Environmental Review

City of Gosnells Town Planning Scheme No. 6

Amendments 166 and 169

EPA Assessment No: 2176 and 2177

Prepared for City of Gosnells
May 2023

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Invitation to Make a Submission

The Environmental Protection Authority (WA) (EPA) invites people to make a submission on the environmental review (ER) for the proposed scheme amendments for Maddington Kenwick Strategic Employment Area (MKSEA) Precincts 2 and 3B.

The MKSEA is located in the Cities of Gosnells and Kalamunda in an area bounded by Bickley Road, Welshpool Road, Tonkin Highway and Roe Highway, and is proposed for potential future business development. MKSEA is divided into a number of planning precincts, of which Precincts 2 and 3B are the subject of this ER, which are situated within the City of Gosnells.

The City of Gosnells is proposing two amendments to Town Planning Scheme (TPS) No. 6. Amendment 166 seeks to rezone 66.8 hectares (ha) within MKSEA Precinct 3B from 'General Rural' to 'Business Development' and amendment 169 seeks to rezone 177.7 ha within MKSEA Precinct 2 from 'General Rural' to 'Business Development'. The EPA has determined that the proposed MKSEA TPS amendments 166 and 169 are to be assessed under Part IV of the *Environmental Protection Act 1986* and that an ER is required.

This ER document has been prepared in accordance with the EPA's 2020 Procedures Manual (Part IV Divisions 1 and 2). The ER document is the report by the Responsible Authority (the City of Gosnells) on their environmental review, which describes the proposed scheme amendments and likely effects on the environment.

The ER document is available for a public review period of 90 days from 8 May 2023, closing on 7 August 2023.

Information on the proposed scheme amendments from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposed scheme amendments to the Minister for Environment.

Why write a submission?

The City of Gosnells seeks information that will inform the EPA's consideration of the likely effect of the proposed scheme amendments, if approved, on the environment. This may include relevant new information that is not within the ER, such as alternative courses of action or approaches.

In preparing its assessment for the Minister for Environment, the EPA will consider information in submissions, the Responsible Authority's responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992* (WA).

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce workload for an individual or group. If you join a small group (up to 10 people) please indicate the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the ER. When making comments on specific elements of the ER:

- Clearly state your point of view and give reasons for your conclusions
- Reference the source of your information, where applicable
- Suggest alternatives to improve outcomes to the environment.

What to include in your submission

Include the following in your submission to make it easier for the City of Gosnells to consider your submission:

- Your contact details – name and address
- Date of your submission
- Whether you want your contact details to be confidential
- Summary of your submission, if your submission is long
- List points so that issues raised are clear, preferably by environmental factor
- Refer each point to the page, section, and if possible, the paragraph of the ER
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for submission is 7 August 2023.

The City of Gosnells prefers submissions to be made electronically via the following website: www.yoursay.gosnells.wa.gov.au

Alternatively, submissions may be:

- **Posted to:** City of Gosnells, PO Box 662, Gosnells WA 6990; or
- **Delivered to:** City of Gosnells, 2120 Albany Highway, Gosnells

If you have any questions on how to make a submission, please contact the City of Gosnells Future Planning Team on 08 9397 3000 or email council@gosnells.wa.gov.au.

Scoping Checklist

Table E1 provides referencing of the tasks identified in the Environmental Review Instructions (endorsed, 21 December 2018) within this Environmental Review document.

Table E1: Scoping checklist

Task	Required work	ER section/s
Environmental factor: Inland waters		
1	Describe the total water cycle for the Yule Brook catchment, with particular focus on the MKSEA. Discuss the hydrology and hydrogeology, particularly as it relates to wetland and ecological diversity within and adjacent to the amendment areas. Include information and discussion on the water budget for the area, the existing drainage management practices and any known impacts on the wetlands and waterways in, and adjacent to the amendment areas.	**Section 2.6.4** **Section 2.6.4.1** **Section 2.6.4.2** **Section 2.6.4.3**
2	Identify and assess the values and significance of hydrological and soil characteristics within the amendment areas and immediate adjacent area (i.e., Greater Brixton Street Wetland Complex) and describe these values in a local and regional context.	**Section 2.6.4.2** **Section 2.6.4.1** **Section 4.2.3.3**
3	Identify and map wetlands and watercourses within and adjacent to the amendment areas.	**Figure 11**
4	Using a pre and post development water balance model, describe and assess the potential impacts (direct and indirect) as a result of future development and associated infrastructure including any drainage, dewatering/use of fill/impervious surfaces/ waste water, on water quantity and quality of surface and ground waters in relation to significant wetlands and waterways.	**Section 4.2.5** **Section 4.2.8** **Appendix F**
5	Predict the extent, severity and duration of potential impacts, including changes to local and regional groundwater flows and levels, drawdown, local water quality and impacts to other groundwater users as a result of future development including infrastructure and provide measures to mitigate these impacts.	**Section 4.2.5** **Section 4.2.8** **Appendix D** **Appendix E** **Appendix F**
6	Identify and map wetlands and waterways proposed to be retained for conservation purposes within and adjacent to the amendment areas.	**Figure 11**
7	Identify and map wetland areas and waterways proposed to be impacted by future development including associated infrastructure (drainage management) within and adjacent to the amendment areas.	**Figure 11**
8	Determine the boundaries of wetlands and buffer requirements to significant wetlands and watercourses within and adjacent to amendment areas. Boundary and buffer studies should consider the characteristics of hydrology, hydric soils and wetland vegetation, and the water balance of the wetland and/or wetland dependent vegetation.	**Section 4.2.4** **Appendix G**
9	Prepare a foreshore area report including a map and identify the environmental and water management requirements over Yule Brook, to determine and depict the extent of the waterway foreshore areas to be protected, in accordance with *Operational Policy 4.3: Identifying and establishing waterways foreshore areas* (DoW, 2012). Include the width of any future Multiple Use Corridor.	**Section 4.2.3.8** **Appendix E**
10	Describe how the principles of water sensitive urban design will be incorporated and implemented in the amendment areas, consistent with the Better Urban Water Management framework (WAPC, 2008).	**Section 4.2.5** **Appendix D** **Appendix E**

Task	Required work	ER section/s
11	Detail and discuss how future drainage practices and waste water management within the site, is to be managed, considering the broader catchment. This management should ensure the hydrological balance and water quality of significant wetlands and watercourses within and adjacent to the amendment areas (such as the GBSW and Yule Brook) will be maintained.	**Section 4.2.6**
12	Describe how drainage management practices could be adapted in the future to mitigate impacts of climate change on significant wetlands and waterways, within and adjacent to the amendment areas.	**Section 4.2.5** **Section 4.2.6**
13	Detail and discuss how development activities will not mobilise potentially poor quality groundwater resulting from past agricultural land uses.	**Section 4.2.8.2**
14	Describe the planning or other mechanisms that will ensure drainage and waste water management will protect significant wetlands and watercourses within and adjacent to the amendment areas.	**Section 4.2.9.2**
15	Describe the ongoing management requirements for the amendment areas to ensure the hydrology of the GBSW is maintained.	**Section 4.2.5** **Section 4.2.6** **Section 4.2.9.2**
16	Detail how major storm events in Yule Brook will be managed in the future.	**Section 4.2.5**
17	Based on the outcomes of the above and taking into consideration the principles of avoidance and minimisation, identify an environmentally acceptable area for development.	**Section 2.3** **Section 2.5** **Section 4.2.9.1**
18	Provide a summary of residual impacts of future development and associated infrastructure within and adjacent to the amendment areas.	**Section 4.2.10**
19	Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.	**Section 4.2.10** **Section 4.2.11**
20	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	**Section 4.2.9.2**
21	Prepare a local water management strategy in accordance with the Guidelines for local water management strategies (DoW, 2013).	**Appendix D** **Appendix E**
22	Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives.	**Section 4.2.9.2** **Appendix D** **Appendix E**
23	Prepare a program to report on the performance of Yule Brook for major storm events upstream, downstream and through the MKSEA.	**Appendix D** **Appendix E**
Environmental factor: Flora and vegetation		
24	Identify and describe the vegetation and flora species present and likely to be present within and immediately adjacent to the amendment areas. Demonstrate how surveys are consistent with current EPA policy and guidance set out below. Include a summary of survey findings and an analysis of the significance of flora and vegetation in local and regional contexts as appropriate in accordance with relevant guidance set out below.	**Section 4.3.3**
25	Note: if surveys were undertaken at the referral stage, survey results and a demonstration of how the guidance has been followed are to be included in the environmental review. Ensure species database searches and taxonomic identifications are current.	**Appendix J**
26	Provide a map depicting the recorded locations of significant flora, ecological communities and vegetation in relation to the amendment areas in accordance with the relevant guidelines set out below. Clearly show any areas/lots unable to be surveyed.	**Figure 12** **Figure 13** **Figure 14** **Appendix H**

Task	Required work	ER section/s
27	Provide a map depicting areas of vegetation and flora to be retained and protected, including appropriate buffers from future development and associated infrastructure. Assess the potential direct and indirect impacts of future development and associated infrastructure on the identified environmental values. Include a quantitative assessment of levels of impact on significant flora, listed ecological communities and all vegetation units. Describe and assess the extent of any cumulative impacts within local and regional contexts as appropriate.	**Figure 12** **Figure 13** **Figure 14** **Figure 14** **Section 4.3.5.1**
28	Determine the ecological water requirements of; and identify buffers to significant vegetation.	**Section 4.3.3.9** **Appendix G**
29	Identify and quantify (in ha) areas of vegetation and significant flora that are not proposed for retention.	**Section 4.3.5.1**
30	Describe the planning or other mechanisms that will ensure vegetation identified for retention will be protected.	**Section 4.3.6**
31	Describe the ongoing management requirements to ensure retained areas of vegetation within the amendment areas are managed appropriately and identify which planning or other mechanisms are required to ensure this management is implemented.	**Section 4.3.6.2**
32	Describe the ongoing management requirements for the amendment areas, which would ensure the vegetation of the Brixton Street Wetlands is maintained, and what planning or other mechanisms are required to ensure this management.	**Section 4.3.6.2**
33	Describe any proposed avoidance, mitigation and management measures to reduce the potential impacts of future development and associated infrastructure. Include any proposed management and/or monitoring plans that will be implemented pre- and post-development to ensure residual impacts are not greater than predicted.	**Section 4.3.6**
34	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	**Section 4.3.6.2**
35	Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives.	**Section 4.3.6.2**
36	Identify, describe and quantify the potential residual impacts (direct, indirect and cumulative) that may occur following completion of future development and associated infrastructure after considering and applying avoidance and minimisation measures.	**Section 4.3.7**
37	*No text included in the EPA Instructions*	**N/A**

Task	Required work	ER section/s
Environmental factor: Terrestrial fauna		
38	In accordance with the requirements of EPA Guidance: a) conduct a Level 1 (basic) terrestrial fauna survey, including a desktop study that incorporates existing regional terrestrial fauna surveys and databases; and b) as required based on the outcomes of the Level 1 (basic) survey undertake terrestrial fauna surveys, including targeted surveys for significant species, to identify and characterise terrestrial fauna and fauna habitat, at a local and regional scale, that may be impacted directly and indirectly by future subdivision, development and provision of associated infrastructure. This should include sampling inside and outside the amendment areas and consideration of cumulative impacts. For significant species, this must include information on: i. the abundance, distribution, ecology and habitat preferences, together with baseline information and mapping of local and regional occurrences; i. a population size and importance of the population from a local and regional perspective; and ii. information on conservation value of each habitat type (e.g., breeding, migration, feeding, resting) from a local and regional perspective, including the percentage representation of each habitat site in relation to its local and regional extent.	**Appendix J** **Appendix K** **Section 4.4.3**
39	Note: Surveys should include both Terrestrial Vertebrate Fauna and Short-range Endemic (and/or other significant) Invertebrate Fauna. Survey results and a demonstration of how the requirements have been met are to be included in the ER. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys.	**Appendix J** **Appendix K**
40	Where surveys were undertaken prior to the issuing of these ERD instructions, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. IBSA data packages should be provided in accordance with EPA Guidance. Multiple surveys should be combined in one report. Separate reports are required for Short-range Endemic Invertebrate Fauna and Vertebrate Fauna.	**Section 4.4.3.1** **Appendix J**
41	Describe the values and significance of fauna and fauna habitat that may be impacted directly and indirectly by future subdivision, development and provision of associated infrastructure and describe the significance of these values in a local and regional context. Habitats that are important to significant species, and the reasons for their importance, should be identified. Discussions of habitats should quantify the absolute and relative areas of the habitats in question, and that these discussions should be supported by tables and figures that illustrate the extents of habitats.	**Section 4.4.5**
42	Provide a map illustrating the known recorded locations of conservation significant species, other significant fauna and fauna habitat in relation to the amendment areas. Clearly show any areas/lots unable to be surveyed.	**Figure 15**
43	Provide a map depicting areas fauna habitat to be retained and protected from future subdivision, development and provision of associated infrastructure.	**Figure 15**
44	Detail, map and quantify areas of fauna habitat not proposed to be retained.	**Figure 15** **Section 4.4.5.2**
45	Describe and assess the extent of direct and indirect impacts as a result of future development and associated infrastructure to terrestrial fauna taking into consideration cumulative impacts and the significance of fauna and fauna habitat. This should include an assessment of the risk posed to any significant species as a result of future development and associated infrastructure. For significant species, this should be done on a species-by-species basis. Significant species discussed should include short-range endemic and other significant invertebrates.	**Section 4.4.5**
46	Predict the residual impacts to terrestrial fauna after considering and applying avoidance and minimisation measures.	**Section 4.4.5**

Task	Required work	ER section/s
47	Discuss proposed management, monitoring and mitigation methods to be implemented to ensure residual impacts (direct and indirect) are not greater than predicted.	**Section 4.4.6.2**
48	Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives.	**Section 4.2.11** **Section 4.3.8**
49	Describe the ongoing management requirements and the planning or other mechanisms that will ensure that significant fauna habitat will be protected and managed appropriately.	**Section 4.4.6.2**
50	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	**Section 4.4.6.2**
Environmental factor: social surroundings		
51	Characterise the heritage and cultural values within and adjacent to the amendment areas to identify sites of significance and their relevance within a wider regional context.	**Section 4.5.3**
52	Conduct appropriate Aboriginal heritage surveys to identify Aboriginal sites, values and/or cultural associations.	**Appendix L** **Appendix M**
53	Conduct appropriate consultation to identify concerns in regard to environmental impacts as they affect heritage and cultural matters.	**Appendix L** **Section 4.5.3.2**
54	Provide a description and figure(s) of the heritage and cultural values and proposed impacts within and adjacent to the amendment areas (including the Greater Brixton Street Wetlands).	**Figure 17** **Section 4.5.5**
55	Assess the impacts on heritage sites, values and/or cultural associations, associated with the future development including those arising from changes to the environment which may impact on cultural and heritage significance (including the Greater Brixton Street Wetlands).	**Section 4.5.5**
56	Predict the residual impacts on heritage sites, values and/or cultural associations, for direct, indirect and cumulative impacts after consideration of the mitigation hierarchy.	**Section 4.5.7**
57	Outline the mitigation and management measures to ensure impacts to heritage site, values and /or cultural association (direct and indirect) are minimised, and not greater than predicted.	**Section 4.5.6**
58	Identify and discuss the potential sources and impacts of noise, dust, and odour which could impact on residents within and adjacent to the amendment areas.	**Section 4.5.3.4**
59	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	**Section 4.5.6**

Executive Summary

The Maddington Kenwick Strategic Employment Area (MKSEA) is a strategically important area within the Perth metropolitan region. The MKSEA has ideal and efficient transport and employment access and has been identified for future commercial and industrial development. The MKSEA is made up of precincts 1, 2, 3A, 3B (City of Gosnells) and 3C (City of Kalamunda). Subdivision and development is progressing in precincts 1, 3A and 3C. In relation to precincts 2 and 3B (and a small portion of Precinct 3A), this Environmental Review assesses amendments 166 and 169 to the City of Gosnells Town Planning Scheme (TPS) No. 6, which proposes to include these precincts in the 'Business Development' zone.

The MKSEA also has outstanding natural and cultural values and is recognised as a place to conserve and enhance these values, particularly the adjacent Greater Brixton Street Wetlands (GBSW).

The Western Australian Planning Commission, City of Gosnells and City of Kalamunda have been planning the sustainable development of the area for more than 20 years in collaboration with landowners, stakeholders, traditional owners, government agencies, conservation groups and the community.

The Western Australian Government has endorsed the strategic planning direction through *Bush Forever* (2000), *Economic and Employment Lands Strategy: non-heavy industrial* (2012), *Perth and Peel@3.5 Million* (2018), *South Metropolitan Peel Sub-regional Planning Framework* (2018) and the *Metropolitan Region Scheme* (MRS).

The Environmental Protection Authority (EPA) has also provided detailed advice when assessing the MRS Amendments 1300/57, 1301/57 and 1302/57 that encompass the MKSEA, where they advised the MRS amendments "*can be managed to meet the EPA's environmental objectives, through the preparation of future local planning scheme provisions and structure plans to manage and protect key environmental values*". The proposed scheme amendments (including local scheme provisions) and the draft MKSEA Structure Plan responds to this advice and the EPA's 'Section 16' advice[1].

The draft MKSEA Structure Plan has been developed to guide implementation of development within MKSEA precincts 2 and 3B in accordance with the proposed 'Business Development' zoning, to ensure development is compatible with the retention and protection of important environmental values in the open space network. Avoiding direct and indirect impacts to environmental values has been fundamental to preparation of the draft MKSEA Structure Plan.

