentine-Jarrahdale, mapped in Figure 12 and listed in Appendix 2. All Bush Forever sites are classified as Environmentally Sensitive Areas under the *Environmental Protection Act 1986*.

Only two Bush Forever sites (no.s 368 and 372, the eastern and western blocks of the Lowlands Bushland, including Hymus Swamp) are wholly zoned as Conservation under the current Serpentine-Jarrahdale Town Planning Scheme No. 2. Bush Forever site no. 77 (Yangedi Swamp) is also partially zoned in the SJ Scheme for Conservation.

The majority of remaining Bush Forever sites are reserved for Public Open Space or zoned Rural and are located on privately owned property. Several these sites are managed by the Department of Parks and Wildlife. A small number of sites are also zoned as Special Use or are part of Local Road reserves.

Under the current proposed Green Growth Plan, Bush Forever sites not classified as Conservation under the Town Planning Scheme No. 2 will be protected as Conservation Reserves under Phase 1 or Phase 2 of the Plan (Figure 11).

The Shire of Serpentine-Jarrahdale has also identified Areas of Natural Beauty in Town Planning Scheme No. 2 (Figure 12), four of which partially overlap with Bush Forever sites.

Regional Ecological Linkages

Regional Ecological Linkages have been proposed across the Shire to encompass natural linkage features connecting key isolated natural areas, including a number of major waterways. The Regional Ecological Linkages have been previously designated by the State Government as part of Bush Forever, Perth's Greenways and the System Six Study, and are now reflected in the Perth and Peel @3.5 million sub-regional planning frameworks (WAPC, 2015), although it is noted that only those designated as Bush Forever have some protection for conservation purposes. Regional Ecological Linkages are presented on Figure 12.

Clearing of native vegetation and development creates isolated natural areas surrounded by extensive areas of pasture, houses, roads and exotic plants. This has become a significant issue on the coastal plain and foothills, making it increasingly difficult for fauna to move across the plain in both east-west and north-south directions. Isolation also makes it difficult for fauna and vegetation to cope with multiple disturbances including fire, weeds, rubbish dumping, feral animals and climate change.

Identification of Ecological Linkages is designed to protect existing natural areas that occur along the linkages, improve their resilience through management and revegetation of their buffers, and allow safe movement and growth of fauna and flora. It is noted; however, that many ecological linkages are associated with infrastructure corridors for roads, rail and drainage, and are generally reserved for purposes other than conservation. Accordingly, many ecological corridors are often subject to disturbance.

The protection of such natural areas and linkages is considered a priority for the Shire over the revegetation of continuous corridors due to ecological importance and resource limitation (Ironbark Environmental, 2008).

The proposed Ecological Linkages should not be confused with Multiple Use Corridors and Trails, which were not developed on ecological criteria and are not expected to achieve significant biodiversity conservation. However multiple use corridors do form an important part of the ecology of the Shire.

Local Natural Areas

A *Local Biodiversity Strategy for the Shire of Serpentine-Jarrahdale* was finalised in 2008 (Ironbark Environmental, 2008) in order to prevent the further loss of natural areas and conserve biodiversity within SJ Shire. The Strategy identified 6,333 ha of natural areas targeted for protection and management comprising 7% of the Shire's original native vegetation. The corridor between Byford and Keysbrook in particular was identified as important for conservation.

Local Natural Areas are defined as natural areas existing outside of Bush Forever sites and Department of Parks and Wildlife areas and regional parks. This includes bushland, wetlands and waterways located on private land and local reserves. The 6,333 ha of natural areas in the Shire identified by the Local Biodiversity Strategy include:

- Local Natural Areas (LNAs) (4,521 ha) (2,073 ha on Swan Coastal Plain/Foothills and 2448 ha on Darling Plateau and Scarp);
- Bush Forever sites in private ownership (1,531 ha); and
- Bush Forever sites under Council management (281 ha).

The Local Biodiversity Strategy outlines four goals to retain, protect and manage Local Natural Areas to conserve the biodiversity of the Shire into the future.

- Goal 1: Retention of Local Natural Areas
- Goal 2: Protection (and retention) of representative vegetation types
- Goal 3: Protection (and retention) of special ecological features and processes
- Goal 4: Management and restoration of Local Natural Areas

Local Natural Areas are presented on Figure 12. Of the 6333 ha of LNAs and private Bush Forever sites, priority is placed on those on the Swan Coastal Plain, foothills and Darling Scarp, because so much of this native vegetation has been cleared.

Draft targets for the protection of specific types of natural areas have been proposed to provide the greatest chance of conserving biodiversity within the Shire through rehabilitation of natural areas, and revegetation of new areas to increase native fauna habitat. In addition, targets are also focussed on particular biodiversity features such as rare species, wetland vegetation and ecological linkages located within the 4,503 ha, or 11% of original vegetation remaining west of the South West Highway. The targets have been developed by assessment of constraints of zoning, planned development and extent of native vegetation remaining in the Shire. The targets for protecting specific vegetation complexes are presented in Table 7. In addition, the following feature targets have also been identified:

- All Declared Rare Flora, Specially Protected Fauna, Priority Species and Threatened Ecological Communities are to be protected. All wetlands, wetland vegetation in good condition are to be protected along with adequate buffers.
- All riparian vegetation retained as first preference and protection of 10% of verified natural areas within 5 years and 20% within 10 years.
- Protect and increase viability and resilience of areas within regional ecological linkage areas within 5 years. As a lower priority where more than 500 meters exist between resilient natural areas support ecological revegetation projects to create habitat stepping stones.

- Retain all verified Local Natural Areas, parks and trees which support locally characteristic flora and fauna such as Black Cockatoos, *Eucalyptus lane poolei* and *Eucalyptus laelei*. Protect all habitats of locally characteristic flora and fauna, where such habitat occurs on properties proposed for development.

Key mechanisms proposed for the implementation of the Local Biodiversity Strategy are the development of:

- Council Reserves Management Strategy;
- Local Planning Policy for biodiversity conservation which proposes additional requirements for rezoning, structure planning and subdivision; and
- Stewardship program.

In order to achieve the specific targets of the Local Biodiversity Strategy the following actions were proposed (Shire of Serpentine-Jarrahdale, 2008):

- biodiversity targets to be supported by the Council, the community and State Government;
- Local Natural Areas identified by desk top studies to be assessed, identified and verified;
- Special Control Areas (Natural Area) to be investigated as a protection mechanism through the Town Planning Scheme;
- Review of the existing Conservation Zone initiative and expansion of the zone;
- Investigation of a stewardship program linked to grants;
- Development of partnerships to deliver further stewardship programs;
- Trial strata cluster and other rural subdivisions with conservation as a focus;
- Development of criteria for subdivision for conservation;
- Assessment of all reserves with natural areas and determination of priorities based on assessments while continuing to carry out priority management;
- Development of a Local Planning Policy (LPP) for Biodiversity Conservation, trial of the policy in a number of development settings;
- Allocation of resources for the LPP implementation and ensure developers and stakeholders are aware of LPP requirements;
- Utilisation of the Mundijong Whitby Structure Plan process as a test case for the new initiatives; and
- Establishment of a GIS/Biodiversity data base information and its ongoing management.

To continue to successfully implement the Local Biodiversity Strategy it has been recognised that specific Local Natural Areas should be prioritised for protection in order to maximise the environmental benefit of these areas by:

- ensuring protected Local Natural Areas contribute to a representational target (Table 7) and specific biodiversity feature targets;
- giving Local Natural Areas that meet a greater number of targets a higher priority for protection; and
- ensuring that protected Local Natural Areas have a relatively high ecological viability and have been assessed for their ecological viability and management needs.

It has also been recognised that working successfully with landowners of private properties containing Local Natural Areas is critical to successfully implementing the Local Biodiversity Strategy and protecting the Shire's Local Natural Areas.

Since the preparation of the Local Biodiversity Strategy a number of these and other relevant actions have been instigated, including:

- adoption of a *Biodiversity Incentives Strategy for Conservation on Private Property in October 2010* (Ironbark Environmental, 2010). As well as the development of a stewardship program, the Strategy also proposes grants scheme linked to the program;
- finalisation of Local Planning Policy No. 26 Biodiversity Planning which requires any scheme amendment, structure plan or detailed area plan proposed within 100m of a Local Natural Area to be accompanied by a Natural Area Initial Assessment to verify the values of the natural area and describe areas to be retained, protected and/or managed.
- development of the Healthy Habitats Program – a stewardship program which promotes protection of natural areas by landowners on private property through; provision of information/advice on bushland management, access to funding to assist in carrying out bushland management activities (Fencing, weed/pest control, dieback management and revegetation); http://www.landcaresj.com.au/news-resources/healthy-habitats
- grants scheme for private property owners linked to the stewardship program;
- Five Year Natural Area Management Strategy attached to the Natural Reserves Asset Management Plan; and
- rate relief linked to Conservation Zoned properties and Special Use Conservation Living properties.

