City of Wanneroo Water management study

Prepared for City of Wanneroo

By Urbaqua

May 2023

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1 INTRODUCTION

This Water Management Study supports *the City of Wanneroo Local Planning Strategy*. It provides more detailed information on the water resources of the City of Wanneroo (the City). It clarifies the future development requirements of the City with regards to water resources, consistent with draft *State Planning Policy 2.9 Planning for Water* and the draft *Planning for Water Guidelines* (WAPC, 2021) and the legislations, policies and guidelines of the State's water agencies. It also provides guidance for the activities of the City in relation to the management and maintenance of critical water resources and infrastructure such as drinking water, groundwater, irrigation and drainage to achieve agreed objectives for the City.

The information provided is applicable at a regional scale, summarised from a number of key publications. These publications should be referred to, to obtain more a more detailed description of the assets and issues, including but not limited to:

- Draft City of Wanneroo Local Planning Strategy 2023
- East Wanneroo District Structure Plan (WAPC, 2021)
- Draft State Planning Policy 2.9- Planning for Water
- Draft State Planning Policy 2.9- Planning for Water Guidelines
- North West Sub Regional Planning Framework
- North West Sub Regional Planning Framework – Regional Water Management Strategy V1 & V2
- North West Corridor Water Supply Strategy
- Rural Planning Guidelines
- State Planning Policy 2.5- Rural Planning

The vision of the City of Wanneroo Local Planning Strategy, which reflects the community's aspirations outlined in the Strategic Community Plan 2021 – 2031, is as follows:

> "A City that sustainably manages urban growth by facilitating developments that are sensitive to their surrounding natural environments, meet the housing and employment needs of local residents and connect people to places."

Although the report aims to convey the most current information, it is recognised that the state of our water resources is constantly changing. The information should therefore be used as a broad indicator of condition for comparative purposes only, and its validity and currency should be checked prior to its use for detailed planning purposes.

2 THE CITY OF WANNEROO

The City is a large outer metropolitan council with 36 suburbs stretching from Girrawheen in the south to Two Rocks in the north and covers an area of 687 square kilometres. The City lies on the north-eastern urban corridor of the Perth metropolitan area, about 12km from the Perth Central Business District at its nearest point.

Of the total area of the City, about a third is zoned Urban, while the rest is a combination of Rural, Industrial, City Centre, open space, national parks, state forest and conservation estate.

The City's environmental assets include 32km of coastline, wetlands, nature reserves, underground water resources, productive soils, significant deposits of basic raw materials and high quality areas of natural vegetation that will be protected as development occurs.

The City currently has a population of around 224,000 people, and is anticipated to reach approximately 370,000 residents by the year 2041. To accommodate this growth, an additional 55,000 dwellings will be required across the City (draft City of Wanneroo Local Planning Strategy, 2023).

In total, there is approximately 5600ha of undeveloped land earmarked for urban development or expansion, the majority of which is located in the northern corridor.

It is recognised that urban expansion may result in the removal of vegetation and encroach on various habitats and natural systems. The additional people and their activities (transport, recreation, work life, commerce and industry) also has the potential to put pressure on various natural resources. This report will seek to highlight any critical issues and make recommendations for inclusion of mitigating strategies in the Local Planning Strategy.

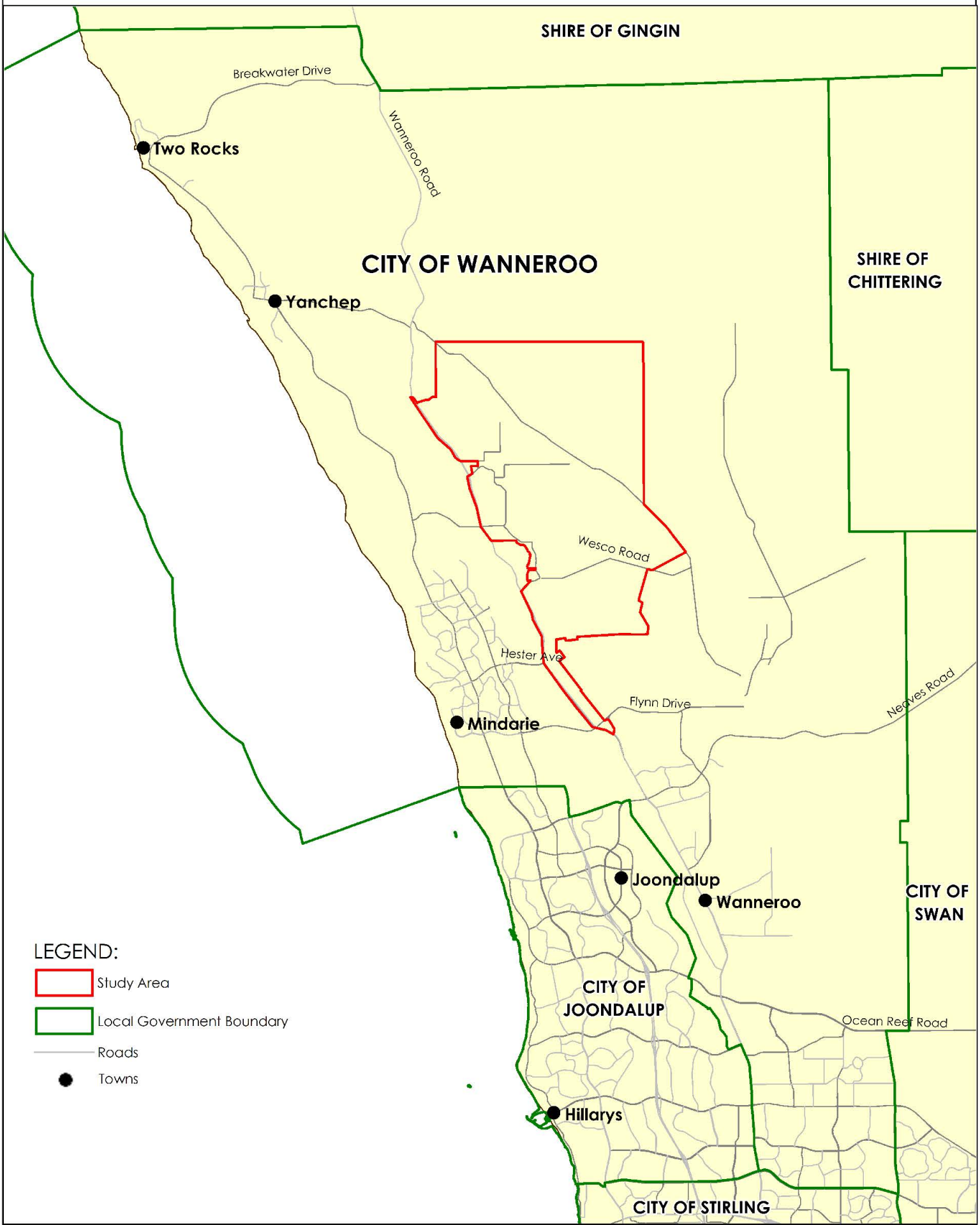
2.1 Key focus area

The City has identified the potential for increased rural tourism in the North Wanneroo Rural area (Figure 1) and that access to available groundwater in this area is a particular issue. This report will consider this issue from a water management perspective together with the implications of land use intensification which may result from more rural tourism activities occurring, particularly in the Landscape Enhancement zone.

The North Wanneroo rural area comprises approximately 7,500 hectares, including 3,820 hectares of rural land and 3,650 hectares of State Forest. It includes Carabooda, Nowergup and the western part of Neerabup as well as the rural land east of Wanneroo Road, adjacent land parcels including State Government investigation areas, open spaces and current and proposed public purpose reservations. It also includes a portion of State Forest, where State Government investigations are proposed for a new agricultural precinct.

This region is known as the 'FoodBowl' of the North and is a major producer of fruit and vegetables, poultry, eggs and nursery supplies including turf, cut flowers and plants to Perth local markets. The Precinct is important to the State and the City as a key agricultural and horticultural area that needs to be protected to support the local economy. However, landowners in North Wanneroo face major challenges as a result of climate change and the State Government's plans to reduce water allocations to growers by 10% from 2028, which is outlined in its Gnangara Groundwater Allocation Plan (DWER, 2022).

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 1 - Study Area



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Data source: Landgate, DWER, MRWA Created by: RM Projection: MGA: zone 50.

0 5,000
metres
Scale 1:180,000 @ A4

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2.2 Strategic and policy guidance

Strategic and policy guidance for environmental matters within the City is provided by the following documents at both local and State level:

- State Planning Policy:
  - 2: Environment and Natural Resources
  - 2.1: The Peel-Harvey Coastal Plain Catchment
  - 2.3: Jandakot Groundwater Protection
  - 2.4: Basic Raw Materials
  - 2.5 Rural Planning
  - 2.7 Public Drinking Water Source
  - 2.8: Bushland Policy for the Perth Metropolitan Region
  - 2.9: Water Resources
  - 2.10: Swan Canning River System
  - 3.4: Natural Hazards and Disasters
- Perth and Peel@3.5million: South Metropolitan Peel Framework March 2018
- Guidance for the Assessment of Environmental Factors 33: Environmental Guidance for Planning and Assessment
- Strategic Community Plan: City of Wanneroo 2021-2031
- Corporate Business Plan 2022-23 – 2025-26
- City of Wanneroo local planning policies
- Local Biodiversity Plan 2018/19 - 2023/24
- Local Environmental Strategy 2019
- Climate Change Adaptation and Mitigation Strategy 2020/21 – 2025/26
- Yellagonga Integrated Catchment Management Plan
- City of Wanneroo Coastal Management Plan 2021 and supplementary report: Environmental and Social Context.
- Water Sensitive Cities Benchmarking and Assessment: City of Wanneroo, 2022

The key relevant aspects of these documents are summarised briefly below.

2.2.1 State Planning Policy

As the Local Planning Strategy Guidelines published by the Department of Planning, Lands and Heritage in 2021 contain summaries of the relevant State Planning Policies and the *Southern Metropolitan Peel Subregional Planning Framework* (March 2018), it is not considered necessary to repeat them here. It should also be noted that draft *State Planning Policy 2.9: Planning for Water* is considered to be a seriously entertained proposal by the WAPC and should be used by the City to guide decision making.

Draft SPP 2.9: Planning for Water replaces SPPs 2.2, 2.3, 2.7, 2.9, 2.10 and the Government Sewerage Policy.

2.2.2 Perth and Peel@3.5million: South Metropolitan Peel Framework 2050

The frameworks provide direction and guidance to government agencies and local governments on land use, land development, environmental protection, infrastructure investment and the delivery of physical and social infrastructure. Perth and Peel@3.5million (WAPC, 2018) provides a long-term and integrated framework for land use and infrastructure provision to cater for a future population in the Perth and Peel regions of 3.5million.

North-West sub-region: this covers the cities of Joondalup and Wanneroo. In 2011 it had a population of 322,490 people or 17.5 per cent of the total regional population. The population is expanding annually by 3 per cent and is anticipated to double by 2050 to 740,330 people.

Currently, the population is relatively evenly distributed between Joondalup and Wanneroo; however, it is anticipated that post-2021, the rate of growth will be considerably stronger in the City of Wanneroo due to its supply of undeveloped Urban zoned land and continuing demand for coastal living. By 2050, the City of Wanneroo is projected to accommodate nearly three-quarters of the sub-region's total population.

Urban expansion and investigation areas have been identified in East Wanneroo (including South Gnangara and West Jandabup) and South Pinjar. These areas are in close proximity to existing development and infrastructure within the Wanneroo locality and form a logical consolidation of existing urban areas.

Limited areas of land in Wanneroo, Jandabup and Gnangara were identified as sites that required further Planning Investigation.

2.2.3 *Guidance for the Assessment of Environmental Factors 33: Environmental Guidance for Planning and Assessment*

Guidance for the Assessment of Environmental Factors 33: Environmental Guidance for Planning and Assessment provides an overview of environmental protection processes in Western Australia as they apply land use planning and development under the Environmental Protection Act 1986. While the focus is generally on information to support the referral and assessment of land use planning proposals, the document also provides general advice on how to protect a range of biophysical factors including their ecological, cultural and social significance and the management of potential pollutants, waste and water as part of land use planning decision making.

2.2.4 *2021-2031 Strategic Community Plan: City of Wanneroo*

The *Strategic Community Plan* (SCP) is the City's most important planning document, providing future direction over the next ten years. The City will monitor the progress of the SCP against the following 7 strategic goals:

- Goal 1: An inclusive and accessible City with places and spaces that embrace all
- Goal 2: A City that celebrates rich cultural histories, where people can visit and enjoy unique experiences
- Goal 3: A vibrant, innovative City with local opportunities for work, business and investment
- Goal 4: A sustainable City that balances the relationship between urban growth and the environment
- Goal 5: A well-planned, safe and resilient City that is easy to travel around and provides a connection between people and places
- Goal 6: A future focused City that advocates, engages and partners to progress the priorities of the community
- Goal 7: A well-governed and managed City that makes informed decision, provides strong community leadership and valued customer focused services

2.2.5 *Corporate Business Plan 2022-23 – 2025-26*

The *Corporate Business Plan* links the Strategic Community Plan objectives to key actions, projects and strategies. The Corporate Business Plan provides guidance and direction with respect to the City's goal to achieve "a sustainable City that balances the relationship between urban growth and the environment". Key projects to achieve this goal are:

- Urban Forest Strategy (Finalise Strategy)[1]
- Environmental Management System (Finalise EMS Architecture)
- Coastal Management Plan (Implement Actions)
- Waste Services Review (Implementation of Review

This is supported by the following performance measures

- Waste diverted from landfill
- Increase in vegetation canopy
- Energy and fleet use emissions reduction
- Responsible water use
- Efficient planning and building approvals processes

2.2.6 *City of Wanneroo Local Planning Policies*

The following local planning policies have some relevance to the consideration of water resources as part of planning decision making.

- Local Planning Policy 1.1: Conservation Reserves
- Local Planning Policy 2.1: Residential Development
- Local Planning Policy 4.1: Wetlands
- Local Planning Policy 4.13: Caves and Karstic Features
- Local Planning Policy 4.18: Earthworks and Sand Drift
- Local Planning Policy 4.21: Coastal Assets
- Local Planning Policy 4.3: Public Open Space
- Local Planning Policy 4.4: Urban Water Management
- Local Planning Policy 4.8: Tree Preservation
- Local Planning Policy 4.9: Subdivision of Rural Zoned Land
- Local Planning Policy 5.3: East Wanneroo

Other Council policies of relevance include:

- Environment Policy 2019
- Street Tree Policy 2018

2.2.7 *Local Biodiversity Plan 2018/19 – 2023/24*

The City of Wanneroo is located on the Swan Coastal Plain of the Southwest Bioregion of Western Australia, a region that is globally recognised as one of the planet's major biodiversity hotspots.

The Local Biodiversity Plan 2018/19 – 2023/24 (LBP) is a revision of the City's first Local Biodiversity Strategy adopted in 2011. This revision sets out a refined approach to the protection, retention and management of natural assets to enable protection of the natural environment,

[1] This was finalised in 2022

conservation of local biodiversity, and engagement with the local community in the importance of biodiversity.

The primary aim of the LBP is to outline the City's targets for the retention, protection and management of local natural areas. Proposed targets for protection of vegetation complexes within each biodiversity planning precinct were based on land zoning. The LBP will be implemented over 5 years through a comprehensive list of actions.

2.2.8 *Local Environmental Strategy 2019*

The Local Environmental Strategy identifies key environmental concerns and makes recommendations to improve the quality of natural and built environments in the City through identified opportunities and related existing and potential future initiatives. It identifies six key themes of:

- Flora and Fauna – biodiversity and native vegetation
- Land and waste – contamination and management
- Community – sense of place and liveability
- Climate Change impacts
- Air and Energy – including air quality and energy reduction
- Water – including availability and quality

Key current initiatives for water include:

- CoW Water Conservation Plan
- Local Planning Policy 4.4: Urban Water Management
- Yellagonga Integrated Catchment Management Plan 2015 – 19
- Local Planning Policy 4.1: Wetlands – Continued compliance administration with State Government groundwater protection legislation

Potential future initiatives include:

- Effectively plan for the City's water future by maximising water use efficiency and improving water sensitive urban design applications.
- Continue to identify potential new water sources for the Wanneroo agricultural area and Rural zone.
- Investigate the development of planning mechanisms to promote water efficiency, water capture and reuse technologies, and alternative water sources in new developments
- Continue to investigate groundwater and surface water quality improvement initiatives across the City (e.g. improving water use efficiency, retrofitting stormwater infrastructure, soil improvement, and investigating domestic stormwater technologies).

2.2.9 *Climate Change Adaptation and Mitigation Strategy 2020/21 – 2025/26*

The City's Strategic Community Plan 2013/14 to 2022/231 aspires to achieve a sustainable natural, built and healthy environment. In response to this community vision, an action within the City's Corporate Business Plan 2015/16 – 2018/19 was the preparation of the Climate Change Adaptation and Mitigation Strategy (CCAMS).

The purpose of the CCAMS is to identify areas where the City and the community it represents, are exposed to the effects of climate change and provide risk management adaptation measures to reduce the risk, as well as to identify practical mitigation measures that would aid with the mitigation of the impacts of climate change.

2.2.10 *Yellagonga Integrated Catchment Management Plan 2021-2026*

The Yellagonga Integrated Catchment Management Plan 2021-2026 will be implemented by the City of Joondalup and City of Wanneroo in partnership with the Yellagonga Regional Park key land manager, the DBCA.

The Plan builds upon the extensive monitoring and conservation management work undertaken in the Yellagonga catchment through the continued collaboration between the two Cities and the DBCA. The aim of the Plan is to provide a holistic and long-term strategic plan to improve catchment health and protect the diverse values of the Park. The objectives of the Yellagonga Integrated Catchment Management Plan 2021-2026 are:

- Objective 1: To build upon the achievements, experiences and outcomes of the YICM Plan 2015-2019 and continue to implement an integrated and effective approach to catchment management.
- Objective 2: To work in partnership with key stakeholders to improve catchment management and protect and enhance the ecological values of the Yellagonga Regional Park.
- Objective 3: Ensure positive environmental, social and economic outcomes for the Yellagonga Regional Park and its wetlands.
- Objective 4: Consider the long-term protection of the Yellagonga Regional Park with a focus on addressing the current and future impacts of climate change.

2.2.11 *City of Wanneroo Coastal Management Plan 2021 and supplementary report: Environmental and Social Context.*

The supplementary report: Environmental and Social Context contains a detailed description of the key coastal processes affecting the City and the resultant coastal risk issues, values and physical characteristic that may impact coastal planning and management. The key objectives of the Coastal Management Plan is to facilitate appropriate access to the coast and vibrant and distinct coastal nodes that offer varied opportunities for enjoyment by the community, whilst ensuring that development is sustainable and sympathetic to the coastal location by conserving and protecting natural, cultural and heritage assets.

2.2.12 *Water Sensitive Cities Benchmarking and Assessment: City of Wanneroo, 2022*

The City of Wanneroo has been recognised as a Waterwise Council with 'Gold' status for the third year running. As part of the Waterwise Council program, the City undertook the Water Sensitive Cities Index benchmarking assessment in 2022, which demonstrated that the strongest areas of performance in the achievement of water sensitive city goals were to (i) ensure good water sensitive governance, (ii) achieve equity of essential services and (iii) promote adaptive infrastructure. The weakest performance was evident for the goals to (iv) Improve ecological health and (ii) Increase community capital. This led to the following recommended actions:

- Action 1: Build a clear Vision for a Water Sensitive Wanneroo
- Action 2: Foster community engagement, collaboration and ownership of a water sensitive city
- Action 3: Continue to build partnerships to collaboratively deliver improved water system management
- Action 4: Improve connectivity of blue-green assets by increasing canopy and addressing urban heat
- Action 5: Increase community support for trees on private and public land
- Action 6: Require urban heat mitigation in new developments

- Action 7: Promote the importance of retaining and creating healthy and biodiverse habitats in urban areas
- Action 8: Encourage uptake of alternative fit-for-purpose water supply options
- Action 9: Identify opportunities for drainage retrofits to provide economic, social and environmental benefits
- Action 10: Consider the water-energy nexus & address greenhouse gas emissions

Since the assessment the City has progressed with Actions 2, 3, 4, 5, & 7. The City has developed an Urban Forest Strategy which has been endorsed by Council in November 2022. The Urban Forest Strategy will address Actions 4, 5, 6 & 7.

Community engagement has been a focus in the last 12 months with additional sustainability and environment related community workshops organised focusing more on water, biodiversity and increasing canopy cover.

Interactive/interpretive demonstration waterwise gardens have been commissioned.

3 ENVIRONMENTAL CONTEXT

3.1 Climate

Typically for the south-west of Western Australia, the City has a Mediterranean climate which is hot and dry during the summer and cool and wet during the winter. There is very limited, and no long-term, data available within the City, however records for Pearce RAAF airbase (weather station 9053), Perth Airport (weather station 9021) and Wanneroo (weather station 9105) are provided below and are considered reasonably representative of the City (Figure 2).

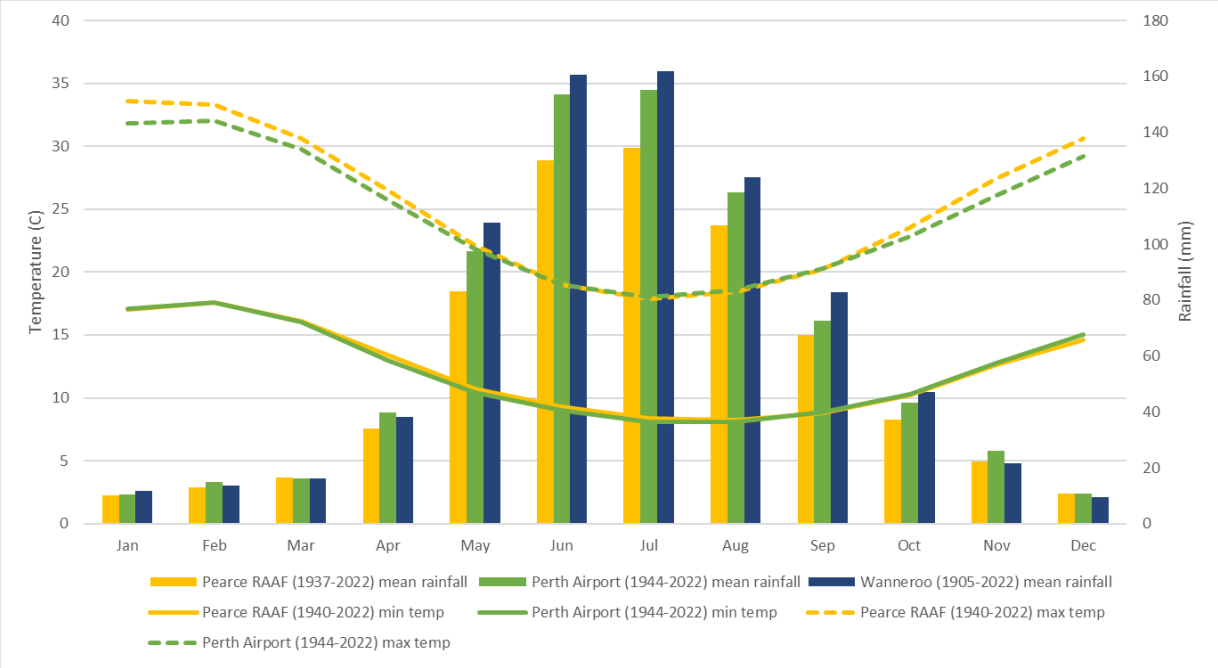


Figure 2: Average monthly rainfall and average monthly temperatures recorded at Pearce RAAF, Perth Airport and Wanneroo weather stations.

Temperature data (Figure 2) indicates that the annual mean maximum temperatures range between 17.9°C and 33.6°C (Pearce RAAF) and the annual minimum temperatures range between 8.2°C and 17.6°C (BOM, 2023).

The annual average rainfall is 794mm (1905-2022). The seasonal rainfall distribution indicates approximately 70% of the rainfall occurs during the months of May to August.

3.1.1 Extreme weather events

Geoscience Australia (2005) describes two groups of extreme weather events that have the potential to affect the City: cool and warm season storms.

Cool season storms

During the cooler months of the year the south-west of Western Australia experiences moist westerly winds that generally produce over eighty per cent of the region's annual rainfall. Cold fronts embedded in the westerly flow bring the rain and strong winds on an irregular cycle every few days. Each front is unique, varying with the strength of wind and amount and distribution of rainfall (GA 2005).

Some of the more vigorous fronts produce severe wind gusts in excess of 90 km/h or may spawn tornadoes. The level of threat to life and property may also be described in terms of wind strength. Damaging winds refer to wind gusts between 90 and 125 km/h, and destructive winds refer to wind gusts in excess of 125 km/h. These events are not necessarily accompanied by lightning, but they are still referred to as 'storms' (GA 2005).

Warm season storms

Compared to eastern and northern Australia, thunderstorms are infrequent in the City during the warm season between October and April, occurring on average five to six times. In addition, only a small number of these reach a level of severity that poses a serious threat to the community. The number of warm season thunderstorm days varies considerably from year to year, ranging from fourteen (14) in 1991-92, to just one in the 1990-91 and 1993-94 seasons (GA 2005).

The predominant form of flooding experienced in the City is flash-flooding caused by high intensity rainfall that exceeds the short-term capacity of waterways and drainage systems. Usually, this type of flooding is short lived although it can cause significant inconvenience especially in urban areas and in some instances, can result in costly damage to property and infrastructure.

3.1.2 Climate change – IPCC scenarios

In 2021 the Intergovernmental Panel on Climate Change (IPCC) released their sixth assessment report, concluding that:

- Warming of the atmosphere and ocean system is unequivocal;
- Many of the associated impacts such as sea level change (among other metrics) have occurred since 1950 at rates unprecedented in the historical record;
- There is a clear human influence on the climate; and
- It is extremely likely that human influence has been the dominant cause of observed warming since 1950, with the level of confidence having increased since the fifth report.

One of the key developments since the IPCC's last assessment report in 2014 is the strengthening of the links between human-caused warming and increasingly severe extreme weather, which the authors say is now "an established fact". The IPCC also pointed out that the longer we wait to reduce our emissions, the more expensive it will become. These changes have the potential to have a major impact on human and natural systems throughout the world, including Australia.