The draft MKSEA Structure Plan aims to provide for the expansion of the GBSW, beyond the boundary of Bush Forever site 387. This will be accomplished because the draft MKSEA Structure Plan has been developed using three important design principles:

- No development within the GBSW (Bush Forever site 387).
- Avoid development of wetlands, waterways and their buffers/foreshore, native vegetation and fauna habitat in 'good' or better condition (where possible) outside the GBSW.
- Focus development in areas which are 'degraded' or 'completely degraded'.

[1] *Environmental values and pressures for the Greater Brixton Street Wetlands on the Swan Coastal Plain.* Advice in accordance with section 16(j) of the Environmental Protection Act 1986, EPA, October 2022.

As a result, the draft MKSEA Structure Plan will provide for over a quarter of the amendment areas to be included in Biodiversity Asset POS areas (transferring them from private to public ownership), with potential for this land to be included in an expanded GBSW and therefore provide an approximate 50% increase in the size of the original GBSW Bush Forever site. Implementation of the draft MKSEA Structure Plan will result in this land being acquired or ceded free of cost and protected via reservation.

175 ha of 'completely degraded' predominantly non-native vegetation is proposed for development. Only 0.4% of the amendment areas, or 1.1 ha, contains 'good' or better condition native vegetation that is proposed to be cleared. Overall implementation of amendments 166 and 169 through the draft MKSEA Structure Plan will almost entirely avoid the clearing of valuable native vegetation, wetlands and fauna habitat. Some unavoidable loss of conservation significant flora, communities and wetlands is anticipated within existing public road reserves, where road upgrades and widening is necessary to facilitate future industrial development. However, an on-ground management offset incorporating revegetation and rehabilitation measures will counter balance the significant residual impacts on these matters.

For the GBSW, controlled development of adjacent areas provides an opportunity to remove and manage existing threatening processes such as uncontrolled access, rubbish dumping, weed incursion, fire risk, vermin and addition of nutrients which can be conveyed downstream by stormwater run-off. It provides opportunities for rehabilitation and coordinated long term management that will enhance environmental, heritage, cultural, community and scientific outcomes.

Potential impact to the GBSW ecosystem from development of the adjacent areas include changes in hydrology, such as changes in surface and groundwater quality and quantity due to increased impervious surfaces, increased peak flows and volumes, or mobilisation of pollutants. The change to water quality are anticipated to be positive, with pollutant sources from unmanaged land with ad-hoc and semi-rural uses being removed, and replaced with best practise management of stormwater and groundwater. Compared to the current rural land use, development will result in a significant reduction in sediments, total nitrogen (74%) and phosphorus (72%) and contribute to a reduction in nutrients ultimately entering the Swan and Canning River system. This can be achieved through implementation of Local Water Management Strategies which adopt a Water Sensitive Urban Design (WSUD) approach. Stormwater management uses a treatment train approach, and is proposed to be detained, treated and infiltrated within private lots, then within road reserves and finally within open spaces, all within the site and prior to any discharge. Subsoil drainage will not be used to lower groundwater levels, and the existing controls that are in place are proposed to be retained, which will mitigate the extent of change to the GBSW and other downstream environments. Further, the proposed approach to developing the land sets aside a large multiple use corridor and other green spaces that can potentially be used to adaptively manage the hydrological regime in the future, in the event that climate change results in reduced rainfall and other conditions which affect the hydrology of the amendment areas and GBSW.

To mimic the natural water cycle, the stormwater strategy has been designed so the post-development peak flow rates within Yule Brook and the tributary traversing the GBSW will not exceed pre-development peak flow rates. A small increase in total annual water volume flowing into Yule Brook (1.8%) and the tributary that traverses the GBSW (3.9%) is predicted, accounting for

predicted future climate change. For storms up to the 1% Annual Exceedance Probability (AEP), the Yule Brook tributary that traverses the GBSW will not experience any increase in peak flows rates and therefore there will be no new breakout flows or ponding as a result. It is noted that the primary inputs/drivers to the hydrology of the GBSW will be maintained, and rainfall will remain the dominant contributor to the GBSW ecosystem.

The draft MKSEA Structure Plan has been developed based on sound sustainable development and best practice environmental management principles and will largely avoid direct environmental impacts. Some unavoidable impacts are predicted within existing public road reserves where road upgrades and widening are necessary, which will be counter balanced by an on-ground management offset. New areas of open space will likely become part of a larger GBSW reserve. Best practice stormwater design will ensure indirect impacts are avoided and mitigated, so that the existing hydrological regime which supports the GBSW ecosystem is maintained.

The implementation of the amendments 166 and 169 through MKSEA Structure Plan, including the associated mitigation measures and planning mechanisms, can meet the EPA's environmental objectives.

Table ES1 provides a summary of the assessment.

Table ES1: Assessment summary

Potential Impacts	Mitigation hierarchy	Planning Mechanisms	Residual Impacts	Predicted Outcome
Key Environmental Factor: **Inland Waters**				
• Impacts to current surface and ground water cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and adjacent to the amendment areas. • Impacts to water quality of significant wetlands and waterways within and adjacent to the amendment areas. • Loss of foreshore functions and wetland dependent vegetation and impacts to other water dependent ecosystems. • Risk to public safety from Yule Brook overflows during major storm events.	<u>Avoid</u> • Proposed amendments do not extend over GBSW. • Retention, protection and enhancement of inland water values, including Yule Brook, foreshore areas, conservation category wetlands (CCWs) and buffers, buffer zone to GBSW and residual wetland function of disturbed resource enhancement wetlands. <u>Mitigate</u> • Preparation and implementation of: o Local Water Management Strategy (LWMS). o Urban Water Management Plan/s (UWMP). o Conservation Area Management Strategy and Plan/s (CAMS) o Construction Environmental Management Plans (CEMP). o Acid Sulfate Soils Management Plan (ASSMP) <u>Rehabilitate</u> • N/A	<u>TPS No. 6 provisions</u> • Subdivision and development to be in accordance with an approved Structure Plan. • The Structure Plan to provide for the protection of high value environmental areas within POS areas. • Completion of site specific environmental surveys, where required. • Preparation and implementation of: o LWMS o UWMP o CAMS o CEMP <u>MKSEA Structure Plan</u> • Structure Plan layout to provide Biodiversity Asset POS areas over Yule Brook and determined foreshore area, all determined CCWs and buffers, buffer zone to GBSW along its south-eastern boundary, and other high value environmental areas. <u>Subdivision and development control</u> • Assessment of applications by City of Gosnells to ensure consistency with approved Structure Plan. • Approval conditions to require preparation and implementation of relevant management plans.	<u>Water Quantity</u> • Increase in total volume of water flowing through the GBSW (3.87%) and Yule Brook (1.80%), including adjustments for future climate change, due to increase impermeable surfaces. Change may counteract drying trend. No significant impact on ecosystem health and function expected. <u>Water Quality</u> • Net reduction in nutrients (74% total nitrogen and 72% total phosphorus) due to the removal of rural land uses and adoption of a water sensitive drainage design. <u>Significant residual impacts:</u> • Loss of up to 0.7 of CCW values (road widening) <u>Assessment</u> • Low residual risk. Significant residual impacts can be offset.	• **EPA objective: *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.'*** • Notwithstanding substantial threatening processes from existing land use and historical changes to the hydrological regime (including drying as a result of climate change), ecosystem function has demonstrated resilience over time. • The change in water quantity is minor and within current seasonal and climatic hydrological variability and may counteract the longer term drying trend. • The decrease in nutrients is likely to enhance ecosystem function. • Significant residual impact to CCW can be counter balanced by an offset. <u>Conclusion</u> • Subject to the mitigation measures and planning mechanisms, the scheme amendments and associated development can be implemented in a manner which is likely to achieve the EPA objective.

Potential Impacts	Mitigation hierarchy	Planning Mechanisms	Residual Impacts	Predicted Outcome
Key Environmental Factor: **Flora and Vegetation**				
• Direct loss through clearing • Loss of fauna habitat (vegetation loss) short and long term • Impacts to wetland and riparian vegetation and ground water dependent ecosystems through changes to hydrology • Spread or intensification of weeds and Phytophthora dieback • Increased fire risk to significant flora and vegetation within and adjacent to the amendment areas including the GBSW • Fragmentation.	<u>Avoid</u> • Proposed amendments do not extend over GBSW. • Retention and protection of 70.4 ha (28% of total amendment areas) to protect all significant remnant flora and vegetation values. • Retention of 73% of all native vegetation. • Retention of 93% of native vegetation in 'good' or better condition. • Retention of all threatened ecological communities, and all occurrences of priority and threatened flora (excluding within existing public road reserves) <u>Mitigate</u> • Preparation and implementation of: o Local Water Management Strategy. o Urban Water Management Plan/s. o Conservation Area Management Strategy and Plan/s. o Construction Environmental Management Plans o Tree Protection Management Plan o Bushfire Management Plan. <u>Rehabilitate</u> • N/A	<u>TPS No. 6 provisions</u> • Subdivision and development to be in accordance with an approved Structure Plan. • The Structure Plan to provide for the protection of high value environmental areas within public open space areas. • Completion of site specific environmental surveys, where required. • Preparation and implementation of: o LWMS o UWMP/s o CAMS/s o CEMP/s <u>MKSEA Structure Plan</u> • Structure Plan layout to provide Biodiversity Asset POS areas over occurrences of threatened ecological communities, threatened flora and determined buffers, and other high value environmental areas outside of existing public road reserves. <u>Subdivision and development control</u> • Assessment of applications by City of Gosnells to ensure consistency with approved Structure Plan. • Approval conditions to require preparation and implementation of relevant construction and bushfire management plans.	• Loss of up to 1.1 ha (7% of total occurrence within amendment areas) of Guildford complex vegetation in 'good' or better condition. • Areas of retained wetland and riparian vegetation which convey stormwater runoff may experience varied seasonal timing for the emergence and growth of different flora species. • Loss of 0.07 ha of Banksia Woodlands TEC. <u>Significant residual impacts:</u> • Loss of up to 206 spider-net grevillea threatened flora individuals • Loss of up to 1.0 ha of Muchea Limestone TEC vegetation <u>Assessment</u> Low residual risk. Significant residual impacts can be offset.	• **EPA objective:** ***'to protect flora and vegetation so that biological diversity and ecological integrity are maintained'.'*** • All high value flora and vegetation values have been avoided and will be protected, managed and enhanced, with the exception of some impacts to conservation significant ecological communities and flora due to necessary road upgrades. • Significant residual impact can be counter balanced by an offset. • Existing rural threatening process will be removed or mitigated. • Flora and vegetation have demonstrated resilience to historic hydrological changes and threatening processes. • The change in water quantity is minor and within current seasonal and climatic hydrological variability and may counteract the drying trend. <u>Conclusion</u> • Subject to the mitigation measures and planning mechanisms, the scheme amendments and associated development can be implemented in a manner, which is likely to achieve the EPA objective.

Potential Impacts	Mitigation hierarchy	Planning Mechanisms	Residual Impacts	Predicted Outcome
Key Environmental Factor: **Terrestrial Fauna**				
• Fauna mortality as a result of construction activities. • Loss of significant fauna habitat including black cockatoo habitat - breeding, roosting and foraging. • Direct or indirect impacts or loss of other significant fauna and fauna habitat found to be present during surveys. • Fragmentation of fauna habitat and loss of ecological connectivity. • Degradation of fauna habitat and habitat modification from introduction and increased spread of weeds and/or disease, altered surface water flows, altered groundwater and edge effects. • Disturbance to waterbirds (including migratory species) from impacts to wetlands. • Altered fauna behaviour due to noise, lighting and human presence. • Change in feral animal abundance and/or movement.	<u>Avoid</u> • Proposed amendments do not extend over GBSW. • Retention and protection of 70.4 ha (28% of total amendment areas) to protect all significant remnant flora and vegetation values. • Future retention of 73% of mapped native vegetation (and associated fauna habitat), including potential habitat for black cockatoos and quenda. <u>Mitigate</u> • Preparation and implementation of: ○ CAMPS/s ○ CEMP/s ○ Wildlife Protection Management Plan ○ Tree Protection Management Plan <u>Rehabilitate</u> • N/A	<u>TPS No. 6 provisions</u> • Subdivision and development to be in accordance with an approved Structure Plan. • The Structure Plan to provide for the protection of high value environmental areas within public open space areas. • Completion of site specific environmental surveys, where required. • Preparation and implementation of: ○ LWMS ○ UWMP/s ○ CAMS/s. ○ CEMP/s <u>MKSEA Structure Plan</u> • Structure Plan layout to provide Biodiversity Asset POS areas over high value environmental areas. <u>Subdivision and development control</u> • Assessment of applications by City of Gosnells to ensure consistency with approved Structure Plan. • Approval conditions to require preparation and implementation of relevant construction and bushfire management plans.	• Black cockatoos: loss of up to 49 potential habitat trees, 2.75 ha of potential foraging habitat and trees that may provide roosting habitat. • Quenda: loss of up to 9.6 ha which may provide suitable habitat. • Peregrine falcon: loss of potential habitat (open rural areas and paddocks) • The loss of up to 0.7 ha and 8.7 ha potential habitat for two native bee species respectively. <u>Assessment</u> Low residual risk	• **EPA objective: '*to protect terrestrial fauna so that biological diversity and ecological integrity are maintained*'**. • All high value flora and vegetation values (and associated native fauna habitat) would be avoided, protected, managed and enhanced. • All high value vegetation values (and associated native fauna habitat) have been avoided and will be protected, managed and enhanced, with the exception of some impacts to conservation significant vegetation due to necessary road upgrades. • Development is primarily limited to areas with no fauna habitat values. • Existing rural threatening processes will be removed or mitigated. • The loss of 9.6 ha of habitat values from the removal of vegetation is not considered significant, particularly given 89% (8.5 ha) of this vegetation to be removed is in 'degraded' condition. <u>Conclusion</u> • Subject to the mitigation measures and planning mechanisms the scheme amendments and associated development can be implemented in a manner which is likely to achieve the EPA objective.

Potential Impacts	Mitigation hierarchy	Planning Mechanisms	Residual Impacts	Predicted Outcome
Key Environmental Factor: **Social Surroundings**				
• Disturbance to Aboriginal heritage sites and/or cultural association within the area. • Changes to environment which may impact on Aboriginal Heritage sites. • Impacts to the natural and historical heritage values of the GBSWs. • Impacts to the amenity including noise, odour and dust (temporary or permanent).	<u>Avoid</u> • Proposed amendments do not extend over GBSW. • Retention of surrounding social values, including Yule Brook, which is of Aboriginal heritage significance. <u>Mitigate</u> • Preparation and implementation of: o Conservation Area Management Strategy and Plan/s. o Construction Environmental Management Plans • Application of other statutory requirements, including: o Section 18 consent under the *Aboriginal Heritage Act 1972* (to be replaced by the *Aboriginal Cultural Heritage Act 2021*). o Part V regulation under the Environmental Protection Act 1986 o Environmental Protection (Noise) Regulations 1997 <u>Rehabilitate</u> • N/A	<u>TPS No. 6 provisions</u> • Subdivision and development to be in accordance with an approved Structure Plan. • The Structure Plan to provide for the protection of high value environmental areas within public open space areas. • Completion of site specific environmental surveys, where required. • Preparation and implementation of: o LWMS o UWM/s o CAMS/s o CEMP/s <u>MKSEA Structure Plan</u> • Structure Plan layout to provide Biodiversity Asset POS areas over high value environmental and cultural heritage areas, including Yule Brook. <u>Subdivision and development control</u> • Assessment of applications by the City of Gosnells to ensure consistency with approved Structure Plan. • Approval conditions to require preparation and implementation of relevant construction and bushfire management plans.	None anticipated <u>Assessment</u> Low residual risk	• **EPA objective: '*To protect social surroundings from significant harm.*'** • Existing rural threatening processes will be removed or mitigated. • Creation of Biodiversity Asset POS network which will enable future retention and enhancement of all significant Aboriginal and cultural heritage values within and adjacent to the amendment areas (including Yule Brook and GBSW), and provides for improved access to these areas. • Future construction impacts and complaints are manageable through CEMPs <u>Conclusion</u> • Subject to the mitigation measures and planning mechanisms, the scheme amendments and associated development can be implemented in a manner which is likely to achieve the EPA objective.

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
DAWE	Department of Agriculture, Water and the Environment (now DCCEEW)
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water (previously DAWE)
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
WAPC	Western Australian Planning Commission

Table A2: Abbreviations – General terms

General terms	
CCW	Conservation category wetland
ESA	Environmentally sensitive area
FCT	Floristic community type
IBRA	*Interim Biogeographic Regionalisation of Australia*
MUW	Multiple use wetland
NVIS	National Vegetation Inventory System (ESCAVI 2003)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PEC	Priority Ecological Community
REW	Resource enhancement wetland
T	Threatened
TEC	Threatened ecological community
UFI	Unique feature identifier

Table A3: Abbreviations –Legislation

Legislation	
EP Act	*Aboriginal Cultural Heritage Act 2021*
EPBC Act	*Aboriginal Heritage Act 1972*
BC Act	*Biodiversity Conservation Act 2016*
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BF Act	*Bush Fires Act 1954*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EP Act	*Environmental Protection Act 1986*
PD Act	*Planning and Development Act 2005*
RIWI Act	*Rights in Water and Irrigation Act 1914*

Table A4: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
m	Metre
m^2	Square metre
m AHD	m in relation to the Australian height datum

1 Introduction

The Maddington Kenwick Strategic Employment Area (MKSEA) is a strategically important area within the Perth metropolitan region. The MKSEA has ideal and efficient transport and employment access and has been identified for future commercial and industrial development. The MKSEA is made up of precincts 1, 2, 3A, 3B (City of Gosnells) and 3C (City of Kalamunda). Subdivision and development is progressing in precincts 1, 3A and 3C. In relation to precincts 2 and 3B (and a small portion of Precinct 3A), this Environmental Review assesses amendments 166 and 169 to the City of Gosnells Town Planning Scheme (TPS) No. 6, which proposes to include both precincts in the 'Business Development' zone. The City of Gosnells have prepared the draft MKSEA Structure Plan for precincts 2 and 3B to guide the proposed future development of the amendment areas.