Places of Natural Beauty

The Scheme contains provisions relating to Places of Natural Beauty, Historic Buildings, and Objects of Historical or Scientific Interest, where clearing of land or removal of trees is not permitted without the approval of Council. The listed natural places are:

- 6. Lowlands - Including Thomas Peel's House, on the Serpentine River, West Serpentine, which is a large estate of 1657 ha, comprising Lot 2 of Cockburn Sound Loc. 16.
- 31. Yangedi Swamp, Cockburn Sound Loc. 16, Part Lots 4, 5, 6, 76, 77 and 80. Places of Natural Beauty;
- 32. Red Gum Patch, Cnr. Alice and Redcliffe Roads, Cardup;
- 33. Manjedal Brook, from its source East of Nettleton Road along its length to Kargotich Road; and
- 36. Jarrah Road Swamp, Part Peel Estate lot 809, Jarrah Road, Serpentine.

Site 6: Lowlands is located west of Serpentine, and comprises the conservation area, Bush Forever site 368 and Bush Forever site 372. The area that links the two Bush Forever sites is not considered in the Green Growth Plan nor other future planning documents. However it can been seen that the area between could be regarded as a significant local biological and ecological corridor between the two BF sites.

Another significant Area of Natural Beauty is the Manjedal Brook (Site 33), which is north of Mundijong. This area is considered in the Mundijong Whitby District Structure plan, however the proposed industrial area west of this, as indicated in the Green Growth Plan, planning of this area need to take into account the Manjedal Brook.

Site 31 Yangedi Swamp is located within Bush Forever site 77 and Site 36 Jarrah Road Swamp is a recognised conservation category wetland, whilst Site 32. Red Gum Patch is next to Cardup Reserve but is not incorporated into Bush Forever or recognised as a local natural area.

2.5.2 Protected flora, fauna and ecological communities

At the Commonwealth level, flora, fauna and ecological communities may be recognised as matters of national environmental significance and are protected under the *Environment*

*Protection Biodiversity Conservation Act (*EPBC Act), *1999,* administered by the Department of Environment. The categories of threatened flora and fauna protected under the EPBC Act are (i) extinct in the wild (ii) critically endangered, (iii) endangered and (iv) vulnerable. An additional category of "conservation dependent" exists, which requires special consideration but is not protected under the EPBC Act.

The Commonwealth lists a number of matters of national environmental significance in SJ Shire including 29 threatened species, seven migratory species and three threatened ecological communities (TECs): *Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain* and *Corymbia calophylla – Xanthorrhoea preissii woodlands and shurblands of the Swan Coastal Plain* which are both known to occur in SJ Shire, and *Claypans of the Swan Coastal Plain* which is noted as being likely to occur within SJ Shire (DoE, 2016).

The threatened species listed under the EPBC Act include the critically endangered native bee (*Neopasiphae simplicior*), Muchea Bell, Selena's Synaphea, and the endangered Australasian Bittern, Carnaby's Black-Cockatoo, Australian Painted Snipe, Woylie, Cinnamon and Star Sun-orchids, Purdie's Donkey-orchid, and King Spider-orchid (see Appendix 2 for the full listing).

Flora and fauna is also protected at the State level under the *Wildlife Conservation Act, 1950,* administered by the Department of Parks and Wildlife. The *Wildlife Conservation (Specially Protected Fauna) Notice, 2010* recognises four categories of Rare and Endangered fauna taxa, and the *Wildlife Conservation (Rare Flora) Notice 2012* recognises two categories of rare flora. In addition, the Department of Parks and Wildlife also classifies flora and fauna under five different Priority codes, with different management requirements.

The Department of Parks and Wildlife lists a number of threatened species in SJ Shire which are summarised in Table 8 and listed in Appendix 2.

Table 8: Threatened and priority flora and fauna in the Shire of Serpentine-Jarrahdale (DPaW, 2016)

Conservation Status (*Wildlife Conservation Act, 1950*)	# Species
Rare or likely to become extinct	24
Protected under international agreement	4
Other specially protected fauna	3
Priority 1	13
Priority 2	8
Priority 3	27
Priority 4	21
Priority 5	2
Other recorded native species	844
Total	**886**

One of the key species of focus of the Perth and Peel Green Growth Plan for 3.5 million (Government of WA, 2015) is Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), a species of Specially Protected Fauna known to feed, breed and roost throughout the Jarrahdale, Mundijong and Serpentine areas. They are a partially migratory species that breed in the

wheatbelt in winter to mid-spring and wander in flocks to coastal areas for foraging in the non-breeding season. This bird species is listed as Critically Endangered under the Commonwealth EPBC Act and is now reliant on parkland areas in the Shire for feeding habitat. The main threats to the long-term survival of the species are loss of nesting hollows and food resources due to land clearing (Ironbark Environmental, 2008). Breeding and roosting areas of Carnaby's Cockatoo have been mapped and are presented on Figure 12. Potential feeding areas are not depicted on this figure as they are too detailed and are very similar to the extent of remnant native vegetation.

Under the *Wildlife Conservation Act 1950*, a TEC is an ecological community that has been identified as being subject to processes that threaten to destroy or significantly modify it across much of its range. TECs located within SJ Shire, listed in the *Perth Biodiversity Project – Local Government Biodiversity Planning Guideline*s (2004), and confirmed by the Department of Parks and Wildlife (former Department of Environment and Conservation) in 2007 are presented in Table 9 below.

Table 9: Threatened Ecological Communities found within the Shire of Serpentine-Jarrahdale (Ironbark Environmental, 2008)

Threatened ecological community	WA criteria Designation (2007)	EPBC Act category (2016)	Community Identifier
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Critically Endangered	Endangered	SCP3a
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Critically Endangered	Endangered	SCP3c
Banksia attenuata and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain	Endangered	-	SCP20b
Southern wet shrublands of the Swan Coastal Plain	Endangered		SCP02
Shrublands on dry clay flats	Endangered	-	SCP10a
Corymbia calophylla – Eucalyptus marginata woodlands on sandy clay soils of the southern Swan Coastal Plain	Vulnerable	-	SCP3b
Herb rich shrublands in clay pans	Vulnerable	-	SCP08
Herb rich saline shrublands in clay pans	Vulnerable	-	SCP07
Dense shrublands on clay flats	Vulnerable	-	SCP09

The following TECs recognised by Department of Parks and Wildlife are considered to comprise the federally recognised and critically endangered *Claypans of the Swan Coastal Plain* TEC and are found to occur at Duckpond Nature Reserve and Brickwood Reserve in particular:

- Herb rich shrublands in clay pans;
- Herb rich saline shrublands in clay pans;
- Dense shrublands on clay flats; and
- Shrublands on dry clay flats.

2.5.3 Tree Protection

The Salmon White Gum (*Eucalyptus lane-poolei*) and Darling Range Ghost Gum (*Eucalyptus laelei*) have been identified in particular as two species of locally characteristic trees that require protection due to their endemic presence in the Shire. The Salmon White Gum is uncommon in the metropolitan region and is found only in a few places in the Foothills around Keysbrook, Mundijong and Byford. The Darling Range Ghost Gum is confined to the Darling Range between the Helena Valley and Harvey, usually in the Darling Scarp. These trees occur locally in the Serpentine National Park on hillsides above the Serpentine Falls and along Gobby Road in Keysbrook (Ironbark Environmental, 2008).

The TPS No. 2 includes specific provisions for the preservation and planting of trees (Section 7.13) with the objectives of:

- preserving the landscape attributes within the Shire and protecting significant and sensitive areas from the negative effects of clearing of native vegetation;
- enhance the amenity, convenience and natural beauty of various parts of the Shire by facilitating:
    - reduction in soil salinity;
    - prevention of erosion;
    - provision of habitats for native fauna;
    - provision for aesthetic pleasure; and
    - retention of the landscape quality
- encouraging, requiring planting or replanting of areas considered by the Council to be deficient in tree cover;
- where appropriate, to provide for visual screening of buildings or other development; and
- to control the removal or destruction of or damage to trees.

Scheme provisions outline the following prescribed requirements for tree preservation:

- removal, destruction or damage of trees within the Shire is not permitted without prior Council approval (specifically of trees of a size having at least one well defined stem or trunk of a height greater than 4 m or diameter greater than 150 mm measured at a height of 1.2 m above the natural ground level)
- the Council may declare an area of land to be a tree preservation area based on historical, cultural heritage or scientific significance;
- removal, destruction or damage of trees and other natural vegetation within the Shire is not permitted without prior Council approval where trees/vegetation are located:
    - within 100 m of a watercourse;
    - in an area with a slope in excess of 1 in 5; or
    - in an area designated a tree preservation area.
- the Council may identify a tree/group of trees/species of trees on private land requiring preservation by the landowner

Council approval for removal of trees is exempt in a number of cases, including; trees or vegetation which is native or non-native and under a certain size, where trees constitute a threat to life/property, where trees are located within building envelopes, access ways, or near to utility infrastructure, where trees are commercially grown, where removal has been approved as part of subdivision conditions, or as a requirement for undertaking of public works. However, if vegetation has been planted as a condition of subdivision, it is not permitted to be removed.