3.1.3 Climate change- regional trends

As the conclusions of the IPCC's sixth report have yet to be translated into regional models, it is considered appropriate to continue to utilise the information in *CSIRO's Climate Change in Australia* which was produced in 2015 to provide information at the level of Regional Clusters. The City of Wanneroo is in the Western Australian Southern and South-Western Flatlands sub-cluster (Hope et al., 2015).

In 2015, CSIRO predicted 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, 2015), and recent commentary from the climate community has suggested that the higher

emissions scenarios (RCP8.5) are now more likely. Temperature is predicted to increase by 0.5 to 1.2˚C by 2030 (CSIRO, 2015) (Figure 3). This rise in temperature has the potential to impact on plants, animals and people, through increased heat stress and increased risk of bushfires.

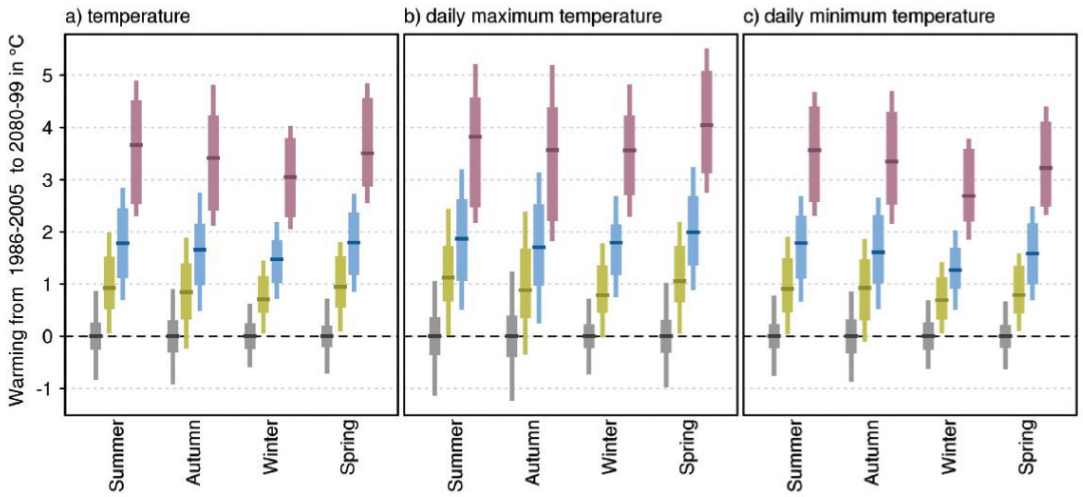


Figure 3: Projected seasonal surface air temperature changes (Source: CSIRO, 2015)

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 et al., 2015).

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) (Figure 4), 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 stream-flows 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.

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 et al., 2015).

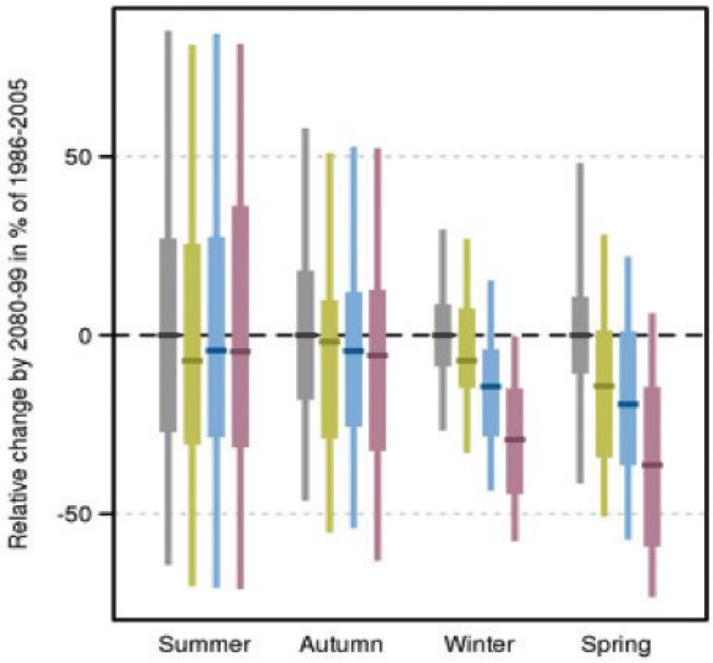


Figure 4: Projected seasonal rainfall changes (Source: CSIRO, 2015)

The Department of Water and Environmental Regulation have stated (with respect to the south-west of WA) that:

> *"due to the declining historic climate trend over the past 30 years, and evidence that this trend is likely to continue (measured southerly movement of the jet-stream and complete agreement of all global climate models), we cannot make future planning decisions based on a historical climate data"* (DoW, 2015c).

This issue provided a driver for the Department to develop *Selection of future climate projections for Western Australia* (DoW 2015c) which included a review of future climate projections for WA, identification of a suitable baseline climate period for statewide use and development of standard monthly climate anomalies based on the following regions, variables, scenarios and time horizons:

- **Regions**: South-west, Central-west, Pilbara, Kimberley, Central
- **Variables**: Rainfall, temperature, relative humidity, radiation, FAO56 reference potential evapotranspiration (derived), Penman evaporation (derived)
- **Scenarios**: Wet, median, dry
- **Time horizons**: 2030, 2050, 2070, 2100

The report identifies that the regional average change in annual rainfall for the South-west for 2030 relative to the baseline period is –14% for the dry scenario, –5% for the median scenario, and –2% for the wet scenario. Potential evapotranspiration (PET) at 2030 is projected to increase by 2–3%, with a 0.7 °C increase in temperature.

The drying and warming climate trend in the strategy area poses a threat to water dependent ecosystems including internationally, nationally, and regionally important wetlands. Development may provide opportunities to mitigate these impacts through diversion of surface water and maintenance of superficial groundwater levels.

Similarly, these trends may lead to reductions in available groundwater resources over the long term and development can assist with sustaining groundwater levels by encouraging at source infiltration and limiting the use of groundwater drainage.

3.1.4 Climate change- local trends

There are limited long-term continuous records of data available for sites in the coastal area of the City, in particular for temperature where no unbroken record could be found. Annual rainfall at Wanneroo is observed to have decreased by approximately 100 mm during the 1985 to 2010 period (Figure 9) which equates to approximately 65 mm/10 years.

Although the available data is somewhat sparse, the general trend in the City is indicative of gradually increasing temperatures and declining rainfall, which supports modelled scenarios (Figures 5 to 9).

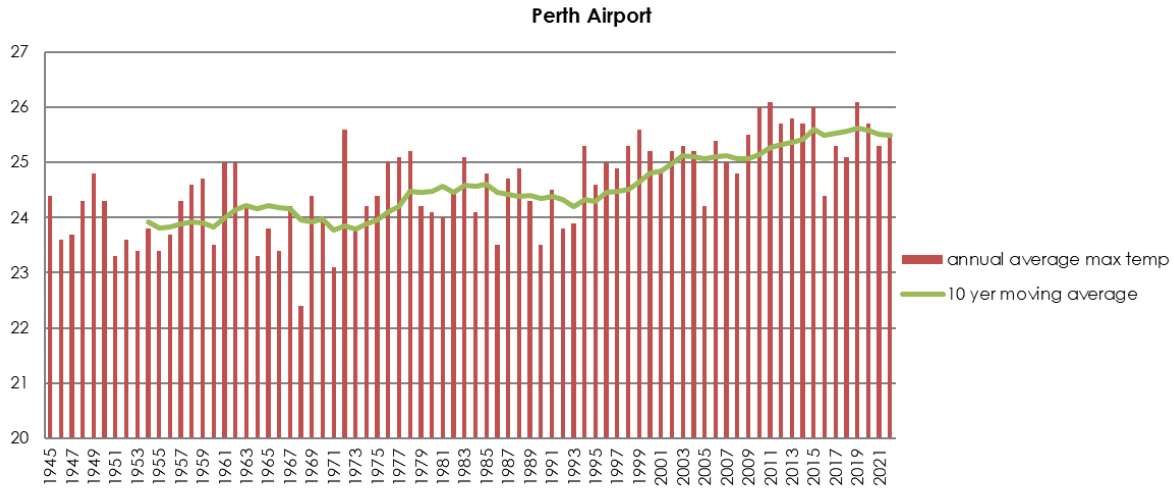


Figure 5: Perth Airport climate record – annual average maximum temperature

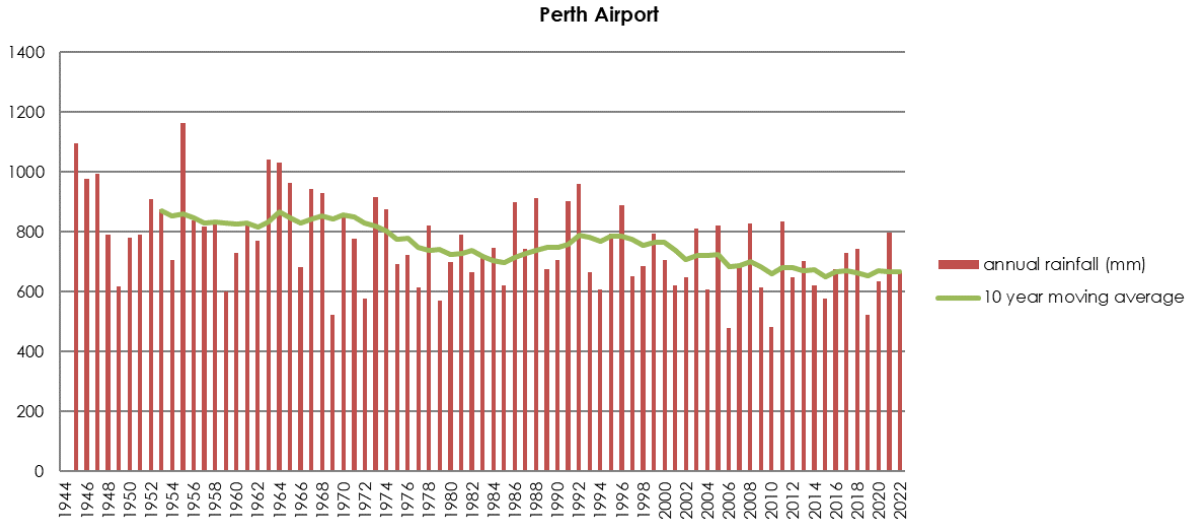


Figure 6: Perth Airport Climate Record – Annual Rainfall

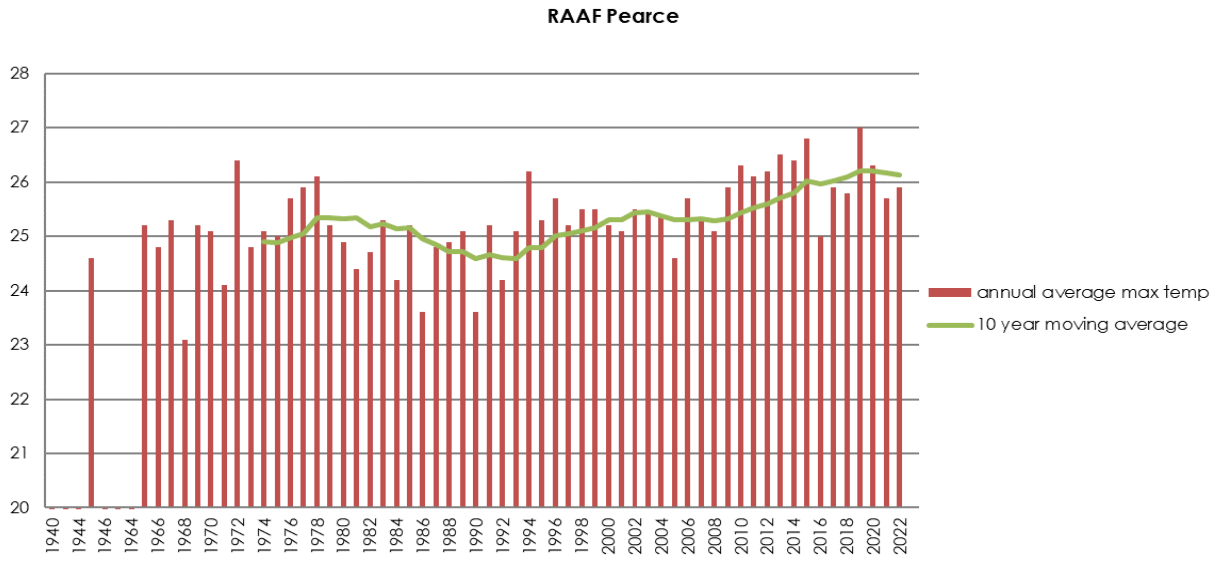


Figure 7: RAAF Pearce Climate Record – Annual Average Maximum Temperature

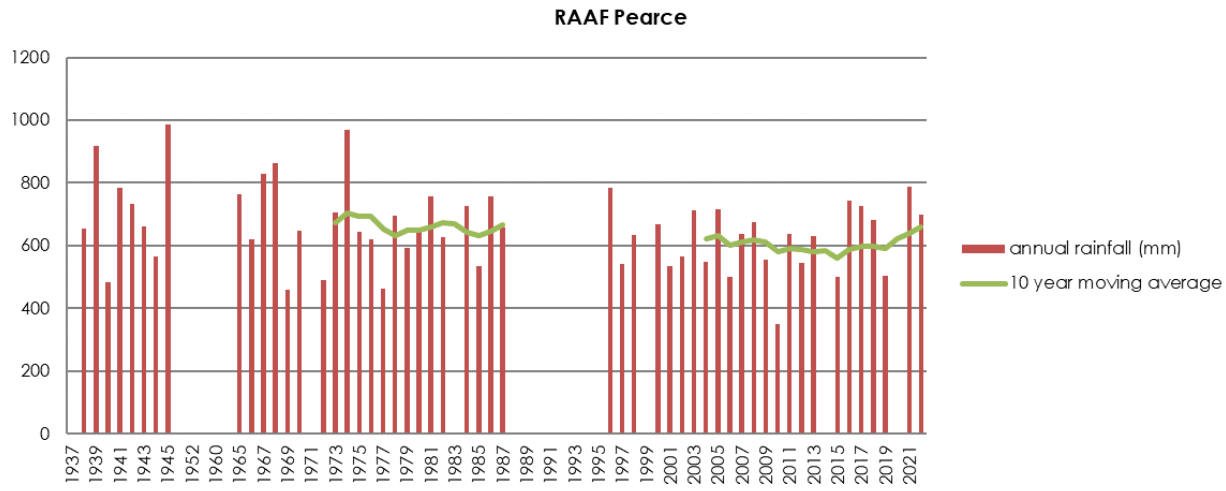


Figure 8: RAAF Pearce Climate Record – Annual Rainfall

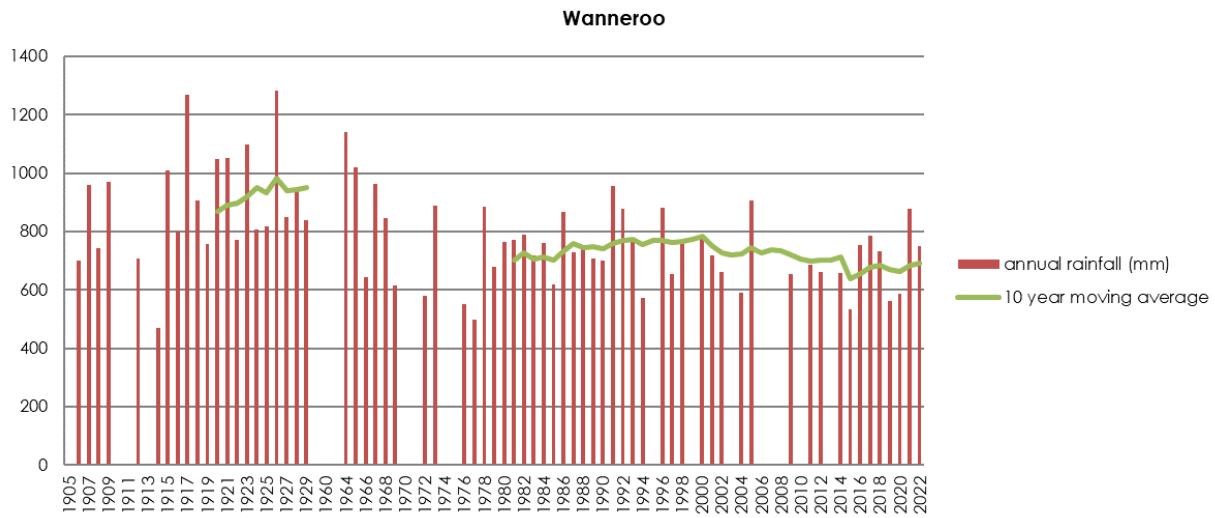


Figure 9: Wanneroo Climate Record – Annual Rainfall

3.1.5 Urban heat

The urban heat island effect occurs when temperatures increase in urban areas relative to surrounding natural or rural environments. These higher urban temperatures can be caused by factors such as reduced shading, abundance of materials that absorb heat, reduced evapotranspiration and waste heat from infrastructure and vehicles (CRCWSC, 2021).

Urban heat islands can negatively affect people and infrastructure, particularly during prolonged heat waves (CRCWSC, 2021), which may place greater stress on vulnerable segments of the community such as infants, the elderly, poorer people and ethnic minorities who are highly affected by thermal stress (Feyisa et al., 2014).

The urban heat island effect is a function of time of day and the day of the week. This means that during heat waves, urban heat can be reduced by changing human activities to those of a weekend day (Earl et al., 2016).

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) undertook research into the cooling benefits of public open space. The CRCWSC (Coutts *et al*, 2015) notes that greenspace can help to cool urban environments - urban parks of various sizes are often observed to be cooler than the surrounding urban landscape. It is noted that the effects of green space tends to be localised, and their influence varies with size, design (e.g. amount and distribution of trees), irrigation regimes and the local meteorology. Their influence also varies with the nature of the surrounding urban landscape. The CRCWSC research also quantified the effects of parks on urban cooling, finding that during an extreme heat event in a park in Carlton in Melbourne in January 2014, air temperatures were up to 1.2 °C cooler in and around the park than the adjacent streets. Furthermore, human thermal comfort (the way people feel), was measured at up to 10 degrees lower. There appeared to be some downwind cooling to the southeast of the park under the northerly wind direction at the time (Coutts *et al*, 2015).

Air temperature reductions were found by the CRCWSC to be a function of the rate and timing of irrigation (Broadbent et al., 2017). Park size also plays a positive role in the cooling effect. To maximize the cooling effects of parks, tree vegetation canopy cover should be increased and the choice of species for greening can be optimised towards those with high transpiration rates (Feyisa et al., 2014).

In addition to irrigation, the planting of canopy trees in public open space will also deliver urban heat benefits. Additional research into optimal tree placement suggests that clustering trees delivers greater reductions in air temperature and radiant temperature below the canopy than isolated trees. It is also recommended that groups of clustered trees should be interspersed with open spaces, as groups of trees provide shading during the day, while the open spaces between allows for surface cooling and ventilation (wind) at night (Coutts and Tapper, 2017).

3.1.6 Issues for planning, land use change and development

Key climate considerations for strategic planning in the City 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 to retain mature trees and implement green infrastructure or other water sensitive design solutions to mitigate heat increases in urban environments. Development should incorporate passive solar design and breezeways and provide vegetated areas and shade in public and private places.

Consideration may be given to increasing minimum National Construction Code (NCC) 2022 (updated version of BCA) requirements from 6 to 7 or more stars to reduce energy requirements for cooling in future.

- **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 should be adequate to manage and/or respond to extreme weather conditions.

3.2 Coastal processes

Development occurring adjacent to the coast is potentially vulnerable to changing sea levels and coastal processes which are affected by astronomical tidal ranges, storm surges, wave set-up, sea level rise and tsunami.

The City of Wanneroo has prepared a *Coastal Management Plan* (CoW, 2021) which acknowledges the significant coastal processes affecting the City. The plan includes a framework that will guide the management and use of the City's coastline over the next 15 years. This includes information for developers to inform proposals for development within the foreshore area. Accordingly, it is not considered necessary to replicate information on coastal processes in this report, as it is assumed that the City has incorporated the recommendations of the Coastal Management Plan 2021 into the draft Local Planning Strategy.

3.2.1 Issues for planning, land use change and development

Development currently underway in coastal parts of the City has largely been undertaken in a way that considers coastal impacts and has made suitable provision for setbacks and foreshore reserves. Future development in the City will have to continue to satisfy the requirements of *State planning policy No* 2.6 – *State coastal planning policy* (WAPC 2013).

Changes to the way coastal hazards are assessed as well as advances in our understanding of coastal processes mean that some areas where infill development is under consideration may be subject to coastal hazards over the planning timeframe. Where this is the case, SPP2.6 requires the implementation of coastal hazard risk management and adaptation planning. This may restrict the nature and/or extent of infill development in some locations and in others may necessitate the use of the following notification on the certificate of title: VULNERABLE COASTAL AREA – This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years.

The Western Australian Planning Commission has adopted a vertical sea level rise of 0.9 m when considering the setback distance and elevation to allow for the impact of coastal processes over a 100-year planning timeframe (2010 to 2110). As well as potentially having implications in terms of coastal setback requirements, sea level rise also has an influence on groundwater levels and drainage at the coast and should be considered in the design of subdivisions, as indicated in the City of Wanneroo Coastal Management Plan. In addition, where groundwater is under consideration as a water source, developments should consider the potential for increasing salinity in the future.

Key coastal process considerations for strategic planning in the City are:

- **Sea level rise and coastal processes** – which are likely to result in increased inundation of coastal areas and foreshores leading to impacts on environmental and social values and public and private infrastructure and assets. Future planning and

development should consider the City's Coastal Management Plan (CoW, 2021) and be consistent with State Planning Policy: 2.6 State Coastal Planning. Rising sea levels may also impact on the functionality of stormwater drainage systems that drain to the ocean or coastal foreshores.

- **Coastal hazard risks** – which should be continually monitored and appropriate adaptation actions taken as necessary.

3.3 Topography, geology and soils

3.3.1 Topography

The topography is undulating with a general increase in elevation away from the coast from the west to east (0m AHD to approximately 100 m AHD). The dominant topographic features of the western parts of the region are the undulating series of low coastal dunes and wetlands running parallel from north to south, characteristic of the Swan Coastal Plain.

The elevation of the City increases from the western coastline to the centre before decreasing further east to include another series of low-lying wetlands, and then rising again towards the inland boundary. The highest elevation of the City is found in the north east, at the edge of the Gnangara Mound (Figure 10).

3.3.2 Geology

Broad scale geological mapping is provided in Figure 11. The City is located within the Perth Basin, a north trending sediment-filled trough extending approximately 1000 km along the south-western margin of the Australian continent. Rifting of the continental plates and deposition of sediments commenced in the early Permian along the Darling Fault, culminating in the separation of Greater India from Gondwana by the Early Cretaceous. Post break-up tectonic activity abated and the Perth Basin subsided. Sediment deposition has continued episodically though to the current day in progradational shallow water and fluvial environments (Pennington Scott 2009).

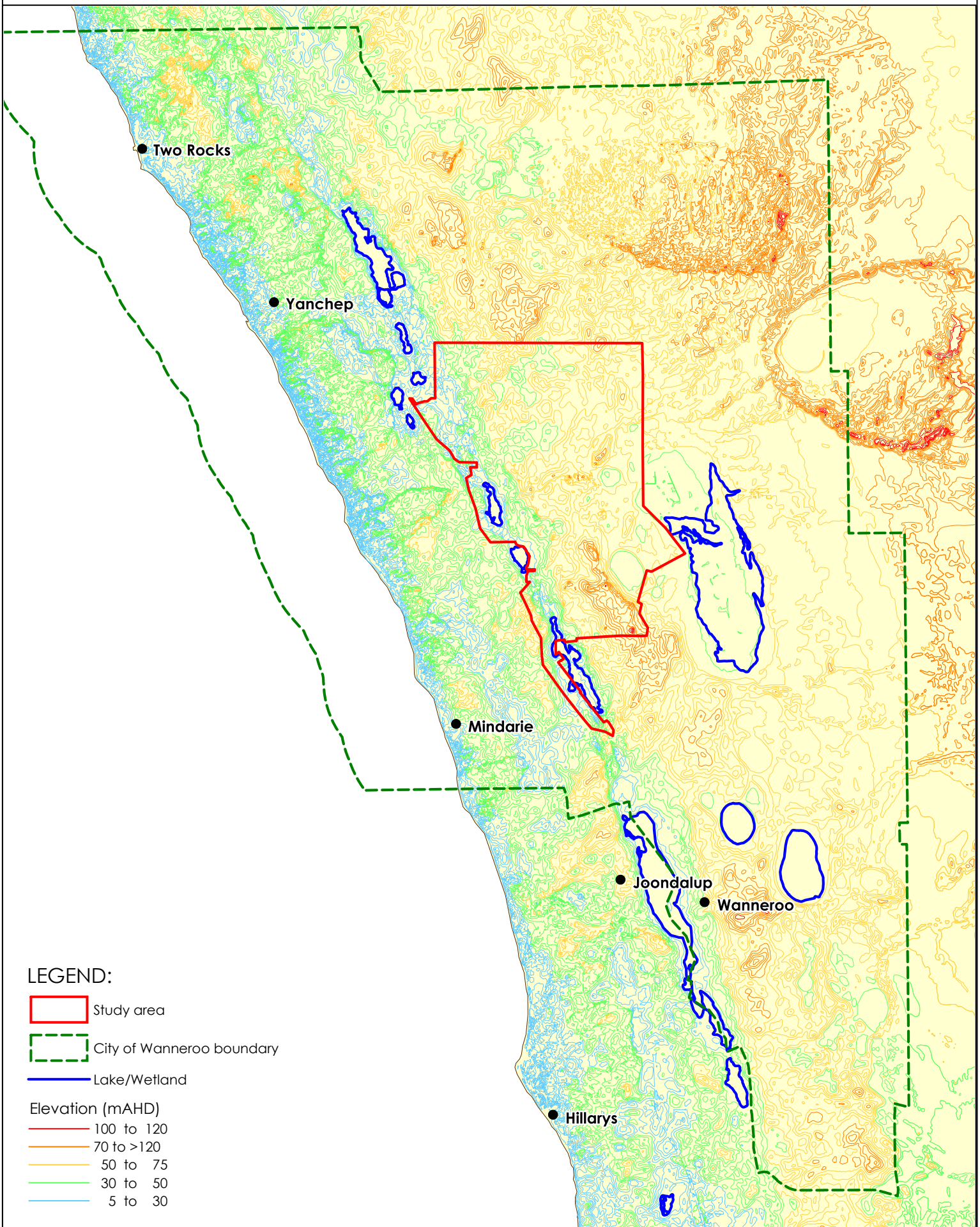
The Darling Scarp (Darling Fault) provides a distinct line of separation between the Archean Yilgarn Craton to the east and the Mesozoic to Cenozoic deposits of the Swan Coastal Plain to the west.