The location of the MKSEA and the precincts are shown in **Figure 1**. The extent of amendment areas 166 and 169 (254.8 ha) are shown in **Figure 2**.

1.1 Purpose and scope

Pursuant to the Section 48A of the *Environmental Protection Act 1986* (EP Act) the Environmental Protection Authority (EPA) determined that the two scheme amendments require assessment (EPA assessment numbers 2176 and 2177) and the following environmental factors need to be addressed:

- Inland Waters
- Flora and Vegetation
- Terrestrial Fauna
- Social Surroundings.

This ER has been prepared in accordance with the *Instructions for Environmental Review* (the 'Instructions') and the following EPA guidance:

- *Environmental Impact Assessment (Part IV divisions 1 and 2) Procedures Manual* (EPA 2018a)
- *Statement of Environmental Principles, Factors and Objectives* (EPA 2020)
- *Instructions on how to prepare an Environmental Review Document* (EPA 2018c)
- *Environmental Factor Guidelines* for the applicable EPA factors.

Section 1.5 outlines the structure of this ER.

1.2 Responsible authority

The City of Gosnells initiated amendments 166 and 169 to TPS No. 6, which were referred to the EPA pursuant to Section 48A of the EP Act. The City of Gosnells is the responsible authority under the terms of the EP Act and will be the primary contact during the assessment process of the ER.

The primary contact at the City of Gosnells is:

Future Planning Team

PO Box 662 GOSNELLS WA 6990
Phone: (08) 9397 3000
Email: council@gosnells.wa.gov.au

1.3 Environmental impact assessment process

All local and regional planning schemes, as well as any amendments to these schemes, are required to be referred to the EPA by the responsible authority under Section 81 or 38 respectively of the *Planning and Development Act 2005*, such that the EPA can determine under Section 48A of the EP Act whether environmental impact assessment of the scheme or scheme amendment is required.

On 15 April 2016, the City of Gosnells referred TPS No. 6 amendment 166 (MKSEA Precinct 3B) to the EPA under Section 48A of the EP Act.

On 16 January 2017, the City of Gosnells referred TPS No. 6 amendment 169 (MKSEA Precinct 2) to the EPA under Section 48A of the EP Act.

On 30 August 2018, the EPA determined that both amendments require assessment through an ER.

On 21 December 2018, the EPA published the *Instructions for Environmental Review* for the proposed scheme amendments, which outlined that the scheme amendments require assessment, because '*the implementation of the schemes through future subdivision, development and provision of infrastructure could have significant environmental effects on key environmental factors.'*

For each of determined preliminary key environmental factors, the Instructions outline:

- EPA factor and EPA objective for that factor.
- **Relevant activities** – relevant development activities that may have a significant impact on that factor, in the context of the proposed scheme amendments.
- **Potential impacts and risks** to that factor, in the context of the proposed scheme amendments.
- **Required work** to be completed by the responsible authority to address that factor.
- **Relevant policy and guidance** which is applicable to that factor and the assessment process.

The City of Gosnells engaged Emerge Associates to prepare the ER in accordance with the Instructions.

The City of Gosnells is responsible for advertising the ER document and scheme amendments, in accordance with Section 84 and 85(1) of the *Planning and Development Act 2005*. Subsequent to the public review period, the City of Gosnells will provide a copy of all received submissions regarding environmental issues to the EPA. The City of Gosnells will address the submissions and provide to the EPA a *Response to Submissions* document.

The EPA will then report to the Minister for the Environment on the environmental factors relevant to the amendments and the recommended Ministerial Statement conditions (if any), which they should be subject to and any recommendations as it sees fit. In consideration of the EPA's report and recommendations, the Minister for Environment, with agreement of the Minister for Planning, will then determine what environmental conditions (if any) are necessary to be applied to the scheme amendments, should they be approved.

1.4 Other Approvals and Regulation

If the proposed scheme amendments are approved, there will be additional planning and environmental approvals required before future commercial and industrial development within the amendment areas can be implemented. These are outlined in **Table 1**.

Table 1: Other planning and environmental approvals

Legislation	Type of approval	Decision making authority	Application to proposed scheme amendments
Planning and Development Act 2005 *Planning and Development (Local Planning Schemes) Regulations 2015* *City of Gosnells Town Planning Scheme 6*	Structure Plan	• Western Australia Planning Commission (WAPC) • City of Gosnells	The 'Business Development' zone proposed in the scheme amendments requires any future development within the amendment areas to be implemented generally in accordance with a structure plan. The City of Gosnells have prepared the draft MKSEA Structure Plan, which has been used to determine the anticipated future environmental impacts of development within the amendment areas (**Section 2.3**). The draft MKSEA Structure Plan will need to be finalised and approved prior to implementation of future commercial and industrial development. Prior to its approval, the MKSEA Structure Plan will need to address the requirements of TPS No. 6 (including any scheme provisions or environmental conditions inserted as a result of this environmental review process, where applicable).
	Subdivision Application	• WAPC	The amendment areas contain various rural land parcels of varying size and ownership. As such, applications by individual proponents to subdivide land (including through amalgamation) are likely as part of future commercial and industrial development. Such applications will need to address the requirements of TPS No. 6 (including any scheme provisions or environmental conditions inserted as a result of this environmental review process, where applicable) and the approved structure plan. Any subdivision approvals would include conditions (including environmental), which would need to be satisfied before subdivided lot titles are issued.
	Development Application	• WAPC • City of Gosnells • Metro Outer Joint Development Assessment Panel	Much of the anticipated future commercial and industrial development is likely to be progressed through development applications (such as bulk earthworks or other non-subdivisional works). Similar to subdivision applications, development applications will also need to address the requirements of TPS No. 6 and the approved structure plan, and would also be subject to approval conditions.

Legislation	Type of approval	Decision making authority	Application to proposed scheme amendments
Environmental Protection Act 1986	Part V works approvals and licencing	• Department of Water and Environmental Regulation (DWER)	If individual proponents of future commercial and industrial development propose to establish and operate 'prescribed premises' (as listed in the *Environmental Protection Regulations 1987*), then this will require applications for works approvals and operating licences to be lodged with and approved by DWER. Any such approvals will be issued by DWER and will be subject to conditions and ongoing environmental compliance requirements.
Environment Protection and Biodiversity Conservation (EPBC) *Act 1999* (Commonwealth)	Environmental Approval	• Department of Climate Change, Energy, the Environment and Water (DCCEEW) • Minister for the Environment	Where individual proponents of future development propose an action which is likely to result in significant impacts to Matters of National Environmental Significance (MNES), the action must be referred to DCCEEW under the EPBC Act. If the proposed action is likely to significantly impact MNES, then DCCEEW will undertake an environmental assessment of the proposed action and the Minister for the Environment will determine whether to issue an approval. Any such approvals will be subject to conditions and ongoing compliance.
Aboriginal Heritage (AH) *Act 1972*[2]	Section 18 Consent	• WAPC • Minister for Aboriginal Affairs	Consent under Section 18 of the AH Act is required to impact an Aboriginal heritage site. Future development within the amendment areas may result in such impacts, triggering Section 18 requirements. Any such development proponents will likely need to undertake consultation with traditional owners of the land and lodge a Section 18 application with the Department of Planning, Lands and Heritage for consideration. The Minister for Aboriginal Affairs determines whether to approve a Section 18 consent, and whether any associated conditions are placed on the approval.
Rights in Water and Irrigation Act 1914	• Section 5C licence to take water • Section 26D licence to construct or alter a well • Section 11 permit to interfere with bed and banks of a watercourse	• DWER	Some future development works within the amendment areas may involve interaction with groundwater and/or surface water resources, such as: • Installation of groundwater bores • Abstraction of groundwater • Works in and around the bed and banks of a watercourse Applications to undertake such activities will be required to be lodged with DWER, who will assess such proposals and determine whether to issue approvals and any associated conditions.

Subject to Section 48I of the EP Act, proposals within an assessed scheme are not required to be referred to the EPA under Section 38 of the EP Act.

[2] The Aboriginal Cultural Heritage Act 2021 will replace the AH Act in July 2023. The Section 18 consent process will be replaced by the respective consent mechanism under the new act.

1.5 Structure of the ER

The structure of the ER is generally consistent with that outlined in the *Instructions on how to prepare an Environmental Review Document* (EPA 2018c), and includes the following sections:

- **Section 1** – which introduces the ER.
- **Section 2** – which outlines the proposed scheme amendments, their background and land use planning context.
- **Section 3** – which outlines the stakeholder engagement undertaken to date in relation to environmental considerations applicable to scheme amendments 166 and 169.
- **Section 4** – which outlines and addresses the determined preliminary key environmental factors. For each factor the following information is presented:
  - EPA objective – statement of the EPA's objective for the factor.
  - Policy and guidance – a list of the relevant policies and guidance for the factor.
  - Receiving environment – a description of the existing environment.
  - Potential environmental impacts – an overview of the potential environmental impacts as a result of future implementation of the proposed scheme amendments (through subdivision, development and provision of infrastructure).
  - Assessment of impacts – an assessment of the potential environmental impacts and their significance.
  - Mitigation measures – discussion of the proposed measures to mitigate potential environmental impacts utilising the mitigation hierarchy (avoid, minimise, rehabilitate).
  - Residual impact – statement of the residual impact after application of the mitigation measures and assessment of whether this is significant.
  - Predicted outcomes – a description of the predicted environmental outcome against the environmental objective.
- **Section 5** – which discusses offsets.
- **Section 6** – which provides a holistic environmental impact assessment for the amendments and associated future development of the amendment areas.

The ER also includes supporting figures and technical appendices.

2 Town Planning Scheme No. 6 Amendments 166 & 169

2.1 Background

The MKSEA has been identified for a combination of development and conservation through the strategic land use planning framework, key documents include:

- Bush Forever (WAPC 2000)
- *Economic and Employment Lands Strategy: non-heavy industrial* (WAPC 2012)
- *Perth and Peel@3.5 Million* (WAPC and DPLH 2018a)
- *South Metropolitan Peel Sub-regional Planning Framework* (WAPC and DPLH 2018b).

To enable future commercial and industrial development of MKSEA, the Western Australian Planning Commission (WAPC) have made four amendments to the Metropolitan Region Scheme (MRS) to rezone land within MKSEA from 'Rural' to 'Industrial', as summarised in **Table 2**.

As a result, all MKSEA precincts are zoned 'Industrial' under the MRS (**Figure 3**). The Greater Brixton Street Wetlands (GBSW), situated between Precinct 2 and Precinct 3B, are reserved for 'Parks and recreation' or 'Public purposes' under the MRS and form Bush Forever Site 387. Some residual 'Rural' zoned lots remain within the GBSW, which are privately owned.

Table 2: MRS Amendments completed within MKSEA

Amendment no.	Spatial extent	MRS amendment	Gazettal date
1211-41	MKSEA Precinct 1	'Rural' to 'Industrial'	August 2012
1300-57	MKSEA Precinct 3C (City of Kalamunda)	'Rural' to 'Industrial'	October 2016
1301-57	MKSEA Precinct 2	'Rural' to 'Industrial'	October 2016
1302-57	MKSEA Precinct 3A & 3B	'Rural' to 'Industrial'	October 2016

As required by planning legislation, the City of Gosnells have progressed local planning processes to bring the local planning scheme into alignment with the MRS. This has involved the completion of a range of feasibility, baseline and other technical and environmental investigations and studies across MKSEA, including those relating to environmental considerations.

To date, two amendments to TPS No. 6 have been approved to rezone MKSEA Precinct 1 and Precinct 3A (**Table 3**). **Figure 2** shows the current TPS No. 6 zoning of MKSEA.

Table 3: TPS No. 6 amendments completed within MKSEA to date

Amendment no.	Spatial extent	TPS No. 6 amendment	Approval date
126	MKSEA Precinct 1	'General Rural' to 'Business Development'	October 2013
165	MKSEA Precinct 3A[1]	'General Rural' to 'General Industry'	December 2016

Note 1: excludes land within the area of amendment 166

2.2 Amendments 166 and 169

To bring the MKSEA and TPS No. 6 into full alignment with the MRS, the City of Gosnells initiated amendments 166 and 169 in 2016 and 2017 respectively.

2.2.1 Proposed zoning

The amendment will rezone MKSEA Precinct 3B and Precinct 2 from 'General Rural' to 'Business Development'. The 'Business Development' zone is defined as follows:

> '*To provide for the progressive and planned development of areas for commercial and industrial uses generally in accordance with a Structure Plan.*'

The 'Business Development' zone is a blanket zone across the amendment areas. The details of conservation areas, open space, roads and commercial and industrial uses is prescribed within a Structure Plan approved by the WAPC in accordance with the *Planning and Development (Local Planning Schemes) Regulations 2015*.

2.2.2 Spatial extent

Amendment 166 covers approximately 66.8 ha[3] generally aligning with MKSEA Precinct 3B and generally bounded by Coldwell Road, Brook Road and Bickley Road. A small portion of Precinct 3A is also included in amendment 166, in addition to the road reserves for Grove and Brook Roads.

Amendment 169 covers approximately 177.7 ha[3] generally aligned with MKSEA Precinct 2 and bounded by Boundary Road, Tonkin Highway, Victoria Road and Bickley Road. It is noted that amendment 169 does not include the road reserves of Boundary, Brentwood and Victoria Roads.

The amendment areas are shown in **Figure 2** and the geographic relationship between the amendment areas and GBSW (Bush Forever site 387) is shown in **Figure 3**.

2.2.3 Scheme provisions

The following provisions have been developed as part of this ER and will be inserted into the City of Gosnells TPS No. 6 text for both amendment areas. These provisions specify the environmental requirements to be addressed through the subsequent stages of the land use planning process.

- Subdivision and development are to be in accordance with an approved Structure Plan, which shall be prepared in accordance with *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 Part 4. The approved Structure Plan together with all approved amendments shall apply in relation to the land within the area of the Structure Plan. The zones designated in the Structure Plan and the permissibility of uses within those zones shall be given due regard when determining applications within the Structure Plan area.
- The Structure Plan must provide for the protection and enhancement of the following environmental values within Biodiversity Asset public open space areas:
  - Conservation category wetlands within private lots and buffers
  - Threatened ecological communities within private lots and buffers
  - Yule Brook and a determined foreshore reserve.

[3] The areas quoted in the EPA Instructions are incorrect and have been corrected in this ER based on the referred scheme amendments and associated spatial data provided by the City.

- Prior to the approval of the Structure Plan, a Conservation Area Management Strategy shall be prepared and approved by the City of Gosnells. The purpose of the strategy is to define a consistent approach to the short and long-term management of Biodiversity Asset public open space areas identified within the Structure Plan.
- Where subdivision applications affect land, which has not been directly surveyed for flora and vegetation or terrestrial fauna, suitable surveys are to be undertaken to support the application to determine if significant flora, vegetation and fauna values occur. If such values are identified, then they must either be protected or necessary environmental approvals must be attained if they are to be impacted (including the provision of offsets where required).
- Where subdivision applications affect land that contains environmental values identified in the Structure Plan, the local government will recommend to the WAPC that a condition of subdivision approval be imposed, requiring a Conservation Area Management Plan to be prepared for any applicable Biodiversity Asset public open space areas, which will detail how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Development applications on land that contains environmental values identified in the Structure Plan, shall be accompanied by a Conservation Area Management Plan (unless an existing Conservation Area Management Plan already applies to the land), that details how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Prior to the commencement of subdivisional or development works, a Construction and Environmental Management Plan shall be prepared by the proponent and approved by the local government. The plan shall outline the construction management actions to be implemented and is to be consistent with the management actions identified in any applicable Conservation Area Management Plan.
- Prior to the approval of the Structure Plan, a Local Water Management Strategy shall be prepared and approved for each MKSEA precinct included within the Structure Plan area. The purpose of each strategy is to define the water management strategy for future development proposed in the Structure Plan area.
- Prior to commencement of subdivision or development works, an Urban Water Management Plan shall be prepared and approved. The purpose of the plan is to detail how the water management strategy documented in the Local Water Management Strategy will be implemented as part of subdivision or development works.

2.3 Draft MKSEA Structure Plan (Precincts 2 and 3B)

The City of Gosnells began preparing the MKSEA Structure Plan across precincts 2 and 3B in 2017. The draft MKSEA Structure Plan shows the most current and applicable layout of anticipated future development within the amendment areas and is shown in **Appendix A** and **Figure 4**.

The draft MKSEA Structure Plan will be an important statutory planning tool to facilitate the expansion of the GBSW beyond the boundary of Bush Forever site 387, consistent with the EPA's Section 16 strategic advice (EPA 2022) for the GBSW.

This will be accomplished because the draft MKSEA Structure Plan has been developed using three important design principles:

- No development within the GBSW (Bush Forever site 387).
- Avoid development of wetlands, waterways and their buffers/foreshore, native vegetation and fauna habitat in 'good' or better condition (where possible) outside the GBSW.
- Focus development in areas which are 'degraded' or 'completely degraded'.

The portions of the draft MKSEA Structure Plan shown as 'public open space/conservation' (**Appendix A**) will meet the 'Biodiversity Asset' public open space (POS) classification, as detailed in the City of Gosnells *Public Open Space Strategy* (CoG 2014). The Biodiversity Asset POS classification provides for conservation land uses (such as retention of significant environmental values, installation of fencing, revegetation, rehabilitation) and ancillary recreational land uses where appropriate (such as interpretative signage, walking trails and boardwalks). Once created, Biodiversity Asset POS areas will ultimately be ceded to the City of Gosnells for long-term management.