Tree planting may be required as part of planning approval or building licence approval where tree cover is considered deficient at a development/lot.

Anecdotal evidence has suggested that the tree preservation requirements may not be achieving their intent, particularly with regards to protection of native vegetation. Consideration may be given to alternative ways of tree preservation.

Alternative/additional ways to deliver tree protection include:

- Use of the Shire's significant tree register;
- Preparation of an Urban Forest Strategy which addresses biodiversity objectives, as well as urban heat and amenity;
- Public education regarding benefits of trees (air quality, urban heat island effect, habitats for native fauna, social/mental health, protecting biodiversity in one of the world's top biodiversity hot spots) – materials, signage, lectures, walking tours;
- Development of a Register of Significant Trees; requiring specific conditions/Council approval for modifications/Tree Preservation Orders during development applications;
- Stewardship programs, supported by training workshops, tree management reference materials and technical advice/support, rental of tools/equipment;
- Financial incentives via development incentives, rate rebates, or grants/subsidies (dieback treatment, nest boxes, pest control, weeding or towards landcare groups/school groups towards tree planting/management).

A number of these strategies have been recommended for implementation in the Shire's Local Biodiversity Strategy, described in section 2.5.1.

Alternatively, SJ Shire may consider the establishment of a valuation system for trees across the Shire. Estimating and promoting the financial value of the services that trees provide is another method of encouraging the protection of trees in a community. Air pollution reduction, temperature control (cooling and combatting the urban heat island effect), erosion control wildlife habitat, and visual amenity are key services provided by trees which may be recognised and valued. Trees may then be recognised as community assets and listed on a local government Asset Register. The recognition of trees as assets then has implications not only for their management, but also for the decision making processes that involve trees. This valuation can also be used for the purposes of insurance, compensation and litigation.

There are several methods of placing a monetary value on the amenity provided by individual trees or woodlands. The Helliwell system is one such system which allows for a monetary value to be placed on the visual amenity provided by an individual tree asset using the process of allocating point scores under a number of factors such as tree size, life expectancy, or suitability to setting. Scores are then combined to give an overall comparative score for a tree or woodland. A value to this point score may then be attached through the use of a monetary conversion factor (The Arboricultural Association, 2016).

Other tree valuation systems include Capital Asset Value for Amenity Trees (CAVAT), i-Tree and the Burnley method. These systems differ significantly in methodology, data requirements and outputs. While the Helliwell system is entirely based on expert judgement the Burnley method focuses solely on visual amenity value and have very low field data requirements. The i-Tree system requires data collected from a sample or a complete inventory of the street tree population as well as community-specific information (such as programme management costs, city population size, and price of residential electricity) to output customised benefit and cost data. CAVAT focuses on wider benefits of trees to communities rather than purely visual amenity, but not on the detailed benefit and cost data outputs. The CAVAT and i-Tree systems can meet the needs of both small communities and large metropolitan areas. However, if limitations on data availability can be overcome, i-Tree offers significant advantages of flexibility, detailed output and permits a wide range of benefits to be assessed.

The City of Stirling is implementing a valuation system based on the Helliwell system, while the City of Perth is currently using the *City of Perth Street Tree valuation method* (2013) to value its green infrastructure assets. The City of Perth framework has been adopted by Council (policy No 20.9) to provide a numeric dollar value of the replacement cost of trees. The tree value is based on monetary value, tree size, aesthetics, locality, species, special species, form, condition, habitat and significance. It recognises the need to consider future growth heights and vegetation form when placing other assets such as park or street lighting or solar powered parking ticket machines in close proximity to green assets. The City has mapped its trees and valued them on the basis of Policy no 20.9. This allows them to be included in the asset register and managed appropriately, in recognition of their value.

2.5.4 Key strategic environmental planning issues for consideration

Key biodiversity considerations for strategic planning are:

- **Regionally significant areas** – are represented by Bush Forever Sites. The Draft *Strategic Conservation Plan for the Perth and Peel Regions* (Government of WA, 2015) proposes to reserve currently unreserved Bush Forever Sites as part of its conservation commitments. It is also recommended that consideration is given to the need for verification of the values of these areas as part of their future management and/or protection.
- **Local Natural Areas** - The Local Biodiversity Strategy identifies 6,333 ha of natural areas targeted for protection and management comprising 7% of the Shire's original native vegetation. The goals, targets and actions of the Local Biodiversity Strategy should be incorporated into the Shire's Local Planning Strategy;
- **Ecological linkages** – are important to facilitate fauna movement and species adaptation to changing climate and conditions. Where these linkages are associated with infrastructure corridors, consideration should be given to the achievement of multiple objectives including biodiversity conservation through, for example, modification to the reserve purpose. Multiple use corridors can also provide important linkages where native vegetation and habitat is created.
- **Tree preservation** – Consideration should be given to contemporary mechanisms to achieve appropriate tree coverage across the Shire. This may include preparation of an Urban Forest Strategy which considers multiple objectives or the incorporation of trees into the Shire's asset register through appropriate valuation.
- **Management of conservation areas** - there are a number of issues that affect the viability of conservation areas which are vested in the Shire which need to be actively managed by SJ Shire. These include:
    - **Uncontrolled access** – which leads to direct loss of biodiversity as well as impacts from rubbish dumping, weeds and bushfires.
    - **Disease** - Dieback (*Phytophthora cinnamomi*) affects vast areas of the jarrah forest, spreading through water and transport of infected soil, gravel and other materials. It has been identified in several of the Shire's TECs and is known to occur throughout the area.
    - **Weeds -** Many Shire reserves with high biodiversity values have the aggressive weeds watsonia and lovegrass. Many Shire reserves still suffer high disturbance, which encourages weed invasion**.**
    - **Feral animals** - Feral animals, especially cats, rabbits and foxes, have a major impact on the native flora and fauna.

2.6 Hazards and natural disasters

2.6.1 Bushfire risk

In accordance with the Map of Bush Fire Prone Areas gazetted by the Department of Fire and Emergency Services, the large majority of SJ Shire is classified as a bushfire prone area, with the exception of areas cleared for urban development, large water bodies, and areas affected by mining.

Future planning and development within Bush Fire Prone areas will need to meet the requirements of *State Planning Policy 3.7: Planning in Bushfire Prone Areas* (SPP 3.7) (2015) and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, 2015). It is noted that Objective 5.4 of State Planning Policy 3.7 is to "Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values, environmental protection and biodiversity management and landscape amenity, with consideration of the potential impacts of climate change." This is an important consideration for the Shire.

2.6.2 Flood risk

Many rivers and brooks pass through the townships of SJ Shire, flowing down from the Darling Scarp across the Swan Coastal Plain. These waterways are a key natural attribute attracting residents to the area. However there is an associated flood risk to development near any waterway.

The Shire currently has floodplain management strategy within the District Water Management Strategy (DoW 2008) for the Byford Townsite with indicative flood levels and provisions for minimum habitable building heights. Consistent with *State Planning Policy 2.9: Water Resources* and SJ Shire *Local Planning Policy No 6 Water Sensitive Design*, a similar approach will be required to support any further development within SJ Shire in proximity to waterways to minimise risk of flooding.

Further to the above, SJ Shire contains a portion of the Peel-Harvey catchment. As shown in Figure 9, the associated 100 year ARI flood risks of the Peel Inlet can be seen with the associated floodway and flood fringe. Affected areas are largely in the central western portion of the Shire, where the Serpentine River connects to the Birriga Main Drain, and consequently portion of the Serpentine River flood upstream.

2.6.3 Key strategic environmental planning issues for consideration

Key hazards and natural disasters considerations for strategic planning are:

- **Bushfire risk** – large parts of SJ Shire are identified being Bush Fire Prone. Future planning and development within Bush Fire Prone areas will need to meet the requirements of *State Planning Policy 3.7: Planning in Bushfire Prone Areas* (SPP 3.7) (2015) and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, 2015); and
- **Flood risk** – Portions of SJ Shire associated with waterways may be subject to risk of flooding. Any proposed development should be consistent with *State Planning Policy 2.9: Water Resources* and SJ Shire *Local Planning Policy No 6 Water Sensitive Design* and address flood risk appropriately, as part of the delivery of integrated water cycle management and water sensitive urban design outcomes.

It is not considered necessary to include a special control area in the future scheme to highlight either bushfire risk or flood risk as these issues are adequately addressed through existing State Planning policy as described above.

2.7 Heritage

2.7.1 Aboriginal Heritage

The original inhabitants of the Serpentine-Jarrahdale area are the ***Gnaala Karla Boodja*** Aboriginal people of the Noongar group of south-west Western Australia. The ***Gnaala Karla Booja*** region encompasses the towns of Capel, Donnybrook, Balingup, Wickepin, Narrogin, Williams, Mundijong, Kwinana, Brookton, Pingelly, Wagin, Harvey, Collie, Pinjarra, Mandurah and Boddington (SWALSC, 2016).