The upper surface of the Swan Coastal Plain in the City can be divided into four geomorphic units, the Safety Bay Sands, Tamala Limestone, Coastal dunes, and Bassendean sands, the Perth Coastal System and the Bassendean Dune System. These units overlie the Cretaceous Leederville, Lancelin and Osborne Formations and comprise the Coolyena and Warnbro Groups. The study area overlie the Coastal Dunes and Tamala Limestone.

3.3.3 Soils

Broad soil landscape zones are presented in Figure 12. The City lies on two soil landscape zones; the Bassendean Zone (Swan Coastal Plain) and the Perth Coastal Zone. The study area lies predominately on the Perth Coastal Zone. Summary descriptions of the relevant landscape zones are provided in Table 1.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 10 - Topography



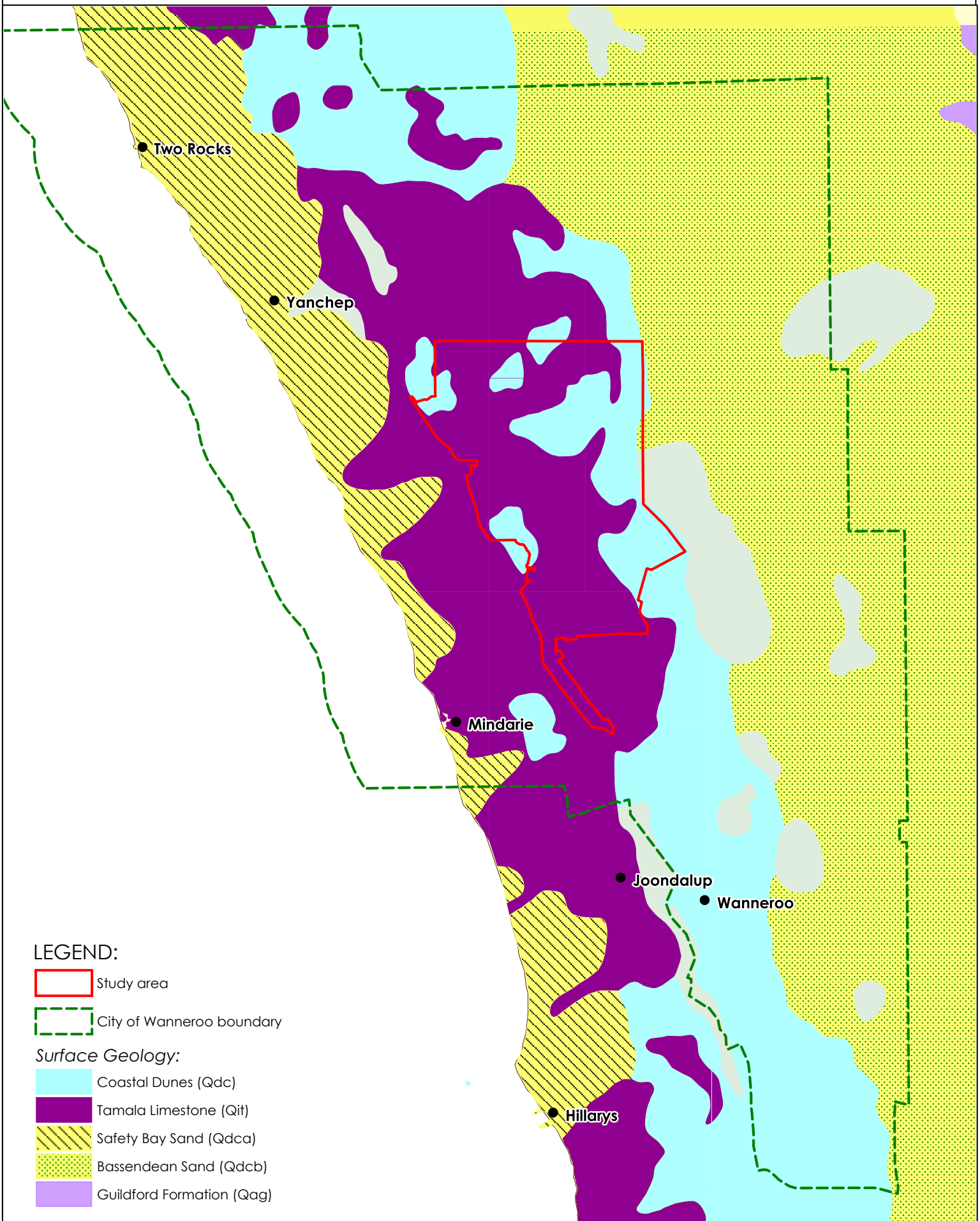
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City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 11 - Geology

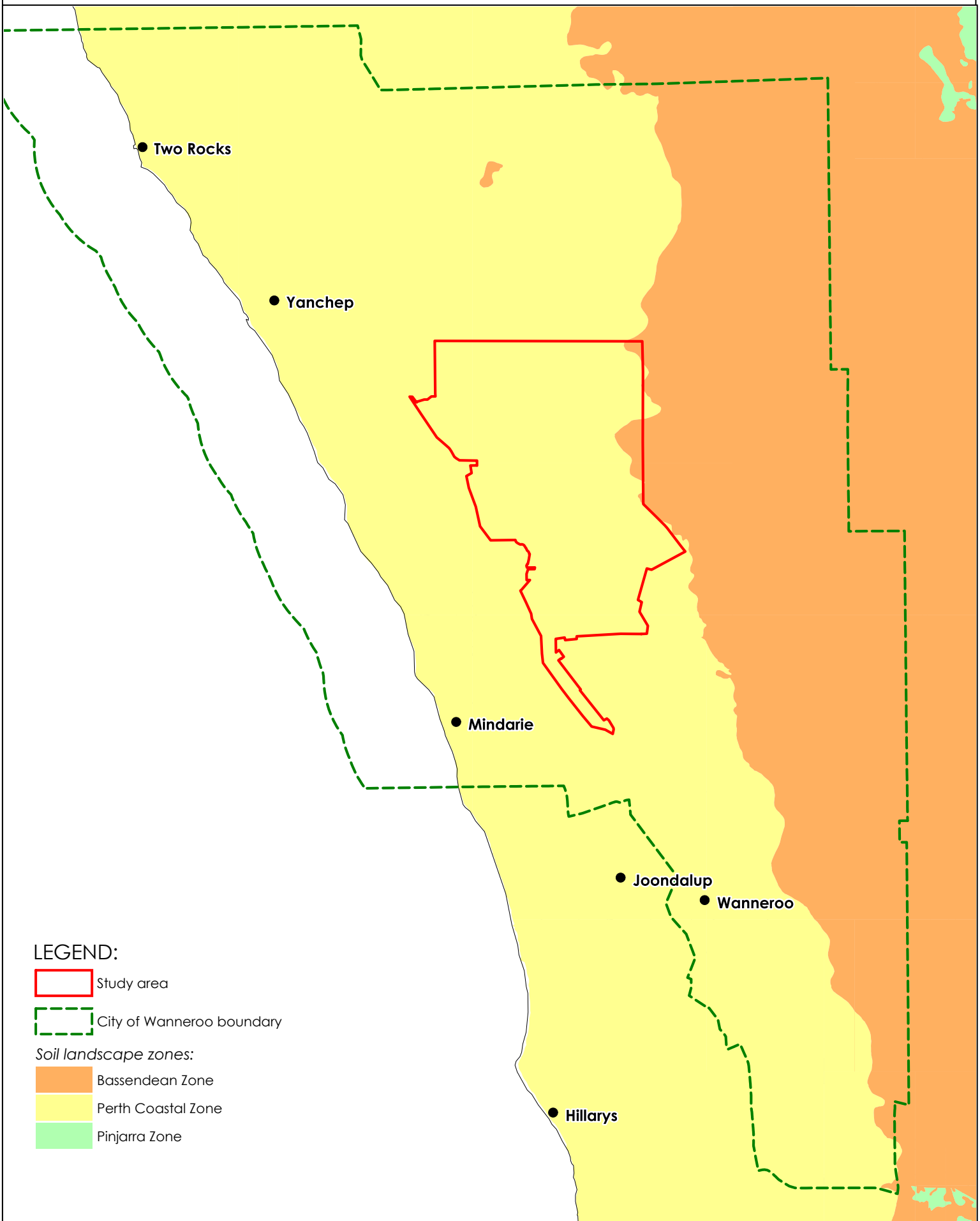


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City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 12 - Soil Landscape Zones



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Table 1: Soil landscape zones of the City

Soil/ landscape zone	Description	Permeability	Nutrient retention
Bassendean Zone (Swan Coastal Plain)	These are the oldest of the three dune systems, thought to be about 800,000 years old, and so are the most leached, infertile and acidic. The sands contain little silt or clay, and very low levels of nutrient elements, with any nutrient element content being associated with organic matter. The dunes are low lying hills with poorly drained areas between the hills The depth to ground-water varies from close to the surface to at most 10 m below the surface.	high	low
Perth Coastal Zone	This zone is described as coastal sand dunes and calcarenite. It comprises the youngest dunes of the Swan Coastal Plain, the Quindalup dunes next to the coast. East of these are the Spearwood system dunes. Limestone is present in these systems as pipes in the profile of the Quindulup dunes and the western margin of the Spearwood dunes, as well as limestone rock at the base of both dune systems. Between these two systems parallel series of inlets, swamps and lakes are present. The soils under the swamps and lakes are rich in organic matter and have often been drained and used for vegetable production. Soils are mainly calcareous and siliceous sands, and calcarenite and contain very low levels of nutrients.	high	low

Source: (Bolland 1998 and Moore 2004)

3.3.4 Soil landscape land quality and capability

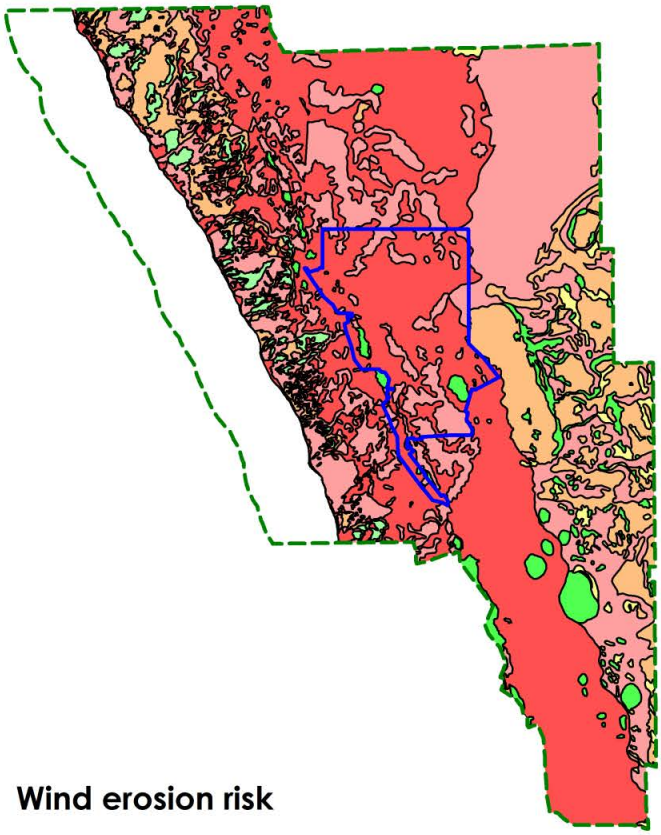
The Department of Primary Industries and Regional Development also provides data on soil landscape land quality and land capability. Issues that may arise as a result of development that have the potential to impact on environmental values include soil and water erosion, poor drainage and nutrient export. Mapping of soil units with these land qualities is shown in Figure 13. This demonstrates that large areas of the City have the potential to be affected by soil and water erosion, poor drainage and nutrient export and that the location of each issue is variable across the City.

3.3.5 Acid sulfate soils

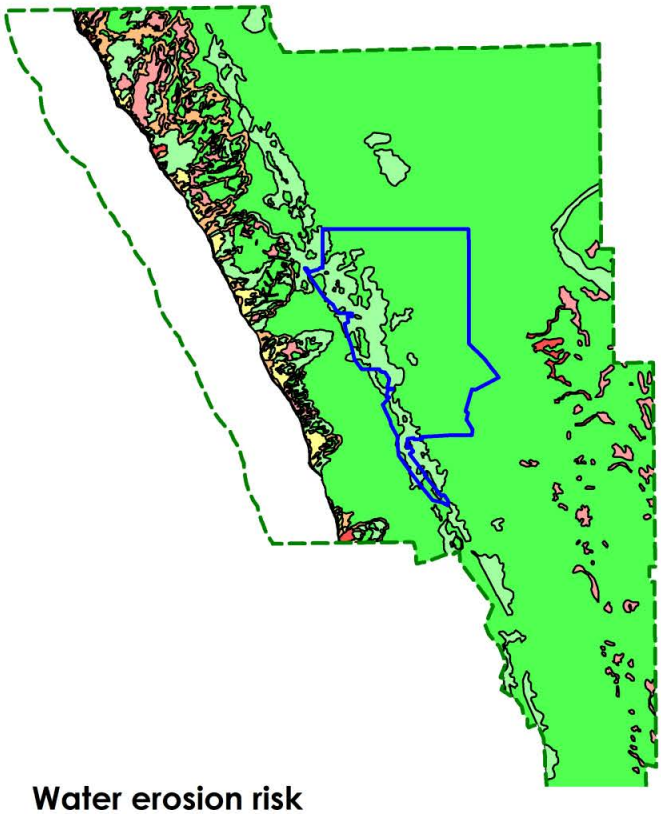
Acid sulfate soils are soils and sediments that contain iron sulfides. They occur naturally in Western Australia and are harmless when left in a waterlogged, undisturbed environment. However, when exposed to air, through drainage or excavation, the iron sulfides in the soil react with oxygen and water 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, 2012a).

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, 2012).

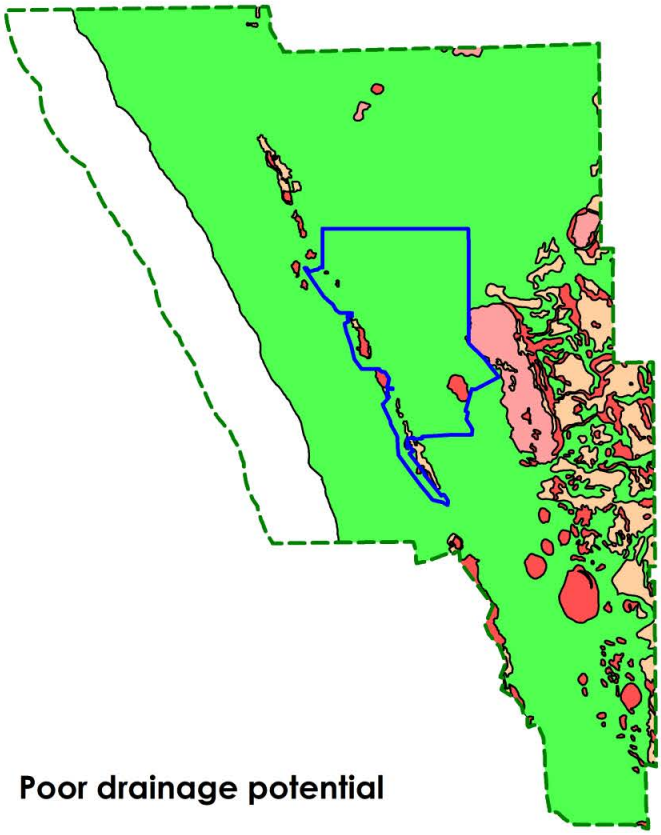
City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 13 - Soil landscape land quality and capability



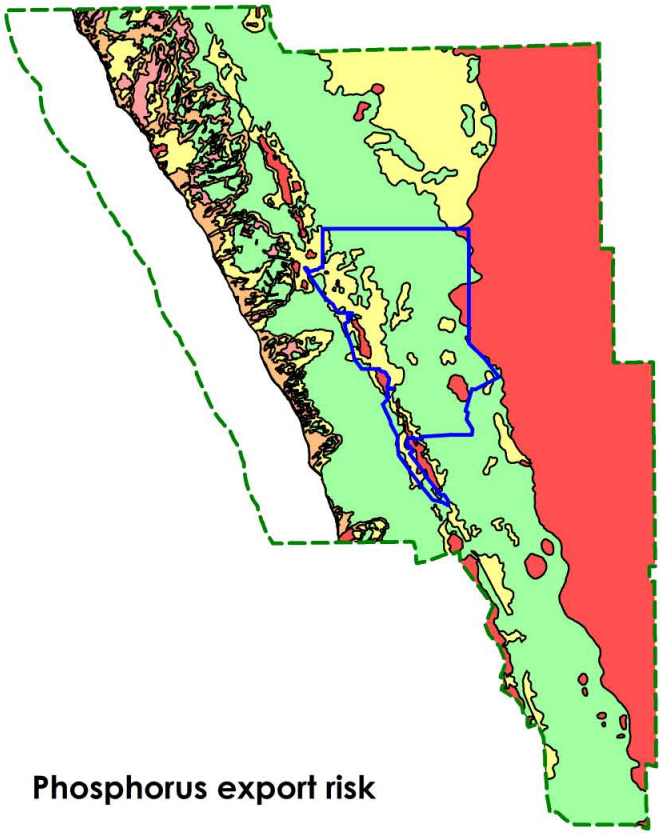
Wind erosion risk



Water erosion risk



Poor drainage potential



Phosphorus export risk

LEGEND:

- Study area
- City of Wanneroo boundary

Proportion of land affected

- <3% of map unit
- 3-10% of map unit
- 10-30% of map unit
- 30-50% of map unit
- 50-70% of map unit
- >70% of map unit

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The presence of acid sulfate soils can lead to wetland acidification in two key ways; discharge of acidified drainage water, and lowered water levels in areas of acid sulfate soils leading to wetlands drying out and wetland sediments being exposed to the air. This causes the sulfides in the soil to oxidise and produce sulphuric acid upon rewetting, which then lowers the pH of the water (URS, 2008).

Acidification can have a dramatic effect on wetland ecology. Flora and fauna that are less tolerant of acidic conditions may be reduced in number or die off completely. If acidification takes place suddenly, mass deaths of fish or other organisms may occur. There can be other, less visible effects on wetland fauna, such as habitat reduction, growth abnormalities, a fall in breeding success and chronic toxicity caused by the release of heavy metals from wetland sediments in the acidic conditions. Acidification may ultimately lead to a loss of species diversity and a complete change in the ecology of the waterbody to acid-tolerant species (URS, 2008).

Predictive maps for risk of acid sulfate soil occurrence on the Swan Coastal Plain have been prepared by the Department of Water and Environmental Regulation by identifying the landforms most likely to host acid sulfate soil in their natural environment. High priority for low-lying coastal landforms was based on the hypothesis that potential acid sulphate soil material was confined to superficial layers of landscapes within 5 m of the current mean sea level (DEC, 2012b). Figure 14 shows the two risk categories:

- Class 1 - (red) high to moderate risk of acid sulfate soils occurring within 3m of natural soil surface
- Class 2 - (orange) moderate to low risk of acid sulfate soils occurring within 3m of natural soil surface but high to moderate risk of acid sulfate soils beyond 3m of natural soil surface

  Areas outside these two categories are at low risk or have not been assessed due to the absence of geological and geochemical information.

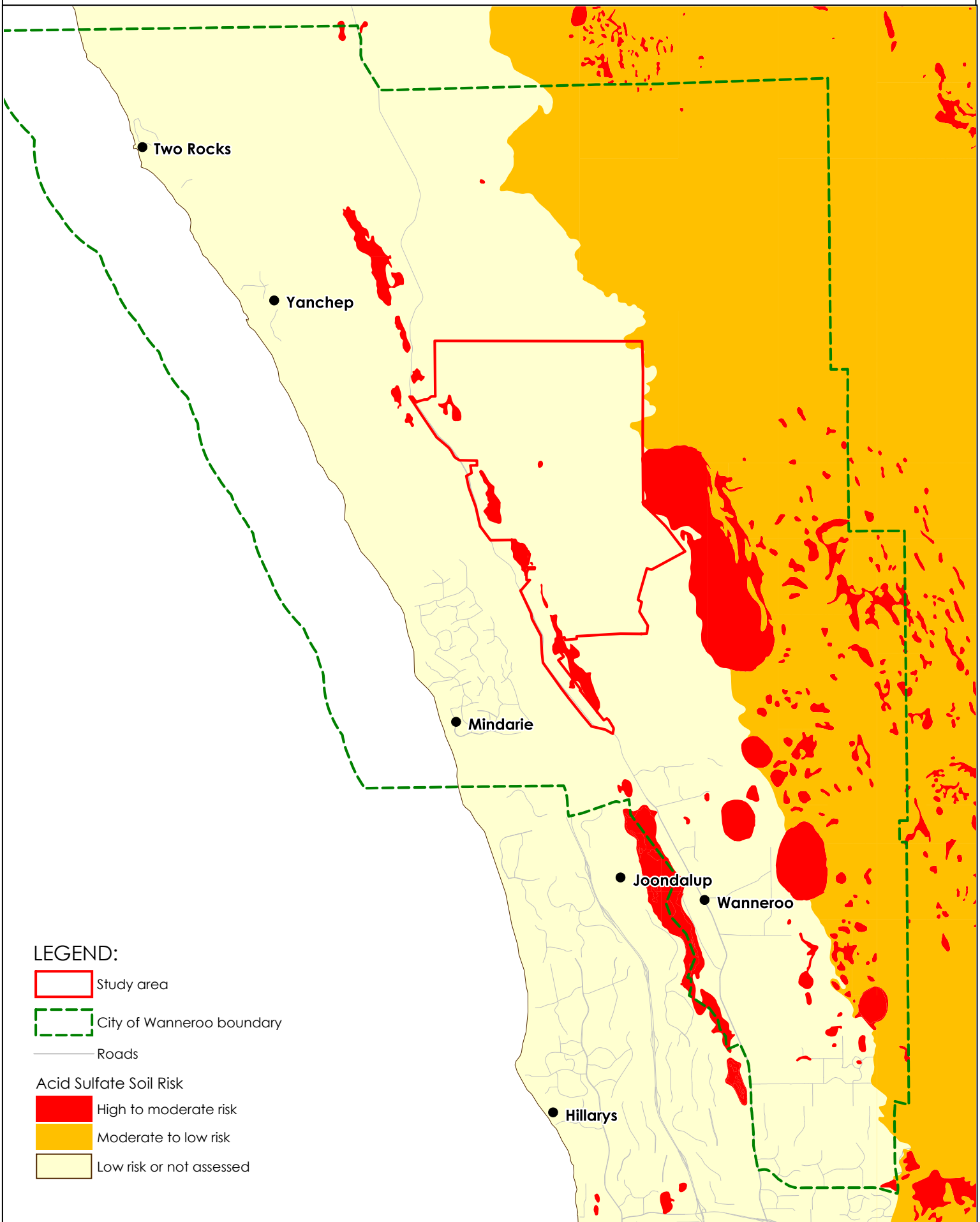
The City contains extensive acid sulphate soils due to the historically high water tables and surface water expressions such as wetlands and lakes. Currently, the City manages acid sulphate soils through the planning and development process by ensuring that applicable conditions are applied to planning approval that aim to prevent mobilisation of acid sulphate in the groundwater. They are also managed in site specific projects such as the Yellagonga Integrated Catchment Management Plan which aims to improve the quality of the Yellagonga wetlands. The Local Environmental Strategy also contains guidance for landowners on the importance of acid sulphate soil management, and the importance of ensuring healthy soils and groundwater.

3.3.6 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 Water and Environmental 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 Water and Environmental Regulation. Reported sites are classified, in consultation with the Department of Health, based on the risks posed to the community and environment.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 14 - Acid Sulfate Soil Risk



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The Department of Water and Environmental Regulation maintains a database and mapping (Figure 15) of contaminated sites which records information on sites classified:

- contaminated - remediation required
- contaminated - restricted use
- remediated for restricted use

Other sites reported to the Department of Water and Environmental Regulation, including sites awaiting classification are recorded separately by the Department of Water and Environmental Regulation and have not been mapped.

3.3.7 Sewage sensitive areas

Sewage Sensitive Areas are identified in the *Government Sewerage Policy* (2017) as areas in which development has the potential to affect water dependent ecosystems, natural waterways and estuaries, wetlands and selected coastal inlets and embayment that have been recognised at either the State or National level as having high ecological, social, cultural and/or economic values and are sensitive to contamination associated with land use and development. Within these areas, additional controls on the disposal of on-site sewerage apply.

The Government Sewerage Policy sets a one hectare minimum lot size in sewage sensitive areas that are unable to be connected to sewerage, primarily to manage cumulative impacts on the environment and water resources. This is supported by AS/NZS 1547:2012, which recommends a conservative approach be adopted where cumulative environmental risks are deemed to be high. Additional setbacks of on-site systems from sensitive water resources also apply. Secondary treatment systems with nutrient removal are generally required for on-site sewage disposal in public drinking water source areas and sewage sensitive areas.