The draft MKSEA Structure Plan proposes a network of Biodiversity Asset POS areas in response to the identified environmental values which require future retention and protection, including:

- Occurrences of threatened ecological communities and buffers.
- Occurrences of threatened and priority flora.
- The Yule Brook watercourse and foreshore area.
- Buffers to the Greater Brixton Street Wetlands, including the removal and realignment of Boundary Road.
- Conservation categories wetlands and buffers.
- Threatened fauna habitat.

Additionally, a fundamental assumption of the draft Structure Plan layout is for no change to occur to the existing conservation land uses within the Greater Brixton Street Wetlands.

As a result, the draft MKSEA Structure Plan will provide for over a quarter of the amendment areas to be included in Biodiversity Asset POS areas (transferring them from private to public ownership), with potential for this land to be included in an expanded GBSW and therefore provide an approximate 50% increase in the size of the original GBSW Bush Forever site. Implementation of the draft MKSEA Structure Plan will result in this land being acquired or ceded free of cost and protected via reservation.

The draft MKSEA Structure Plan is accompanied by an Environmental Assessment and Management Strategy (EAMS) and Local Water Management Strategy (LWMS) for Precincts 2 and for 3B. These documents outline the environmental responses of the Structure Plan layout, as well as the future environmental management strategies and controls to be implemented as development proceeds. The EAMS documents are provided in **Appendix B** (Precinct 2 or amendment 169) and **Appendix C** (Precinct 3B or amendment 166). The LWMS documents are provided in **Appendix D** (Precinct 2 or amendment 169) and **Appendix E** (Precinct 3B or amendment 166).

The draft MKSEA Structure Plan and the associated EAMS and LWMS documents may require amendment to include information arising from the EPA assessment and any relevant environmental conditions. This will occur prior to approval of the MKSEA Structure Plan.

It is important to note that there are some minor differences between the extent of the amendment areas, MKSEA precincts and the draft MKSEA Structure Plan boundary, as detailed in **Section 2.5**. As such, the site boundaries presented in the EAMS and LWMS documents, whilst similar to that in ER, may not align exactly due to these minor differences.

2.4 Approved MKSEA Structure Plan (Precinct 3A)

A portion of amendment 166 (comprising part of lots 413 and 414 Grove Road) is situated within precinct 3A and therefore is not included within the extent of the draft MKSEA (precinct 2 and 3B) Structure Plan. With respect to this land:

- The portion of lot 414 within amendment 166 is a privately owned land parcel, of which:
  - The portion north of Yule Brook is subject to the approved MKSEA Precinct 3A Structure Plan (provided in **Appendix A** and shown on Inset A of **Figure 4**), which identifies the majority of the land for non-developable land uses associated with the Yule Brook 'foreshore setback' or a '30m buffer to resource enhancement wetland 7635'. A portion is also identified as a '20m interface buffer' which is not proposed to support industrial development, but may be used for drainage infrastructure.
  - The portion south of Yule Brook is outside of any current structure planning area. It has been inferred and assumed that this area will wholly comprise a foreshore area for Yule Brook, given this is the land use proposed in the respective structure plans for the immediately adjacent areas which bound this land to the north and south. As such, no development of this area is assumed.
- The portion of lot 413 within amendment 166 is part of the Kenwick Rail Freight Facility, which is being constructed by the Public Transport Authority. This area has been cleared as part of these construction works.

2.5 Environmental impact assessment area

It is important to note that the amendment areas do not exactly align with the draft MKSEA Structure Plan area, these include:

- As illustrated in **Figure 2** amendment 169 excludes Boundary, Brentwood and Victoria Roads. Notwithstanding this, these roads will be upgraded as development proceeds and importantly most of Boundary Road will be closed, removed and rehabilitated; facilitating improved connectivity to the GBSW and increasing the area of the Bush Forever site. As such, it is important this ER considers and assesses any potential environmental impacts of these road upgrades. The City of Gosnells understands the upgrading and removal of these roads will not be technically covered by the environmental approval for amendment 169, although it is noted these roads are covered by the MRS amendments and associated EPA referrals (see **Table 2**).
- As illustrated in **Figure 4** (Inset A) amendment 166 includes a portion of Lots 413 and 414 in the west of the amendment areas which falls outside of the draft MKSEA (Precinct 3B and 2) Structure Plan and into the approved MKSEA Precinct 3A Structure Plan. As such, the land uses shown in the approved MKSEA Precinct 3A Structure Plan apply to this area where applicable, as discussed in **Section 2.4**. On this basis, the outcomes of the environmental assessment of the environmental values within Precinct 3B presented in this ER apply equally to the area of Lot 414 and 413 within the amendment 166 area.

To address this misalignment, a 'site' boundary has been developed to fully encompass both the boundaries of the amendment areas and structure planning areas, and is shown in **Figure 5**. The 'site' boundary is 10.3 ha larger (254.8 ha) than the amendment areas due to the inclusion of the applicable portions of Boundary, Brentwood and Victoria Roads. The site boundary is depicted in **Figure 4** to **Figure 17** and has been used as the basis for the environmental impact assessment documented in this ER.

In this context, the site has been categorised into two land use categories to inform the environmental impact assessment process. These are shown in **Figure 6** and are defined as follows:

- '**Future development footprint**', which encompasses the areas where physical impacts of future development associated with implementing the amendments are anticipated to occur. This includes the areas identified in the structure plans for commercial and industrial land uses, composite land uses, the road network, multiple use corridors and drainage areas. This comprises a total area of approximately 185.4 ha.
- '**Future environmental retention areas**', which encompass the areas outside of the development footprint where existing environmental values are to be protected. This includes the proposed Biodiversity Asset POS areas identified in the structure plans, which will provide for the retention of conservation category wetlands, threatened ecological communities, threatened flora, Yule Brook, and associated buffers and foreshore areas. This comprises a total area of approximately 70.4 ha.

2.6 Local and regional context

2.6.1 Existing rural land uses and private land tenure

The site supports a variety of existing rural land uses, including:

- Rural-residential
- Equine and small-scale livestock properties
- Light commercial
- Truck and machinery lay down areas
- Waste and recycled material storage and stockpiling
- Wrecked-car storage.

Existing land uses give rise to threatening processes, indirect environmental impacts and cause pollution by the nature of their operations, particularly given the absence of a contemporary surface water drainage system across the site. Currently there is little or no treatment of the quality of surface water runoff, which ultimately flows through GBSW and Yule Brook.

The site is currently vulnerable to detrimental and unlawful activity such as rubbish dumping, wood collection, weeds, pest animals, unauthorised access (including four-wheel-drive and trail bikes) and arson.

In this context, a 'do nothing' scenario of maintaining existing land uses across the site causes environmental harm presently and in the future. The orderly future development of the site in accordance with proper planning and land management will have environmental benefits, including:

- Phasing out of any existing land uses which causes environmental impacts due to the unregulated nature of their activities.

- Construction of a contemporary and effective stormwater management and drainage system, to control and manage stormwater runoff quality and quantity more effectively.
- Introduction of new commercial and industrial land uses, all of which would be subject to contemporary environmental and planning regulation (including current best practice urban water management) as part of their applications to regulators to establish and then operate.
- Retention and protection of important environmental values, including long term conservation management and engagement by the City of Gosnells.

2.6.2 Adjacent land uses

The site is located adjacent to the following land uses:

- Existing light industrial and commercial land use to the south in the suburb of Maddington.
- Existing rural land uses to the east in the suburbs of Wattle Grove and Orange Grove.
- Existing reserves, primarily being the GBSW, which are situated between the two amendment areas.
- Existing areas of commercial and industrial development to the immediate north (MKSEA Precinct 3A) and south (MKSEA Precinct 1).
- A series of major roads, which bound MKSEA, including Roe Highway, Welshpool Road, Tonkin Highway and Bickley Road.
- A freight railway line to the west (adjacent to Roe Highway).
- Suburban residential areas to the north, west and south in the suburbs of Wattle Grove, Kenwick and Beckenham, respectively.

2.6.3 Climate

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. The Gosnells locality receives a mean annual rainfall of 804 mm, based on records between 1961 and 2021 at the Gosnells City weather station (BOM station 9106), situated approximately 2 km south of the site. The months between May and August typically receive the majority of rainfall. The Gosnells locality experiences a mean annual minimum temperature of 13.5°C and a mean annual maximum temperature of 25.6°C, based on records between 1991 and 2021 at the same weather station.

The south-west of Western Australia is experiencing a long-term decline in annual rainfall, as shown in **Plate 1**. Since 1970, there has been an approximate 10-20% drop in winter rainfall, which has occurred as a series of step-changes, as opposed to a gradual decline (BoM 2015). High rainfall years, which were common prior to 1970, have been absent since this time.

The south-west of Western Australia is also experiencing a long-term increase in the annual mean temperature anomaly (being the difference between the long-term average temperature and the actual recorded temperature), as shown in **Plate 2**.

Based on these long-term trends and the continued impacts of climate change, it is anticipated that the annual rainfall in the south-west of Western Australia (and within the site) will continue to decline, whilst temperatures will further increase.

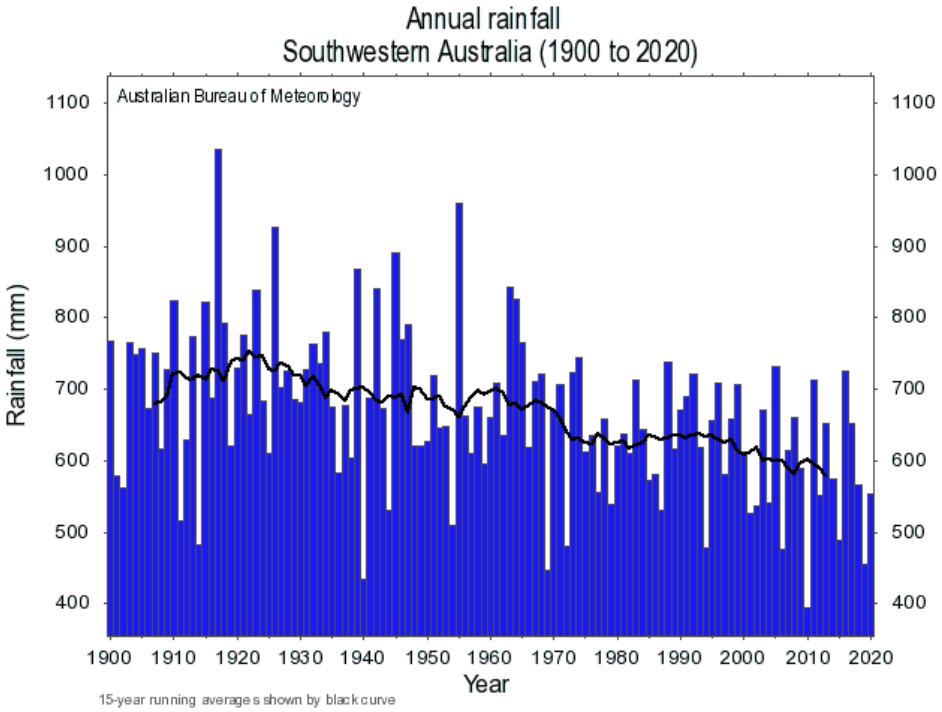


Plate 1: Annual rainfall in south-western Australia 1900 to 2020 (BoM 2021)

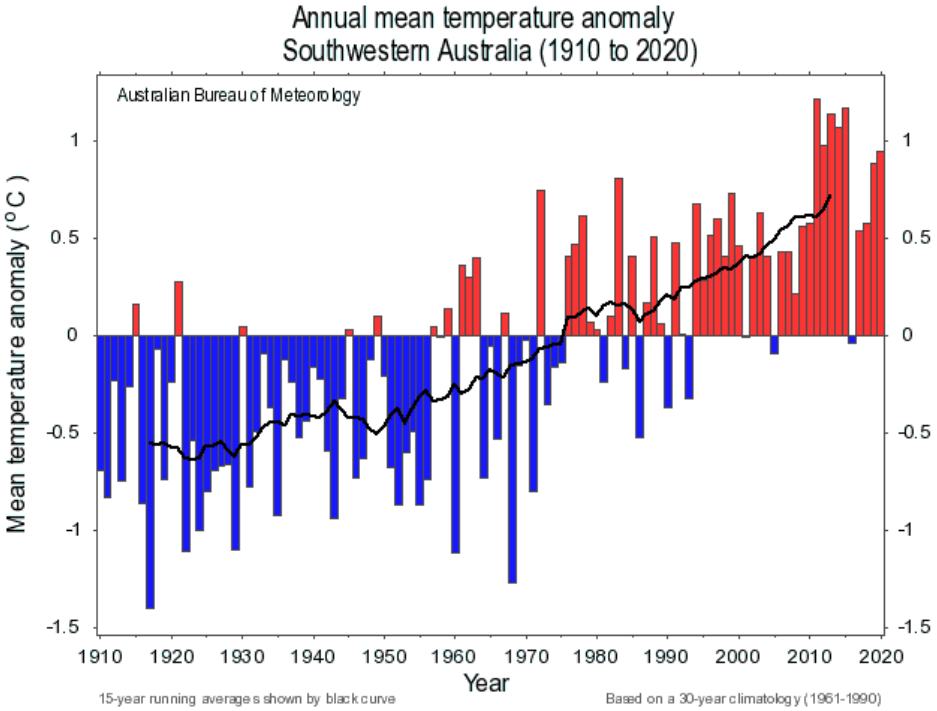


Plate 2: Annual mean temperature anomaly in south-western Australia 1910 to 2020 (BoM 2021)

2.6.4 Yule Brook sub-catchment and Greater Brixton Street Wetlands

The site is situated within the Yule Brook sub-catchment, as shown in **Figure 7** and **Plate 3**, which forms the northern-most section of the larger Swan Avon Canning River Catchment.

The upper reaches of the Yule Brook sub-catchment occur east of the Darling Scarp, incorporating the suburb of Lesmurdie (and parts of Kalamunda, Walliston and Carmel). A series of surface water channels convey runoff flows to west, including via Lesmurdie Falls at the Darling Scarp. There are two primary surface water features within the sub-catchment, being Woodlupine Brook and Yule Brook, which comprise relatively natural watercourses with extensive remnant vegetation in the upper catchment areas. However, both watercourses vary in form and condition west of the Darling Scarp, with higher levels of disturbance and riparian vegetation clearing in areas where the waterways flow through rural land and beneath roads. Yule Brook passes through the site within Precinct 3B, hydrologically downstream of the GBSW. In its lower reaches, Yule Brook is designated as a 'Main Drain' and is managed by the Water Corporation.

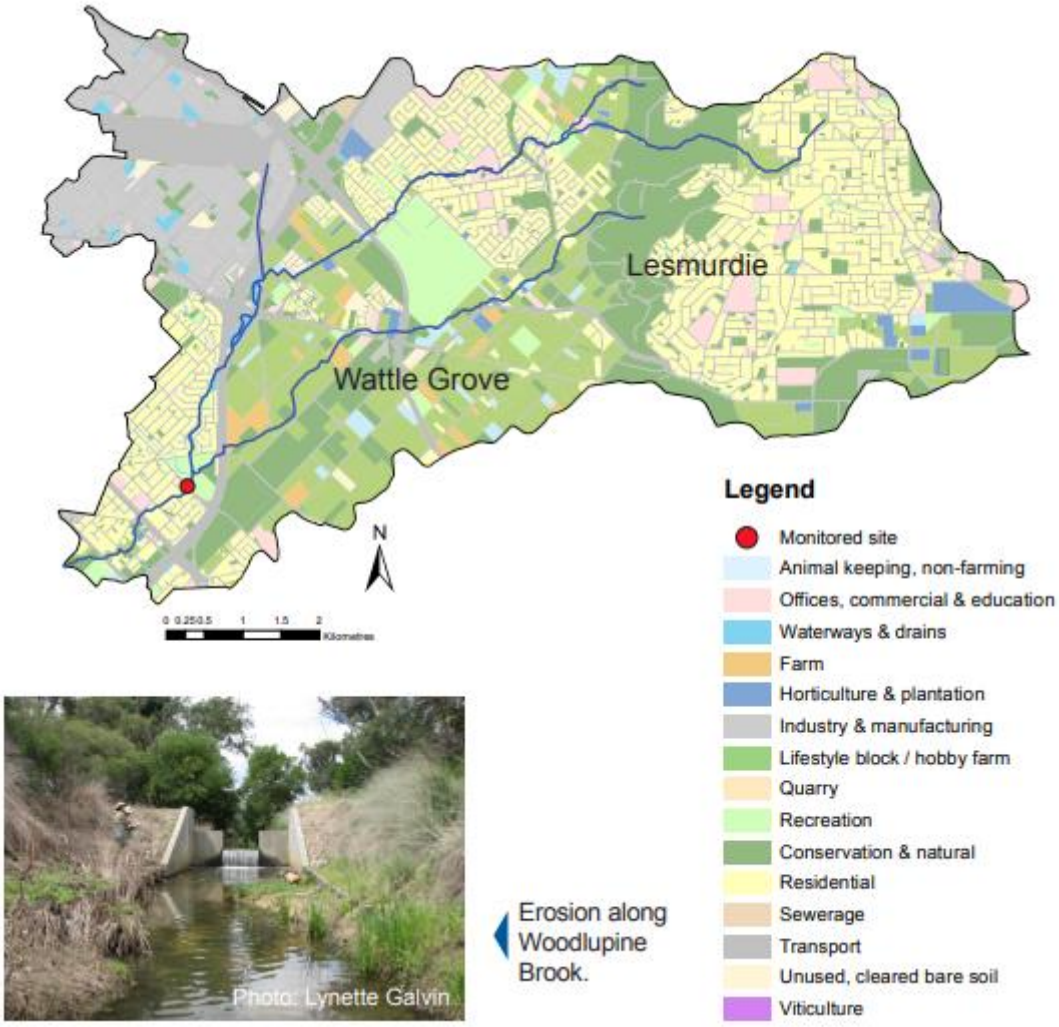
A detailed Water Balance Assessment of the portion of the Yule Brook sub-catchment applicable to the site has been completed as part of this ER, incorporating MKSEA Precinct 2 and Precinct 3B, in addition to the GBSW. This is detailed in **Section 4.2.6.**

The results of the Water Balance Assessment can be used to infer the general characteristics of the total water cycle for the wider Yule Brook sub-catchment, which is summarised as follows:

- The primary water input is rainfall. Being at the northern edge of the Swan Avon Canning River Catchment, there are unlikely to be any significant inflows from adjoining areas into the sub-catchment area.
- The majority of the sub-catchment is situated on the Pinjarra Plain landform, which is characterised by impermeable soil layers often resulting in expressions of perched groundwater. This landform significantly affects the flow of water across the sub-catchment. In this respect:
    - The majority of surface water runoff ultimately flows into surface water channels, including both natural waterways and artificial constructed drains. As outlined above, the primary arterial waterways within the catchment are Yule Brook and Woodlupine Brook.
    - Where surface water runoff infiltrates below the surface, the majority of water is likely to be maintained as perched groundwater rather than infiltrating further into underlying regional aquifers, due to the impermeable substrate layers typical of the Pinjarra Plain. This perched groundwater can then move laterally through the catchment, until it intersects drainage lines or reaches more permeable soil layers enabling deeper groundwater recharge.
- The primary water outputs would comprise evapotranspiration and surface water export via Yule Brook, into the Canning River. Between 2007-2011, the average annual flow of Yule Brook was 7.9 GL, representing approximately 18.6% of the average inflow to the Canning River.