The area around Mundijong is also within Aboriginal country known as Beeliar, which was associated with the legendary Aboriginal leader Midgegooroo and his son Yagan. Ethnohistorical evidence shows that rivers, creeks and wetlands in this region were most intensively occupied, given the availability of fresh water and food resources. In particular, the alluvial plains and associated warran or native yam grounds and riparian resources such as Typha were of crucial economic importance to Aboriginal people (McDonald & Thomson, 2012).

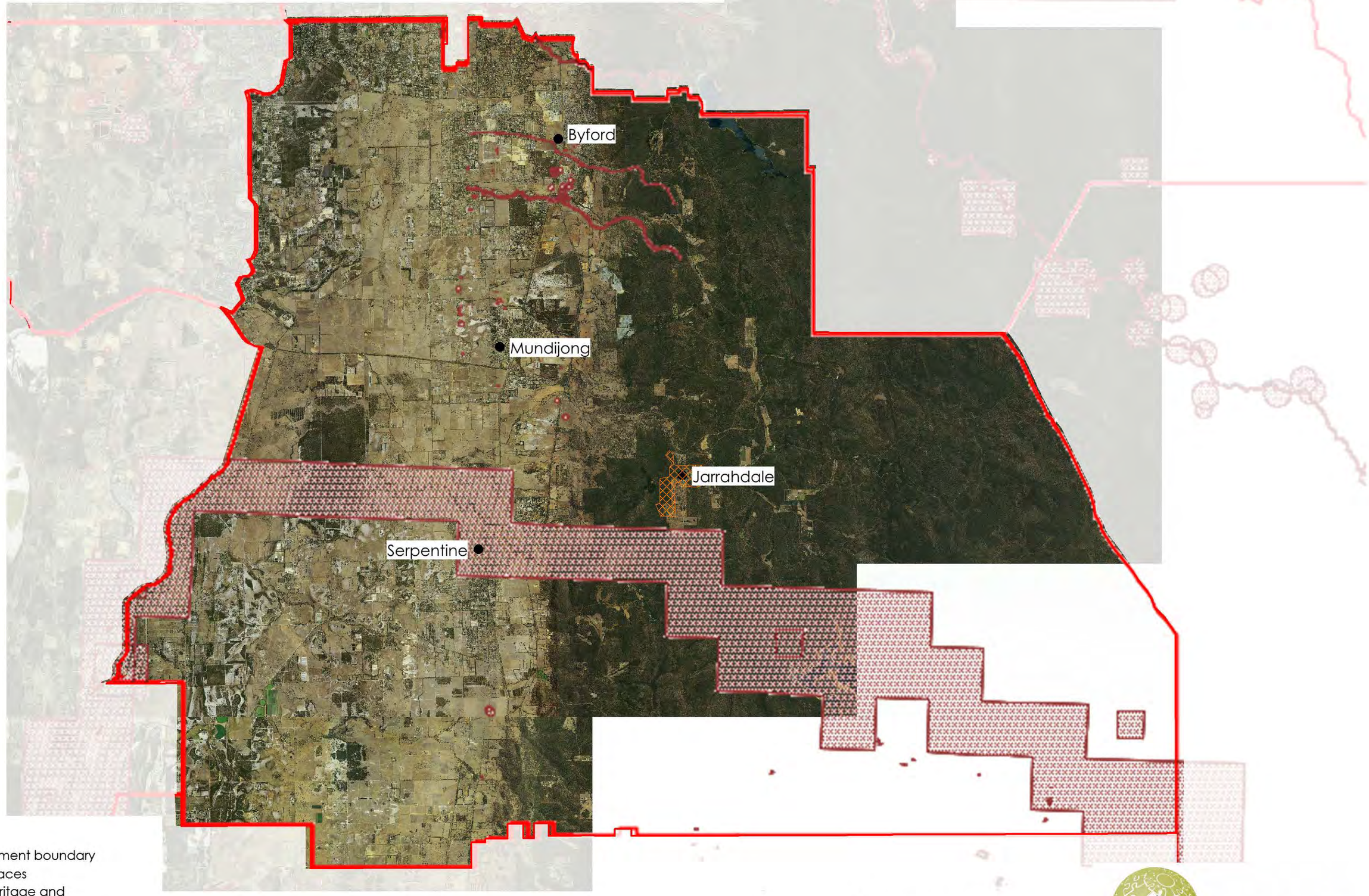
The Department of Aboriginal Affairs maintains a register of known Aboriginal sites, which records the places and objects of significance that the ***Aboriginal Heritage Act 1972 (WA)*** applies to. The presence of an Aboriginal site places restrictions on what can be done to the land. Anyone who wants to use land for research, development or any other cause, should investigate whether an Aboriginal site is present.

There are currently 30 registered Aboriginal Heritage sites and over 50 other heritage places in the Shire of Serpentine-Jarrahdale (Figure 13). The Serpentine River in particular is the largest registered site with particular cultural significance. The ***Barragup mungah*** – fish weir on the Serpentine River has long been recognised by local Noongar people as amongst the most important traditional meeting places for Noongar from the Swan, Peel and Darling Ranges areas (SWALSC, 2016).

On 8th June 2015, Indigenous Land Use Agreements (ILUAs) were executed across the South by the Western Australian Government and six Aboriginal groups, including the Gnaala Karla Boodja. The ILUAs bind the State Government Departments 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 recommended by the government that 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 (DAA, 2016).

As part of the South West Native Title Settlement, a maximum of 300,000 hectares of reserve land and a maximum of 20,000 hectares of freehold land will be allocated to the Noongar Boodja Trust as part of the Noongar Land Estate. The land being allocated primarily includes land that is currently Unallocated Crown Land, Unmanaged Reserves and Aboriginal Lands Trust properties in the South West. Government agencies may also identify currently held freehold land and reserves for which they hold management orders as surplus to their needs and eligible for transfer. The Department of Lands will engage with local governments as required under section 14 of the ***Land Administration Act 1997*** (WA) after SWALSC or the Trustee has selected land, at the Assessment stage of the land transfer process (Government of WA, 2015).

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 13 - Heritage sites



Legend
- Local government boundary
- Populated places
- Aboriginal heritage and other heritage places
- Jarrahdale historical, heritage and townscape precinct

Data source: SJ Shire DAA, Landgate Created by: RM Projection: MGA50: zone 50.

Scale 1: 140,000 at A3
0 5.6 km

essential environmental

2.7.2 Post European Settlement Heritage

European settlement in the Shire of Serpentine-Jarrahdale dates from the 1830s, with land cleared and used primarily for farming and obtaining timber. The population was minimal until the late 1800s when many townships were established (including Byford, Cardup, Jarrahdale, Mundijong, and Serpentine), aided by the opening of timber mills in the 1870s and the construction of the South Western Railway from Perth to Bunbury in 1893, originally for timber transportation. In 1891 the state government opened up additional land in the area for farming by declaring the Serpentine Agricultural Area. Brickmaking was also a significant industry which contributed to the development of Byford and surrounding townships during this time, after the discovery of shale in Cardup in the 1850s. The Cardup brickworks did not close until 2012.

The opening of the South Western railway prompted further growth through the early 1900s, however, the post war years saw the most residential development with the population of the Shire increasing from 1,830 in 1961 to 21,162 in 2013, (ABS, 2016).

A large number of historic heritage sites are located within the Shire, and registered with both the Heritage Council of WA and the Shire of Serpentine-Jarrahdale Municipal Inventory (State Heritage Office, 2016). A number of key sites, including the Mill Brook Historical Cottage, Lowlands Homestead (Serpentine Farm), Brickwood Bushland, and Serpentine National Park, are also part of the Register of National Estate and the National Trust. In 1997 the entire Jarrahdale townsite, including the mill office, timber stores and worker's cottages, was entered on the National Trust's List of Classified Heritage places, the seventh Western Australian town to be so classified. A Prisoner of War (POW) camp was also located outside of the townsite during World War Two.

2.7.3 Key strategic environmental planning issues for consideration

Key heritage considerations for strategic planning are:

- **Protection of heritage sites and values** - While heritage is primarily managed through State and Commonwealth legislation, opportunities exist to protect and promote both Aboriginal and European cultural heritage through joint management arrangements with traditional owners and optimise opportunities for Indigenous training, employment and businesses.
- **Engagement with traditional owners** – is required to meet legislative requirements of Native Title. Increased benefits may be observed through an elevated level of involvement of the Gnaala Karla Boodja traditional owners within the Shire in terms of land and cultural heritage management.

3 SUMMARY

Serpentine-Jarrahdale Shire is one of the largest local governments in the greater Perth metropolitan region, situated approximately 45km south of the Perth CBD and 13km east of the coast. It is largely rural in character, with small but growing settlements of Byford, Mundijong, Serpentine, Jarrahdale and Cardup.