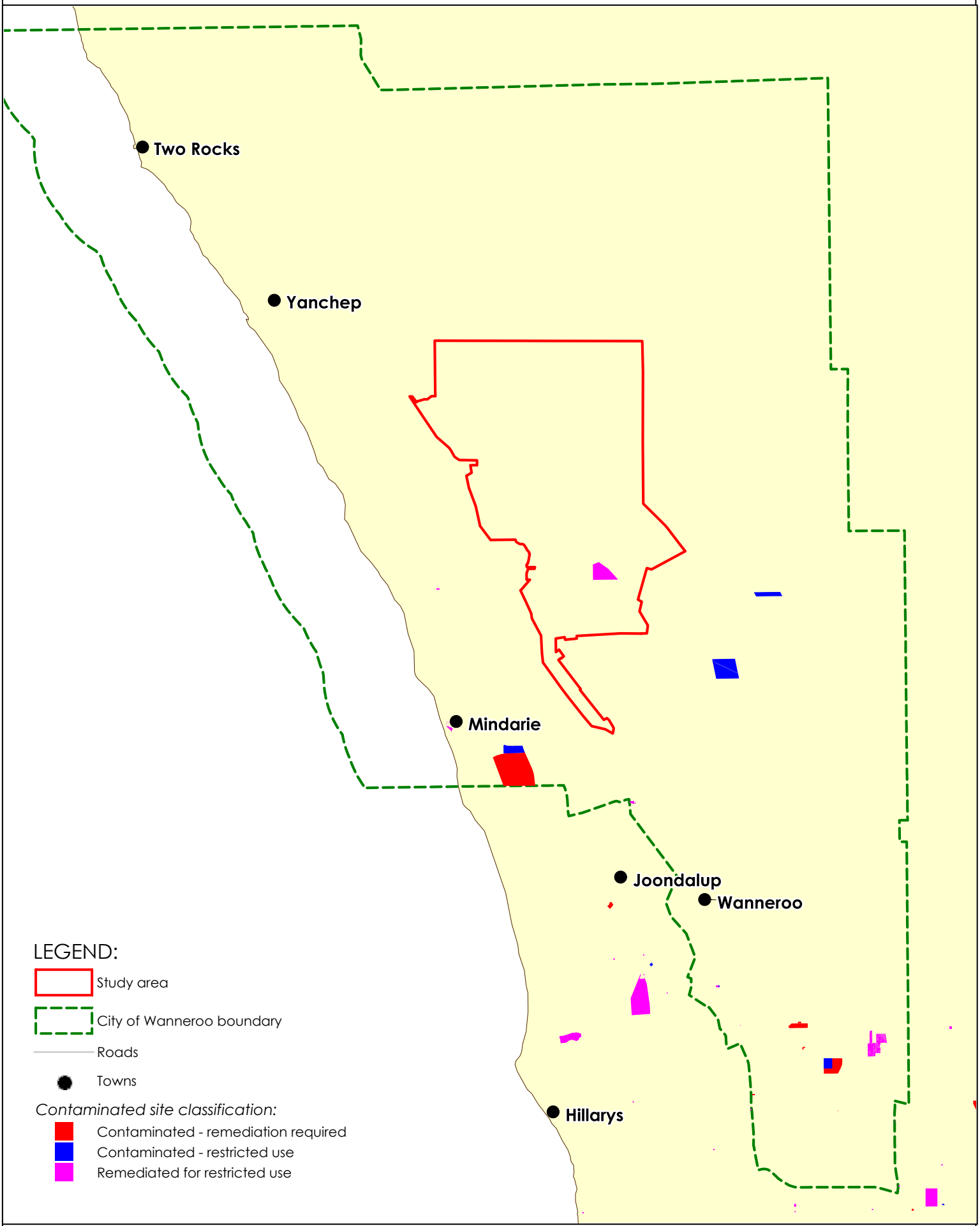
Sewage Sensitive Areas have been mapped by the Department of Planning, Lands and Heritage and are shown on Figure 16.

3.3.8 Issues for planning, land use change and development

Key land resource considerations for strategic planning are:

- **Land capability and land quality** – minimise risks to soil stability and waterlogging as well as of nutrient export associated with development through site specific assessments of soil capability and implementation of best practice site management and construction techniques.
- **Acid sulphate soils** - Declining soil and land quality can occur because 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 high risk where changes in groundwater (including dewatering for redevelopment) are likely, is required, consistent with current best practice.
- **Contaminated sites** - Consideration should be given to the remediation of contaminated sites where necessary as part of any future development.
- **Sewage sensitive areas** – are identified in the *Government Sewerage Policy* as areas which may be impacted by the on-site disposal of wastewater. Ensure all development complies with the setbacks and other requirements for on-site disposal of wastewater as outlined in the *Government Sewerage Policy*.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 15 - Contaminated Sites



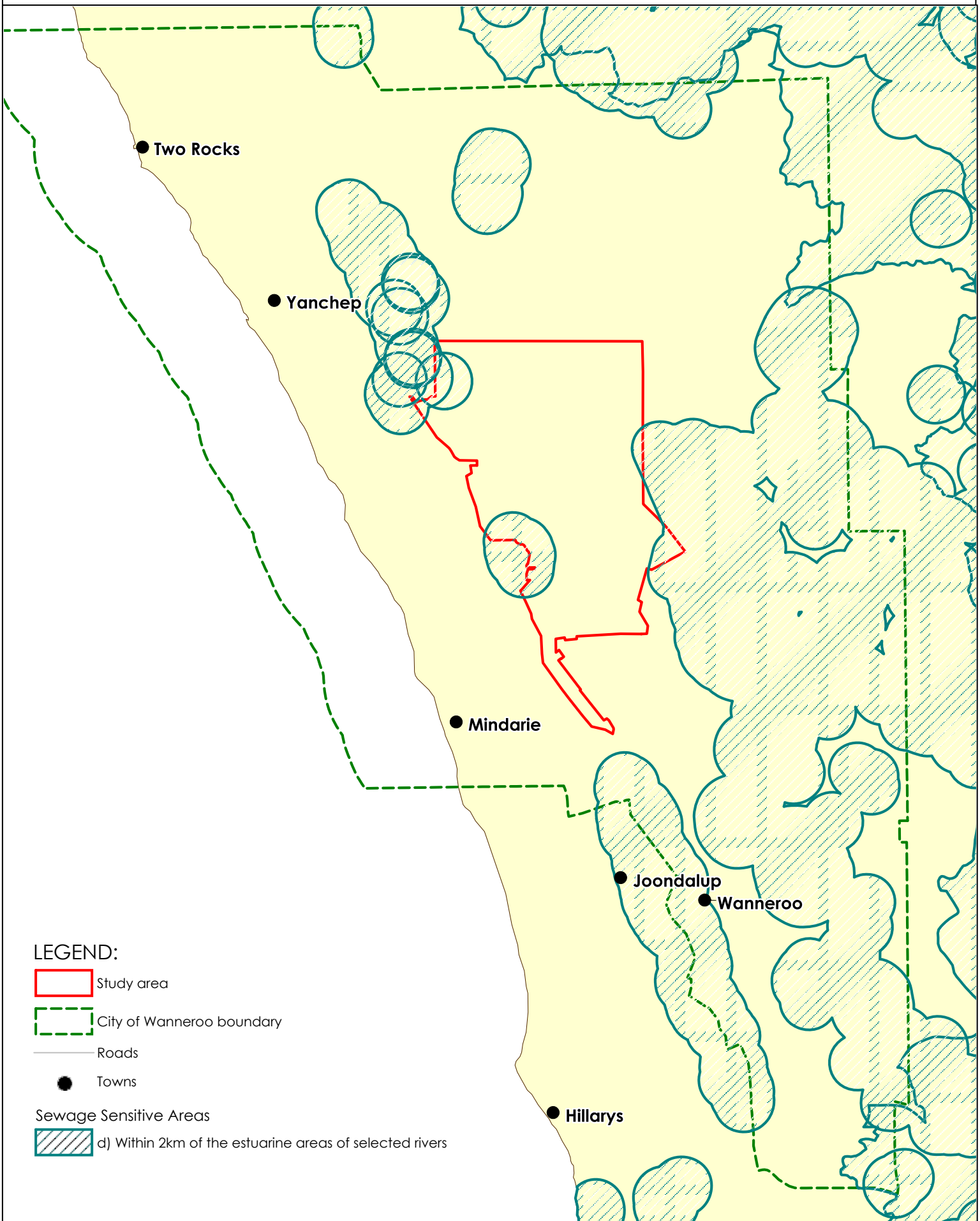
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Figure 16 - Sewage Sensitive Areas



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3.4 Heritage

Wanneroo has played a vital role in food production which pre-dates European settlement, when two Noongar tribes, the Whadjuk and Yued people, moved around the coastal sand-plain hunting and gathering as they went (City of Wanneroo, North Wanneroo Rural Discussion Paper). Its water and food sources on the shores of its lakes made it an important environment for Noongar families.

Noongar people have lived in south-western Australia for tens of thousands of years. The City is within Noongar country and Noongar people continue to be its custodians.

During preparation of the Perth-Peel regional water management plan in 2012 (DoW, 2009f), the South West Aboriginal Land and Sea Council and the then Department of Water organised workshops with local Noongar Elders to capture their views on water planning and management in the Perth-Peel region. A statement that arose out of those workshops provides insight into the Noongar people's unique connection and perspective on the region's water resources. Following are some excerpts from the statement:

> *"We are part of Australian culture and have been for time immortal in the Perth-Peel region. Noongar people of the south-west of Western Australia know how our Dreaming explained the creation of the environment and the relationships between its parts. The Dreaming describes our philosophy of life. We live by this and take our responsibility in our environment seriously. Sun, water, humans, other animals, plants, rain, water and wind are inextricably associated in maintaining balance in ecosystems. Binjareb, Wadjuk and Yued people from various Boodjar (country) in the Perth-Peel region link into a wider community of Noongar peoples and further to other connected Aboriginal groups.*
>
> *Noongar knowledge is owned by a collective and has developed over many generations. We as a collective of custodians wish to share our knowledge to manage water resources into the region's future. In the Perth-Peel region, geographical features and places with energy mark lived experiences of our ancestral spirits' journeys throughout Noongar country. These sites are the foundations of our culture and as custodians we have most important knowledge of sites and the associated activities. They are fundamental to the sense of self. Our ancestral spirits followed pathways to sites, along waterways, forming a strong connection with the land and water. Sacred sites and sites of significance are an integral part of Noongar culture. They are places that bear the marks of Noongar creative spirits, who continue to have a presence in land formations and water.*
>
> *Life in our rivers needs space in order to flow freely and flourish. In Noongar ways of caring for Boodjar, to destroy or damage a site is a distressing and dangerous act, which threatens not only living and unborn generations, but also the spiritual forces and order of the world. Our intent as Noongar people is to protect and maintain our living cultural heritage by addressing the impacts of misuse of the Perth-Peel region water systems."*

The Aboriginal Cultural Heritage Act 2021 will replace outdated Aboriginal cultural heritage laws and protect Aboriginal heritage in Western Australia. It provides a new way of protecting Aboriginal cultural heritage by giving Aboriginal people a much stronger say in managing their cultural heritage.

Before the *Aboriginal Cultural Heritage Act 2021* comes into operation there will be a transitional period of at least 12 months during which the regulations, statutory guidelines and operational policies will be developed to ensure the *Aboriginal Cultural Heritage Act 2021* will have its intended effects. The transitional period will allow for the new Aboriginal cultural

heritage management system to be fully established and to enable parties to prepare for the new system.

During the transitional period the Aboriginal Heritage Act 1972 will remain in force to allow proponents to continue to seek section 18 consent for any activity that will impact Aboriginal sites. Any section 18 consents applied for and granted during this period will be limited to 5 years and will be subject to additional protection mechanisms, including the requirement to report new information about the existence or the characteristics of Aboriginal cultural heritage.

When the Aboriginal Cultural Heritage Bill 2021 becomes the law, there will be better protection for Aboriginal cultural heritage and more heritage that is important to Aboriginal people will be protected.

The Department of Planning, Lands and Heritage maintains a register of known Aboriginal sites, which records the places and objects of significance that the Act 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.

The Department of Planning, Lands and Heritage has previously identified several sites of Indigenous significance in the City including Doogarch Site, the Wanneroo Scarred Tree and Orchestra Shell Cave, which are also recorded on the Register of the National Estate. Many of these sites relate to the plan area's rivers and waterbodies. These sites are shown in Figure 17.

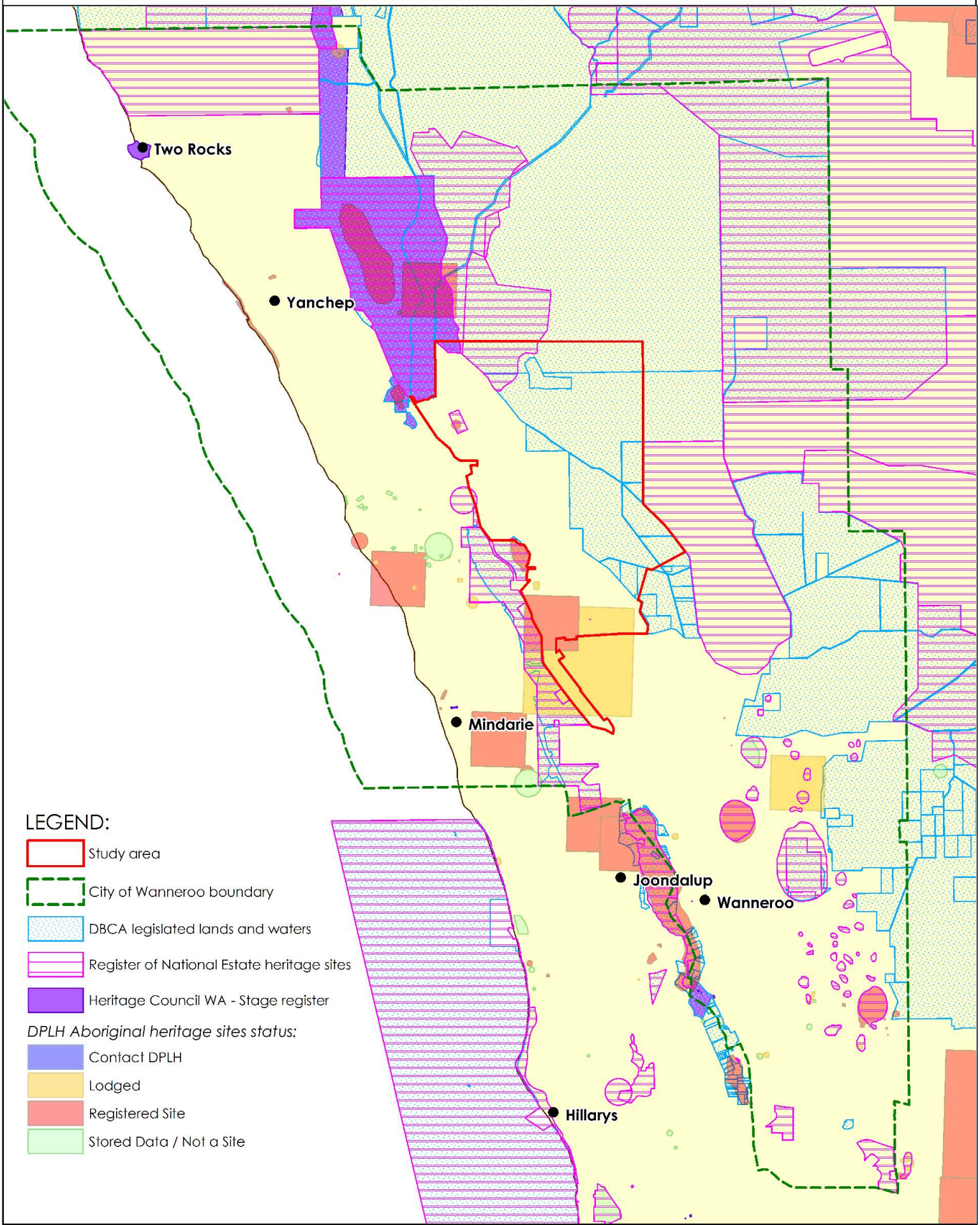
3.4.1 Post European settlement heritage

The City is also rich in history from the post-European settlement era. As European settlement occurred, agricultural activities formed an integral part of the area's prosperity and growth. Today, Wanneroo's landscape, topography, natural vegetation and close proximity to the Perth metropolitan region continues to place it at a strategic advantage for agricultural production (City of Wanneroo, North Wanneroo Rural Discussion Paper).

The Heritage Council of Western Australia maintains the *State register of heritage places* under the *Heritage of Western Australia Act 1990* (WA) to protect and recognise places of cultural heritage significance within the state. The register includes buildings, structures, gardens, cemeteries, landscapes and archaeological sites.

Under the Act, if a place is listed on the *State register of heritage places,* any changes or works that may affect its significance must be referred to the Heritage Council of Western Australia for advice. Sites listed on the State register include Yanchep National Park, the Army Barracks, Yanchep Inn, Gloucester Lodge and Poole, Tram Cottage, McNess Guest House, Ghost House Ruins and an Administration Building within Yanchep National Park, the North-West Stock Route from Yanchep to Neergabby, Coopers Lime Kiln, Buckingham House, Perry's Paddock and Cottage, Luisini Winery Group and Cockman House. The Muchea / Pearce Air Weapons Range is also listed on the Commonwealth heritage register. These sites are shown in Figure 17.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 17 - Heritage



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3.4.2 Natural heritage

The natural and rural character of the City is highly valued by residents and visitors alike. The City contains extensive areas of national park (Yanchep and Neerabup National Park), state forest and other lands managed by the Department of Biodiversity, Conservation and Attractions interspersed by cleared or partially cleared rural land, particularly in the north and eastern areas of the City.

Many residents have been drawn to the City for the opportunity it offers for a rural or semi-rural lifestyle within commuting distance of Perth and surrounding urban centres, others have been resident in the City for several generations and have strong ties to existing communities. There can be competition for developed and developable land between these different demographic groups and there is substantial pressure in some localities to allow for construction of ancillary accommodation to enable smallholdings to provide for multiple generations.

The City is also of significance as a day-trip destination, with extensive walking and cycle trails through outstanding natural areas, such as Lake Joondalup reserves.

Supporting and sustaining the values of this rural environment requires that sufficient uncleared and protected land is retained to preserve the natural character of the City whilst providing for a growing population and a vibrant tourist industry. In addition, it is important to recognise the impacts that surrounding development can have on reserved and protected areas in particular through hydrological change increasing or decreasing the accessibility of water for dependent flora and fauna as well as through water quality decline and loss of connectivity.

3.4.3 Issues for planning, land use change and development

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 Whadjuk traditional owners within the City in terms of land and cultural heritage management.

Development in the City is required to comply with the requirements of the *Aboriginal Cultural Heritage Act 2021*, which provides a modern framework for the recognition, protection, conservation and preservation of Aboriginal cultural heritage whilst recognising the fundamental importance of Aboriginal cultural heritage to Aboriginal people.

In order to proceed with development in these locations it will be necessary to clearly define the values to be protected and include commitments for future ongoing management and monitoring of wetlands, watercourses and biodiversity.

3.5 Surface water

3.5.1 General hydrology and catchment descriptions

Catchments in the City can be described in four major catchment groups: Swan Coastal Plain catchments (comprising the majority of the City); Swan/Canning Estuary catchments; Moore-Hill Rivers catchments and Ellen Brook catchments.

Swan Coastal Plain catchments

The Swan Coastal Plain catchments do not have any significant waterways present. However, a chain of parallel lakes and swamps occur in an approximately linear north-south alignment within these catchments, including Lake Pinjar, Mariginiup Lake and Jandabup Lake in the east. Occurring parallel and to the west of this series of wetlands is Loch McNess, Yonderup Lake, Wilgarup Lake, Pipidinny Swamp, Beonaddy Swamp, Carabooda Lake, Nowergup Lake, Neerabup Lake, Lake Joondalup and Lake Goollelal (Figure 18). These wetlands are directly connected to and primarily fed by groundwater from the superficial aquifer of the Gnangara Mound.

Due to the decline in water levels in shallow groundwater systems across the Gnangara Mound, a number of the Swan Coastal Plain wetlands are artificially supplemented to meet Ministerial Conditions (No.817). This includes Nowergup Lake and Lake Jandabup which are supplemented with groundwater abstracted from the Leederville aquifer (DoW, 2009).

Ellen Brook catchments

Ellen Brook is a natural, ephemeral waterway with its headwaters just south of Gingin. At 71,500 hectares, it is the largest sub-catchment of the Swan Canning catchment. Only a small portion of this catchment is located within CoW boundaries in the north-east corner. Much of the Ellen Brook catchment has been cleared for agriculture and urban use. Land use is predominantly cattle grazing and horticulture in the north and urban settlements and small-scale light industry in the south. Some remaining areas of vegetation have high conservation value, containing several threatened ecological communities, priority flora and the critically endangered western swamp tortoise (SRT 2009).

Moore-Hill Rivers basin

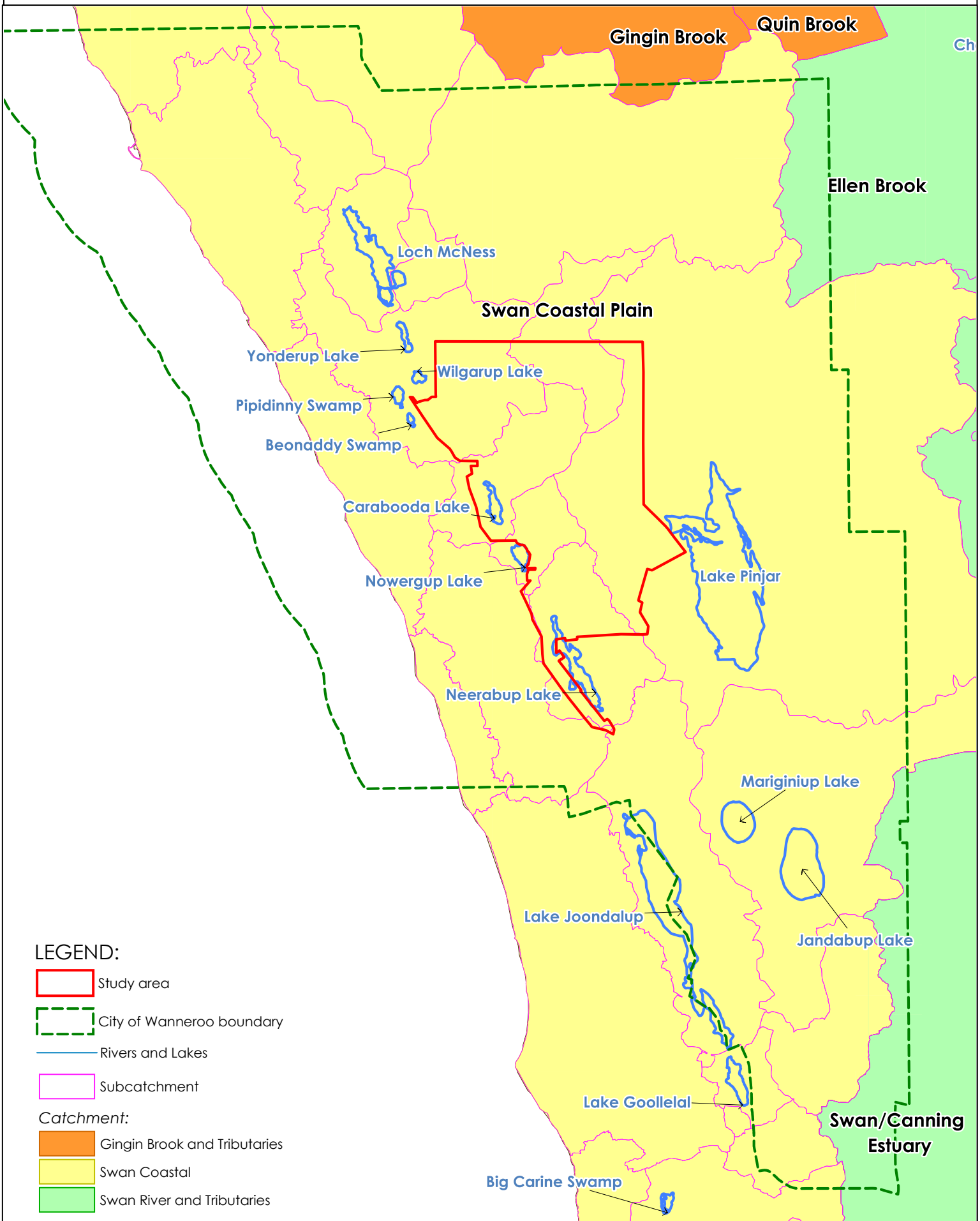
The Moore-Hill rivers basin is within the Gingin Brook and Tributaries management area and contains both major drainage lines and ephemeral lake systems. The Moore-Hill Rivers catchment is extremely large with an area of 2,453,400 hectares (NWC 2005). Only a very small portion of the most southern area of the catchment is located within the City, including approximately 150 hectares of the Gingin Brook subarea, as shown in Figure 18.

Swan/Canning Estuary catchments

The Swan River and Tributaries surface water allocation area covers a narrow area of the south-eastern corner of the City of Wanneroo. The area includes the north-eastern portion of the Bennett Brook catchment.

Bennett Brook was once a natural creek system, however its tributaries to the west have been modified to deeply incised drains to allow development. The brook is fed primarily by groundwater seepage from the Gnangara Mound and also receives stormwater from the surrounding industrial, residential and rural areas.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 18 - Catchment Plan



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3.5.2 Wetlands

Some specific wetlands and lakes of the City have been recognised for their particular ecological, economic and social values and are afforded various levels of protection from the Commonwealth and State Governments. Developments should consider, not only their direct impacts on these areas but the indirect impacts they may have through the interruption of the natural hydrological and hydrogeological systems linked to important wetlands, sometimes over significant distances.

Drainage close to wetlands and watercourses can lead to long-term lowering of groundwater levels within and diversion of overland stormwater flows away from them. Water dependent ecosystems within and on the banks of wetlands and watercourses can be negatively impacted by reduced access to both surface and groundwater.

Similarly, where surface water flows are increased, any resulting additional inundation can also negatively impact on ecosystems. However, the drying climate may lead to circumstances where it will be desirable to divert some overland surface water flows to wetland areas and development should maintain opportunities for this to occur if required.

North Wanneroo contains a wetland spine that extends north east of Wanneroo Road and includes ground water areas and lakes.

There are no wetlands of international significance within or in close proximity to the City.

Nationally and regionally important wetlands

Nationally important wetlands within the City that are in the *Directory of important wetlands in Australia* include the following (shown in Figure 19):

- Loch McNess System; and
- Lake Joondalup.