Further discussion of various elements of the total water cycle of the Yule Brook sub-catchment is provided in the following sections:

- **Section 2.6.4.1**, in relation to the geomorphology of the sub-catchment.
- **Section 2.6.4.2**, in relation to the GBSW, which are the primary and most significant remnant wetland chain within the sub-catchment.
- **Section 2.6.4.3**, in relation to the Yule Brook, which is the primary and most significant watercourse within the sub-catchment.



Erosion along Woodlupine Brook.

Plate 3: Yule Brook sub-catchment and land-uses. Shows alignment of Woodlupine Brook (northern feature) and Yule Brook (southern feature) (SRT 2011)

2.6.4.1 Geomorphology

The Yule Brook sub-catchment, including the site, is located in the eastern portion of the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area. The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp and Darling Plateau to the east. Broadly, the Swan Coastal Plain consists of two sedimentary belts of different origin; the western side consisting of three dune systems composed of soils deposited by the wind and the eastern side consisting of alluvial material washed down from the adjacent Darling Scarp (Seddon 2004).

The majority of the Yule Brook sub-catchment and the site is situated on the alluvial Pinjarra Plain (**Figure 7**). As such, the geomorphology of the site is generally characterised by a relatively flat landscape, which supports surface water flows and channels that can lead to water-logging and the formation of seasonal wetlands, typical of the Pinjarra Plain. These surface water features carry water and sediments from the upper reaches of the Yule Brook sub-catchment toward the Canning River.

The Pinjarra Plain is characterised by soils of the Guildford Formation, which include a combination of sand, mud, clay and mixtures of these (V & C Semeniuk Research Group 2001). Clay layers are generally impermeable and restrict the flow of water, in contrast to sandy layers, which allow for the flow of water (both horizontally and vertically).

Within these soil types, the upward movement of groundwater or downward infiltration of surface water can transport elements to form iron-rich (ferricretes) or calcium-rich (calcretes) cemented layers. These cemented layers are highly impermeable and can form the base of claypan wetland systems, such as those within the GBSW (Lane and Evans 2019).

Upland areas also occur intermittently within and adjacent to the site, comprising dunal landforms and sandy soils typical of the Bassendean Dune system. These dunes are characterised by sometimes thick upper horizons of quartz-dominated sand, which have been leached of minerals and organic material, over a deeper horizon containing the accumulated organic material and minerals. The sandy nature of these soils means they are highly permeable to the flow of water.

2.6.4.2 Greater Brixton Street Wetlands (GBSW)

The GBSW are a complex series of regionally and nationally significant wetlands, comprising areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands). The vast majority of the GBSW comprises native vegetation which is highly biodiverse, supporting at least 611 native plant taxa, threatened and priority flora, threatened ecological communities, and habitat for threatened and priority fauna, discussed further in **Section 4.3.3** and **Section 4.4.3**.

Unlike the majority of seasonal wetlands within south-west Australia which are freely connected to regional groundwater, the GBSW rely almost solely on rainfall to fill due to the underlying clay-dominated soils of the Guildford formation, which are waterlogged through winter and form deep pools in clay depressions (DBCA 2018).

The GBSW are situated in the western portion of the Yule Brook sub-catchment, outside of and between the two amendment areas. MKSEA Precinct 2 is hydrologically upstream of the GBSW, whilst Precinct 3B (and Yule Brook) is hydrologically downstream of the GBSW.

The GBSW are reserved for 'Parks and recreation' or 'Public purposes' under the MRS and comprise Bush Forever Site 387 (**Figure 3**) and covers an area of approximately 176 ha. Several existing roads dissect the GBSW, including Brixton Street, Bickley Road and Boundary Road, as well as a number of rural properties along Brook Road and Boundary Road. The land tenure across the GBSW is variable, with the primary landowners and management authorities including the Department of Biodiversity, Conservation and Attractions (DBCA), the University of Western Australia and the WAPC. Notwithstanding, some privately owned rural properties still occur amongst the publicly reserved portions of the GBSW.

Brook Road and Boundary Road abut the majority of the GBSW where they interface with the site. Historical development of the wider locality has resulted in the construction of artificial drainage lines within road reserves, which still exist throughout the site. Both Brook Road and Boundary Road contain constructed roadside drains, which capture and direct surface water runoff (as well as intersected groundwater flows). Upstream of GBSW within Precinct 2, there is a single surface water discharge point from the Boundary Road roadside swale into the GBSW (approximately 700 m north-

east of Bickley Road), with surface water flowing north-west through the GBSW via a surface water tributary to Yule Brook, which then discharges flows via a single culvert under Brook Road and ultimately flows into Yule Brook. These features are shown in **Figure 11**.

2.6.4.3 Yule Brook

Yule Brook is the primary natural watercourse within the Yule Brook sub-catchment and flows through amendment area 166 (Precinct 3B), as shown in **Figure 7** and **Plate 3**.

The site contributes to the Yule Brook sub-catchment (with the exception of a small portion in the south of Precinct 2 which drains to the Bickley Brook sub-catchment to the south). The Yule Brook flows out of the site to the west, ultimately discharging to the Canning River upstream of the Kent Street Weir.

Key tributaries of the primary Yule Brook channel include Woodlupine Brook (which connects with Yule Brook outside of and hydrologically downstream of the site) and the surface water tributary which flows through the GBSW from Precinct 2, as shown in **Figure 11**.

The annual flows within Yule Brook have declined in recent years; the longer-term (35 year) average flow is > 9,700,000 kL, whereas the shorter term (10 year) average flow is 8,200,000 kL (at Brixton Road gauging station (monitoring location 616042), located downstream of MKSEA, as shown in **Figure 7**). When comparing the short-term average with longer-term average the trend shows a decline of annual surface water runoff in Yule brook of approximately 15%.

2.6.5 Conservation areas

There are currently no reserves within the site that protect existing environmental or conservation assets, such as Yule Brook, conservation category wetlands, remnant native vegetation or threatened species and ecological communities. These conservation assets are currently held in private ownership within 'Rural' zoned land.

The following conservation areas occur in the surrounding local area (**Figure 7**):

- Bush Forever Site 387 – GBSW, which comprises a combination of public and privately owned land identified for conservation purposes, situated between the two amendment areas.
- Bush Forever Site 320 – Hartfield Park Bushland, approximately 700 m north-east of the site.
- Bush Forever Site 246 – aligning with the Canning River and its foreshore reserve, approximately 2 km south-west of the site.
- Bush Forever Site 53 – Clifford Street Bushland, approximately 700 m south-east of the site.
- Bush Forever Site 283 – Queens Park Bushland, approximately 1.5 km north-west of the site.

3 Stakeholder Engagement

3.1 Key stakeholders

The key stakeholders in relation to the proposed scheme amendments are considered to include:

- Whadjuk Noongar traditional owners
- Owners of private land within the amendment areas
- City of Gosnells
- City of Kalamunda
- Department of Planning, Lands and Heritage and the Western Australian Planning Commission
- Department of Water and Environmental Regulation, including the Environmental Protection Authority Services Directorate
- Department of Biodiversity, Conservation and Attractions
- Department of Climate Change, Energy the Environment and Water (Commonwealth)
- Public Transport Authority
- Water Corporation
- University of Western Australia
- Friends of Brixton Street Wetlands
- Surrounding residents and community.

3.2 Stakeholder engagement process

3.2.1 Planning for MKSEA over the long-term

Land use planning for MKSEA has been a long-term process that has involved a range of stakeholder consultation initiatives and processes to date. The following broad groups of consultation have been undertaken to date:

- Public advertising of regional and sub-regional planning strategies which identify MKSEA for future commercial and industrial development, such as the *Economic and Employment Lands Strategy: non-heavy industrial*, *Perth and Peel@3.5 Million* and the *South Metropolitan Peel Sub-regional Planning Framework*. State government agencies led this consultation.
- Public advertising of MRS amendments for land comprising MKSEA. This has included MRS amendments 1211-41 (Precinct 1), 1300-57 (City of Kalamunda), 1301-57 (Precinct 2) and 1302-57 (Precinct 3). The WAPC led this consultation.
- Public advertising of TPS No. 6 amendments for land comprising MKSEA. This has included TPS No. 6 amendments 126 (Precinct 1) and 165 (Precinct 3A). The City of Gosnells led this consultation.
- City of Gosnells targeted consultations with affected landowners, Whadjuk Noongar traditional owners and the local community.
- City of Gosnells targeted consultation with relevant Government agencies.

3.2.2 TPS No. 6 amendments 166 and 169

In accordance with the *Planning and Development (Local Planning Schemes) Regulations 2015*, public advertising of the proposed scheme amendments will be required. The EPA have recommended a

public advertising period of 90 days (greater than the minimum required advertising period of 60 days), which the City of Gosnells propose to adopt.

Public advertising of the amendments will occur concurrently, once the following criteria are satisfied:

- The WAPC has reviewed the amendment documents and advised the City of Gosnells that the amendments are suitable to be advertised.
- The City of Gosnells has forwarded the ER to the EPA and the EPA has advised that the ER has been completed in accordance with the Instructions, or 30 days have elapsed since the ER is forwarded without the EPA having advised whether or not the review has been completed in accordance with the instruction, whichever occurs first.

Following completion of the public advertising period, the City of Gosnells will consider any submissions received during the public advertising period. This will involve preparation of a *Summary and Response to Submissions* document, which will conclude whether any modifications to the ER are required to address matters raised within submissions.

3.3 Stakeholder consultation outcomes

Table 4 provides a summary of the key stakeholder consultation actions completed to date in relation to the proposed future commercial and industrial development of the site.

Table 4: Summary of stakeholder consultation

Stakeholder/s	Date/s	Consultation description
Landowners	October 2006	Three information evenings held to present findings of baseline technical studies (environmental, infrastructure, drainage, traffic, transport) and consult landowners to identify specific opportunities and constraints to the development of MKSEA for commercial and industrial purposes. There was broad support for progressing planning for the area, with landowners expressing a frustration at the lack of certainty around the future land use intent for the area. In response, the City prepared a draft concept plan to reflect the outcomes of the technical studies and landowner consultation.
Landowners and surrounding residents	March 2007	Two information evenings held to present concept plan and invite submissions. The concept plan was updated in response to submissions received and it was then advertised between December 2007 and February 2008.
All stakeholders (public advertising period)	November 2015 – January 2016	MRS Amendments 1301-57 and 1302-57 (MKSEA precincts 2 and 3 respectively) publicly advertised by the WAPC. Following consideration of the submissions received, WAPC recommended to approve both amendments, which was agreed by the Minister for Planning.
Landowners, community groups and academia	October 2017	Environmental Symposium – Rich and Rare: Knowing and Caring for the GBSW and Yule Brook.
Whadjuk Noongar traditional owners	October 2018	Completion of site-specific investigations of mapped Aboriginal heritage sites within MKSEA. Discussed in detail in **Section 4.5**.
Department of Biodiversity, Conservation and Attractions	December 2020 and February 2021	Emerge Associates liaised with DBCA to request information in relation to the site and the GBSW which could be applicable to preparation of the ER. DBCA provided a number of references and spatial data for use in the ER.

Stakeholder/s	Date/s	Consultation description
DWER – EPA Services Directorate, DWER Water Science	August 2020, October 2020, May 2021, October 2022, December 2022, January 2023.	A number of meetings were held between the City of Gosnells, Emerge Associates and DWER - EPA Services Directorate, where the following items were discussed: • Clarifications around the ER Instructions and requirements • Discussions around potential impact mitigation strategies • Methodology for the water balance assessment (including discussions with DWER Water Science officers) • Further work required to inform finalisation of the ER. The outcomes of these meetings have guided preparation of the ER.

4 Environmental Principles and Factors

This section considers the proposed scheme amendments in relation to the environmental principles of the EP Act (**Section 4.1**) and the key environmental factors determined by the EPA:

- Inland Waters (**Section 4.2**)
- Flora and Vegetation (**Section 4.3**)
- Terrestrial Fauna (**Section 4.4**)
- Social Surroundings (**Section 4.5**).

4.1 Object and Principles of the *Environmental Protection Act 1986*

The object of the EP Act is "*to protect the environment of the State, having regard to the following principles*" and **Table 5** outlines how the principles of the EP Act have been considered as part of the proposed scheme amendments.

Table 5: Consideration of EP Act principles

Principle	Consideration
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b. assessment of the risk-weighted consequences of various options.	Comprehensive environmental studies have been undertaken in relation to inland waters, flora and vegetation, terrestrial fauna and social surroundings. These studies are described under the relevant preliminary key environmental factor and provide a comprehensive understanding of the existing environmental values within the site. The proposed scheme amendments (and associated future development footprint and future environmental retention areas) have, as much as practicable, taken into account the outcomes of the environmental technical studies to mitigate potential environmental impacts through avoidance, minimisation and rehabilitation measures.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Environmental values within the site are currently located within a number of privately owned land parcels, which are not accessible to the public, nor are these environmental values currently managed for conservation purposes. Implementation of the proposed scheme amendments will enable environmental values identified for retention to be brought into public ownership, ensuring their long-term viability for the benefit of future generations. Environmental impacts will be managed such that the risks of adverse impacts are minimised and the quality of the environment is maintained or enhanced in the long-term wherever possible.

Principle	Consideration
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	As outlined above, a range of thorough and detailed site-specific investigations have been undertaken to determine the existing biological diversity and ecological integrity of the site. These investigations have informed the proposed scheme amendments (and associated future development footprint and future environmental retention areas). Extensive impact avoidance measures are proposed, which will facilitate the future retention and conservation of significant environmental values within the site that support high biological diversity and ecological integrity.
4. Principles relating to improved valuation, pricing and incentive mechanisms a. Environmental factors should be included in the valuation of assets and services. b. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. c. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. d. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Future environmental retention areas have targeted significant environmental values. These are generally of suitable area, shape, geometry, condition and connectivity such that they have some ecological viability and resilience, which means ongoing and long-term maintenance and management costs of these reserves will be minimised while preserving the original ecological viability of the environmental values. In contrast, smaller, isolated and more disturbed areas of environmental values are typically less ecologically viable and have not been targeted for future retention. The ecological viability of such areas is more difficult to maintain or restore in the long-term, and ongoing management costs become increasingly higher, which is generally not practical for land management authorities. With respective to the 'polluter pays' principle, any future land uses which require a works approval and operating licence under Part V of the EP Act will be responsible for funding such requirements, including the provision of any required onsite infrastructure to suitably mitigate potential or anticipated emissions to the environment.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Future implementation of commercial and industrial development across the site will take all reasonable and practical measures to minimise the generation of waste and its discharge into the environment. This will include the use of reticulated sewer and water as part of future development, as well as removal of existing potentially polluting land uses within the site.

4.2 Key Environmental Factor: Inland Waters

4.2.1 EPA objective

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

4.2.2 Relevant policy and guidance

Table 6: Relevant policy and guidance for the inland waters environmental factor

Policy and Guidance	Consideration for the proposed amendments
Statement of Environmental Principles, Factors and Objectives (EPA 2020a)	Referred to in the identification and assessment of potential impacts for each key environmental factor.
Environmental Factor Guideline – Inland Waters (EPA 2018)	Consulted in the consideration of potential impacts to inland waters as a result of the proposed amendments.
Better Urban Water Management (WAPC 2008)	Considered during preparation of the Local Water Management Strategy (LWMS) documents prepared for MKSEA Precinct 2 and Precinct 3B, which are relevant to this ER.
Interim: Developing a local water management strategy (DoW 2008a)	
Operational Policy 4.3 Identifying and establishing waterway foreshore areas (DoW 2012)	Considered as part of the biophysical assessment completed for Yule Brook, as documented in the Precinct 3B LWMS referred to in this ER.
Identification and investigation of acid sulphate soils and acidic landscapes (DER 2015a)	Considered during completion of the ASS investigation completed by Emerge Associates (2018a) for MKSEA Precinct 2 and Precinct 3B, which are relevant to this ER.
Treatment and management of soil and water in acid sulphate soil landscapes (DER 2015b)	

4.2.3 Receiving environment

4.2.3.1 Studies and investigations

The City of Gosnells (and other parties) have undertaken a range of studies and investigations related to inland waters across MKSEA (including the site), as summarised in **Table 7**. These studies and investigations have assessed baseline conditions, as well as the potential impacts and required management measures associated with proposed commercial and industrial land uses.