The Community Vision for SJ Shire is for

> *A sustainably developed Shire, where the community, local economy and natural environment are interconnected and thriving.*

This Vision is enhanced through the Rural Strategy which aims to:

> *preserve and enhance the Shire's rural character and its role as an important economic contributor to the Shire and broader region.*

SJ Shire has commenced the process of preparing a Local Planning Strategy (LPS) and new Local Planning Scheme to guide future growth and development. In order for these outcomes to be achieved in the future, it is critical that the natural and environmental assets of SJ Shire are recognised, and any environmental opportunities and constraints are considered as part of the LPS process. This report provides a snapshot of the SJ Environmental context and highlights opportunities and constraints for consideration.

The key environmental context and considerations are summarised as follows:

- Increasing population and settlement which requires the planning and development of new communities and associated infrastructure;
- Declining rainfall and increasing temperatures have the potential to impact on the health of the environment and the community, as well as the maintenance of public lands and capacity of infrastructure systems including those managed by SJ Shire;
- The landforms of SJ Shire, which comprise the Swan Coastal Plain in the west, the Darling Scarp, and the Darling Plateau in the east, underpin the soil, water and vegetation characteristics and their associated issues. The broad environmental issues associated with each land form are as follows:
    - Swan Coastal Plain – is largely seasonally waterlogged, with sands over clays at risk of erosion, waterlogging, nutrient export and acidification. This area has been extensively cleared for agricultural and residential uses;
    - Darling Scarp – comprises steep gradients where the risk of erosion increases with clearing of vegetation; and
    - Darling Plateau – which is mostly vegetated, with incised valleys containing waterways and dams. Gravel pits and rock quarries are located towards the edge of the plateau and along the scarp.
- Minerals and basic raw material extraction is occurring throughout the Shire. Any further extraction has the potential to impact on the health of the community and the environment through loss of vegetation, erosion, noise, dust and light. Consideration should be given to the potential future use of the site and requirements for rehabilitation on closure.
- SJ Shire is located in the catchment of the RAMSAR-listed Peel-Yalgorup system which terminates in the Peel-Harvey Estuary. This system has historically been impacted by high levels of nutrients, predominantly from agricultural land uses, which reach the estuary via both surface and groundwater pathways. Consideration should be given to the location of any land use which is likely to result in increased transport of nutrients to surface and/or

groundwaters in SJ Shire, including actions to manage the risk to the Estuary. This includes residential, rural residential, agricultural and industrial uses.

- A portion of the Jandakot Groundwater Mound is located within SJ Shire. Land use within the public drinking water source area must be consistent with *State Planning Policy 2.3: Jandakot groundwater protection* (draft for public comment, 2014) and address risks to the water quality of the water source.
- Groundwater in the Leederville aquifer throughout SJ Shire is mostly allocated, although some capacity remains within the superficial aquifer to supply groundwater for non-drinking water needs which may include irrigation of public open space and for agriculture, as well as for industrial use where the quality is fit-for-purpose.
- Areas of SJ Shire are subject to the risk of flooding. This is largely associated with drains running across the Swan Coastal Plain portion, which are managed to achieve either rural or urban drainage standards. It should be noted that flood mapping has not been completed for all waterways and any new development in proximity to a waterway or drain will need to consider flood risk, consistent with *State Planning Policy 2.9: Water Resources*.
- Less than 10% of the vegetation complexes across the Swan Coastal Plain portion of the Shire are currently contained in secure conservation reserves, with only 12% remaining uncleared. The SJ Shire *Local Biodiversity Strategy* (LBS) provides targets for the conservation of important biodiversity values. Although the LBS is being implemented through an incentives strategy for conservation on private land, limited additional protection has been achieved. Consideration should be given to the prioritisation of protection of Local Natural Areas for incorporation into the LPS and scheme.
- The majority of SJ Shire is indicated as being located within a Bush Fire Prone Area of Western Australia as designated by the Fire and Emergency Services (FES) Commissioner. Any future planning and development within a designated Bush Fire Prone area should be consistent with the requirements of *State Planning Policy 3.7 Planning in Bushfire Prone Areas*.
- While heritage is primarily managed through State and Commonwealth legislation, opportunities exist to protect and promote both aboriginal and European cultural heritage through joint management arrangements with traditional owners and optimise opportunities for Indigenous training, employment and businesses. This should include effective engagement with the *Gnaala Karla Boodja* Aboriginal people of the Noongar mob.

The above considerations and the implications for management and planning are broadly summarised in Figure 14**.**.

Within this local environmental context, consideration should also be given to emerging global, national and regional environmental priorities. These include:

- Climate change leading, in addition to the issues raised above, to global (land and ocean) temperature rise, sea level rise, ocean acidification and increases in extreme weather;
- Reducing greenhouse gas emissions and energy use through improved energy efficiency and increased use of renewable energy;
- Reducing resource consumption and a move towards community acceptance of smaller environmental footprints;
- Innovation leading to the creation of new ways to address sustaining problems including poorly functioning communities, water scarcity and congestion, which result in improved urban form and optimised delivery of services and infrastructure; and
- Enhanced liveability of communities which are adaptive and able to respond to changing environments and community priorities.

It is recognised that SJ Shire desires a sustainable, connected and thriving community into the future. This supports many opportunities for environmental innovations. Key areas of focus may include:

- Local-scale service provision which enables disconnection of communities from large centralised systems. This includes locally supplied power, water, wastewater and non-drinking water. Consideration could also be given to decentralised waste-management strategies which optimise reuse and recycling of waste materials.
- Local food supply including native food (bush tucker: quandongs, bush tomatoes, and native citrus) which reduces transport needs, provides local employment and optimises closed-circuit practices including industrial ecology techniques;
- Improved built form which does not require imported fill for development on clay soils or in areas of high groundwater. The urban form should also respond to local climate conditions including prevailing winds (breezes) and maximise amenity through green infrastructure.
- Provision of "lifestyle lots" in a manner which does not impact on good quality and productive farmland or areas of high biodiversity value. This may include areas immediately surrounding satellite communities which self-supply their water, sewerage and power needs.
- Eco-tourism opportunities which celebrate the unique natural beauty and biodiversity of the Shire. This may include accommodation, entertainment and artistic opportunities as well as adventure and recreational activities. This could be extended to educational opportunities associated with practical and on-ground environmental learning.

Shire of Serpentine Jarrahdale - Environmental Profile
Figure 14 - Key environmental issues

Legend

- local government boundary
- Populated places
- Regionally significant ecological linkages
- Darling Scarp and Swan Coastal Plain delineation
- 100yr ARI Floodway & flood fringe
- Public drinking water source area P1 & P2
- Waterways

Green Growth Plan: Classes of action

- Industrial
- Rural residential
- Urban

Mine site status

- Operating
- Proposed
- Under Development

Geomorphic wetlands

- Conservation
- Resource Enhancement

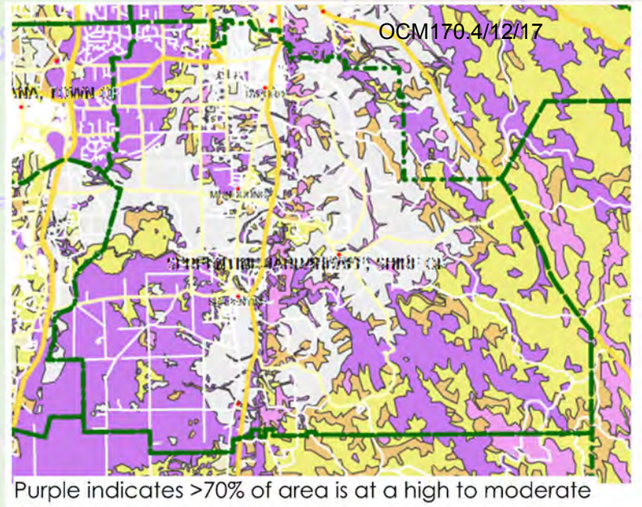
Administrative planning categories

- Bush Forever
- Bush Forever, DPaW Conservation
- Bush Forever, DPaW Conservation,
- Bush Forever, DPaW Other
- Bush Forever, Reg Park
- DPaW Conservation
- DPaW State Forest
- DPaW State Forest, Reg Park
- DPaW Other
- Regional Park
- Local Natural Areas