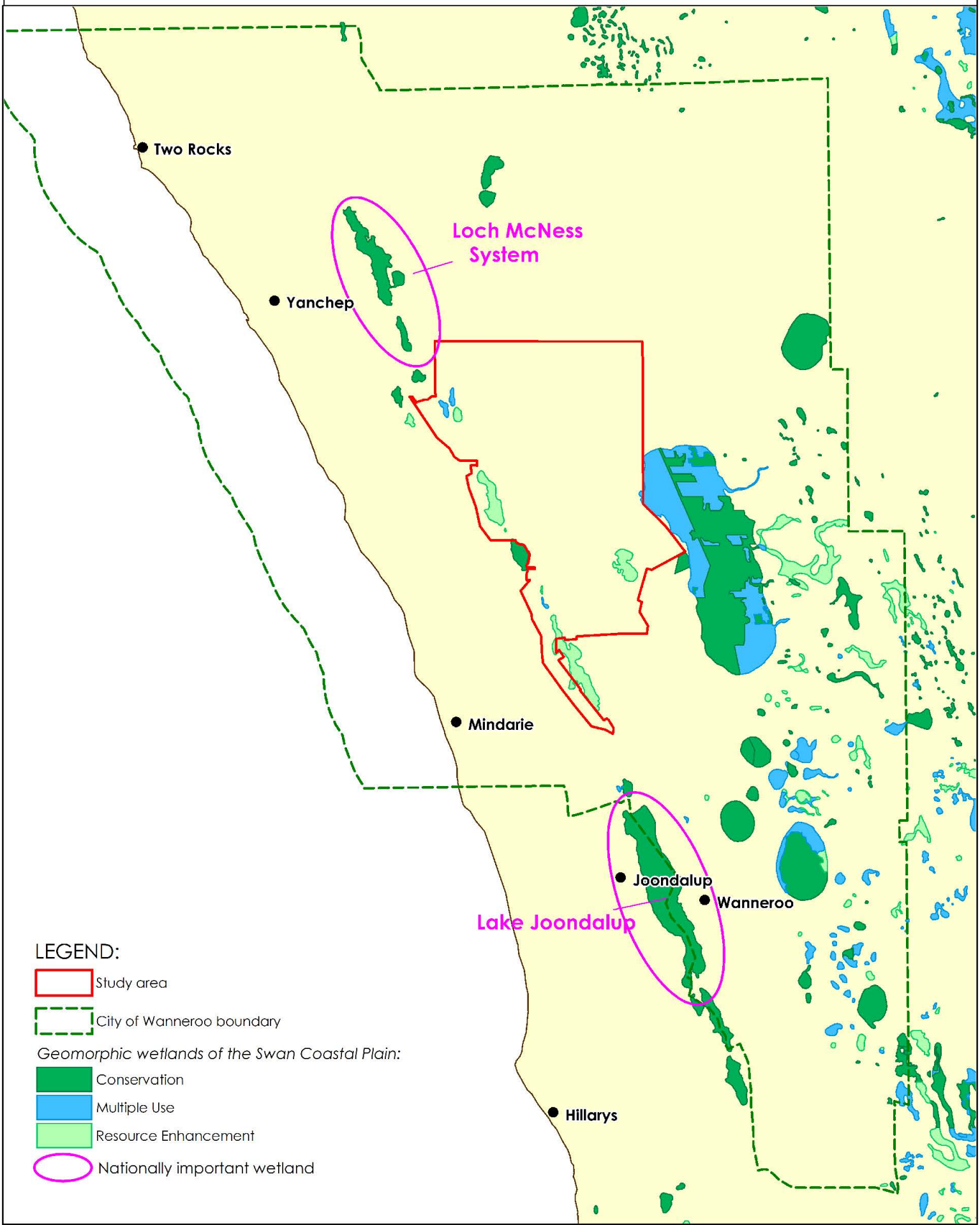
Regionally important wetlands in the City are shown in Figure 19.

The Department of Biodiversity, Conservation and Attractions has evaluated and classified most of the Swan Coastal Plain wetlands. The classification's purpose was to ensure an integrated approach to the management of catchments, and to manage water quantity and quality where these had the potential to affect environmental, cultural and other wetland values. Management objectives were assigned to the following wetland categories:

- Conservation – to maintain and enhance natural wetland attributes and functions
- Resource enhancement – to maintain and enhance existing ecological functions
- Multiple-use – to consider wetlands in the context of catchment and land use planning, in terms of current values and potential value if rehabilitated

The City of Wanneroo contains over 188 wetlands; 86 of which are classified as Conservation Category Wetlands (CCW), 46 Resource Enhancement Wetlands (REW) and 56 Multiple Use Wetlands (MUW) (Figure 19). Key wetlands classified as CCW include Lake Joondalup, Lake Pinjar, Lake Mariginiup, Loch McNess, Gnangara Lake, Nowergup Lake, Beenyup Swamp, Walluburnup Swamp, Wilgarup Lake and Lake Adams, which form part of a complex of wetlands extending north-south along the Swan Coastal Plain and comprise some of the oldest and last remaining freshwater wetland systems.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 19 - Wetlands of National and Regional Significance



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Other significant wetlands include Karli Spring, a groundwater fed spring of important native heritage value located within the City's foreshore reserve in Alkimos (City of Wanneroo, Local Biodiversity Plan 2018/19 – 2023/24).

Table 2: Geomorphic Wetlands within the City of Wanneroo

Wetland Name	UFI	Classification	Management Category
Badgerup Lake	8165	Sumpland	Conservation
Beenyup Swamp	8169	Sumpland	Conservation
Beonaddy Swamp	8016	Sumpland	Resource Enhancement
Bustard Landing	8098	Dampland	Conservation
Bustard North	8119	Dampland	Conservation
Bustard Swamp	8099	Dampland	Conservation
Camel Swamp	7938	Dampland	Resource Enhancement
Carabooda Lake	8009	Sumpland	Resource Enhancement
Coogee Swamp	8015	Lake	Resource Enhancement
Gnangara lake	8130	Lake	Conservation
Hawkins Road Swamp	8093	Sumpland	Conservation
Jandabup Lake	15006, 8114, 7957	Lake	Conservation, Resource Enhancement, Multiple Use
Jinbub Swamp	7956	Sumpland	Multiple Use
Lake Adams	7959, 7960	Dampland	Conservation
Lake Joondalup	7954	Lake	Conservation
Lake Pinjar	13373, 7915, 7931, 7948, 7917, 7939, 7935, 7916, 15005, 7933, 7947, 7937, 7929, 13374	Sumpland	Conservation, Multiple Use
Little Badgerup Lake	8132	Sumpland	Conservation
Little Coogee Flat	7945	Dampland	Conservation
Little Coogee Swamp	7941	Dampland	Resource Enhancement
Little Dundarbar Swamp	8117	Sumpland	Multiple Use
Little Mariginup	8161	Sumpland	Conservation
Loch McNess	8010	Lake	Conservation
Mariginup Lake	7953	Lake	Conservation
Mindarie Lake	8013	Sumpland	Multiple Use
Neerabup Lake	8019	Sumpland	Resource Enhancement
Nowergup Lake	8021	Lake	Conservation
Pauls Swamp	8159, 8160	Sumpland	Conservation, Multiple Use
Pinesend Farm Swamp	8153	Dampland	Multiple Use
Pippidinny Swamp	8012	Sumpland	Conservation
Snake Swamp	8135, 8116	Dampland	Resource Enhancement, Multiple Use

Wetland Name	UFI	Classification	Management Category
Wallubuenup Swamp	15458	Sumpland	Conservation
Wilgarup Lake	8022	Sumpland	Conservation
Yonderup Lake	8011	Lake	Conservation
Not Applicable	14308, 15459	Dryland	Not Applicable

Note: many "unknown" wetland names, UFI numbers: 8076, 8113, 8068, 8062, 8335, 10882, 8128, 8131, 8155, 8101, 8102, 8103, 14476, 8104, 8088, 8085, 8136, 8127, 8107, 8122, 8057, 8066, 8201, 7930, 14242, 8077, 8078, 14261, 8111, 15900, 14245, 14253, 14254, 15442, 15443, 7950, 14244, 13530, 7943, 8073, 7949, 7923, 7924, 7928, 13066, 8084, 8087, 8124, 8094, 8145, 8120, 7927, 8134, 8070, 8123, 15022, 8133, 8154, 8157, 8341, 8112, 8144, 7921, 7922, 8061, 8340, 8018, 7920, 7936, 8058, 8059, 8060, 8138, 10722, 8072, 8075, 8105, 8121, 8118, 8100, 10721, 7946, 9716, 8096, 8097, 10774, 8017, 15901, 8003, 13920, 7934, 8125, 8067, 8074, 8164, 8106, 8108, 8129, 7951, 7932, 8079, 8081, 8082, 15258, 8126, 8069, 13917, 8110, 7926, 7940, 8020, 8014, 7925, 14241, 14247, 15312, 13821, 8086, 8083, 8092, 13956, 8095, 7944, 13627, 8338, 8065, 8002, 14248, 14252, 15902, 7942

The *Gnangara groundwater allocation plan* notes that the Gnangara groundwater system's wetlands are drying and lower groundwater levels have caused the drying of cave pools and wetlands in Yanchep National Park, such as Crystal Cave, Loch McNess (Wagardu2) and Lake Wilgarup (DWER, 2022a).

3.5.3 Drainage and flood protection

Drainage for developments located on the Swan Coastal Plain, in particular in the area of sandy soils close to the coastline is typically focussed on infiltrating on-site.

The landscape and hydrology of much of the City means that whilst short duration or 'flash' flooding can be problematic, particularly in urban centres, major flooding events are uncommon.

While there are no areas designated as being at risk of riverine flooding in the City, existing and new areas of development are required to be designed to provide adequate protection from flooding from installed drainage systems, consistent with the *Decision Process for Stormwater Management in WA* (DWER, 2017) and the *Stormwater Management Manual for Western Australia* (DWER, 2022c).

3.5.4 Surface water quality

The catchments of the Swan Canning River system, including Bennett Brook and Ellen Brook, are the subject of the *Swan-Canning water quality improvement plan* (SRT 2009) which contains catchment management measures and control actions. It was developed as a part of the Coastal Catchments Initiative, with the aim of reducing nitrogen and phosphorus inputs to the Swan-Canning river system. The City contains only a very small part of the upper Ellenbrook catchment with the remainder predominantly holding no surface watercourses.

Lakes and wetlands in the City generally have very small surface water catchments being mainly groundwater fed as the vast majority of rainwater infiltrates through the typically sandy soils to recharge the superficial aquifer. Water Quality within the lakes and wetlands of the City is characterised by high nutrient levels from agricultural and septic tanks arriving via the superficial aquifer and leading to potential algal blooms and eutrophication.

3.5.5 Surface water use

The City contains parts of three surface water allocation areas proclaimed under the *Rights in Water and Irrigation Act 1914* that correspond to surface water catchments that are mapped in Figure 18. These areas are:

- Moore-Hill Rivers
- Swan River and tributaries (including Ellenbrook and Swan-Canning Estuary catchments)
- Swan Coastal

There are no reservoirs nor public drinking water source areas (surface water) within the City.

Surface water availability and licensing

Surface water availability reporting and licensing is based on surface water allocation areas, subareas and irrigation districts which have been defined by the Department of Water and Environmental Regulation on the basis of natural catchment boundaries and administrative boundaries. It is illegal to take water from a watercourse in a proclaimed area without a licence.

The surface water allocation areas proclaimed under the *Rights in Water and Irrigation Act 1914 (*as shown previously on Figure 18 are:

- Swan River and tributaries
- Swan coastal
- Moore-Hill Rivers

The Swan Coastal surface water allocation area comprises the majority of the City. Only very minor parts of the Moore-Hill Rivers and Swan River and tributaries surface water allocation areas are included within the City.

3.5.6 Issues for planning, land use change and development

Key water resource considerations for strategic planning, consistent with *State Planning Policy 2.9: Water Resources* are:

- **Wetlands –** are an important ecological feature of the City and should be protected and managed in accordance with the assigned management category. This includes provision of adequate buffers and protection via appropriate reservation. Drainage strategies should also consider strategies to enhance wetland health and be based on the individual wetland characteristics and site conditions
- **Flood risk** – exists in existing and future development areas from constructed drainage systems and should be managed in accordance with Department of Water and Environmental Regulation recommendations and draft *State Planning Policy 2.9: Planning for Water* and the *Planning for Water Guidelines*.
- **New drainage systems** – All future development should demonstrate they are implementing best practice water sensitive urban design solutions consistent with *State Planning Policy 2.9: Planning for Water* and the *Planning for Water Guidelines*. In order to protect the groundwater resources particularly where associated with public drinking water source areas, it will be important to ensure that the stormwater management strategy does not infiltrate 'clean' rainwater through 'dirty' soil.
- **Drainage system capacity** – Future brownfield development that increases the level of impervious surfaces may impact on the capacity of existing drainage network.

Consideration should be given to opportunities to retrofit the existing system to improve the management of stormwater quality and increase detention and retention of stormwater as part of future development.

- **Erosion and sediment control –** is critical to maintaining the health of wetlands within the City as well as protect the function and capacity of installed drainage systems and vegetated stormwater management assets. Improved sediment management will also reduce the costs of mitigation works and wastes.

3.6 Groundwater

3.6.1 General hydrogeology and aquifer descriptions

The eastern portion of the City is dominated by the Gnangara groundwater system. The major aquifers present (in order of increasing depth) are:

- Superficial aquifer
- Mirrabooka aquifer
- Leederville aquifer
- Yarragadee aquifer

The Superficial aquifer is a mainly freshwater, unconfined aquifer recharged directly from rainfall. The aquifer is widely used in the City as the predominant source of water for horticulture, irrigation of public open space and gardens (Gnangara Sustainability Strategy Taskforce 2009).

The Mirabooka aquifer is a semi-confined to confined freshwater aquifer present in the southern part of the City. The aquifer is recharged indirectly via downward flow from the Superficial aquifer and because of its highly variable thickness it cannot be relied on to provide large volumes of water (Gnangara Sustainability Strategy Taskforce 2009).

The Leederville aquifer is a mainly confined aquifer with variable salinity, usually increasing with depth. Recharge within the northern part of the Gnangara groundwater system occurs indirectly via the superficial aquifer (DWER, 2022a). The aquifer is predominantly used for public drinking water supply.

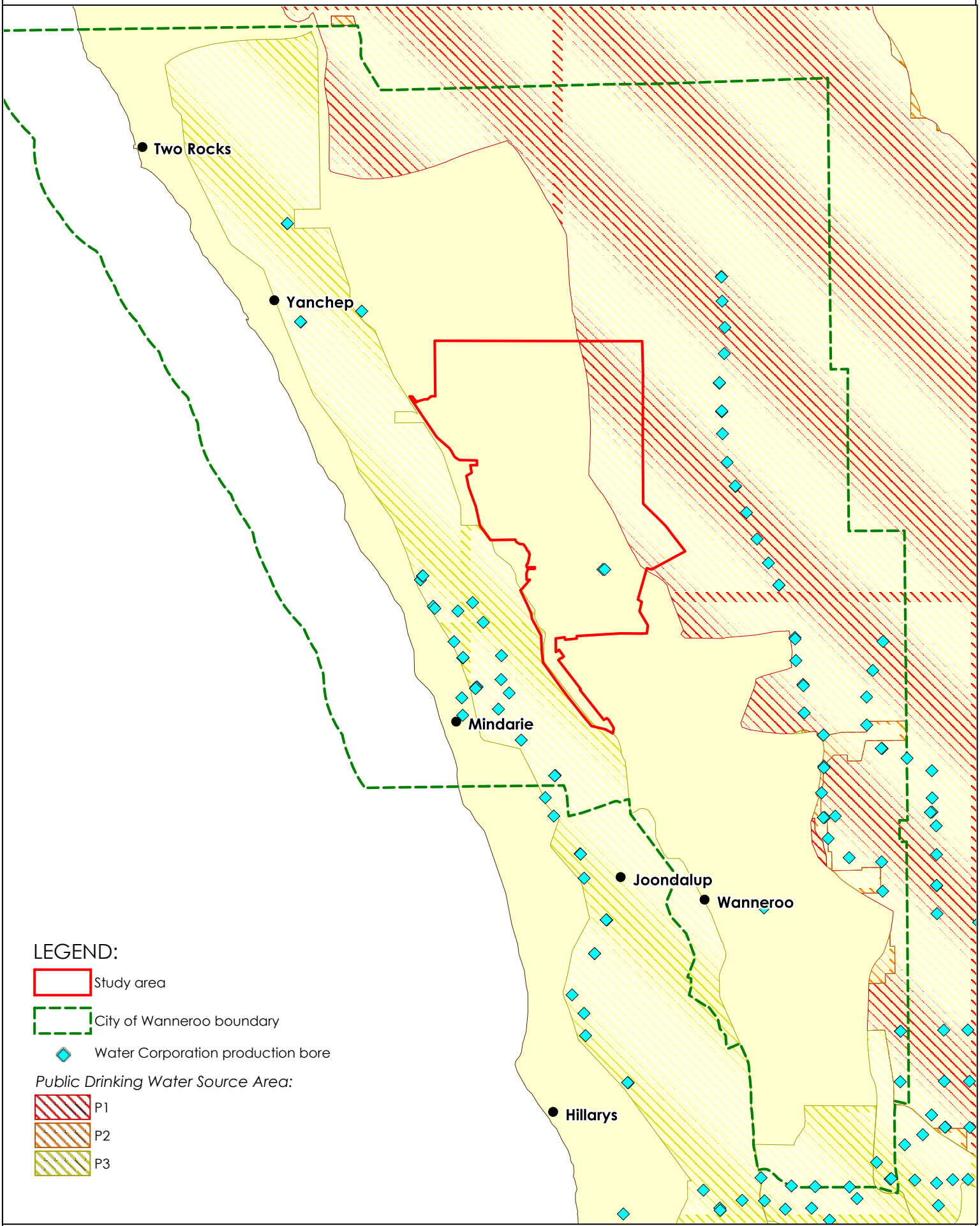
The Yarragadee aquifer is a confined aquifer with variable salinity, usually increasing with depth. The Yarragadee aquifer is recharged by downward leakage of groundwater from the Leederville aquifer where the South Perth Shale is absent, and from the Superficial aquifer where the Leederville is absent. The aquifer is predominantly used for public drinking water supply (Gnangara Sustainability Strategy Taskforce 2009).

3.6.2 Public drinking water source areas

The protection of public drinking water supplies, including drinking water reservoirs and borefields, is achieved through the proclamation of water reserves, catchment areas and underground water pollution control areas as public drinking water source areas (PDWSA) under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.

There are two underground water pollution control areas (Gnangara Groundwater System and Perth Coastal Groundwater System) within the City (Figure 20).

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 20 - Public Drinking Water Supply Areas (Groundwater Only)



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Groundwater is drawn from the Superficial, Leederville and Yarragadee Aquifers within the Gnangara Groundwater System to supply the Water Corporation's integrated water supply scheme for the Perth Metropolitan Area. The Gnangara underground water pollution control area consists of areas identified as Priority 1, Priority 2 or Priority 3 based on land use management criteria which are detailed in the *Gnangara Land Use and Water Management Strategy* (WAPC 2001).

Draft *State Planning Policy 2.6: Planning for Water* (and State Planning Policy 2.7: Public Drinking Water Source Policy) notes that the protection of public drinking water source areas and other sources of public drinking water should not be compromised. There is a presumption against development or land uses that pose an increased risk to public drinking water source areas. Land use planning decision making is to be consistent with DWER *Water Quality Protection Note No.25: Land use compatibility tables for public drinking water source areas*. Proposals inconsistent with this document should not be supported (WAPC, 2021).

The Policy also requires local planning schemes to:

- include Priority 1 areas within the Water Catchment reservation;
- include Priority 2 areas within the 'Rural-Water Protection' zone (or equivalent); and
- identify Priority 3 and Priority 3* areas as Special Control Area (or equivalent)

in the local planning scheme.

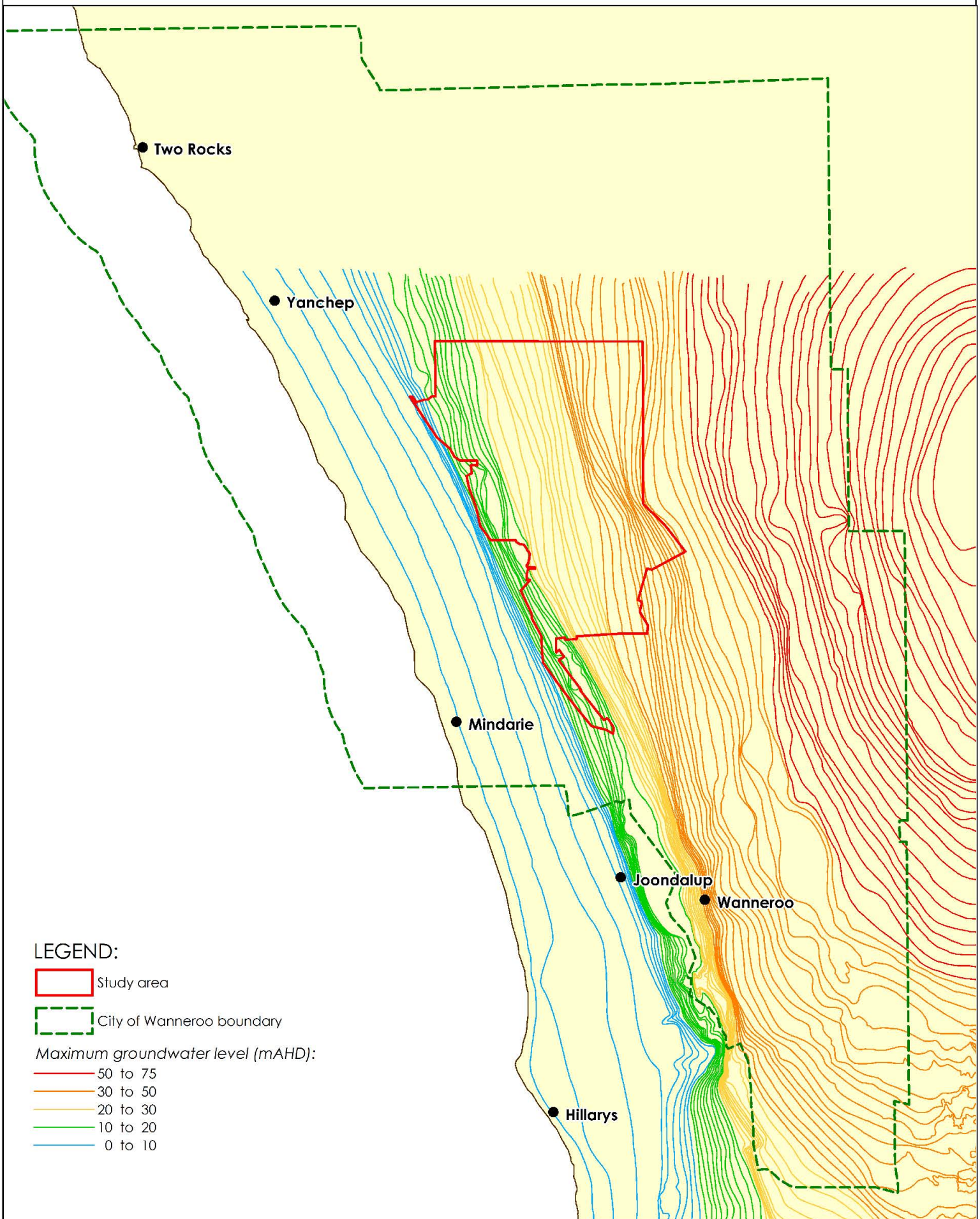
All Priority 1 and Priority 2 drinking water source areas within the City's boundary are reserved for Parks and Recreation or State Forest, and this, together with State Planning Policy 2.9 (and 2.7), is considered to provide adequate land use control to protect the groundwater resource. However, large areas of the Priority 3 PDWSAs are located within urban, residential and commercial zones. It is recommended that some awareness of the additional requirements for development in these areas as outlined in with DWER *Water Quality Protection Note No.25: Land use compatibility tables for public drinking water source areas* are incorporated into the local planning strategy and scheme via a special control area.

3.6.3 Groundwater levels and drainage

Department of Water and Environmental Regulation contour data for groundwater levels in superficial aquifers throughout the City are presented in Figure 21. This information includes contours derived from maximum recorded groundwater levels in the Perth groundwater atlas (DoW 2003). Levels vary seasonally and over time. Site specific data, including average levels by year, is available from the Department of Water and Environmental Regulation's Water Information Reporting (WIR) portal (http://wir.water.wa.gov.au).

While the contours do not extend to the northern border of the City, groundwater levels increase in depth from the coast to the scarp but it is generally deep (greater than 10m metres from the natural ground surface) over much of the City. It should be noted that water levels in the Superficial aquifer have generally been in decline for the past 40 years because of decreasing rainfall, continued use of groundwater, and pine plantations limiting recharge. The largest declines of about 10 metres are in the northern and central part of the Gnangara plan area (the City of Wanneroo). The decline in water levels represents the loss of more than 1,000 GL of storage from the Superficial aquifer since 1980 (DWER, 2022c).

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 21 - Groundwater Levels



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Due to the depth to groundwater and sandy soils (which have high permeability and infiltration capacity), drainage is generally not a major issue in the City. However, recent work undertaken by the Department of Water and Environmental Regulation to support the East Wanneroo District Structure Plan (DSP) utilising the Perth Regional Aquifer Modelling System (PRAMS) is a regional scale groundwater model suggests that groundwater levels are predicted to rise with development (Urbaqua, 2021). Of particular note is the prediction that "with no intervention, there will be larger areas where groundwater levels are within 2m of the natural surface and increased inundation of lakes and wetlands following development of stage 1 becoming even more extensive in the longer term following full development of the DSP area" (Urbaqua, 2021).

3.6.4 Groundwater quality

Groundwater quality varies according to geology and position within the groundwater flow system relative to recharge and discharge. Factors such as land use, groundwater abstraction and climate can also affect the quality of groundwater (DoW 2009).

Salinity

Since 1995 the salinity of the groundwater of the Gnangara groundwater system has generally remained constant. The lowest salinity groundwater is found on the crest of the mound where it is derived from rainfall. Within the City, salinity generally increases with depth. In clay areas, particularly along Ellen Brook, the groundwater is relatively more saline. Salinity has also increased down-gradient of lakes and wetlands due to the evaporative concentration of salts (DoW 2009) as shown in the following statistics:

- Groundwater in the Superficial Aquifer ranges from fresh to marginal, with the lowest salinity levels found near the crests of the mound (< 250 mg/L TDS) but can be up to 1000 mg/L TDS
- Groundwater in the Mirrabooka Aquifer is fresh at less than 350 mg/L TDS
- Groundwater in the Leederville Aquifer ranges from fresh to saline, with > 3000 mg/L TDS at depth in some parts of the system
- Groundwater in the Yarragadee aquifer ranges from fresh to saline, with > 3000 mg/L TDS along the eastern margin

Salinity in the Perth Coastal groundwater system increases closer to the coast, due to the presence of a salt wedge and fresh groundwater interaction with ocean waters. Rising salinity has been recorded adjacent to the coast in Yanchep and Quinns (DWER, 2022b).

Nutrients

In natural systems, levels of nutrients such as nitrate and phosphorous are generally very low (< 1 mg/L and 0.2 mg/L respectively). Elevated levels of nutrients have the potential to adversely affect the quality of wetlands and waterways and may cause health problems in livestock and humans.