Many of the studies and investigations completed to date have informed previous stages of the strategic land use process for MKSEA, including preparation of local planning policies, MRS amendments and structure planning.

Table 7: Inland waters studies and investigations applicable to the site and GBSW

Investigation	Author	Scope	Spatial coverage
Hydrological study of the Greater Brixton Street Wetlands	VCSRG (2001)	Study of the wetland and hydrological complexes at a large and small scale.	Greater Brixton Street Wetlands.
MKSEA Environmental Review – Flora, Vegetation, Fauna and Wetlands	Cardno BSD (2005)	Wetland assessment, comprising a review of the geomorphic wetland dataset.	Entire MKSEA boundary (excluding GBSW). Includes the site.
MKSEA Engineering Feasibility Study	GHD (2005)	Development of a drainage, groundwater and nutrient management strategy. Identified issues and constraints to future development.	Entire MKSEA boundary (excluding GBSW). Includes the site.
MKSEA Surface Water and Groundwater Investigation and Monitoring	Aquaterra (2008)	Surface and groundwater monitoring and investigation.	Entire MKSEA boundary. Includes the site.
Final MKSEA Surface Water and Groundwater Monitoring and Investigation	Endemic (2012)	Surface and groundwater monitoring and investigation.	Entire MKSEA boundary. Includes the site.
MKSEA Precincts 2 and 3 District Water Management Strategy	TME (2014)	District Water Management Strategy (DWMS)	Entire MKSEA boundary (excluding GBSW). Includes the site.
Geotechnical Investigation MKSEA Precincts 2, 3B, 3C	JDSi (2017)	Geotechnical assessment	MKSEA Precincts 2, 3B, 3C. Includes the site.
Hydrological function of the Greater Brixton Street Wetlands – Data sourcing and review	DPAW (2017)	Review of data and investigations to develop the understanding of the local hydrological function of GBSW.	Portion of GBSW south-west of Brixton Street (outside of the MKSEA boundary)
Swan Canning Catchment Nutrient Report – Yule Brook	DWER and DBCA (2019)	Annual reporting on nutrient concentrations within Yule Brook.	Yule Brook catchment, monitoring location approximately 800 m downstream of MKSEA.
MKSEA Precinct 2 Local Water Management Strategy (**Appendix D**)	Emerge Associates (2022c)	Local Water Management Strategy (LWMS)	MKSEA Precinct 2 only. Includes part of the site.
MKSEA Precinct 3B Local Water Management Strategy (**Appendix E**)	Emerge Associates (2022d)	Local Water Management Strategy (LWMS)	MKSEA Precinct 3B only. Includes part of the site.
Buffer Assessment (**Appendix G**)	Emerge 2022	Provides an assessment of buffers required for significant environmental values	MKSEA Precincts 2 and 3B. Includes the site.

4.2.3.2 Regional context

Section 2.6.4 outlines the geomorphology characteristics of the site and locality. In summary:

- The site is situated on the alluvial Pinjarra Plain, near the eastern edge of the Bassendean Dunes, approximately 2 km west of the Darling Scarp (**Figure 7**). This is characterised by a relatively flat landscape, which supports surface water flows and channels leading from the Darling Scarp to the Canning River, that can lead to water logging and the formation of seasonal wetlands.
- Soil types are typically those of the Guildford Formation, which include sand, mud, clay and a mixture of these. Clay layers are typically impermeable and restrict water flow. Highly impermeable cemented layers also occur and form the base of claypan wetland systems.
- Some upland areas occur intermittently, comprising remnants of the Bassendean Dune system. These comprise leached sands, which are highly permeable to the flow of water.
- Within the Pinjarra Plain, groundwater (including perched groundwater) typically occurs close to the natural surface levels, with separation generally increasing where sandy dunes occur.

4.2.3.3 Greater Brixton Street Wetlands

Section 2.6.4.2 provides an overview of the GBSW and its values. With respect to inland waters considerations, the key considerations are summarised as follows:

- The GBSW are a complex series of regionally and nationally significant wetlands, comprising areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands).
- The GBSW are situated outside of the site and between the two amendment areas. MKSEA Precinct 2 is hydrologically upstream of the GBSW, whilst Precinct 3B is hydrologically downstream of the GBSW.
- Unlike most seasonal wetlands on the Swan Coastal Plain which are connected to regional groundwater (i.e. expressions of groundwater), the GBSW rely almost solely on rainfall and surface water inflows to fill due to the underlying clay-dominated soils of the Guildford formation, which are waterlogged through winter and form deep pools in clay depressions (DBCA 2018). The underlaying clay and cemented layers are generally impermeable and lead to a perched groundwater table, with negligible interaction with the deeper aquifer (regional groundwater). This is supported by groundwater and surface water level monitoring, which shows that both ground and surface waters in the vicinity of the GBSW reserve are highly responsive to rainfall (DPaW 2017).
- As shown in **Figure 11**, the GBSW are bounded by existing roads that contain roadside drains, which capture and direct surface water runoff and intersected groundwater. Upstream of GBSW, there is a single surface water discharge point from the Boundary Road roadside drain flowing into the GBSW (approximately 700 m north-east of Bickley Road), with surface water flowing north-west through the GBSW via the Yule Brook tributary, which then discharges flows via a single culvert under Brook Road and ultimately flowing into Yule Brook.
- GHD (2005) concluded that the GBSW have been hydrologically isolated from their surrounds, primarily through the network of roadside drains which are considered to have altered surface water flows.

A water balance assessment of the site, inclusive of the GBSW, is provided in **Section 4.2.6**.

4.2.3.4 Geotechnical conditions

Existing topographic contours across the site range from 7 m Australian height datum (AHD) at the western extent of the site to 25 m AHD in the south-east (DoW 2008b), as shown in **Figure 8**. The site is generally flat, with a gentle down slope from east to west towards Yule Brook, with the exception of isolated sandy upland areas in the western and eastern extents of Precinct 2.

The Geological Survey of Western Australia, as documented in *Perth Metropolitan Region 1:50,000 Environmental Geology Series Armadale Part Sheets 2033 I & 2133 IV* (Jordan 1986), indicates the site is underlain by white clay of the Guildford Formation and is comprised of:

- **Sand (S_8)**: white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.
- **Clayey sand (S_C)**: silty in part, pale grey-brown, medium to coarse, poorly sorted, sub-angular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin.
- **Sand (S_{10})**: white to pale grey at surface, yellow at depth, fine to medium-grained, moderately well sorted, subangular to subrounded quartz, of eolian origin, over other units.
- **Sand (S_{12}):** structureless, yellow, fine-grained, subangular and medium to coarse-grained subrounded to rounded quartz, feldspar and heavy minerals common, minor silt and clay, of colluvial origin.
- **Sandy silt (Ms_4):** cream to pale brown alluvium, clayey in part, fine to medium-grained sand, of alluvial origin.
- **Sandy clay (Cs):** white-grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp.

Figure 9 shows the mapped extent of the above soils units across the site. **Section 2.6.4** provides further information on the geomorphology of the locality.

Detailed geotechnical investigations undertaken over the site indicate soil characteristics are generally consistent with regional mapping (JDSi 2017). Soils underlying the site are generally comprised of topsoil or fill to depths ranging from 0.1 m to 1.2 m, overlying sand, clayey, silty or gravelly materials. The depth of sand overlying less permeable material ranges from 0 m to over 2 m. The clayey and sandy materials encountered include stiff to hard clay or clayey sand/ sandy clay. These areas are likely to be associated with seasonally perched groundwater. Soil permeability was measured to be relatively high in sandy soils (greater than 10 m/day) and lower in more clay-dominated areas (0.1 m/day within sandy clay).

4.2.3.5 Acid sulfate soils

Regional acid sulfate soils (ASS) risk mapping indicates that the majority of the site is classified as having a 'moderate to low' risk of ASS occurring within 3 m of the natural soil surface. Areas associated with Yule Brook are classified as having a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface. ASS mapping published by DWER (2018) is shown in **Figure 10**.

A site-specific ASS investigation completed by Emerge Associates (2018a) across the broader MKSEA, which included the site, found no significant evidence of ASS within the shallow portion of topsoil comprising Bassendean sand, coffee rock and fill soil types, but some evidence of potential ASS within Guildford Formation (i.e. clayey sand/sandy clay) and silty sand (alluvium deposits).

Overall, the investigation identified limited to no ASS risk within the upper 2.0 m of the soil profile, with isolated areas of medium risk, associated with the silty sand and Guildford formation soil types.

4.2.3.6 Groundwater

Site-specific groundwater monitoring investigations indicate maximum groundwater level (MGL) across Precinct 2 ranges from the surface to over 5 m below ground level, whilst within Precinct 3B it ranges from the surface to over 1.7 m below ground level (Emerge Associates 2022d, c).

Nutrient concentrations measured in groundwater in 2012 were typical of the sites historical uses for grazing and rural agriculture, and nutrient concentrations generally exceed relevant surface water quality guideline values (ANZECC and ARMCANZ 2000; SRT 2009b; Emerge Associates 2018c, d).

Further information on the characteristics of groundwater underlying the site is available in the LWMS documents provided in **Appendix D** and **Appendix E** (Emerge Associates 2022d, c).

4.2.3.7 Surface water features

The site is situated within the Yule Brook sub-catchment (with the exception of a small section of Precinct 2), as shown in **Figure 7**. The upper extents of the catchment include the suburbs of Lesmurdie and Kalamunda (east of the Darling Scarp), with surface water then flowing to the west through parts of the low-lying suburbs of Forrestfield, Wattle Grove and Kenwick. Two main surface watercourses dissect the catchment; Woodlupine Brook and Yule Brook. Both surface watercourses are relatively natural and undisturbed in their upper reaches near the Darling Scarp, however, vary in form and condition west of this within rural and residential areas, due to significant historical disturbance and modification. Both watercourses ultimately join and discharge to the Canning River south-west of the site.

Section 2.6.4.3 provides further information on Yule Brook. In summary:

- Yule Brook flows through Precinct 3B of the site in a south-westerly direction.
- Yule Brook enters Precinct 3B via two culverts beneath Welshpool Road East and exits via three culverts beneath Roe Highway.
- Within Precinct 3B, Yule Brook follows its natural alignment through various privately owned land parcels, however much of its riparian vegetation has been cleared or heavily disturbed.
- South west of the site, Yule Brook is maintained as a Water Corporation main drain and has been significantly modified in some areas.
- The Yule Brook tributary that traverses the GBSW conveys surface water runoff from Precinct 2 through GBSW (connecting within Precinct 3B).
- The annual flows within Yule Brook have declined in recent years. When comparing the short term average with longer term average the trend shows a decline of annual surface water runoff in Yule brook of approximately 15%.

Other surface water features within the site are generally limited to an extensive network of constructed, open and unlined drains, occurring along roadsides and between some lots. The drains convey surface water runoff and also intercept seasonal groundwater, as discussed in **Section 4.2.3.3**.

Hydrological modelling of the site and upstream catchments has previously been undertaken, as documented in the LWMS documents (Emerge Associates 2022d, c) (**Appendix D** and **Appendix E)**.

4.2.3.8 Yule Brook foreshore area

Emerge Associates completed a biophysical assessment of Yule Brook to determine the foreshore area required to protect the values of Yule Brook. The assessment is based on *Operational Policy 4.3: Identifying and establishing waterways foreshore areas* (DoW 2012) and considered various biophysical criteria, including topography, soil type, erosion, geology, hydrology, climate, vegetation, habitat, heritage and function. The assessment is documented in Section 3.6 of the *MKSEA Precinct 3B Local Water Management Strategy* (Emerge Associates 2022d), provided in **Appendix E**. The assessment concluded that the Yule Brook foreshore area is defined as the outer edge of the floodplain and riparian plant communities connected to the channel.

4.2.3.9 Surface water quality

Surface water quality varies across the site, reflecting current and historical land use practices. Surface water quality within Yule Brook measured upstream of the site was found to have nutrients (total nitrogen (TN) and total phosphorus (TP)) exceeding guideline values set by the Healthy Rivers Action Plan (HRAP) (SRT 2009a). The HRAP was prepared by the Swan River Trust to improve water quality in the Swan and Canning Rivers and provides a long-term and short-term target for nutrient reduction. Although existing nutrient concentrations in Yule Brook may at times exceed the Swan Canning Estuary long term water quality targets, this tributary has largely met the short-term targets since 1994 (Endemic 2012).

Elevated concentrations of copper, iron and zinc (and on occasion hydrocarbons) have been observed within streamflow but are considered typical of rural and road runoff (both within and upstream of the MKSEA catchment). Although several trigger value exceedances have been recorded for some metals and nutrients, these exceedances are typical of soils, topography and land-uses commonly associated with the eastern Swan Coastal Plain.

Further information on the characteristics of surface water quality within the site is provided in the LWMS documents provided in **Appendix D** and **Appendix E** (Emerge Associates 2022c, d).

4.2.3.10 Wetlands

Wetlands are areas which are permanently, seasonally or intermittently waterlogged or inundated with water. Naturally occurring wetland features are common across the Swan Coastal Plain and can contain fresh or salty water, which may be flowing or still. DBCA classifies wetland types based on their inundation characteristics and physical structure, as detailed in **Table 8**.

Table 8: DBCA wetland types (adapted from Hill et al. 1996)

	Basin	flat	channel	slope	highland
Permanently inundated	Lake	-	River	-	-
Seasonally inundated	Sumpland	Floodplain	Creek	-	-
Intermittent inundation	Playa	Barlkarra	Wadi	-	-
Seasonally waterlogged	Dampland	Palusplain	Trough	Paluslope	Palusmont

DBCA assign wetlands a management category which provides an indication of their relative condition and conservation value. Management categories include conservation category wetland (CCW), resource enhancement wetland (REW) or multiple use wetland (MUW).

Based on the DBCA *Geomorphic Wetlands of Swan Coastal Plain* spatial dataset, the majority of the site comprises a wetland landform. 26 wetlands are mapped by DBCA as occurring within the site (wholly or partially); 10 CCWs, 11 REWs, and 15 MUWs, as listed in **Table 9** and shown in **Figure 11**.

Wetlands on the Swan Coastal Plain are grouped into 'consanguineous suites' according to their geomorphic origin and attributes. A total of 62 consanguineous suites are recognised on the Swan Coastal Plain (Semeniuk 1995). The particular 'consanguineous suite' a wetland belongs to can help inform an evaluation of its significance. The site is situated within the 'Mungala' consanguineous suite, which contains approximately 25,979 ha of wetlands, of which approximately 12.6% comprises CCWs.

Table 9: Geomorphic wetlands present within the site.

Unique Feature Identifier (UFI)	Geomorphic classification	Management category	Area (ha)
7637	Palusplain	Conservation	0.92
7785	Palusplain	Conservation	0.72
7797	Palusplain	Conservation	0.07
8031	Sumpland	Conservation	0.44
8033	Palusplain	Conservation	0.69
13131	Sumpland	Conservation	0.07
13826	Sumpland	Conservation	2.30
14426	Palusplain	Conservation	1.40
14962	Palusplain	Conservation	1.81
*15255**	*Palusplain*	*Conservation*	*0.15*
Subtotal (CCW)			**8.42**
7634	Palusplain	Resource Enhancement	1.33
7635	Palusplain	Resource Enhancement	6.32
7636	Palusplain	Resource Enhancement	7.55
8034	Sumpland	Resource Enhancement	1.16
8036	Sumpland	Resource Enhancement	1.32
8045	Palusplain	Resource Enhancement	1.09
13825	Sumpland	Resource Enhancement	0.73
15418	Palusplain	Resource Enhancement	0.69
15983	Palusplain	Resource Enhancement	104.76

Unique Feature Identifier (UFI)	Geomorphic classification	Management category	Area (ha)
15984	Palusplain	Resource Enhancement	1.31
15987	Sumpland	Resource Enhancement	2.93
Subtotal (REW)			**129.19**
7798	Palusplain	Multiple Use	0.56
7799	Palusplain	Multiple Use	3.64
7800	Palusplain	Multiple Use	0.52
7805	Palusplain	Multiple Use	1.31
8046	Palusplain	Multiple Use	0.27
8047	Dampland	Multiple Use	1.25
14963	Palusplain	Multiple Use	5.21
14964	Palusplain	Multiple Use	0.12
15254	Palusplain	Multiple Use	43.36
15296	Palusplain	Multiple Use	4.07
15419	Palusplain	Multiple Use	1.48
15930	Palusplain	Multiple Use	0.95
15985	Palusplain	Multiple Use	2.05
15986	Sumpland	Multiple Use	0.44
16133	Palusplain	Multiple Use	0.32
Subtotal (MUW)			**65.55**

* UFI 15255 is a 41.6 ha CCW associated with the Wanaping Block of the GBSW (section bounded by Wanaping Road, Brixton Street, Roe Highway and Bickley Road). The 0.15 ha portion of this wetland that intersects the site is separated from the rest of UFI 15255 by the Bickley Road carriageway and is mapped within the site over the road bitumen and a slither of an adjacent cleared rural lot. As such, the apparent inclusion of 0.15 ha oh CCW 15255 within the site is only as a result of the coarseness of the Geomorphic Wetlands of Swan Coastal Plain spatial dataset and the reality on the ground is that this CCW does not extend into the site. As such, this 0.15 ha portion has been excluded from the CCW sub-total.

(Emerge Associates 2022b) completed an assessment of mapped wetlands within private lots within the site to determine whether their assigned management categories are appropriate. This involved:

- An assessment of geomorphology and inundation levels to define the most suitable wetland type classification.
- An assessment of 'significant features' such as presence of a threatened ecological community (TEC) or threatened flora (TF) to define the applicable management category.
- Delineation of the boundary of the feature, as determined by presence of significant features, geomorphology and hydrological regimes.