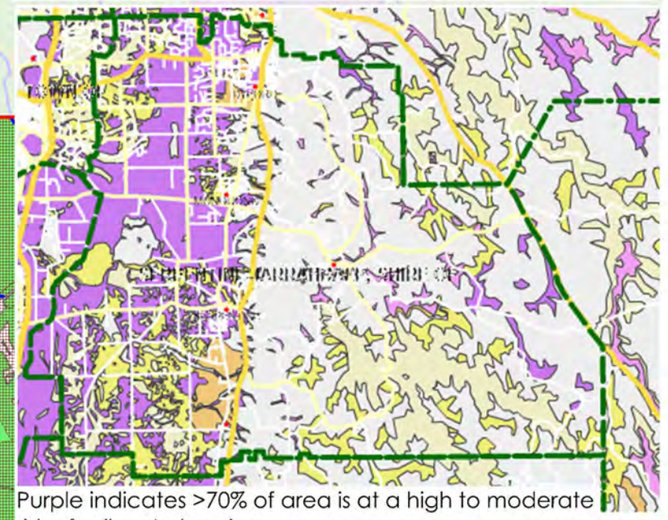
Wungong Reservoir

Serpentine Pipehead Dam

Serpentine Reservoir

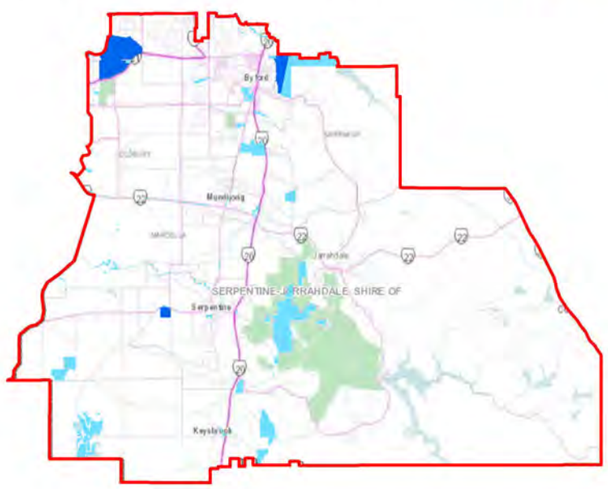


Purple indicates >70% of area is at a high to moderate risk of phosphorus export



Purple indicates >70% of area is at a high to moderate risk of soil waterlogging

Blue areas (light and dark) indicate GGP future conservation reserve areas



Data source: SJ Shire, DPaW, DoP, DoW, Landgate. Created by: RM Projection: MGA: zone 50.

Scale 1: 140,000 at A3

0 5.6km

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The following table provides broad generalisations only. Specific solutions for individual locations should be determined through more detailed planning and assessment as part of the planning and development approvals process.

Table 10: Summary of strategic environmental planning considerations

Key environmental value	Impacts from and on land use Residential /town/ village /commercial	Red – high Industrial	Orange - medium Rural residential	Green - low Rural/agriculture	Shire's role in managing the impact	Recommendations for planning control
Air quality	Haze and smog Light overspill Dust (construction sand)	Noise, dust, light	Haze	Overspray, noise, dust	Manage impacts through enforcement of by-laws and Environmental Health regulations	Provide buffers and management of off-site impacts consistent with SPP 4.1: State Industrial Buffer Policy and DER/EPA buffer guidelines.
	Health risks to residents	Health risks to employees	Health risks to residents	Health risks to residents & livestock		
Soils	Erosion, waterlogging, nutrient export and acidification	Erosion, waterlogging, contamination	Erosion, waterlogging, nutrient export and acidification	Erosion, waterlogging, nutrient export, contamination and acidification	Ensure land clearing and site management practices are implemented which are appropriate to the land use and capability of the soils.	Ensure land use is appropriate to the capability of the land to sustain the land use. This is particularly important for intensive agriculture proposals on the coastal plain and development on the Scarp
	Structural impacts including subsidence and erosion Loss of productive land	Structural impacts including subsidence and erosion Loss of productive land	Structural impacts including subsidence and erosion Loss of productive land	Productivity and structural impacts including subsidence and erosion		
Minerals and basic raw material	Sterilisation of resource	Sterilisation of resource	Sterilisation of resource	Sterilisation of resource	Enforce conditions of development approval with regards to the management of of-site impacts	Ensure planning approvals are consistent with the protection of significant values and that potential off-site impacts are managed.
	Not permitted within this land use however may be affected by off-site impacts including noise, light and dust	Noise, light and dust	Not permitted within this land use however may be affected by off-site impacts including noise, light and dust	Noise, light and dust		
Peel-Harvey catchment	Nutrient pollution via surface water/drainage	Contamination via surface water/drainage	Contamination (incl nutrients) via surface water/drainage	Contamination (incl nutrients) via surface water/drainage	Planning approvals should ensure adequate treatment of surface water	Demonstrate compliance with SPP 2.1 and SPP 2.9

Key environmental value	Impacts from and on land use	Red – high	Orange - medium	Green - low	Shire's role in managing the impact	Recommendations for planning control
	Residential /town/ village /commercial	Industrial	Rural residential	Rural/agriculture		
	Potential for restriction of high polluting land uses under GGP	Potential for restriction of high polluting land uses under GGP	Potential for restriction of high polluting land uses under GGP	Potential for restriction of high polluting land uses under GGP	drainage prior to discharge	
Jandakot Groundwater Mound	Nutrient pollution from infiltration of surface water	Contamination from infiltration of surface water	Contamination from infiltration of surface water	Contamination from infiltration of surface water	Planning approvals should ensure adequate treatment of surface water drainage prior to discharge	Ensure land use is consistent with SPP 2.3 and DoW's water quality protection notes
	Land use is restricted based on P classification	Land use is restricted based on P classification	Land use is restricted based on P classification	Land use is restricted based on P classification		
Waterways and wetlands	Direct impacts from filling, draining, clearing, contamination and erosion	Direct impacts from filling, draining, clearing, erosion, contamination,.	Direct impacts from clearing, erosion, contamination, and/or uncontrolled access by stock	Direct impacts from clearing, erosion contamination, and/or uncontrolled access by stock	Avoid development which results in direct impacts on values	Identify waterways and wetlands with significant values and ensure future development is not proposed in these locations or is managed appropriately
	Mosquitoes, flooding	Mosquitoes, flooding	Mosquitoes, flooding	Mosquitoes, flooding		
Remnant vegetation, biodiversity and fauna habitat	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from agricultural practices, rubbish, uncontrolled access, weeds, pests and feral animals	Identify areas of remnant vegetation with significant values and aim to limit the location of high risk land uses	Protect as appropriate through reservation or use of a special control area. Continue to provide incentives for conservation on private land
	Bushfires, Snakes	Bushfires, Snakes	Bushfires, Snakes	Bushfires, Snakes		
Aboriginal and European heritage	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Identify significant sites should be identified in the Scheme	Decision making should be consistent with the Heritage Act and Aboriginal Heritage Act
	Potential to limit scope of development	Potential to limit scope of development				

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APPENDIX 1: POLICY AND REGUILATORY FRAMEWORK

4.1 Guiding legislation

The management of the environment and natural resources in an urban and regional context is governed by a substantial number of acts and regulations, the most relevant of which are considered to be:

- Aboriginal Heritage Act 1972
- Biosecurity and Agriculture Management Act 2007
- Conservation and Land Management Act 1984
- Contaminated Sites Act 2003
- Country Areas Water Supply Act 1947;
- Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
- Environmental Protection Act 1986
- Health Act 1911
- Heritage of Western Australia Act 1990
- Local Government Act 1995;
- Native Title (State Provisions) Act 1999
- Native Title Act 1993 (Commonwealth)
- Planning and Development Act 2005;
- Rights in Water and Irrigation Act 1914;
- Soil and Land Conservation Act 1945
- Waste Avoidance and Resource Recovery Act 2007
- Water Agencies (Powers) Act 1984;
- Water Resources Legislation Amendment Act 2007;
- Water Services Act 2012;
- Waterways Conservation Act 1976; and
- Wildlife Conservation Act 1950

4.2 State policy context

Strategic guidance for the management of our environment is also provided by a number of State-level policies, strategies and guidelines. These include:

4.2.1 Directions 2031 and Beyond

Directions 2031 recognises the benefits of a more consolidated city while working from historic patterns of urban growth. Importantly, the framework sets achievable goals that will promote housing affordability over the longer term. Directions 2031 addresses urban growth needs and also takes into consideration the need to protect our natural ecosystems.

The framework provides for different lifestyle choices, vibrant nodes for economic and social activity and a more sustainable urban transport network. The framework will also encourage a long-term approach to the provision of infrastructure in an economically sustainable way.

4.2.2 Draft Perth and Peel@3.5million: South Metropolitan Peel

The draft framework considers where future homes and jobs will be located; what community and social infrastructure will be required; better integrated use of existing infrastructure;

protection of important environmental assets and critical services; and staging and sequencing of future development

4.2.3 Draft Green Growth Plan for Perth and Peel @ 3.5 million

The Green Growth Plan sets forth an environmental program for the protection of both Commonwealth matters of national environmental significance and State environmental values, in the context of a projected population growth to 3.5 million by 2050.

4.2.4 State Water Plan (2007)

The S*tate Water Plan* provides a strategic framework manage water resources in Western Australia, highlights and builds upon the *State Water Strategy.* The Plan details priority actions identified in the Strategy, with a larger focus on water policy and planning. Priority actions included developing regional water plans, statutory water management plans, and further study to demand management and supply options including regional areas.

4.2.5 Relevant State Planning Policies

State Planning Policy 2: Environment and Natural Resources (2003)

The environment and natural resources policy defines the principles and considerations that represent good and responsible planning in terms of environment and natural resource issues within the framework of the State Planning Strategy.

The policy will be supplemented by more detailed planning policies on particular natural resources matters that require additional information and guidance. These supplementary policies may also be statements of planning policy and should be implemented in conjunction with this policy.