In the 1980's nitrate concentrations were generally no greater than 1 mg/L across much of the Gnangara Mound but levels frequently exceeded 20 mg/L in the more urbanised areas closest to Perth. Elevated concentrations of nitrate above 1 mg/L across the mound are now more widespread (DoW 2009). Nitrogen levels as nitrate plus nitrite measured in groundwater across the Perth Coastal system between 2002-2007 averaged 0.89-2.3 mg/L (DoW 2012b).

Phosphorous levels in the 1980's were also generally low (< 0.1 mg/L). Today, phosphorous concentrations in the Superficial Aquifer have increased, particularly in horticultural areas

where levels are generally greater than 0.5 mg/L and are as high as 6 mg/L. The application of fertilisers in these areas is the likely cause (DoW 2009).

Groundwater acidification

The most widely known cause of acidification is acid sulfate soils. Discharge of acidic water into waterways and wetlands can cause fish kills and loss of aquatic biodiversity, and may contaminate groundwater with acid, metals and other pollutants that are toxic to humans and other biota (DoW 2009).

On the Gnangara Mound, groundwater pH ranges from < 4 around acid sulfate soil bearing wetlands that dry during the summer months, to between 4 and 6 in groundwater in Bassendean Sand (DoW 2009) pH measured in groundwater In the Perth Coastal system, between 2002-2007 averaged between 6.9 and 7.64 (DoW, 2012). Acid sulphate soils are not considered to be a management issue in the western two thirds of the City but should be considered in proximity to any wetlands and the Gnangara Mound.

3.6.5 Groundwater use

Groundwater management areas

Groundwater availability reporting and licensing is based on groundwater management areas and subareas which have been defined by the Department of Water and Environmental Regulation on the basis of natural catchment boundaries in some cases and administrative boundaries in others. The City contains, either wholly or partially, a total of five groundwater management areas proclaimed under the *Rights in Water and Irrigation Act 1914*. It is illegal to take water from a groundwater aquifer in a proclaimed area without a licence.

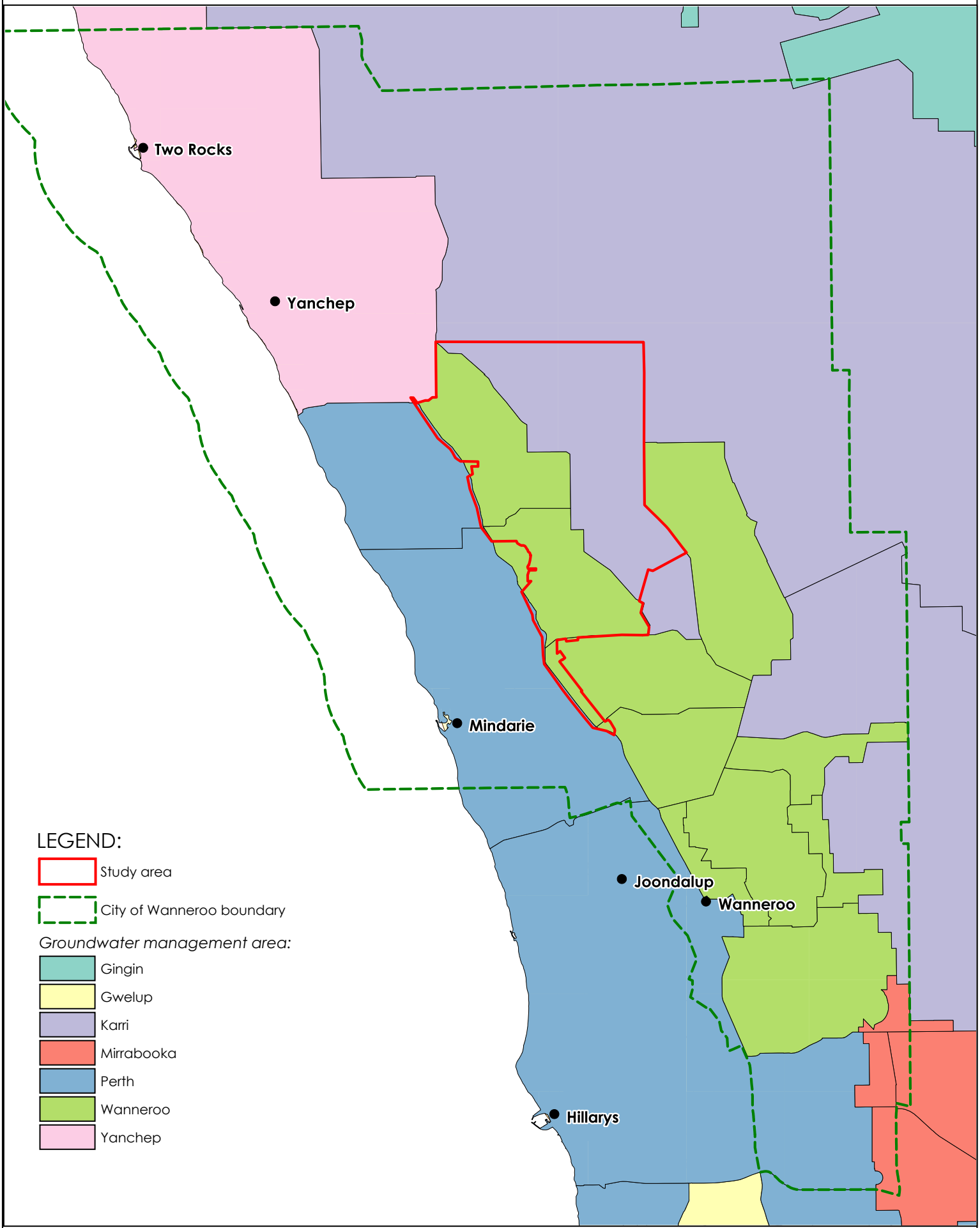
The proclaimed groundwater management areas located in the City (Figure 22) are:

- Gnangara;
- Perth;
- Yanchep;
- Wanneroo;
- Mirrabooka.

The Department of Water and Environmental Regulation undertakes groundwater allocation planning for groundwater management areas to determine how much water is available from a particular resource or area, how much water needs to be left in the system and what conditions will be applied to licences in the local area.

The *Gnangara groundwater allocation plan* (DWER, 2022a) provides a summary of existing water use from the groundwater system (Figure 23). It can be seen that agriculture, public open space, licenced industry and commercial uses and household bores (self-supplying groundwater), account for 60% of groundwater use. The remaining 40% is for public drinking water (DWER, 2022a). This accounts for approximately a third of the total supply of water to the Water Corporation's integrated water supply system as well as contributing to the Goldfields and Agricultural water supply scheme via Mundaring Weir (Water Corporation website, 2023). The Department also estimates that under the current growth rate, domestic garden bore use would increase from 36 GL/year in 2019–20 to about 43 GL/year by 2030 (DWER, 2022a).

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Figure 22 - Groundwater management areas



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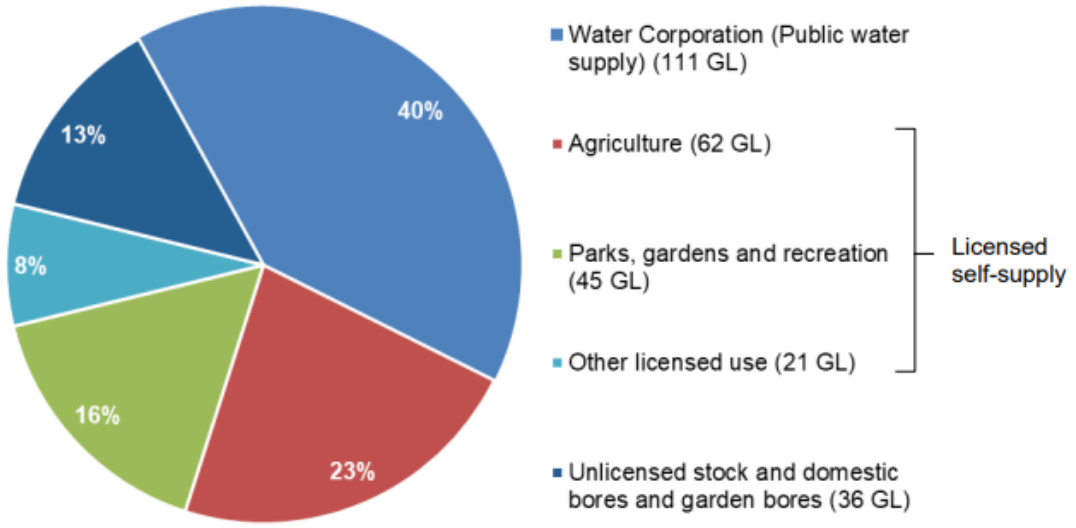


Figure 23: Proportion of water abstracted in 2019–20 for different water uses from all aquifers in the Gnangara groundwater system (DWER, 2022a).

Groundwater availability

Information from the Department of Water and Environmental Regulation demonstrates a general lack of available groundwater resources, with only two of the 19 superficial groundwater sub-areas showing that some allocatable groundwater remains in early 2023 (Figure 24 and Table 3). This is reflective of the recently released *Gnangara groundwater allocation plan* which aims to protect the Gnangara groundwater system from further impacts and rebalance groundwater abstraction to account for reduced rainfall and recharge projected under climate change (DWER, 2022a).

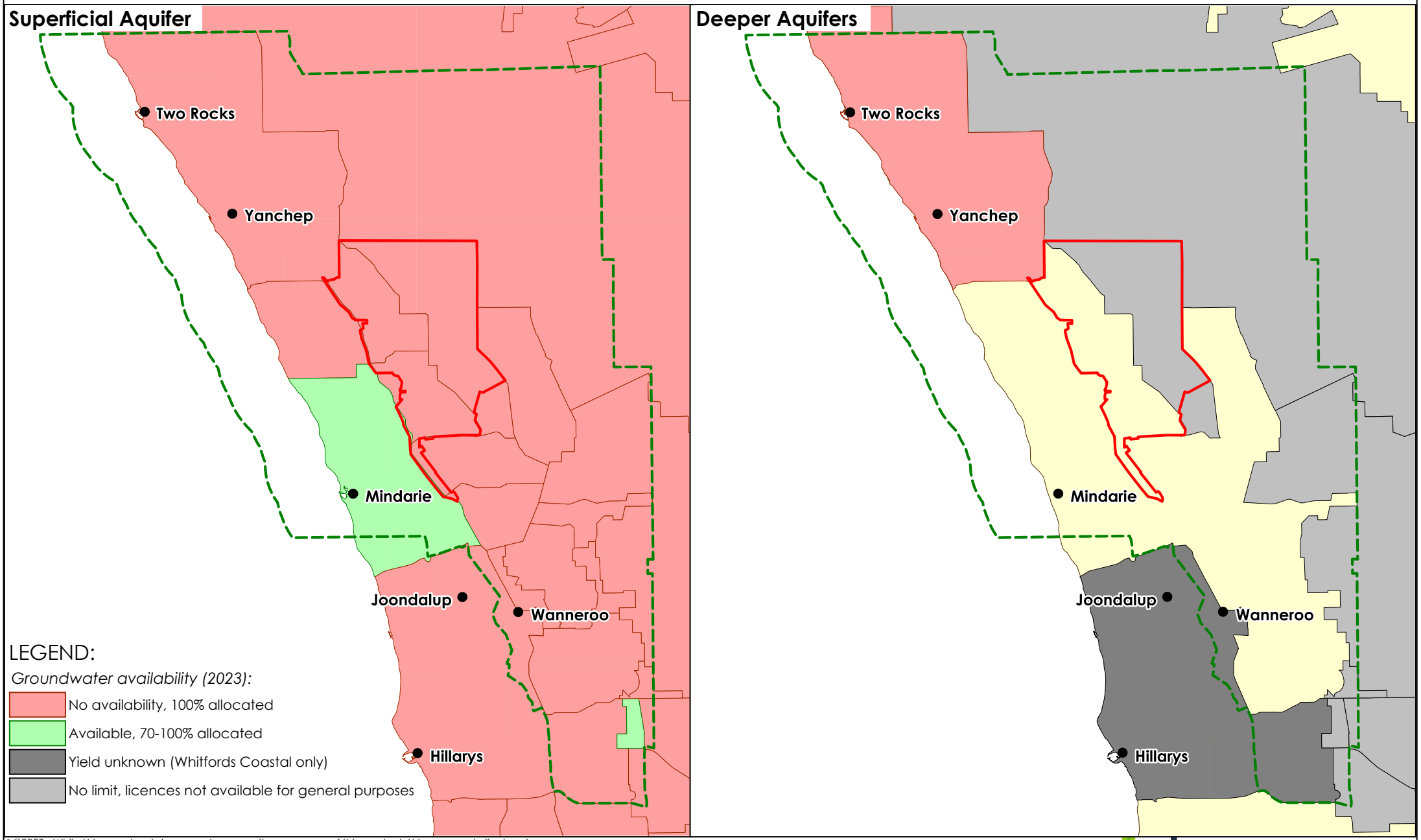
Table 3: Groundwater resource and allocation limits (Feb 2023)

Management Area	Management Sub Area	Resource	Allocation Limit	Allocated Volume	Remaining Volume	% Allocated and Committed
Superficial resource						
Gnangara	Reserve	Gnangara, Reserve, Perth - Superficial Swan	1,417,000	1,573,536	-156,536	111.05%
Gnangara	Wanneroo Wellfield	Gnangara, Wanneroo Wellfield, Perth - Superficial Swan	1,919,000	2,178,200	-259,200	113.51%
Mirrabooka	Ballajura	Mirrabooka, Ballajura, Perth - Superficial Swan	783,000	1,356,583	-593,083	173.25%
Mirrabooka	Improvement Plan 8	Mirrabooka, Improvement Plan 8, Perth - Superficial Swan	73,000	193,060	-128,950	264.47%
Mirrabooka	Landsdale	Mirrabooka, Landsdale, Perth - Superficial Swan	450,000	342,051	107,260	76.01%
Mirrabooka	Plantation	Mirrabooka, Plantation, Perth - Superficial Swan	333,000	322,135	-25,735	96.74%
Perth	Eglinton	Perth, Eglinton, Perth - Superficial Swan	823,000	2,247,820	-1,474,820	279.20%
Perth	Quinns	Perth, Quinns, Perth - Superficial Swan	2,414,000	2,233,593	179,407	92.53%

Management Area	Management Sub Area	Resource	Allocation Limit	Allocated Volume	Remaining Volume	% Allocated and Committed
Perth	Whitfords	Perth, Whitfords, Perth - Superficial Swan	7,918,000	12,849,280	-4,954,280	162.28%
Wanneroo	Adams	Wanneroo, Adams, Perth - Superficial Swan	996,000	1,002,693	-22,193	100.67%
Wanneroo	Carabooda	Wanneroo, Carabooda, Perth - Superficial Swan	7,207,000	8,001,060	-817,905	111.02%
Wanneroo	Carramar	Wanneroo, Carramar, Perth - Superficial Swan	1,349,000	1,598,560	-249,560	118.50%
Wanneroo	Jandabup	Wanneroo, Jandabup, Perth - Superficial Swan	178,000	178,470	-470	100.26%
Wanneroo	Joondalup	Wanneroo, Joondalup, Perth - Superficial Swan	338,000	726,590	-428,090	214.97%
Wanneroo	Lake Gnangara	Wanneroo, Lake Gnangara, Perth - Superficial Swan	1,874,000	6,303,647	-4,482,152	336.37%
Wanneroo	Mariginiup	Wanneroo, Mariginiup, Perth - Superficial Swan	842,000	4,024,020	-3,183,020	477.91%
Wanneroo	Neerabup	Wanneroo, Neerabup, Perth - Superficial Swan	2,273,000	2,473,155	-206,830	108.81%
Wanneroo	Nowergup	Wanneroo, Nowergup, Perth - Superficial Swan	2,483,000	2,735,490	-252,490	110.17%
Wanneroo	Pinjar	Wanneroo, Pinjar, Perth - Superficial Swan	500,000	578,575	-78,575	115.72%
Other than superficial resource						
Gnangara	Reserve	Gnangara, Reserve, Perth - Mirrabooka	0	0	0	0.00%
Gnangara	Wanneroo Wellfield	Gnangara, Wanneroo Wellfield, Perth - Mirrabooka	0	0	0	0.00%
Perth	Whitfords	Perth, Whitfords, Coastal Saline		473,000	0	0.00%
Perth	Perth North Confined	Perth, Perth North Confined, Perth - Yarragadee North.	80,000	80,000	0	100.00%
Perth	Perth North Confined	Perth, Perth North Confined, Perth - Leederville.	1,245,000	1,532,220	-287,220	123.07%
Mirrabooka	Plantation	Mirrabooka, Plantation, Perth - Mirrabooka	0	0	0	0.00%
Mirrabooka	Landsdale	Mirrabooka, Landsdale, Perth - Mirrabooka	0	0	0	0.00%
Mirrabooka	Improvement Plan 8	Mirrabooka, Improvement Plan 8, Perth - Mirrabooka	0	0	0	0.00%
Mirrabooka	Ballajura	Mirrabooka, Ballajura, Perth - Mirrabooka	0	0	0	0.00%
Yanchep	Yanchep Confined	Yanchep, Yanchep Confined, Perth - Leederville.	288,000	320,000	-32,000	111.11%
Yanchep	Yanchep Confined	Yanchep, Yanchep Confined, Perth - Yarragadee North.	0	0	0	0.00%

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Figure 24: Groundwater Availability (2023 Snapshot)



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The *Gnangara groundwater allocation plan* proposes that most licensed groundwater users will be subject to a 10 per cent reduction from 2028, although the reduction for public water supply will be 27 per cent. In addition, the sprinkler roster for domestic garden bore use in the Perth/Mandurah area will be aligned with the two-days-a-week sprinkler roster for scheme water users. It is noted that there will be no reductions to groundwater entitlements used to irrigate school and hospital grounds, for the irrigation of plants or trees for commercial purposes at established nurseries and tree farms, or for a small number of other specified purposes and locations (DWER, 2022a).

In order to support commercial horticultural businesses to meet the requirements of the *Gnangara groundwater allocation plan,* the State Government has initiated the Gnangara horticulture water use efficiency grants program. This program provides a total of $1.5million in matching funding for approved water use efficiency and/or soil amelioration measures. It will close on 30 June 2024, or when funds are fully committed.

The City is working to increase the efficiency of the use of its allocated groundwater resources and has implemented a number of hydrozoning projects and public open space revitalisations. Accordingly, groundwater user by the City is being maintained below the licenced volumes (Table 4). This will assist the City to prepare for the 10% reduction indicated in the *Gnangara groundwater allocation plan*.

Table 4: Licenced groundwater volumes and actual use volumes by the City of Wanneroo

Licence Number	Current Licenced allocation	2018/2019 use	2019/2020 use	2020/2021 use	2021/2022 use
159955	67,125	63,779	60,825	57,385	62,170
181045	63,388	10,741	34,975	36,548	36,655
160004	1,081,010	1,004,863	950,799	1,070,756	1,073,430
159997	1,566,155	1,557,510	1,521,461	1,434,861	1,499,050
159959	596,825	456,655	446,584	420,266	402,469
154060	92,100	77,961	68,263	44,211	52,157
159991	350,045	284,164	246,615	225,082	233,182
159958	119,925	71,515	67,909	72,554	117,604
159963	368,190	190,283	214,348	313,787	350,999
203409*	127,516	NA	NA	110,694	99,557
Total	**4,432,279**	**3,717,471**	**3,611,779**	**3,786,144**	**3,927,273**

In recognition of the limited available groundwater in the City, the Department of Water and Environmental Regulation developed the *North west corridor water supply strategy* (DoW, 2014) to ensure the orderly and equitable allocation of shallow groundwater resources to developers and future licensees (primarily the City of Wanneroo) in the corridor. The strategy arranges for sufficient water to support the creation of playing fields and public open spaces for community sport and recreation.

The strategy uses a schedule to set a volume of water that individual developers will be able to access from the Quinns, Eglinton and Yanchep groundwater subareas to meet all essential public open space requirements (DWER, 2014). The schedule also applies a reduced irrigation rate of 6750 kL/ha/yr (as compared to 7500kL/ha/yr) based on hydrozoning principles and waterwise landscaping. Implementation of the the *North west corridor water supply strategy* is undertaken by the the Department of Water and Environmental Regulation together with the

City as part of the planning approvals process and developers are required to consult both agencies to identify appropriate allocation volumes that will be available.

It is also noted that land use change in the East Wanneroo area may also free up water availability in the Wanneroo Management area, Joondalup, Mariginiup, Lake Gnangara, Adams and Jandabup sub-areas as agricultural activities cease. The volume allocated to agriculture in these areas as reported in *the East Wanneroo District Water Management Strategy* is 12,259,332kL (Urbaqua, 2021). It is also noted that cessation of the use of this groundwater may also impact on groundwater levels (i.e. increase them). Consideration is currently being given to proposals to utilise this water in North Wanneroo to support continued food production and local food security; however, it is recognised that this would likely require a pipeline to convey the water between groundwater management sub-areas.

3.6.6 Issues for planning, land use change and development

Key groundwater resource considerations for strategic planning are:

- **Public Drinking Water Source Areas** – are critical for the continued supply of drinking water for the State and should be protected and managed in accordance with *State Planning Policy 2.9: Planning for Water* (and SPP 2.7: Public Drinking Water Source Areas). Accordingly, it is recommended that a special control area is created in the scheme to protect the drinking water resource with acknowledgement of the relevant policy measures and recommendations included in the Local Planning Strategy.
  Shallow groundwater – Development in areas of shallow groundwater is often associated with the need for imported fill. This, however, often impacts on the ability to retain mature trees and landform. It is recommended that the City supports the application of the IPWEA *Specification: Separation distances for groundwater controlled urban development* (IPWEA, 2016) to minimise the need for imported fill and facilitate tree retention. Development may also require temporary dewatering. Consideration should be given to the quality and management of discharge waters including acid sulfate soils.
- **Groundwater availability** – Limited available allocation remains in all aquifers. Declining rainfall is resulting in reduced recharge and reductions in licenced allocation amounts by the Department of Water and Environmental Regulation will occur in future. This may influence decisions on future industrial or agricultural activities that require water as well as impact the ability of the City to irrigate its areas of public space.

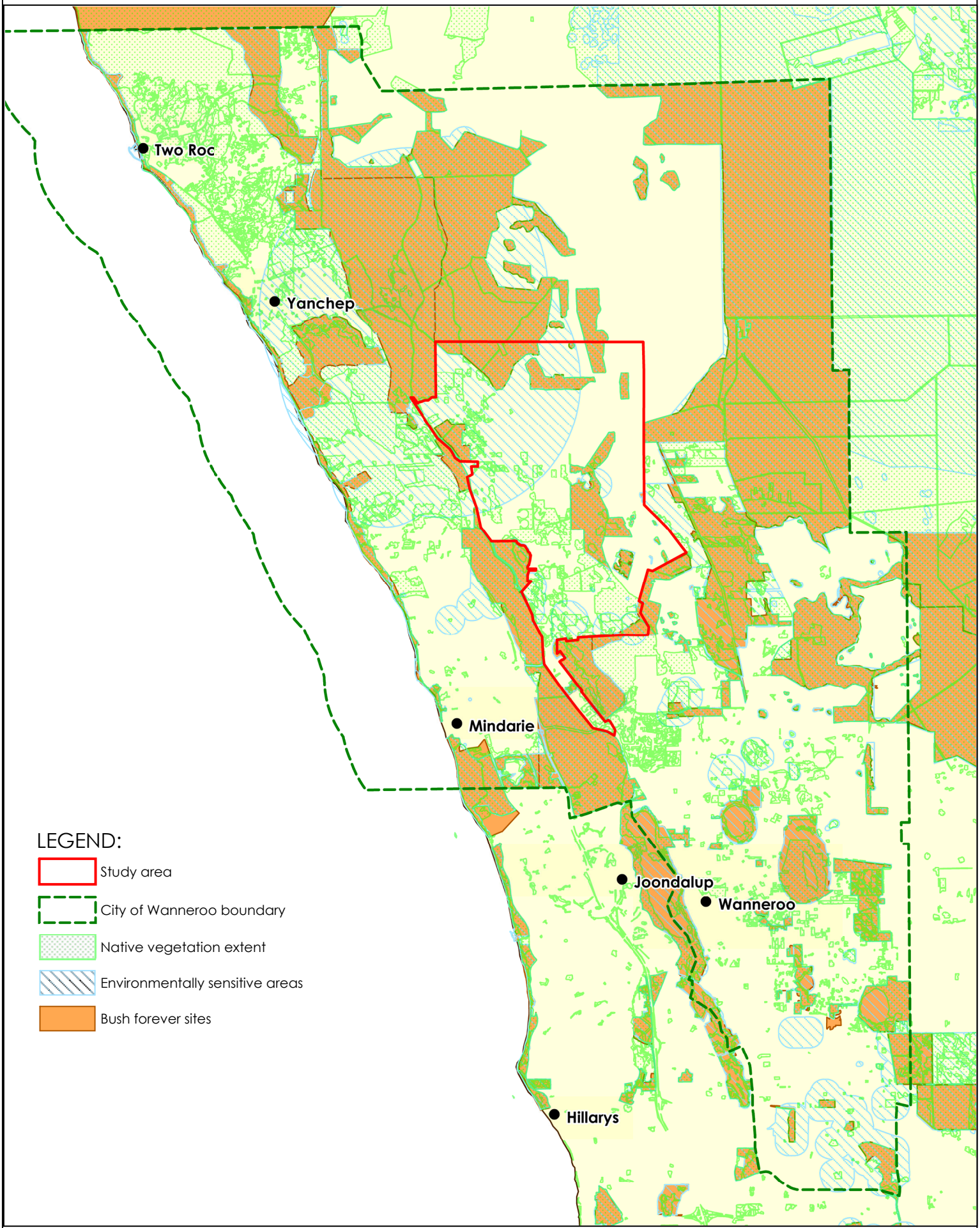
3.7 Flora and Fauna

3.7.1 Regionally significant bushland - Bush Forever sites

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

Bush Forever aims to protect at least 10% of the 26 original vegetation complexes within the Swan Coastal Plain section of metropolitan Perth, and to conserve threatened ecological communities. Four Bush Forever sites are present in the City of Wanneroo (Figure 25). (City of Wanneroo, Coastal Management Plan 2021):

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 25 - Vegetation



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- Bush Forever Site 289
  - Is referred to as Ningana Bushland Yanchep / Eglinton. It is 551.5ha and encompasses both Spearwood Dunes with associated Cottesloe North vegetation complex and Quindalup Dunes and associated Quindalup vegetation complex. More than 60% of the Site is in Excellent to Very Good condition.
  - Vegetation types within the site include:
    - *Eucalyptus gomphocephala* open woodland to woodland
    - *Banksia attenuata* woodlands
    - Open to low closed heaths of *Melaleuca systena* and *Acacia* species over herblands
    - Closed low heaths to shrubland of *Olearia axillaris – Scaevola crassifolia* shrublands

- Bush Forever Site 322
  - Is referred to as Burns Beach Bushland and is 407.9 ha. It encompasses both Spearwood Dunes with associated Central/South Cottesloe vegetation complex and Quindalup Dunes with Safety Bay sands and associated Quindalup vegetation complex. More than 70% of the Site is in Excellent to Pristine condition.
  - Vegetation types within the site include:
    - *Banksia attenuata – Eucalyptus* woodlands
    - *Acacia rostellifera – Melaleuca systena* shrublands
    - *Olearia axillaris – Scaevola crassifolia* shrublands
    - *Spinifex longifolius* grasslands and low shrubland.