(Emerge Associates 2022b) recommended eight wetlands for reclassification to CCW and/or to have changes made to their mapped boundary extent, as listed below in **Table 10**. The remaining wetlands mapped across private lots within the site were concluded to align with their current geomorphic wetland type and management category. The recommended modified wetland boundaries are shown in **Figure 11** and were used to inform the draft MKSEA Structure Plan layout.

Table 10: Summary of proposed modifications to wetland management categories (Emerge Associates 2022b)

UFI	Geomorphic classification	Management category		Boundary changes	Reasoning
		Current (DBCA 2017)	Recommendation		
7785	Palusplain	CCW	CCW	Yes	TEC, TF
7635	Palusplain	REW	CCW (part)	Yes	TEC, TF
14426	Palusplain	CCW	CCW	Yes	TEC, TF
7798	Palusplain	MUW	CCW	Yes	TEC, TF
8033	Palusplain	CCW	CCW	Yes	TEC
8046	Palusplain	MUW	CCW	Yes	TEC, TF
13826	Sumpland	CCW	CCW	Yes	TEC, TF
15983	Palusplain	REW	CCW	Yes	TEC, TF

The balance of the DBCA mapped REWs across the site (i.e. the areas not proposed to be reclassified as CCWs) were considered to have been subject to significant historical disturbance and to support only limited wetland and biodiversity values, with the majority of this land historically cleared and modified. Notwithstanding the level of disturbance, Emerge Associates (2022b) recommended that given these areas are representative of poorly reserved palusplain wetland suites and are located immediately adjacent to the GBSW, this was sufficient basis to retain the REW category.

It is noted that DBCA's regional geomorphic wetland mapping identifies three CCWs as occurring within existing road reserves (rather than private lots); UFIs 7637, 8031 and 14962, totalling approximately 3.2 ha. These are mapped by DBCA as occurring within sections of the Brook Road and Boundary Road reserves which abut the GBSW, and form the outer edges of larger CCW features mapped within GBSW. These road reserves have been historically cleared and support existing bitumen carriageways (comprising at least half of the total road reserve extent), with the remaining areas comprising constructed roadside drains and associated native and non-native vegetation that has established. Given this, the extent to which these areas support a CCW classification is therefore questionable. For the purpose of the ER, a conservative assessment has been made that the actual extent of CCW values within these roads, is up to approximately 1.6 ha (0.9 ha within Boundary Road and 0.7 ha within Brook Road), which accounts for the exclusion of the constructed bitumen sections of the road.

4.2.4 Buffer assessment

A *Buffer Assessment* (Emerge Associates 2022) has been completed for the site and is provided in **Appendix G**. The assessment outlines the buffer requirements for the following environmental values:

- Significant wetlands (CCWs and the GBSW)
- Significant waterways (Yule Brook)
- Significant vegetation (TECs)

Due to the absence of approved and accepted policy and guidance to determine site-specific buffers, the *Buffer Assessment* involved a risk-based assessment of various buffer widths. The assessment concluded that a 50 m buffer zone for significant wetlands and vegetation was considered to provide as effective protection (i.e. the same net risk) as no buffer, 10 m buffer and 100 m buffer and superior protection than a 500 m buffer. Similarly, the foreshore area and 10 m buffer proposed in the Draft MKSEA Structure Plan for the significant watercourse was considered to provide as effective protection as other buffer distances and superior protection than a 500 m buffer.

Further detailed discussion is provided in **Appendix G**.

4.2.5 Proposed water management strategy

A contemporary water management strategy is proposed to be implemented as part of future industrial and commercial development of the site, incorporating water sustainable urban design (WSUD) principles. The water management strategy (for surface/stormwater and groundwater) is documented in the *MKSEA Precinct 2 Local Water Management Strategy* and *MKSEA Precinct 3B Local Water Management Strategy* (Emerge Associates 2022d, c), which have been prepared in accordance with *Better Urban Water Management* (WAPC 2008) and support the draft MKSEA Structure Plan. The LWMS may be subject to further updates and modification as part of the future approval process for the draft MKSEA Structure Plan, following completion of the EPA assessment.

The key elements of the water management strategy for the site, as outlined in each LWMS and in the context of the draft MKSEA Structure Plan layout, are summarised as follows:

- Maintain the peak flow regime to wetlands and sensitive environments within the site so that the hydrology feeding these is maintained.
- Maintain existing key discharge locations and configurations of these to assist in maintaining the existing hydrological regime.
- Avoid changes to existing groundwater controls so that groundwater conditions are maintained.
- Avoid the need for significant imported fill that could potentially alter catchment hydrology.
- Treatment of road reserve runoff at source via extended detention/infiltration in vegetated swales.
- Treatment of lot runoff (i.e., the small event runoff) at source and provide at source detention for the major rainfall event.
- Conveyance of minor and major event runoff from lots and road reserves via vegetated swales and overland flow within road reserves.
- Major event flood storage within Yule Brook and an adjacent vegetated corridor (Precinct 3B) and a vegetated multiple use corridor (Precinct 2) that integrates with surrounding levels and avoids the need to undertake earthworks within the proposed adjacent buffers and/or riparian vegetation areas.

- Minor and major event flows will be detained within swales and detention areas to ensure that pre-development peak flows discharging from Precinct 2 are maintained.
- Utilise reticulated scheme water and wastewater.
- Water efficiency measures (e.g. waterwise gardening/landscaping) to be implemented to reduce water requirements.

Further details on the proposed stormwater management strategy is provided as follows:

- At an individual lot level:
  - Treat the small rainfall event (first 15 mm) generated within industrial and commercial lots at source (within the boundary of each lot), to replicate the existing hydrological regime by allowing the small event to infiltrate as close to source as possible. The specific stormwater infrastructure used to achieve this will be dependent on the underlying soil and groundwater conditions within each lot (with permeability being a constraining factor), but can include:
    - Vegetated bio-retention areas to infiltrate the small event
    - Waterwise landscaped areas to infiltrate the small event
    - Subsurface soakage/soakwells where there is sufficient clearance above groundwater or the underlying low permeability layer.
    - Retention (rainwater) tanks in areas where infiltration onsite is difficult to achieve.
  - Detain major rainfall events generated within industrial and commercial lots at source, to ensure post-development peak flow rates leaving the site are consistent with the current conditions. Lot detention areas for major rainfall events could include infiltration, storage/rainwater tanks, car park areas or other hardstand areas, or formalised storage areas.
- At a precinct level:
  - Provide conveyance of existing upstream flows through the site.
  - Treat the small rainfall event (first 15 mm) generated from road reserves at source, to maintain the existing hydrological regime by allowing the small event to infiltrate as close to source as possible. This will be achieved through the use of roadside swales on the downstream side of roads, which will treat and infiltrate the small event. Swales will be vegetated with native reeds and rushes suitable for removing nutrients, with a layer of high phosphorus retention index (PRI) soil to be located beneath the invert of the swale to provide treatment as runoff infiltrates.
  - Convey the major events via the swale network and road reserves toward the proposed vegetated multiple-use corridor (Precinct 2) or Yule Brook and adjacent foreshore areas (Precinct 3B), which will then detain flows to ensure post-development peak flow rates do not exceed existing pre-development peak flow rates. The multiple-use corridor will comprise a mixture of native vegetation (through revegetation) and existing pasture (shallow rooted grass species), whilst the Yule Brook foreshore area will retain existing riparian vegetation. Detained runoff will then be conveyed out of the site at existing discharge locations and at discharge rates which do not exceed pre-development conditions.

Overall, the water management strategies proposed to be implemented as part of the land uses shown in the draft MKSEA Structure Plan provide for on-site management of water such that the potential for offsite and downstream impacts are minimised. With respect to Yule Brook, the proposed in-line flood storage will serve to reduce the existing flood risk applying to Precinct 3B, including when potential increased rainfall intensity resulting from climate change is taken into account (discussed further below).

Whilst not required under the Better Urban Water Management framework, which guides the preparation of water management strategies for land use planning proposals, the LWMSs for Precinct 2 and Precinct 3B have also accounted for the anticipated future impacts of climate change. Based on CSIRO and BoM climate change projections, temperatures in Western Australia will increase, which will lead to a decrease in annual rainfall and an increase in flood producing rainfall (i.e. rainfall intensity). A sensitivity analysis of the 1% annual exceedance probability (AEP) rainfall event has been completed as part of each LWMS, as this event is likely to produce the greatest extremes in change. This is documented in Section 6 of each LWMS.

For the purpose of the climate change sensitivity analysis, a 1^{o}C temperature increase scenario was selected for analysis, as this is within the ranges of temperature change suggested by the Climate Future Web Tool (CSIRO 2015).

In summary, the sensitivity analysis concluded that when climate change factors are considered:

- Within Precinct 2, an 11% increase in total storage volume will be required to maintain the pre-development 1% AEP peak flow rates. This could be accommodated by an increase in the size of the detention storage within the Multiple Use Corridor shown in the draft MKSEA Structure Plan by approximately 0.94 ha and an increase in top water level by 0.13 m. This could either be accommodated within a portion of an adjacent CCW buffer and wetland (which is already utilised to accommodate part of the 1% AEP inundation area), or through expansion of the Multiple Use Corridor, either at the forthcoming structure planning approval stage (which would require a minor modification to the draft MKSEA Structure Plan layout) or in the future as an adaptive response to climate change, if/when required. Post-development peak flow rates exiting the site (including towards GBSW) can still be maintained when climate change is factored in, such that they do not exceed pre-development peak flow rates.
- Within Precinct 3B, no increase in total storage volume will be required to maintain the pre-development 1% AEP peak flow regime, as the current proposed storage (within future lots and in-line along Yule Brook and adjacent foreshore area) is sufficient to accommodate additional flows associated with the future climate change scenario. Under the scenario tested, the future climate change impacts will involve an increase in peak flows by approximately ~5%, primarily associated with inflows from Yule Brook upstream catchments. However, even when this increase in flows is factored in, the post-development peak flow rates exiting Precinct 3B (i.e. via Yule Brook downstream) can still be maintained such that they do not exceed pre-development peak flow rates.

4.2.6 Water balance assessment

Emerge Associates (2022) have undertaken a Water Balance Assessment (WBA) for the site and adjacent GBSW, provided in **Appendix F**.

The WBA has assessed total water volume inputs and outputs for three defined WBA 'areas', being MKSEA Precinct 2, the GBSW and MKSEA Precinct 3B, and also assesses the differences in the water balance 'pre' and 'post' development (based on the draft MKSEA Structure Plan layout). It is important to note that each WBA area/unit is considered singularly as a whole area in its entirety, rather than being broken into smaller assessment areas. **Plate 4** shows the conceptual water balance and how the three WBA areas are hydrologically linked to one another.

It is also important to note that a WBA assesses the total water volume inputs and outputs for a one year annual period, in contrast to event-based modelling which has been completed and documented in each LWMS (**Appendix D** and **Appendix E**). Notwithstanding, the WBA still considers and is consistent with the outcomes of the drainage modelling completed in each LWMS.

The water balance assessment has considered the hydrological regime and total water cycle of the site and GBSW, which was determined to be complex, interrelated and highly seasonal.

Within the site and adjacent GBSW, the key drivers and features of the hydrological cycle include:

- Seasonally varied annual rainfall
- Rainfall interception and ponding due to vegetation, landform and soils
- Surface water runoff (including from upstream catchments)
- Seasonal perched groundwater due to underlying soil profiles
- Interception of perched groundwater (baseflow) by the existing incised swale network
- Horizontal groundwater throughflow within shallow permeable sandy soils over low permeability clays (predominantly perched groundwater)
- Evapotranspiration which varies across different vegetation types and land uses
- Generally low recharge to the underlying aquifer due to very low permeability clayey subgrades
- Utilisation of shallow/perched groundwater from the underlying soil profiles (by vegetated areas including the GBSW, wetlands, other native vegetation and pasture).

The existing hydrological regime of the site was found to be largely driven by surface water factors rather than groundwater movement, however it is also influenced by evapotranspiration (which is a groundwater dependent process). Groundwater elements are primarily those associated with shallow and perched groundwater within the underlying soil profiles, rather than interaction with deeper regional aquifers, due to the impermeable layers of the underlying soils which occur across the site.

At a high level, the hydrological regime of the site can be considered as the flow of water from upstream areas (Precinct 2) to downstream areas (GBSW, then Precinct 3B). A conceptual water balance diagram is provided in Section 4 of the WBA, and is shown in **Plate 4**.

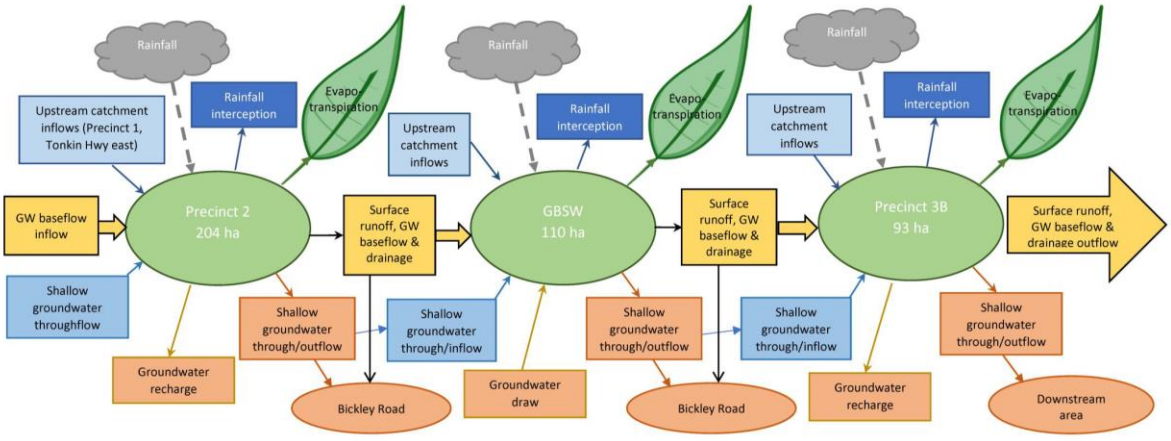


Plate 4: Conceptual water balance diagram (from Section 4 of Water Balance Assessment)

The current (pre-development) hydrological regime identified through the WBA is summarised in **Table 11**. This should be read in conjunction with the full WBA provided in **Appendix F**.

Table 11: Summary of current (pre-development) hydrological regime across the site and GBSW

WBA area	Description of current (pre-development) water regime
Precinct 2	• Hydrological inflows to precinct 2 are primarily from rainfall (~87%) and surface water flows from upstream catchments (~11%) such as MKSEA precinct 1 and areas east of Tonkin Highway. A small proportion of inputs comes from groundwater baseflow or throughflow (~<2%).
	• Hydrological outflows from Precinct 2 are primarily evapotranspiration (~55%) in areas of vegetated rural land (dominated by non-native pasture area, but also containing some areas of remnant native vegetation) and surface water runoff captured by the network of artificial drains (~32%). Remaining outflows are accounted for through: ○ Groundwater baseflow (~6%), which is the groundwater intercepted by open drains. ○ Recharge to groundwater (~3%). This relatively small number is due to the low permeability of the shallow clay/sandy clay profile underlying the site and is consistent with the regional recharge rates of between 2-5%. ○ Rainfall interception (~4%), being the rain physically intercepted by vegetation and stored on leaves and branches of vegetation, stopping it reaching the surface. ○ Groundwater throughflow (~0.09%), being the lateral movement of groundwater (perched or otherwise) through a permeable soil profile, down a groundwater gradient. Within the site this is minimal given permeable sandy layers above the predominant impermeable clay layers are uncommon, isolated and relatively thin.
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GBSW	• Hydrological inflows are similarly dominated by rainfall (~48%) and surface water inflows from upstream catchments (~35%). Upstream catchments inflows are from Precinct 2, entering GBSW via a single culvert (approximately 700 m north-east of Bickley Road) into the Yule Brook tributary that flows through the GBSW, rather than across the full south-eastern interface of GBSW (as a result of the artificial open drain network along Boundary Road intercepting such flows). Additional surface water flows enter from upstream areas at Tonkin Highway and Welshpool Road. Other inflows include: ○ Draw from groundwater (~15%). This is associated with draw primarily from the shallow/perched groundwater within the underlying soil profiles, rather than the deeper regional aquifers. This is driven by evapotranspiration. ○ Groundwater baseflow (~2%) ○ Groundwater throughflow (~0.1%).
	• Hydrological outflows are dominated by evapotranspiration (~50%), due to the heavily vegetated nature of the GBSW, and surface water runoff (~41%) via the Yule Brook tributary that traverses the GBSW (as shown in **Figure 11**) toward Precinct 3B. Other outflows include rainfall interception (~5%) and groundwater baseflow (~4%).
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Precinct 3B	• Hydrological inflows are similarly dominated by rainfall (~45%) and surface water inflows from upstream catchments (~51%). Surface water upstream catchment inflows are from GBSW via the Yule Brook tributary and MKSEA Precinct 3A via overland flow and drainage lines. Remaining inflows are predominantly from groundwater baseflow (~4%).
	• Hydrological outflows are dominated by surface water runoff (~62%) via Yule Brook, which conveys water south-west toward the Canning River. Other outflows include evapotranspiration (~29%) from pasture areas and areas of remnant native vegetation. Minor outflow components include: ○ Groundwater baseflow (~4%) ○ Recharge to groundwater (~2%) ○ Rainfall interception (~2%).

The WBA has also assessed the post-development water regime that is anticipated to occur if the proposed scheme amendments were implemented through future subdivision and development, based on the layout of the draft MKSEA Structure Plan and the proposed water management strategy outlined in **Section 4.2.5**. This allows for consideration of how the water balance within the site (and GBSW) may change as a result of the anticipated future development within the site.