State Planning Policy 2.1: Peel-Harvey Coastal Plain Catchment (2003)

The Peel-Harvey coastal plain catchment policy ensures that land use changes within the Peel-Harvey estuarine system likely to cause environmental damage to the estuary are brought under planning control and prevented.

State Planning Policy 3.7 - Planning in Bushfire Prone Areas

This policy seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure. It applies to all higher order strategic planning documents, strategic planning proposals, subdivision and development applications located in designated bushfire prone areas (unless exemptions apply). This policy also applies where an area is not yet designated as bushfire prone but the proposed development is planned in a way that introduces a bushfire hazard (e.g. revegetation)

State Planning Policy 2.5: Land Use Planning in Rural Areas

Land use planning in rural areas policy aims to support both rural and rural living land uses to cater for both anticipated and unexpected future needs. It contains provisions for protection of rural land and aims to address issues associated with proximity to Cities, economic drivers, tree farms and rural living precincts. Other areas addressed include avoiding land use conflicts and Managing and improving environmental and landscape attributes. This policy is currently under review.

State Planning Policy 2.8 Bushland Policy for the Perth Metropolitan Region

The policy applies to the Perth Metropolitan Region, and deals with two distinct subjects, being Bush Forever areas and local bushland.

The aim of the policy is to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making. This will secure long-term protection of biodiversity and associated environmental values. The policy recognises the protection and management of significant bushland areas as a fundamental consideration in the planning process, while also seeking to integrate and balance wider environmental, social and economic considerations. In general terms, the policy does not prevent development where it consistent with the policy measures in this policy and other planning and environmental considerations.

State Planning Policy 2.9: Water Resources (2006)

The *State Planning Policy 2.9: Water Resources* pledges Western Australia to pursuing sustainability through an integration of environmental protection, social advancement and economic prosperity. This vision is encapsulated in A State Water Strategy for Western Australia (2003), which seeks to develop and protect water resources in an economically and environmentally responsible way by providing a whole government framework for setting strategies and plans for water resources.

This policy is directly related to the overarching sector policy State Planning Policy 2 Environment and Natural Resources Policy and provides clarification and additional guidance to planning decision-makers for consideration of water resources in land use planning strategies, proposals and applications, for example local and regional planning strategies, structure plans, town planning schemes and amendments, subdivisions and development applications, and other town planning mechanisms.

State Planning Policy No 2.7: Public Drinking Water Source (2003)

This policy applies to proclaimed Public Drinking Water Source Areas (PDWSAs) throughout Western Australia. The objective of this policy is to ensure that land use and development within PDWSAs is compatible with the protection and long-term management of water resources for public water supply.

The policy specifies to regions outside the metropolitan region that all priority (P1,P2, and P3) source protection areas should be shown as special control areas in region schemes and local government schemes. This will be in accordance with the recommendations of any relevant land use, water management strategy, or water source protection plan. Furthermore, land uses and developments in all priority source protection areas that have the potential to impact detrimentally on the quality and quantity of public drinking water supplies should not be permitted unless it can be demonstrated, having regard to advice from the Water and Rivers Commission (now Department of Water), that such impacts can be satisfactorily managed.

Planning schemes and decisions on land use and development should have regard for any adopted region scheme policy or relevant environmental protection policy on public drinking water supply.

4.2.6 State-level guidelines

There are a number of State-level guidelines which assist local governments to meet their regulatory requirements. Those that provide guidance for improved environmental management, protection and natural resource use are summarised in Appendix 1 and listed in Table 11 below. It should be noted that these documents are not statutory and provide guidance only.

Table 11: Relevant State-level guidelines

Environment area	Report
General	• Directions Paper on the Integration of NRM into Land Use Planning, (Western Australian Planning Commission, 2013). • Guidance for the Assessment of Environmental Factors No 33: Environmental Guidance for Planning and Development (EPA, 2008) • Western Australian State Sustainability Strategy (State Government of WA, 2003)
Built form	• Building Code of Australia • Capital City Planning Framework (Western Australian Planning Commission, 2013) • Creating Places for People—an urban design protocol for Australian Cities • Directions 2031 and Beyond (Western Australian Planning Commission, 2011) • State Planning Strategy (Western Australian Planning Commission, 2013) • Liveable Neighbourhoods • Guidelines for Planning in Bushfire Prone Areas
Air quality and emissions	• Working together — WA Health Strategic Intent 2010-2015 (Department of Health, 2010)
Water	• Australian Guidelines for Water Recycling • Better Urban Water Management (Western Australian Planning Commission, 2008) • Government Sewerage Policy Perth Metropolitan region (Government of WA, 1995) • Guidelines for the approval of non-drinking water systems in Western Australia - urban developments (Department of Water, 20123) • Health Rivers Action Plan (Swan River Trust, 2008) • Local Water Quality Improvement Plan, Mounts Bay Catchment (Swan River Trust, 2009) • Perth-Peel Regional water plan 2010–2030 Responding to our drying climate (DoW 2009) • River restoration manual, Department of Environment and Conservation, 2004) • State Water Plan (Department of Water, 2007) • Stormwater management manual for Western Australia, (Department of Water, 2004-2007) • Swan Canning Water Quality Improvement Plan (Swan River Trust, 2009)

Environment area	Report
	• Water Forever whatever the weather – Drought-proofing Perth (Water Corporation, 2012)
Green spaces	• Local Government Biodiversity Planning Guidelines for the Perth metropolitan Region (Western Australian Local Government Association and Perth Biodiversity Project).
Waste	• Western Australian Waste Strategy (WA Waste Authority, 2012)

4.3 Local regulatory context

The Shire is in the process of developing a local planning strategy. Planning guidance is currently provided by Shire of Serpentine Jarrahdale town planning scheme 2 and local policy. Some strategic direction is also provided by the Strategic Community Plan.

The strategies and reports that are most relevant to the management of the environment and natural resources across the Shire are outlined below.

4.3.1 Shire of Serpentine-Jarrahdale Town Planning Scheme no. 2

Originally gazetted in 1989, the Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 (the Scheme) provides the statutory basis for land use and development in the Shire. Scheme objective 1.6(d) is "to make provisions for the conservation and preservation of places of natural beauty, historic buildings and objects of historic or scientific interest."

Provisions that are relevant to the protection and management of the environment include:

5.9 Special rural zone

6(b) where a lot contains a building envelope shown on the Plan of Subdivision, no development other than fencing, shall be permitted outside the area defined by the building envelope unless authorised by Council:

6(c) no building shall be constructed within this zone, of materials, the colour or texture of which in the opinion of the Council is undesirable for the locality;

6(f) the Council may by notice served upon individual landowners or upon a subdivider of land within this zone require trees to be planted where it is considered there is insufficient vegetation, and require the preservation of any tree or group of trees and thereafter no landowner or subdivider shall cut, remove, or otherwise destroy any tree or trees so specified unless the Council withdraws the notice;

5.12 Rural Living A and Rural Living B Zones

5.12.4 Notwithstanding sub clause 5.12.2 and 5.12.3 above, where land capability and site constraints dictate a larger lot size than one hectare (Rural Living A) or four hectares (Rural Living B) may be required.

9(e) storm water drainage shall be designed to the satisfaction and specification of the Council. The developer of the estate shall obtain the approval of the Water Authority and Council for drainage proposals prior to commencement of site works;

9(f) the landowner shall be responsible for the establishment and maintenance of firebreaks to the specification and satisfaction of the Council;

9(g) the keeping of horses, sheep, goats and other grazing animals, where permitted, shall be subject to the prior approval of the Council. Approval to keep animals shall not exceed the stocking rates recommended by the Department of Agriculture for the applicable pasture types;

(k) the Council may by notice served upon individual landowners or upon a subdivider of land within this zone require the preservation of any tree or group of trees and thereafter no landowner or subdivider shall cut, remove, or otherwise destroy any tree or trees so specified unless the Council withdraws the notice or order;

The above provisions also apply to the Farmlet Zone.

5.14 Conservation Zone

5.14.2 A Conservation zone is intended to identify land that has a high conservation significance which includes private land with large stands of relatively intact remnant vegetation, all recognised wetlands of significance and some areas covered by the Department of Environmental Protection System 6 recommendations.

5.14.3 The private lands identified for conservation in the rural strategy are not intended for acquisition by the Council or State Government Agencies. Rather the general aim is to encourage and make it easier for landowners to protect and manage the conservation values present.

5.14.7 The implementation of a management plan by the land owner is a means of longer term protection for the site and will be accompanied by a reduced Council rating on the land.

The incentives for these conservation measures will be a reduction in the general rural rate which shall be set at 50% unless otherwise amended by Council.

Land within the conservation zone should also be guided by a management plan and address nutrient management.

5.15 Agriculture Protection Zone

5.15.3 Council will adopt proactive and co-operative approaches with landowners in this Zone to address environmental, catchment, and land degradation problems so that land and environmental values are maintained and rehabilitated.

A rate reduction is also provided where agricultural protection measures are implemented consistent with the scheme and a management plan.