- Bush Forever Site 323
  - Is a link from Burns Beach Bushland to Neerabup National Park and is 106.1 ha. It encompasses Spearwood Dunes with Tamala Limestone sands and Quindalup Dunes with Safety Bay sands. Vegetation complexes are Cottesloe Central and South vegetation complex and Quindalup vegetation complex. Less than 30% of the Site is in Good to Very Good Condition.
  - Vegetation types within the site include:
    - Northern Spearwood shrublands and woodlands
    - Spearwood *Banksia attenuate* or *Banksia attenuata – Eucalyptus* woodlands
    - *Acacia* shrublands on taller dunes

- •Bush Forever Site 397
  - Is the Coastal Strip from Wilbinga to Mindarie, and is 404.7ha in area. Floristically it is similar to Burns Beach Bushland, consisting of Spearwood Dunes with Tamala Limestone sands under Cottesloe Central and South vegetation complex, and Quindalup Dunes with Safety Bay sand under the Quindalup vegetation complex. There is a sumpland within the site that is the only one in the Quindalup Dunes north of Perth in the Perth Metropolitan Region.
  - Vegetation types within the Site include:
    - *Acacia rostellifera – Melaleuca systena* shrublands
    - *Olearia axillaris – Scaevola crassifolia* shrublands
    - *Spinifex longifolius* grasslands
    - Low shrubland.
    - *Frankenia pauciflora* low shrubland on Tamala Limestone Cliffs (seasonal wetland)

3.7.2 Threatened Ecological Communities

There are threatened ecological communities within the City. These communities are all water dependent and whilst their recognition and protection of their locations through the land-use planning system may prevent them from being physically disturbed they remain vulnerable to hydrological impacts. The communities currently listed by the Commonwealth Department of the Environment and Energy *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level by the Department of Biodiversity, Conservation and Attractions and endorsed by the Minister for the Environment are shown in Table 5.

Table 5: Significant Ecological Communities in the City of Wanneroo (Local Biodiversity Plan 2018/19 - 2023/24)

Ecological Community	Protection status under the EPBC Act	Protection status under the WC Act
Threatened Ecological Community		
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	Critically endangered
Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	Endangered	
Banksia Woodlands of the Swan Coastal Plain	Endangered	Priority 3
Shrublands on dry clay flats	Critically endangered	Endangered

3.7.3 Threatened and priority species

The City lies within the South West Biodiversity hotspot and contains a large number of threatened and priority flora and fauna species including the endangered Carnaby's Black Cockatoo and other numerous Commonwealth and State listed threatened and priority species. As these species are listed in the City's *Local Biodiversity Plan 2018/19 - 2023/24* and Coastal Management Plan, it is considered not necessary to replicate them here, although Table 6 and Table 7 show the number of different priority species. The Muchea Bell (*Darwinia foetida*) is the only critically endangered species listed in the City, a plant likely to occur in the area.

Table 6: Threatened flora and fauna in the City of Wanneroo

Fauna - Critically endangered	Fauna - Endangered	Fauna - Vulnerable	Flora - Critically endangered	Flora - Endangered	Flora - Vulnerable
-	11	24	1	13	4

Table 7: Threatened and priority flora and fauna in the City on Wanneroo

Rare or likely to become extinct	Protected under international agreement	Other specially protected fauna	Flora Priority 1	Flora Priority 2	Flora Priority 3	Flora Priority 4	Flora Priority 5
27	21	4	5	15	22	13	0

3.7.4 Native vegetation

The City's *Local Environmental Strategy* (2019) recognises that there are large areas of remnant vegetation within the City of Wanneroo that are contained within land zoned for Urban Development. While there is no existing mechanism for protection of this vegetation (outside of Bush Forever Areas) it is possible that some areas will be protected through the creation of conservation reserves consistent with the City's *Local Planning Policy 1.1: Conservation Reserves* (2021).

In addition, the City's *Local Biodiversity Plan 2018-19* identifies Local Natural Areas and recommends the creation of regional and local ecological linkages to protect biodiversity and enhance the ability for migration of animals and plants. The protection of these areas as part of the land use planning approvals process is also recommended in the City's *Local Planning Policy 1.1: Conservation Reserves* (2021).

3.7.5 Tree preservation

Canopy coverage across the City of Wanneroo (not including the State Forest) is very low, with some new suburbs having coverage of less than 1% (Water Sensitive Cities Benchmarking and Assessment: City of Wanneroo, 2021).

The City's Tree Preservation Policy (LPP 4.8, 2006) provides a mechanism to protect significant trees of the City within vacant land and bushland which will be subject to future development and existing and proposed public open space reserves. It notes that the loss of trees is becoming an increasing community concern, and there are increasing expectations from the community that the City will preserve and enhance the amenity of their localities by addressing this issue.

The City finalised its Urban Forest Strategy in 2022 and is planting 3,500 street trees per year, with portion of this being at the request of residents. It is noted, however, that there is a general lack of support for street trees from the wider community. The City's street tree policy requires one tree per lot in new developments but there is a lack of awareness of when the trees are planted and the trees are often removed or not looked after and die. Narrow verge widths are also an impediment to the provision of tree-canopy (Shepherd & McGrath, 2021).

3.7.6 Nuisance species

Mosquitos

Mosquito populations are a health and amenity concern for existing communities in the City due to the spread of mosquito-borne diseases such as Ross River Virus. Development can result in changes that improve environmental conditions for mosquitos leading to increased mosquito populations and greater prevalence of Ross River Virus and other diseases.

Mosquitos and their larvae are tolerant of a wider range of environmental conditions than the native predators that feed on them. They can adapt to the presence of large amounts of algae as well as wide ranges of pH, sometimes actively seeking out acidic waterbodies for breeding (URS 2008).

Chironomid Midges

Nuisance midges are generally found in large numbers in disturbed wetlands with elevated nutrient levels. The high availability of nutrients fuels the growth of green and blue-green algae which often form blooms in spring and summer. After a period of time these blooms will

collapse and the algae will sink to the bed of the wetland where they provide a rich food source for the larval midges living in the sediments. As the midges have a short life cycle (about three weeks under optimum conditions) they can take advantage of the algal blooms and quickly build up to very large numbers. During such blooms natural predation on midge larvae decreases as many predatory species rely on sight and dense algal blooms limit visibility. Other factors contributing to low predator density include the effects of pollutants, low oxygen levels and reduced habitat diversity associated with the loss of aquatic vegetation (Pinder *et al*. 1992).

Algal blooms

Algal blooms consist of large growths of phytoplankton such as green algae, diatoms or Cyanobacteria. In urban areas, algal blooms commonly occur in wetlands that are surrounded by development and receive stormwater via drains. In rural areas, they may occur in wetlands that are surrounded by intensive agriculture. Some species of Cyanobacteria are toxic to birds, wildlife and humans (for example *Nodularia, Anabaena* and *Microcystis*). Following the collapse of a bloom, algae accumulate in wetland sediments. Bacteria and fungi then break down the dead algae, consuming large quantities of oxygen in the process. Low dissolved oxygen concentrations in the water column may then cause the death of fish and invertebrates (URS 2008).

Anaerobic conditions also encourage the growth of the bacterium *Clostridium botulinum* (botulism) which produces a toxin that causes paralysis and death in waterbirds. Depletion of oxygen can also trigger biochemical processes that release phosphorus normally bound to the sediments. This in turn may fuel further algal blooms in a self-perpetuating manner (URS 2008).

Weeds and feral animals

Weed species are often more vigorous and hardy than native plants and will often "out-compete" them for space light, nutrients and water. Aquatic weeds in particular can spread rapidly to form dense "mats" both above and below the water surface and can alter chemistry, reducing availability of dissolved oxygen needed by native aquatic flora and fauna.

Feral animals, similar to domestic livestock can cause depletion and degradation of native vegetation and lead to erosion of wetland and waterway banks. Whilst fencing can be used to effectively exclude domestic livestock this management practice is less effective for feral animals.

Both weeds and feral animals are a threat to wetlands and waterways, reducing biodiversity and altering water quality. These changes in turn can lead to increasing prevalence of problem mosquitos, chironomid midges and algal blooms.

Pathogens

Pathogens such as Phytophthora Dieback and Marri Canker can lead to the death of endemic vegetation through altering the structure and floristics of natural areas. Dieback is the most widely known pathogen of bushland in Western Australia and is suited to the Bassendean Sands of the Swan Coastal Plain. Dieback is understood to have been introduced to the City of Wanneroo through off road vehicles and is known to occur in bushland to the east of Lake Gnangara (City of Wanneroo, Local Biodiversity Plan 2018/19 – 2023/24).

3.7.7 Issues for planning, land use change and development

All species of flora and fauna are water dependent in some way. All require access to water and many have very specific requirements for water quantity and quality, as well as the frequency of access to the water they need.

Problem mosquitos, chironomid midges and algal blooms are all features of disturbed and degraded wetlands and waterways and their abundance may be increased through land use change and development as well as poor management practices. Appropriate management and restoration of watercourses and wetlands as well as water quality management, particularly pH and nutrients, in development areas is critical to preventing these impacts.

Key flora and fauna considerations for strategic planning are:

- **Protected species and communities** – should be addressed in accordance with the *Environment Protection Biodiversity Conservation Act 1999* and WA *Biodiversity Conservation Act, 2016*
- **Regionally significant (Bush Forever) areas** – are generally reserved for Parks and Recreation in both region and local planning schemes. Any future changes in land use and/or development that abuts these areas should be compatible with the protection of their significant conservation values.
- **Local Natural Areas and ecological linkages** – are not currently well-protected by the scheme, particularly as many of complexes on the Swan Coastal Plain portion of the City are under threshold levels. Ecological linkages are important to facilitate fauna movement and species adaptation to changing climate and conditions. While the need for protection of these areas is highlighted in the City's *Local Biodiversity Plan 2018-19* and *Local Planning Policy 1.1: Conservation Reserves* (2021), it is recommended that consideration be given to the establishment of a special control area to support implementation of these instruments.
- **Tree preservation and establishment** – is critical for the management of urban heat, restoration of ecosystems and the creation of urban amenity. While the street tree planting program is starting to address low canopy levels, additional effort should be made to retain remaining mature trees in development areas. This could be supported through greater recognition in the local planning strategy and the inclusion of a Tree Preservation clause in the scheme.

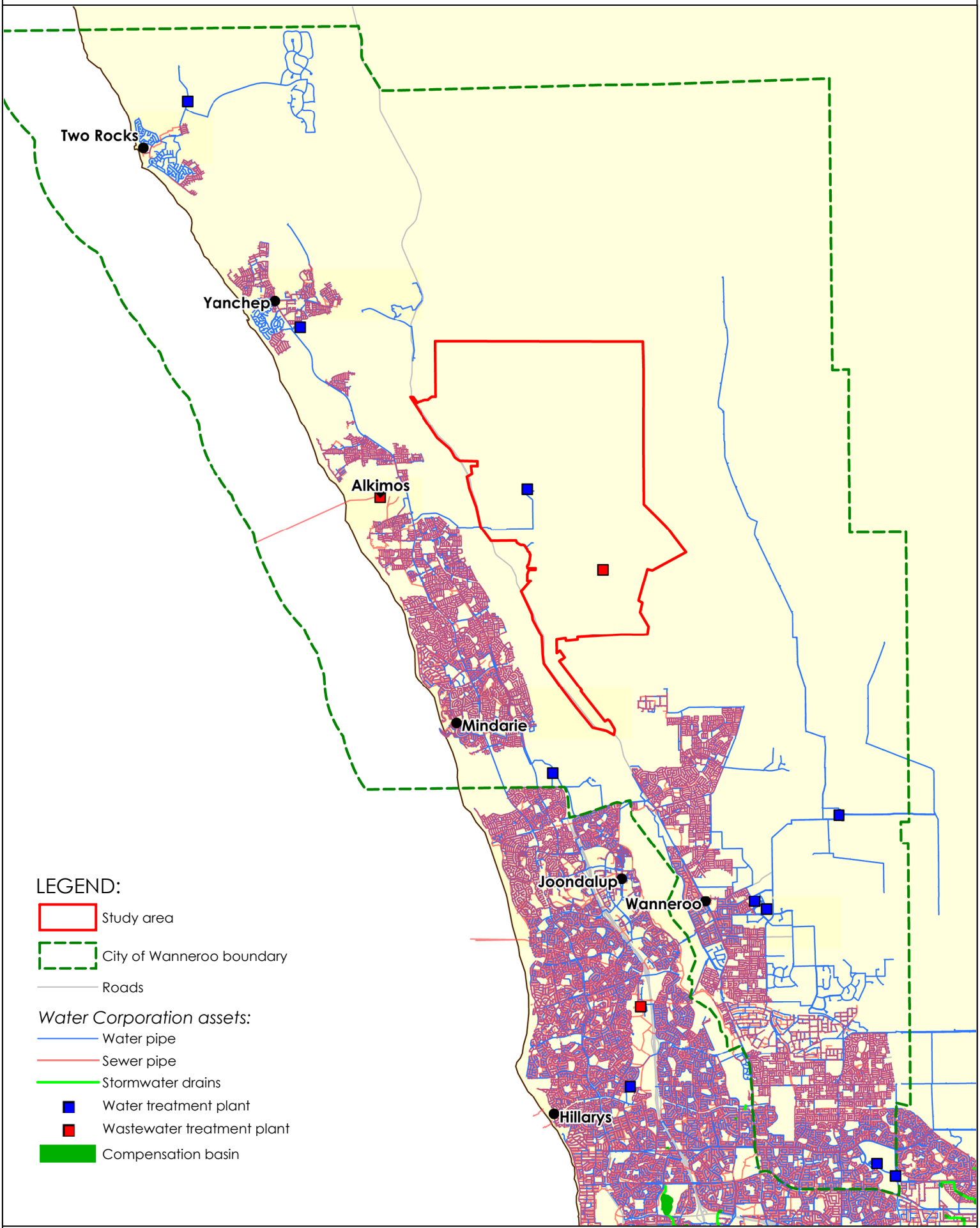
3.8 Water infrastructure

3.8.1 Drinking water

Water Corporation's water distribution infrastructure is present throughout the south west of the City, as well as in areas surrounding Two Rocks, Yanchep, Alkimos-Eglinton in southern and eastern rural areas (Figure 26). Wanneroo groundwater treatment plant, Neerabup groundwater treatment plant and Mirrabooka groundwater treatment plant are the major facilities in the City operating to supply potable water as part of the Integrated Water Supply Scheme. Rural areas of the City of Wanneroo, including Pinjar, Mariginiup, Nowergup, Neerabup, and Carabooda are currently unserviced.

The Water Corporation undertakes water services planning and allocates funds for infrastructure upgrades on the basis of land use planning information. Conceptual water supply planning includes the provision of sites for a future groundwater treatment plant to the immediate west of the Mitchell Freeway reserve in Alkimos, water storage for gravity supply in Nowergup and two sites for water treatment and storage to the east of Two Rocks (WAPC, 2018).

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 26 - Water Infrastructure



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A new desalination plant and associated infrastructure in Alkimos has been proposed within the Alkimos Water Precinct.

Where a development proposal requires drinking water headworks infrastructure, for which the Water Corporation has not allocated funds to suit the developer's schedule, prefunding of the works may be necessary.

There may be potential for alternative service providers to provide essential drinking water services within the City. Where this is proposed, a sufficient level of information is required to demonstrate technical feasibility as well as an understanding of regulatory requirements prior to region scheme amendment.

The second stage of the Groundwater Replenishment Scheme at the Beenyup facility is operational, with the capacity to recharge up to 28 billion litres of recycled water into groundwater supplies each year.

3.8.2 Wastewater

Wastewater from parts of the City sewered by the Water Corporation is collected, pumped to either; Beenyup wastewater treatment plant, located in the City of Joondalup, or Alkimos wastewater treatment plant, located in the City of Wanneroo. The locations of wastewater treatment plants within the City are shown in Figure 26.

It is noted that the two local plants at Yanchep and Two Rocks were graded out by pump stations that direct wastewater southwards to the Alkimos Wastewater Treatment Plant via a gravity main sewer (WAPC, 2018). This was commissioned in 2011 and expansions are now proposed. Construction is expected to start in 2023.

Substantial parts of the City are currently un-sewered including the majority of the north-eastern area of the City of Wanneroo, including the rural precincts of Pinjar, Gnangara, Mariginiup, Banksia Grove, Nowergup, Neerabup, Carramar and Carabooda. Septic tanks are still used in these rural areas of the City.

The *Government Sewerage Policy* (GSP, 2019) identifies requirements for wastewater treatment and disposal in unsewered areas consistent with *AS1547: Onsite domestic wastewater management*. There is also a need to recognise the special requirements in relation to sewage sensitive areas, as shown previously on Figure 16. It should be noted that the GSP has been absorbed into the revised *State Planning Policy 2.9 Planning for Water*, along with other water planning documents, however this is still in draft form. The final SPP 2.9 will replace the GSP (2019).

As previously stated, the Water Corporation undertakes water services planning and allocates funds for infrastructure upgrades on the basis of land use planning information. Prefunding of these works may therefore be required where a development proposal requires wastewater infrastructure which has not been planned for by the Water Corporation. The following wastewater infrastructure works are currently planned in the City:

- Alkimos wastewater treatment plant upgrade
- Connolly Drive wastewater main
- Clarkson and Neerabup wastewater pipeline
- Ellenbrook to Wangara wastewater pipeline

There may be potential for alternative service providers to provide essential wastewater services within the City. Where this is proposed, a sufficient level of information is required to demonstrate technical feasibility as well as an understanding of regulatory requirements prior to region scheme amendment

3.8.3 Non-drinking water

Groundwater

Groundwater use from private bores is widespread throughout the City. As previously discussed, there are substantial parts of the City where current groundwater use is unsustainable and there is insufficient groundwater available to meet likely future demands.

Rainwater

Rainwater use from private rainwater tanks is widespread throughout rural parts of Wanneroo and rainwater tanks are encouraged where appropriate for new residential developments, preferentially plumbed into toilets.

Wastewater recycling

Increased recycling of water that has traditionally been disposed of via wastewater treatment plants is a valuable climate independent source of supply. Currently in the Perth-Peel region, of the 133 GL of wastewater generated at wastewater treatment plants connected to ocean outfalls, only 32.8 GL is reused annually (across major wastewater treatment plants). Both of the Alkimos and Beenyup wastewater treatment plants are connected to ocean outfalls, and generated approximately 37 GL of wastewater in 2017, of which only 14 GL was recycled. This has now increased to 28 GL due to the commencement of Phase 2 of the Beenyup Groundwater Replenishment Scheme.

Increased recycling in the Perth-Peel region relies on collaboration between the state and local government, Water Corporation, industry, business and the community. Recycling treated wastewater could also provide significant environmental benefit through bolstering the groundwater system and the reduced discharge of treated wastewater into receiving environments including oceans and rivers. *Kep Katitjin – Gabi Kaadadjan – Waterwise Perth action plan 2* contains a goal to increase wastewater recycling from 21% in 2022 to 30% by 2030 (DWER, 2022d).

3.8.4 Drainage

There are very few extensive drainage networks within the City. This is partly due to the presence of national parks and reserves which do not require drainage infrastructure and the landscape being dominated by wetlands rather than waterways. The developed areas which require drainage facilities are located mostly in the southern and coastal areas of the City, which are comprised predominantly of sandy soils, leading to a prevalence of small street or precinct-scale drainage systems connected to steep-sided infiltration sumps. Newer development areas have substituted landscaped infiltration areas integrated into public open spaces and in some instances, existing sumps have been removed or modified to improve aesthetic and amenity outcomes. This is supported by the City's Local Planning Policy 4.4: Urban Water Management which requires implementation of water sensitive urban design principles and best management practices for all planning proposals and City operations.

3.8.5 Issues for planning, land use change and development

Key water servicing considerations for strategic planning are:

- **Water for irrigation of open space** – is critical to meet the recreational needs of the community, maintain amenity and address urban heat. The City will need to manage its use of groundwater in accordance with the *Gnangara groundwater allocation plan* (DWER, 2022a) and plan for future reductions is allocation. Developments must also carefully consider the design, function and amount of public and private open spaces provided for new urban areas in the context of maximised water efficiency.
- **Water recycling and reuse** - As water resources in the City become more constrained and as development continues in areas with limited or costly availability of traditional servicing arrangements there may be increasing opportunities for wastewater recycling schemes to become more viable. Guidance for approval requirements and technical information is provided in the *Guideline for the approval of non-drinking water systems in Western Australia: Urban developments* (DoW, 2013).
- **Water and wastewater supply planning** – is undertaken largely by the Water Corporation to meet strategic planning goals. This includes the proposed Alkimos Seawater Desalination Plant on Water Corporation land, next to the existing Alkimos Wastewater Treatment Plant, within the future Alkimos Water Precinct. Where development proceeds ahead of the Water Corporation's planning, alternative servicing solutions will be required.
- **Drainage** - Where no catchment scale arterial drainage planning exists, it will be the responsibility of proponents of development to ensure that the catchment scale hydrology is properly understood and managed appropriately and that the design and construction of drainage infrastructure is coordinated with neighbouring land owners and developers. In addition, the City should seek opportunities to retrofit of water sensitive urban design and removal or modification of sumps to improve amenity access to open space.

4 PLANNING CONTEXT

This water management study supports preparation of a Local Planning Strategy. Accordingly, the following planning context is provided to assist in provision of appropriate information on water management. The key areas of focus include:

- The current level of protection for water resources across the City
- Areas zoned for development but not yet developed
- New areas proposed for land use change
- Planning investigation areas in Perth and Peel @ 3.5 million

These are explained in more detail below.

4.1 Existing levels of protection for water resources

Current City of Wanneroo District Planning Scheme No 2 (DPS2) zoning is shown broadly on Figure 27. Zones and Reserves within the current DPS2 and Metropolitan Region Scheme (MRS) that may offer protection of water resources have been identified as the following:

- Regional Parks & Recreation
- State forest
- Environmental Conservation
- Public Open Space
- Landscape Enhancement
- Drainage & Waterways
- Rural (including Rural Residential and Rural Resource)

The above zones and reserves are shown on Figure 27 in shades of green/blue and have been referred to as "green zones" in the below sections.

It is noted that there has recently been a permanent change in land use, purpose and condition of land within the Gnangara, Pinjar and Yanchep pine plantations, which are located within State Forest 65. This change relates to planning for the Gnangara groundwater system and involves the progressive harvesting of the pine plantation without replanting and post-harvesting land management.

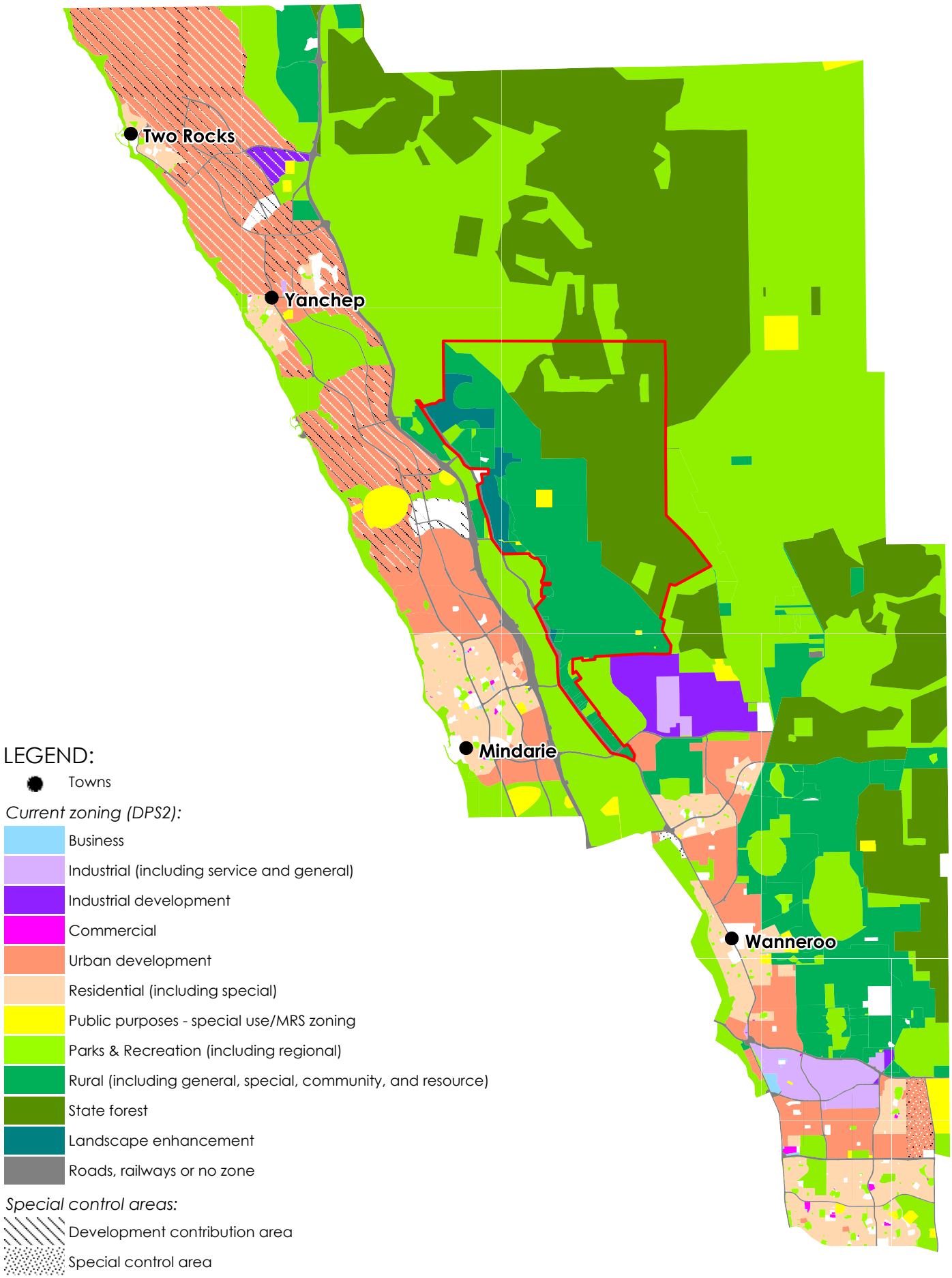
DPS2 also contains special control areas (SCA) 1a, 1b, 1c and 2, as well as development contribution areas (DCAs) 1 and 2. It is noted that DCA 1 & 2 and SCA 2 are unlikely to provide protection to water resources. SCA 1 may provide some protection, as its aim is to protect and enhance the environmental, heritage, and landscape values of the adjacent Yellagonga Regional Park.

Special control areas are also shown on Figure 27.

4.1.1 Priority local natural areas & Bush Forever Sites

Priority local natural areas are those that contain high conservation and ecological values. In the City, local natural areas are prioritised using a multi-criteria analysis based on a set of weighted ecological criteria including regional and local representation, rarity, proximity to wetland and coastal systems, and climate change. The Precinct contains significant local natural areas which range in priority, including Bush Forever sites. In general, Bush Forever areas are protected by "green" zones, however many local natural areas remain unprotected.

City of Wanneroo: Information to Support the CoW Local Planning Strategy
Figure 27 - Existing DPS2 Zoning



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4.1.2 Surface water features

In general, large conservation category and resource enhancement wetlands (CCW and REW) within the City boundary are protected by "green zones". Some small CCW and REWs are located within current DPS2 zones of "Public purposes /special use", "General industrial", "Private clubs and recreation", and "Urban development", which are unlikely to provide protection of the wetlands. These are summarised in Table 8 below.

Table 8: CCW and REWs not protected under current "green" DPS land use zones

Wetland UFI	Wetland type	Wetland Category (CCW and REW only)	Zoning
8136	Sumpland	Resource Enhancement	General industrial
15901	Dampland	Conservation	Private clubs and recreation
14476	Dampland	Conservation	Public purposes – Special use
13066	Dampland	Conservation	Public purposes – Special use
15258	Dampland	Conservation	Public purposes – Special use
8020	Sumpland	Resource Enhancement	Public purposes – Special use
8125	Dampland	Conservation	Urban development and SCA2
15312	Dampland	Resource Enhancement	Urban development and SCA2
13821	Sumpland	Resource Enhancement	Urban development

4.1.3 Public Drinking Water Source Areas

As stated previously, all Priority 1 and Priority 2 drinking water source areas within the CoW boundary are located within the "green" zones, consistent with their State Government ownership. Small portions of the Priority 3 PDWSAs are within parks and recreation areas, however the majority of these areas are located within urban, residential and commercial zones. There is no PDWSA SCA currently contained in DPS2, although this is a recommendation of *State Planning Policy 2.7: Public Drinking Water Source Areas* (2007).

It is recommended that a special control area is created in the new scheme to highlight the presence of Priority 3 and Priority 3* PDWSAs. This should require land use planning decision making to be consistent with DWER *Water Quality Protection Note No.25: Land use compatibility tables for public drinking water source areas* and DWER *Water Quality Protection Note 38: Priority 3* (P3*) areas* and the other relevant policy measures contained within draft *State Planning Policy 2.9: Planning for Water* and the *Planning for Water Guidelines*.

4.2 Areas zoned for development but currently undeveloped

Various precincts within the City have already been zoned for development and have an associated Local Water Management Strategy (LWMS). Some of these strategies were prepared before *State Planning Policy 2.9: Water Resources* (WAPC, 2006) and *Better Urban Water Management* (WAPC, 2008) was released, and are therefore outdated from a water management perspective. As such, these documents may require revision to be in line with requirements set out in the revised SPP 2.9, and the most recent CoW *Local Planning Policy for Urban Water Management* (LPP 4.4, adopted May 2020).

Consideration should also be given to the need to review and update any local water management strategy that is inconsistent with draft *State Planning Policy 2.9: Planning for*

Water and the *Planning for Water Guidelines.* As noted in the *Water Sensitive Cities Benchmarking and Assessment: City of Wanneroo* (Shepherd and McGrath, 2021), greenfield development for the last 10 years or so has been required to incorporate water sensitive urban design measures, primarily in the form of vegetated stormwater assets and multi-functional parks. While this has successfully integrated water management into the urban form, the ability to mitigate urban heat has been exacerbated by the current practice of completely clearing a site for urban development. It is therefore recommended that all new developments in the City are also required to demonstrate how they will mitigate urban heat impacts through establishment of green infrastructure and water sensitive urban design outcomes appropriate to the site and development context. This requirement is consistent with draft *State Planning Policy 2.9: Planning for Water* and the *Planning for Water Guidelines* (WAPC, 2021) which requires *proposals to "maximise opportunities for water in the landscape to enhance amenity, senses of place, liveability and contribute to urban greening and mitigation of urban heat."*

4.3 New areas proposed for land use change

A review of the current DSP2 against the draft local planning strategy map provided to Urbaqua in February 2023 suggests three areas where land use change is proposed:

- East Wanneroo – already rezoned in the Metropolitan Region Scheme and supported by the East Wanneroo District Structure Plan
- Eglinton East – rezoning from Landscape Enhancement to Service Commercial
- South Pinjar, Nowergup and Jandabup – rezoning from Rural to Industrial

Proposed zoning for the LPS is shown on Figure 29. Additional detail is provided in the following sections to describe the proposed changes and any implications for water resources

4.3.1 East Wanneroo

Land within East Wannerroo is proposed to change from General Rurual to Future Urban, approximately from the area of Gnangara to Mariginiup as shown in peach on Figure 28.

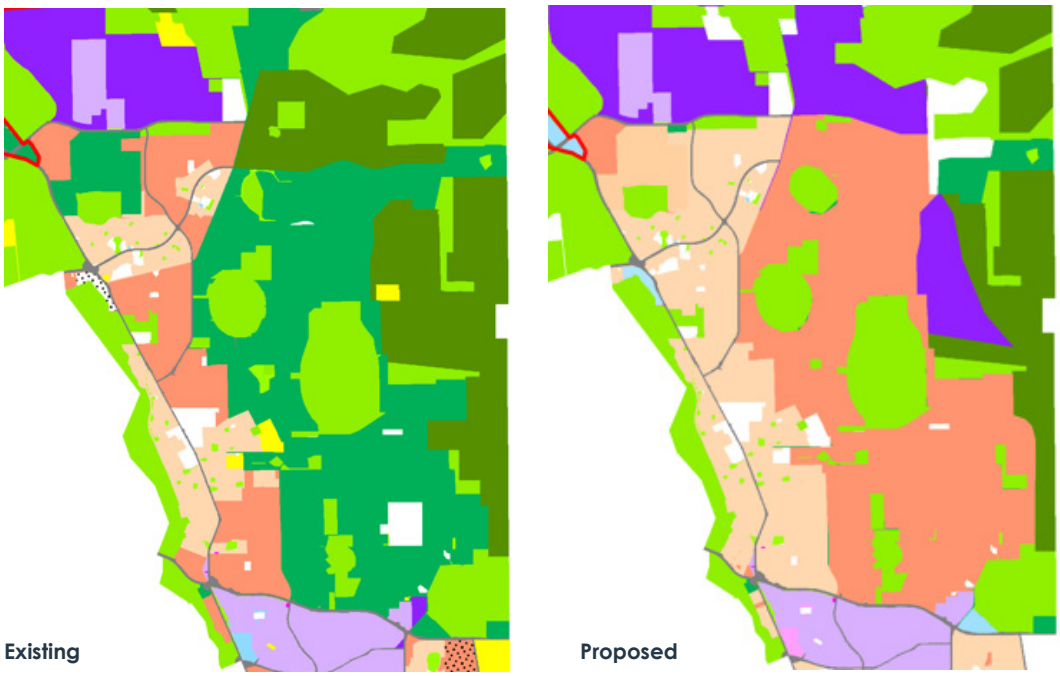


Figure 28: Current vs. future land use in East Wanneroo

Local Planning Strategy Map



Figure 29: **Proposed LPS map (City of Wanneroo)**

The East Wanneroo area is particularly affected by water resources and accordingly the East Wanneroo District Structure Plan (EWDSP) is supported by a District Water Management Strategy (DWMS)(Urbaqua, 2021).

Groundwater and water balance modelling in the EWDSP area identified the risk of significantly rising groundwater in this area following the implementation of the District Structure Plan. The EWDSP DWMS (Urbaqua, 2021) provides detailed guidance on these issues and requirements for supporting technical work and documentation to be provided with local structure plans and subdivisions in the area.

In addition to the direct risks associated with groundwater rise, the EWDSP area does not have a water outlet which means there is an increased risk of localised flooding from both stormwater and inundation from groundwater. Given these flooding and inundation risks, it is critical that local structure plans recognise and address the need for further drainage investigation and planning consistent with the requirements of the EWDSP.

In progressing with local structure planning, to address these risks; groundwater modelling will be needed to design local scale groundwater management systems and provide for connection to a district system, and stormwater modelling will be needed to determine with more confidence, the cross-boundary flows and flood storage volumes and locations.

The EWDSP area also contains several highly valued wetlands and the DWMS provides guidance for work required at subsequent stages of planning and development to protect and manage these important environmental assets. This includes requirements for pre- and post-development monitoring and environmental investigations that need to be completed as part of local structure planning.

While the EDWSP DWMS outlines the future water considerations for the DSP area, it is recommended that implementation of the DWMS is strengthened by direct reference to its requirements in the Local Planning Strategy and Scheme. Consideration could also be given to updating *Local Planning Policy 5.3: East Wanneroo*.

Critical water resource requirements for the EDWSP area are summarised below however, this list is not exhaustive and future planning and development should still refer to the EDWSP DWMS.

- The nature of the groundwater system in the East Wanneroo DSP is such that changes in hydrology in one precinct of the DSP area have the potential to impact significantly on groundwater levels in another precinct, as well as on the health of the important wetlands in the area. A district-scale groundwater system should be designed prior to local structure planning to ensure impacts of groundwater level changes will not impact on wetlands and/or the proposed development.
- Detailed surface water modelling will be required to support future local structure plans and presented in local water management strategies. This modelling will need to include consideration of the risks associated with surface and groundwater interaction both now and in the future. The establishment of appropriate antecedent conditions in drainage infiltration basins and wetlands functioning as part of the surface water management system will need to consider changing groundwater levels and the performance of subsurface drainage systems under flood conditions.
- Development near wetlands will need to consider any associated cultural heritage values. Local structure plans should also propose the inclusion of high value wetlands as reserves for Conservation or Parks and Recreation. Where a precinct contains an unprotected wetland not currently reserved for conservation, a site investigation/ evaluation is required to be conducted prior to local structure planning stage to assess

wetland values consistent with *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia* (DBCA 2017a) and *Wetland identification and delineation: information for mapping and land use planning on the Swan Coastal Plain* (DBCA 2017b). The assessment should inform proposed open space areas and future local structure plan design. Any water management strategies should seek to protect and/or enhance the values of these wetlands. This will need to be demonstrated in Local Water Management Strategies prepared to support local structure plans. Consideration should also be given to the restoration of lower value wetlands that can provide a stormwater management function.

- Rezoning to urban land use within P1 and P2 PDWSAs will likely result in reclassification of these areas to P3* category areas by DWER. These will need to be highlighted as special control areas in future local planning schemes. Some portions of the proposed Urban Expansion area are within P1 and P2 areas, and reclassification will need to be considered by DWER.
- Public drinking water bores and wellhead protection zones are located within the DSP/Future Urban zone, and appropriate buffers will need to be provided.
- Development of the area is expected to proceed through the extension and sequential roll-out of existing water and wastewater services from the western edge of the structure plan area, pushing east from the existing suburbs, consistent with the Staging Plan. This is likely to provide the most efficient and cost-effective way of infrastructure provision. Local structure plans must outline the strategy for the provision of drinking water, wastewater and irrigation of public open space. It should be noted that as groundwater levels in shallow groundwater areas are likely to be controlled via subsurface drainage systems, this could allow approximately 3.4 GL of groundwater to be collected and reused for non-potable supply per year.
- District scale predevelopment monitoring should commence as soon as reasonably practical and continue seamlessly throughout development. Local Water Management Strategies supporting Local Structure Plans for each precinct will be required to report on pre-development monitoring data relevant to their site recorded over a period not less than 18 months (2 winters). Additional site-specific monitoring may be required and should be confirmed with DWER prior to commencement.

For more detailed information on water resource management within the Future Urban area corresponding to the East Wanneroo DSP, please refer to the DWMS.

4.3.2 Eglinton East

The Eglinton East area was identified as a Planning Investigation Area in the North West Metropolitan Sub-regional Planning Framework (WAPC, 2018) and more recently in the *Planning Investigation Areas Update as an Urban Investigation Area* (WAPC, 2022) as an area that provides employment land. The following water management issues are identified for Eglinton East.

- Limitations of existing infrastructure – Water corporation sewer and potable supply infrastructure is located nearby, with the Alkimos WWTP located to the southwest, however the existing capacity in water, wastewater and drainage systems is unknown. Investigations will be required to consider the potential infrastructure requirements for development in this area, but it is likely extensions to the current network will be required.
- Groundwater scarcity - there is no remaining groundwater available for allocation in either the Superficial or Leederville aquifers, however currently around 0.2GL of superficial groundwater licences are associated with the land. This water should be able to be used by the landowner to support activities associated with the change of use, provided it is secured as part of any transfer of land ownership;

- Development in Public Drinking Water Source Areas - development is proposed within a P3 public drinking water source area (blue hatching shown on figure below);
- Development adjacent to wetlands - some areas are adjacent to or contain regionally significant wetlands (Beonaddy Swamp REW and Pippidinny Swamp CCW), and appropriate buffers will need to be considered.
- Acid sulfate soils - there are areas of high and moderate risk of acid sulfate soils within 3 m of the ground surface present in the area associated with the wetlands.

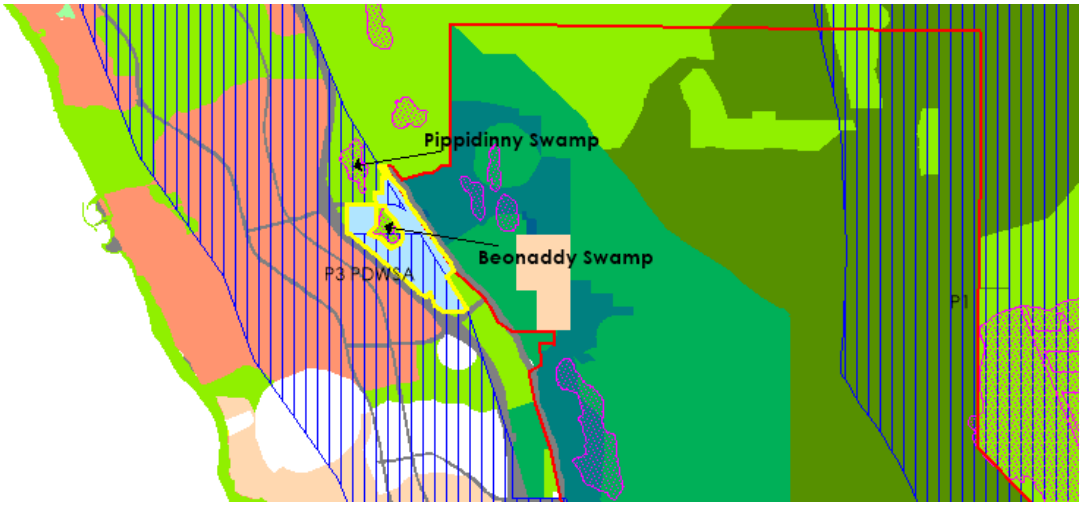


Figure 30: Eglinton East urban investigation area (yellow boundary)

4.3.3 Nowergup, North Pinjar, South Pinjar and Jandabup

Future Industrial zoning is also being investigated by the State Government in some areas that are currently zoned Rural or reserved for State Forest and Parks & Recreation. These areas in Nowergup, North Pinjar, South Pinjar and Jandabup were identified as Industrial Investigation Areas in Perth and Peel @3.5million.

Key issues associated with land use change in these areas are:

- **Protection of public drinking water sources** - Portions of all areas contain public drinking water source areas (dark blue vertical stripes), the majority of which are classified as Priority 1 (P1). As per WQPN 25 Land use compatibility for public drinking water source areas, DWER does not support rezoning of land within P1 or P2 areas to industrial due to the intensification and possible risks to water resources. In addition, onsite wastewater disposal is unlikely to be supported within the P1 area so wastewater servicing will need to be investigated as there is currently no access to sewer in the area. There are also several Water Corporation production bores (black dots) located within or in close proximity to all sites, which will have wellhead protection zones associated with them.
- **Protection of environmental values** - Development in areas containing important wetlands (pink) and regionally significant vegetation (aqua horizontal stripes). Various Bush Forever sites are located within all Industrial Investigation areas. Lake Pinjar (CCW) is located adjacent to Nowergup, and within a small portion of North Pinjar. Little Coogee wetlands (both CCW and REW) are located within North Pinjar, and Hawkins Road Swamp is located within Jandabup. Neerabup Lake (REW) is located close to Nowergup. Development should seek to protect all areas of native vegetation. Appropriate buffers to these wetlands and surface water features will also need to be considered.

- **Limitations of existing infrastructure** - existing capacity in water, wastewater and drainage systems is unknown and Water Corporation services are not present in the area
- **Groundwater scarcity** - there is no remaining groundwater available for allocation in the management sub area.
- **Acid sulfate soils** - there are areas of high risk of acid sulfate soils within 3 m of the ground surface in some locations.

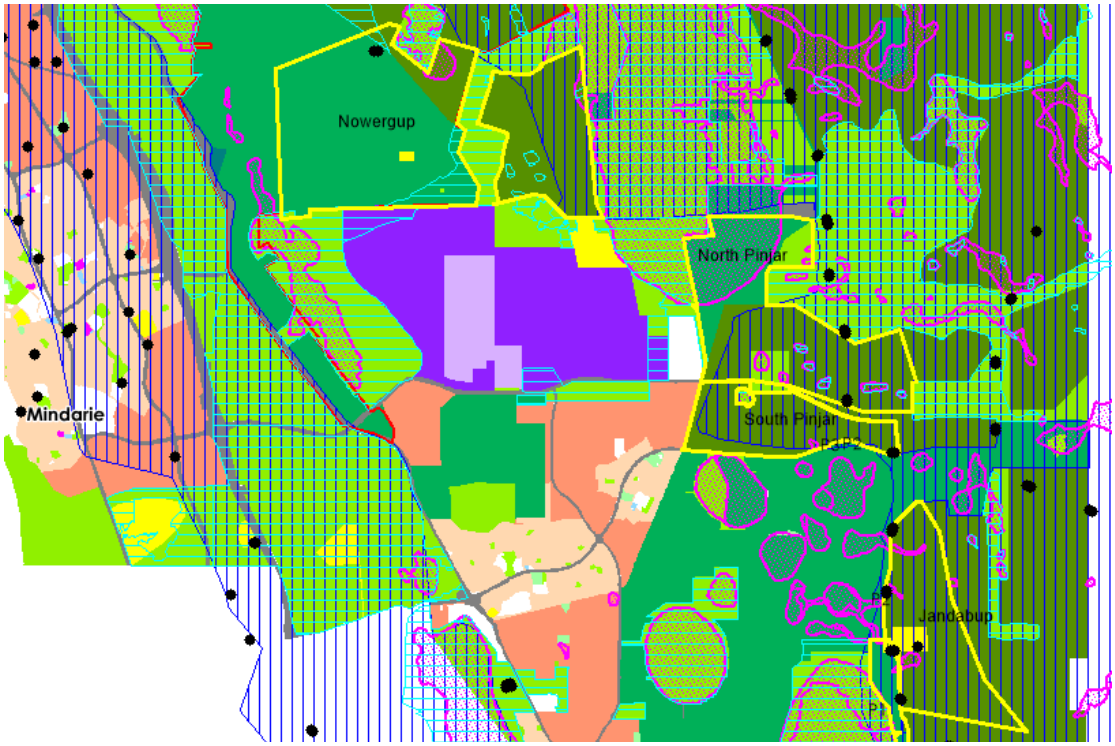


Figure 31: Key water management issues within Industrial Investigation Areas

5 SUMMARY

5.1 Key water management issues affecting the City

The key water management issues that require consideration in the local planning strategy are:

- Climate change including urban heat
- Water sensitive urban design
- Groundwater management including protection of public drinking water sources
- Protection of environmental values of wetlands, waterways and bushland
- Provision of water services

Water-related strategies that are recommended to be incorporated into the local planning strategy to address the above issues are as follows.

- Create a Special Control Area for P3 PWDSAs in the City including recognition of the requirements of DWER *Water Quality Protection Note No.25: Land use compatibility tables for public drinking water source areas* and and DWER *Water Quality Protection Note 38: Priority 3* (P3*) areas* and the other relevant policy measures contained within draft *State Planning Policy 2.9: Planning for Water* and the *Planning for Water Guidelines*.
- Identify and include regional and local green corridors in the local planning strategy.
- Require incorporation of green infrastructure into the public realm that enhances liveability through provision of shade, creation of habitat and ecosystem services and improved climate resilience.
- Require improved built form and building quality design and surrounding landscape which reduces urban heat island effects and improves thermal comfort including retention of canopy trees and creation of urban canopy on private land.
- Include Tree preservation order provisions in the Scheme in order to support the protection of ecologically and/or culturally significant trees in the city.
- Ensure infrastructure and emergency management responses adequately manage and/or responds to extreme weather conditions, including in areas of increasing development and impermeability.
- Require development to protect the values of unreserved CCW and RE wetlands (as shown in Table 8) and local natural areas in the Local Biodiversity Plan. This could occur via the inclusion of a strong presumption against clearing remnant vegetation (local natural areas) in the scheme and a special control area that requires site assessment and description of environmental values in support of any application for development. Clearing of vegetation should only be supported in liaison with relevant State Government Agencies where its conservation value has been assessed as low.
- Review and require an update of old water management strategies to ensure best practice WSUD outcomes consistent with current policy (SPP 2.9 Planning for Water and the Planning for Water Guidelines).
- Implement the requirements in the East Wanneroo District Structure Plan District Water Management strategy.
- Incorporate provisions into the Scheme to require the control of erosion and sediment on subdivision and development sites.
- Protect and promote both Aboriginal and European cultural heritage through joint management arrangements with traditional owners and optimise opportunities for sharing Aboriginal cultural knowledge and Indigenous training, employment and businesses.

5.2 Water management issues affecting the areas proposed for land use change

Common issues that affect the areas of proposed land use change include:

- Limitations of existing infrastructure – some areas have access to services while some others don't. It will be necessary to liaise with the Water Corporation to understand the capacity of each system to determine infrastructure requirements to support the proposed development.
- Groundwater scarcity - there is no remaining groundwater available for allocation in the majority of the City. Where an allocation is required for future public open space that has not been identified by the North West Corridor Water Supply Strategy, an alternative solution may be required. Declining access to groundwater may also impact on the viability of some existing land uses such as horticulture; however, future rising superficial groundwater levels in the East Wanneroo area subsequent to urbanisation may pose an alternative solution.
- Some areas are located within Priority 3 Public Drinking Water Source Areas.
- Development is often proposed adjacent to regionally significant wetlands and/or bushland, which requires consideration of buffers and edge effects. In addition, where the development area contains locally significant vegetation, this should be considered for protection/retention
- Where land use change is proposed within areas with high and moderate risk of acid sulfate soils within 3 m of the ground surface, development should follow current DPLH requirements and DWER guidelines.

It should be noted that the DWER is unlikely to support the rezoning of the proposed industrial areas at Nowergup and Neerabup due to the presence of Priority 1 and Priority 2 PWDSAs, Bush Forever Sites and important wetlands. The Local Planning Strategy should require the reservation of wetlands and Bush Forever sites in a conservation reserve.

The risks to public drinking water sources are considered to be significant. Information that will need to be provided to support this proposed rezoning is outlined in and DWER *Water Quality Protection Note 38: Priority 3* (P3*) areas* and includes:

- Pre-development water quality monitoring program and sampling and analysis plan, including for pathogens, nutrients and other contaminants.
- Sewerage plans developed with a risk assessment process that considers PDWSAs, particularly, location of wellhead protection zones (WHPZs) and giving them the highest protection.
- Incorporation of WHPZs into public open space where possible, preferably in conservation open space
- Use of the Stormwater management manual for Western Australia and Decision process for stormwater management in Western Australia.
- Site-responsive design to direct surface and subsoil drainage away from drinking water extraction points such as via slopes and road cambers (curve upwards in the middle).
- Recognition that current water infiltration rates and groundwater levels may change as a result of urbanisation (b).
- Adequate contingency planning in case of groundwater or surface water contamination, i.e. emergencies (c)
- Risk assessment in accordance with Australian drinking water guidelines.
- Basic raw materials extraction (d) which considers protection of drinking water, for example retain areas of native vegetation in WHPZs, and recontouring prior to development.
- Retention of areas of existing native vegetation as much as possible.

- No underground fuel or chemical storage, i.e. no service stations.
- Commitment to education and raising awareness about PDWSA protection.
- Infrastructure planned, constructed and maintained to protect drinking water source, particularly wellhead protection zones (f).

Notes:

(a) Refer to WQPN no. 25: Land use compatibility tables for public drinking water source areas (Department of Water 2016a)

(b) Refer to Water resource considerations when controlling groundwater levels in urban development (Department of Water 2013)

(c) Refer to WQPN no. 10: Contaminant spills – emergency response (Department of Water 2006)

(d) Refer to WQPN no. 15: Extractive industries near sensitive water resources (Department of Water 2013)

(e) Refer to Use of herbicides in water catchment areas (Department of Health 2007)

(f) Refer to WQPN no. 83: Infrastructure corridors near sensitive water resources (Department of Water 2007)

(g) Refer to Minimum construction requirements for water bores in Australia (National Uniform Drillers Licensing Committee 2012)

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Client: City of Wanneroo

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft	V1	RF/RM/SSh	HBr	Electronic	20 March 2023
Final	V2	SSh	REp	Electronic	1 June 2023
Renamed	V3	SSh		Electronic	11 March 2024

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