5.19 Rural Groundwater Protection Zone

5.19.1 The use and development of land within the Rural Groundwater Protection Zone shall be in accordance with the provisions of the Scheme and Statement of Planning Policy No. 2.3 (Jandakot Groundwater Protection Policy).

7.12 Places of Natural Beauty, Historic Buildings, and Objects of Historical or Scientific Interest

Clearing of land or removal of trees is not permitted without the approval of Council. Natural places are:

1. Whitby Falls - Government Reserve 7125, Near the boundary between former Cockburn Sound Location 23 and 166.

31. Yangedi Swamp, Cockburn Sound Loc. 16, Part Lots 4, 5, 6, 76, 77 and 80.

32. Red Gum Patch, Cnr. Alice and Redcliffe Roads, Cardup.

33. Manjedal Brook, from its source East of Nettleton Road along its length to Kargotich Road

36. Jarrah Road Swamp, Part Peel Estate lot 809, Jarrah Road, Serpentine.

7.13 Tree Preservation and Planting

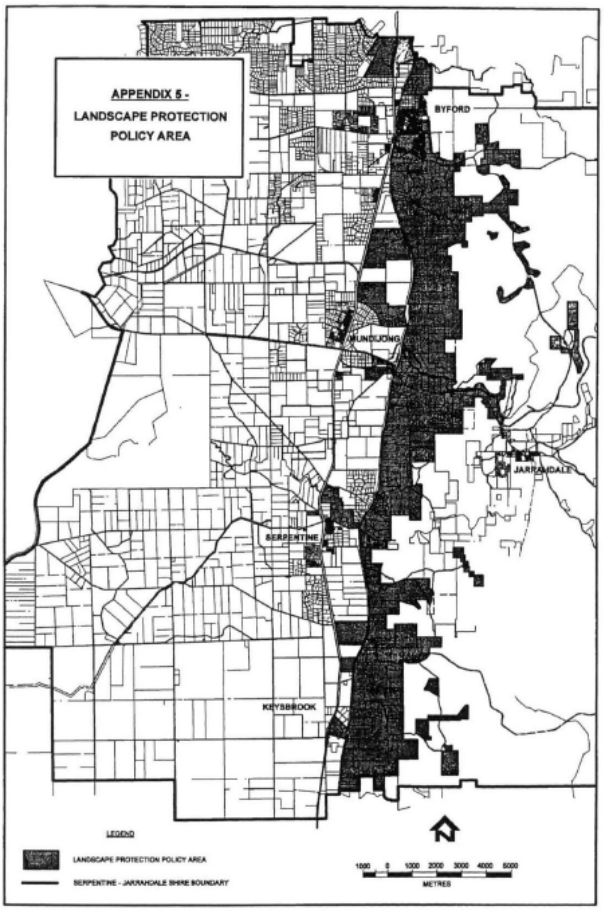
See section 2.5.3.

Special control areas:

(a) Poultry Farm Special Control Area

(b) development contribution areas shown on the scheme map as DCA with a number and included in Appendix 16.

Landscape protection policy area



4.3.2 Shire of Serpentine Jarrahdale Strategic Community Plan 2013-2023

Setting out goals and plans to achieve them with focus on job creation, sustainable development, water management and resource management.

4.3.3 Shire of Serpentine Jarrahdale Rural Strategy Review 2013

Focusses on the Shire's Rural Areas. The overall purpose of the Rural Strategy is to preserve and enhance the Shire's rural character and its role as an important economic contributor to the Shire and broader region.

4.3.4 Urban Growth Strategy (draft)

Identifies urban growth nodes and corridors, congnisant of WAPC planning projections for the Perth Metropolitan Region. Integrates with the Shire's Rural Strategy, particularly where existing rural areas have been earmarked for possible future urban growth.

4.3.5 Shire of Serpentine Jarrahdale Local Biodiversity Strategy

This strategy provides detailed consideration and incentives relative to the biodiversity protection in the Shire's rural areas. There is a broad association between the Biodiversity Strategy and the Rural Strategy.

4.3.6 Mundijong Whitby District Structure Plan

This structure plan is to provide an overall guidance to the structure, vision and objectives identified for the planning and development of Mundijong-Whitby. The District Structure Plan area has been split into seven precincts whose boundaries are premised on specific planning, design and development requirements and include the assumption that larger lot precincts are easier to develop as opposed to those in multiple ownership.

4.3.7 West Mundijong Industrial Area District Structure Plan

The proposal of rezoning of approximately 474 hectares of land west of the Mundijong town site from the 'Rural' zone to the 'Industrial' zone in the Metropolitan Region Scheme. The rezoning will facilitate the redevelopment of the land for light and general industry following an amendment to the local scheme, local structure planning and subdivision consent.

4.3.8 Byford Structure Plan

The *Byford District Structure Plan*, adopted in August 2005, provides a district level framework to guide more detailed planning for the Byford area between the proposed Tonkin Hwy and the Darling Scarp, from Thomas Rd to Cardup Siding Rd. It requires local structure plans to be prepared to provide the level of detailed planning required to facilitate subdivision and development within the district structure plan area.

4.3.9 Local environmental policy context

The local policies which provide guidance for environmental management include:

- LPP04 - Revegetation Policy
- LPP06 - Water Sensitive Design

- LPP08 - Landscape Protection Policy
- LPP09 - Multiple Use Trails
- LPP21 - Management Plans
- LPP25 - Constructed Lakes
- LPP26 - Biodiversity Planning
- LPP28 - Street Tree Policy
- LPP30 - Mineral Sands Extraction
- LPP33 - Construction of Dams
- LPP60 - Public Open Space
- LPP67 - Landscape and Vegetation
- LPP68 - Sustainability Assessment

4.4 Other guiding documents

4.4.1 EPA section 16e

The EPA prepares Strategic Advice to Government under section 16(e) of the Environmental Protection Act 1986. Strategic Advice tends to be related to a specific project or environmental issue. The EPA released its advice on the strategic environmental implications of the proposed future development for a city of 3.5 million people as outlined in the Draft Sub–regional Planning Frameworks and the policy and guidance that can be used to optimise subsequent approval processes to ensure environmental outcomes are delivered in the most efficient and timely manner. The report recommends strategies and actions to address environmental issues that are likely to arise with an increasing population, and provides guidance for future development proposals and scheme amendments so that the EPA's environmental objectives can be met.

4.4.2 Better Urban Water Management

Better Urban Water Management (WAPC, 2008) provides guidance on the implementation of *State Planning Policy 2.9 Water Resources* (2006). It outlines the requirements for integrating land and water planning and improving the achievement of total water cycle outcomes and water sensitive urban design as part of land use planning and development.

Better Urban Water Management is designed to facilitate better management and use of water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning system. The document provides guidance for regional, district and local land use planning, as well as subdivision phases of the planning process. *Better Urban Water Management* is to be used by all stakeholders and decision makers and has statewide application for new urban, commercial, industrial and rural-residential developments.

APPENDIX 2: BUSH FOREVER SITES AND PROTECTED SPECIES REPORTS

Bush Forever sites in SJ Shire

Site no.	Site name
65	Abernethy Road Bushland, Oakford
68	Jackson Road Bushland, Peel Estate
70	Duckpond Bushland, Peel Estate
71	Transit Road Bushland, Jarrahdale
74	Rapids Road Bushland, Peel Estate
76	Kingsbury Drive Bushland, Keysbrook
77	Yangedi Swamp, Keysbrook
78	Page Road Bushland, Keysbrook
266	Wungong Brook, Byford
271	Cardup Brook Bushland, Cardup/Peel Estate
321	Brickwood Reserve and Adjacent Bushland, Byford
347	Wandi Nature Reserve and Anketell Road Bushland, Wandi/Oakford
348	Modong Nature Reserve and Adkacent Bushland, Oakford
350	Byford to Serpentine Rail/Road Reserves and Adjacent Bushland
351	Cardup Brook Bushland, Cardup/Peel Estate
352	Cardup Nature Reserve and Adjacent Bushland, Cardup
353	Banksia Road Nature Reserve, Peel Estate
354	Norman Road Bushland, Whitby/Cardup
360	Mundijong and Watkins Roads Bushland, Mundijong/Peel Estate
361	Norman Road Bushland, Whitby/Cardup
362	Roman Road Bushland, Whitby
365	Byford to Serpentine Rail/Road Reserves and Adjacent Bushland
368	Lowlands Bushland - Eastern Block, Peel Estate
371	Serpentine River; Peel Estate to Serpentine
372	Lowlands Bushland - Western Block (Hymus Swamp), Peel Estate
375	Byford to Serpentine Rail/Road Reserves and Adjacent Bushland
378	Henderson Road Bushland, Peel Estate
426	Myara Brook Bushland, Keysbrook
449	Oscar Bruns Reserve, Wungong
468	Serpentine National Park and Adjacent Bushland, Serpentine

Client: Shire of Serpentine Jarrahdale

Report	Version	Prepared by	Reviewed by	Submitted to Client	
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