Based on implementation of the draft MKEA Structure Plan (**Appendix A**) and the associated future development footprint and future environmental retention areas (**Figure 6**), in addition to the proposed water management strategy (**Section 4.2.5**), the anticipated changes to the existing water balance are documented in Section 6 and Section 7 of the WBA (**Appendix F**). A summary of the anticipated key changes to the existing (pre-development) water balance include:

- Precinct 2 and 3B existing groundcover will change from predominantly pasture, bare ground and vegetation to predominantly hardstand, removing evapotranspiration (and rainfall interception) losses across approximately 65% of the total area of Precincts 2 and 3B (associated with the extent of proposed industrial land uses). This will be partially offset by the retention of natural areas (including wetlands, TECs and Yule Brook), provision and revegetation of wetland buffers, landscaping within future development areas and a large vegetated multiple use corridor (within Precinct 2), which all result in a local increase in evapotranspiration in these areas due to vegetation and the increased availability of water. Notwithstanding, there will still be a net decrease in evapotranspiration losses within Precinct 2 and Precinct 3B.
- The anticipated increase in hardstand within Precinct 2 and Precinct 3B will also affect the other key driver of the WBA, being surface water runoff. The overall volume of surface water runoff is predicted to increase due to increased impermeable surfaces. The magnitude of the increase in surface water runoff is partially offset through the proposed onsite retention of the first 15 mm of rainfall within future development areas (to meet water quality treatment requirements). Notwithstanding, there is still a net increase in water exported as surface water runoff.
- As a result, there will be a net increase in available water of 209,495 kL in Precinct 2 and 111,719 kL in Precinct 3B, over an annual period. The increase in (or residual) water volume over this annual period would likely be temporarily stored within the soil profile and increase groundwater depth and/or hydroperiod locally across Precinct 2 and Precinct 3B. Given many of the water balance components are influenced by groundwater elevation and hydroperiod, it is inferred that the residual water will result in an increase of these factors over an annual period (including increases to groundwater throughflow, groundwater baseflow, evapotranspiration and recharge).
- Due to a combination of increased surface water runoff and a net increase in available water (held within the soil profile and driving groundwater processes), the GBSW will experience an increase in upstream surface water inflows and a minor increase in groundwater driven inflows over an annual period, however it will also experience a corresponding increase in surface water outflows and evapotranspiration (which is driven by available groundwater). The total volume of water passing through the GBSW (i.e. the total inflow and outflow) over an annual period will increase from approximately 1,669,215 kL in the pre-development scenario, to approximately 1,792,783 kL in the post-development scenario (i.e. an increase of approximately 7.4% total volume over an annual period). This annual increase will be primarily experienced at the Yule Brook tributary that traverses the GBSW, which is the sole surface waterway passing through the GBSW receiving flows upstream from Precinct 2 and discharging them downstream to Precinct 3B (and Yule Brook).

- The ultimate discharge destination for the majority of surface runoff (and other excess water) is the Yule Brook and the extent of change to the overall WBA areas should be considered in this context. In the pre-development scenario, the surface water and drainage outflows from Precinct 3B (via Yule Brook) comprise approximately 955,734 kL/year, which will increase to approximately 1,183,789 kL/year in the post-development scenario, a change of approximately 228,055 kL annually.
- Annual flows within Yule Brook have declined in recent years; the longer term (35 year) average flow is > 9,700,000 kL, whereas the shorter term (10 year) average flow is approximately 8,200,000 kL (at monitoring location 616042). There is an approximate 15% decline in flows between the long-term and short-term average for Yule Brook. The WBA shows an increase to Yule Brook flows of approximately 228,055 kL/year, which is approximately 2.3% of the long term average annual Yule Brook flow.
- The WBA also includes assessment of the pre and post development nutrient balance. The water quality balance shows that the proposed development is highly likely to result in a significant reduction in the mass of nutrient inputs (74% reduction in TN and 72% reduction in TP) due to the removal of historical agricultural activities and the adoption of a water sensitive urban design (WSUD) approach within developed areas. This would result in a positive water quality outcome (i.e. a reduction in nutrients) for downstream receptors, including the broader GBSW, Yule Brook and the Canning River.

The Water Balance Assessment has also accounted for the anticipated future impacts of climate change, by including a sensitivity analysis on the post-development scenario utilising a future climate change projection obtained from DWER. This projection is based on data used by the Intergovernmental Panel on Climate Change (IPPC).

A climate change projection for a 'dry' scenario with a time horizon to 2050 was selected, as it provides a pessimistic medium-term prediction, which provides an opportunity to consider a 'worst-case' scenario compared to other options (being 'wet' or 'medium' scenarios). The key changes expected in the future climate change scenario are a reduction in rainfall of approximately 4.4% and an increase in evapotranspiration by approximately 2.6%, relative to the (2010-2020) baseline conditions.

In summary, the sensitivity analysis concluded that the impact of the climate change factors on the water balance is relatively small. The most significant impact is seen in the surface water inflows and outflows in the post-development scenario, which are reduced by approximately 2-3% (relative to pre-development flows), resulting in post-development flows more closely aligned to the pre-development regime. With respect to the GBSW and Yule Brook:

- **GBSW:** Instead of an increase of +7.4% in the total volume of water passing through the GBSW over an annual time period (via the tributary to Yule Brook that flows through GBSW) from the pre-development to the post-development scenario, when climate change is considered the total volume of water increases by a lesser amount, such that the change between the pre-development and post-development scenarios would instead be +3.87% over an annual time period.
- **Yule Brook:** instead of a 228,055 kL increase in total annual flow of Yule Brook from the pre-development to the post-development scenario (which is 2.3% of the long term average annual flow in Yule Brook), when climate change is considered the anticipated flow increase is less; 175,597 kL over an annual period (which is 1.8% of the long term average annual flow in Yule Brook).

4.2.7 Potential environmental impacts

Implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site has potential to directly and indirectly impact on environmental values associated with inland waters. As outlined in the ER Instructions, potential impacts (direct, indirect and cumulative) on the environmental values for this factor in a local and regional context include:

- Impacts to current surface and ground water cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and adjacent to the site.
- Impacts to water quality of significant wetlands and waterways within and adjacent to the site.
- Loss of foreshore functions and wetland dependent vegetation and impacts to other water dependent ecosystems.
- Risk to public safety from Yule Brook overflows during major storm events.

4.2.8 Assessment of impacts

4.2.8.1 Alteration of hydrological regimes resulting in impacts to significant wetlands and waterways

Significant wetlands and waters within and adjacent to the site include Yule Brook, the GBSW and other CCWs. These natural features are water dependent and as such, any alterations to the existing hydrological regime has the potential to impact these features. These hydrological features are largely driven by surface water inputs and perched groundwater expressions, rather than interactions with groundwater from underlying regional aquifers, due to the prevalence of shallow impermeable clay layers across the site.

As outlined in **Section 4.2.5** a key principle of the proposed water management strategy is to maintain the existing flow regime to wetlands and sensitive environments within the site so that the hydrology feeding these is maintained. This is proposed to be achieved through WSUD stormwater infrastructure that will treat, convey and detain stormwater runoff prior to entering wetlands and waterways, such that the existing pre-development peak flow rates are not exceeded in the post-development scenario.

As outlined in **Section 4.2.6**, it is anticipated that there will be a net increase in total available surface water within the site across an annual period, as a result of implementation of future development (and increased impermeable areas), the majority of which will be in the form of surface water runoff conveyed through the proposed swale network, multiple-use corridor and natural watercourses (such as Yule Brook through Precinct 3B, as shown in **Figure 11**). In this respect:

- Existing peak flow rates at internal and external stormwater discharge points (primarily existing culverts) will be maintained, such that the peak rate of surface water flow does not increase. This will ensure sensitive wetland and waterway features are not exposed to increased peak rates of flow, which have the potential to cause flooding, erosion, transport of sediments and loss of vegetation.
- Whilst the majority of the surface water runoff will be conveyed through the site (with excess runoff from Precinct 2 also conveyed via the Yule Brook tributary that traverses the GBSW), it will ultimately be exported from the site (as opposed to being retained) via Yule Brook.

- In consideration of the above, the post-development drainage network has been designed such that peak flow rates experienced through GBSW and Yule Brook will not exceed pre-development peak flow rates.
- The total volume of water flowing through GBSW annually (primarily as surface water flows via the Yule Brook tributary) is expected to increase by approximately +3.87% of pre-development total volume (across an annual period), whilst the total runoff volume of Yule Brook is expected to increase by approximately +1.8% of its long-term average flow volume over an annual period (including consideration of future climate change factors).
- As a result of the increase in the pre-development total water volume, whilst not exceeding the pre-development peak flow rates at defined surface water inflow and outflow points, it is anticipated that the Yule Brook tributary that traverses the GBSW (as shown in **Figure 11**) and Yule Brook will flow more frequently and/or for longer periods of time across the course of the year, to accommodate the additional volumes of water across an annual period.
- The WBA (the results of which have informed these conclusions) considers the total water balance over an annual period. As such, the total net increase in available water calculated through the WBA will be experienced across this same annual period, rather than in any one specific rainfall event.

As outlined in **Section 2.6.3**, Perth's climate is changing, which has already resulted in a long-term reduction in rainfall and increase in temperature; trends which are projected to continue. Given this, and given the significant waterways and wetlands within the site are largely dependent on surface water runoff or expressions of perched groundwater (both of which are primarily influenced by rainfall), it is reasonable to conclude that these waterways and wetlands have been subject to declining water inputs over the long-term (with data available to confirm this is the case for Yule Brook, discussed in **Section 4.2.5**), and that this trend will likely continue into the future. In this context, the GBSW and Yule Brook demonstrate they are resilient systems, which have tolerated annual variety in rainfall and upstream inflows, as well as an underlying long-term drying trend. In this context, the anticipated increase in available water that is anticipated to be received by these waterways and wetlands over an annual period would contribute to counter-acting this long-term drying trend, however only represents a small percentage of the total volumes of water/flow these features experience annually.

4.2.8.2 Impacts to water quality of significant wetlands and waterways

Rural land uses currently occurring across the site can input high nutrient loads to surface and groundwater, due to the nature of the land use (such as application of fertilisers and running of livestock). In addition, the site does not currently contain contemporary stormwater management infrastructure which provides treatment of runoff to remove nutrients.

Implementation of the proposed scheme amendments through future subdivision and development of industrial and commercial land uses are likely to have lower nutrient inputs (DWER 2020), and will also be developed with contemporary stormwater management infrastructure that provides treatment of surface water runoff, to remove nutrient loadings through native vegetation biofilters and/or nutrient retaining soils.

The WBA has assessed the pre and post development nutrient balance. The water quality balance shows that the proposed development, based on the draft MKEA Structure Plan layout, is highly likely to result in a significant reduction in the mass of nutrient inputs (74% reduction in TN and 72%

reduction in TP). This would result in an improvement in water quality (i.e. a reduction in nutrient inputs) for downstream ecosystems, including the broader GBSW, Yule Brook and the Canning River. This is discussed further in Section 7 of the WBA, provided in **Appendix F**.

As such, it is anticipated that improvement in water quality will benefit significant wetlands and waterways.

In addition, consideration has also been given to the management of existing nutrient loads within the underlying soil profile, generated as a result of historical and existing rural land uses. These nutrient loads will continue to be 'flushed' out by rainfall and perched groundwater throughflow irrespective of whether future development of the site occurs or not, given conveyance pathways already exist. Compared to the status-quo of continued rural land use, the proposed future land uses will result in the introduction of nutrient management controls for existing nutrient loads. The key controls in this respect will be the upgrade of existing drains to provide at-source treatment structures, being vegetated treatment swales which meet contemporary WSUD and best-practice standards with respect to nutrient management and bio-retention. As such, existing 'legacy' nutrient loads within the soil can be treated through the proposed WSUD infrastructure as they continue to be 'flushed' out over time and into the future.

4.2.8.3 Loss of foreshore functions and wetland dependent vegetation and impacts to other water dependent ecosystems.

Foreshore functions

Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012) defines a foreshore area as the land that adjoins or directly influences a waterway, whilst functions of a waterway and its foreshore relate to the biological, chemical and physical processes that take place. Within the site, the Yule Brook is the sole natural waterway. The foreshore functions of the Yule Brook have been impacted over time as a result of disturbances caused by historical and existing rural land uses, resulting in a range of land degrading processes such as riparian vegetation (and fauna habitat) clearing, weed infestation, bank disturbance, erosion and nutrient inputs. These impacts are likely to have been emphasised due to the location of Yule Brook within private land parcels (within the site), as opposed to publicly owned/reserved land, which has allowed for rural land uses to occur right up to (and potentially within) the waterway and directly interface with this area without any buffer zones and associated land-use setbacks.

Notwithstanding, the Yule Brook still retains some foreshore functions, which have been considered in determining its foreshore area within the site, discussed in **Section 4.2.3.8**.

Future development of the site for commercial and industrial land uses has the potential to further impact the foreshore functions of Yule Brook, if development was allowed to occur within the foreshore area or in a manner which could cause downstream impacts to the foreshore area. In this context, the draft MKSEA Structure Plan accommodates the proposed Yule Brook foreshore area within a future environmental retention area, such that the future development footprint avoids the foreshore area. This will enable the existing foreshore functions of the Yule Brook to be maintained and enhanced due to the removal of rural land uses from the existing Yule Brook foreshore area and protection and management provided by a future foreshore reserve. Ultimately, the entire foreshore reserve will be contained within publicly owned land, as the future subdivision process enables

reservation of the Yule Brook foreshore from its current private land tenure. This will enable long-term public management to be provided for Yule Brook, which is currently lacking as a result of private ownership and associated land access constraints. The ongoing retention, enhancement and management of the foreshore area will be guided by the Conservation Area Management Strategy and future Conservation Area Management Plan/s.

Wetland dependent vegetation

With respect to wetland dependent vegetation, this is discussed in **Section 4.3.5.1**. In summary, 11.27 ha of wetland dependent vegetation occurs within the site, of which 2.52 ha (22%) occurs within the future development footprint and is therefore anticipated to be lost as part of future industrial and commercial development associated with implementation of the proposed scheme amendments. The remaining 8.75 ha (78%) occurs within future environmental retention areas and is therefore not anticipated to be lost as part of future development.

Other water dependent ecosystems – wetlands

As outlined in **Section 4.2.3.10**, Emerge Associates (2022b) completed an assessment of wetland boundaries and management categories within private lots within the site. Based on this assessment, Emerge mapped the extent of CCWs within private lots the site, as shown in **Figure 11**. All remaining wetlands within private lots within the site were not considered to be of conservation significance, hence were not classified as CCW.

All CCWs mapped by Emerge Associates (2022a) within private lots are identified within future environmental retention areas, including associated buffer zones. As such, no loss of CCWs within private lots are anticipated as part of future development.

As outlined in **Section 4.2.3.10**, DBCA regional geomorphic wetland mapping identifies portions of the Brook Road and Boundary Road reserves as CCWs (based on the outer edges of larger CCW features within the adjacent GBSW). Whilst the extent to which these areas support a CCW classification is questionable due to the presence of existing bitumen carriageways, a conservative assessment (which excludes the bitumen carriageways) indicates that up to approximately 1.6 ha of CCW values may occur. Of these areas:

- All CCW values within the Boundary Road reserve (up to 0.9 ha in total) will not be cleared as part of development or road upgrades, given the draft MKEA Structure Plan provides a 50 m buffer to GBSW in this area, which will result in the relocation of Boundary Road to be outside of this GBSW buffer zone. To facilitate this, the existing bitumen carriageway of Boundary Road will be removed, and then any existing roadside drains and vegetated areas will be left as-is.
- Up to 0.7 ha of CCW values within the Brook Road may be lost, as the Brook Road reserve is identified to be upgraded in the draft MKSEA Structure Plan. This is required to widen the carriageway to be a safe width for the anticipated industrial traffic types and volumes, which will consequently require modification (and likely shifting) of the existing roadside drains to maintain and provide the necessary drainage functionality. This will also provide an opportunity to construct and vegetate new road swales which achieve WSUD standards.

With respect to impacts to mapped REWs; whilst such features are mapped in DBCA's regional geomorphic wetland database across the majority of the proposed development footprint, these wetlands are highly disturbed (with the majority cleared and used for rural land uses), with minimal

remaining wetland and biodiversity values. The residual wetland values associated with their REW classification are limited to the REW being of a poorly reserved palusplain wetland suite and its proximity and hydrological connectivity with the GBSW. Hydrological investigations and assessments completed across the site have concluded that future development can occur across these residual portions of mapped REWs whilst maintaining the overall hydrology of the site and associated hydrological connectivity with the GBSW, and therefore the mapped areas of highly modified REWs are not proposed for retention.

4.2.8.4 Risk to public safety from Yule Brook overflows during major storm events

Emerge Associates (2022d) modelled the existing (pre-development) surface runoff and flows of the Yule Brook as part of the LWMS for Precinct 3B. This report indicated that during major storm events (1% annual exceedance probability), Yule Brook overflows into breakout flows, including within the site. This occurs at Welshpool Road (immediately upstream of Precinct 3B) and a small portion of the northern bank of Yule Brook near Coldwell Road/Courtney Place. On this basis Yule Brook already presents a risk to public safety as a result of overflows during major storm events, given the lack of existing suitable flood management infrastructure.

Emerge Associates (2022d) also modelled the anticipated post-development surface runoff and flows of the Yule Brook, based on implementation of the draft MKSEA Structure Plan layout and proposed water management strategy (outlined in **Section 4.2.5**). Surface runoff from major storm events will be accommodated within a foreshore reserve abutting Yule Brook, such that there are no anticipated breakout flows within Precinct 3B from the largest modelled flood event (1% annual exceedance probability). This foreshore reserve is accommodated in the draft MKSEA Structure Plan and does not comprise part of the future development footprint. As such, the risk of breakout flows from Yule Brook which could present risks to public safety will be reduced following implementation of the proposed scheme amendments and the associated future industrial and commercial development of the site.

4.2.9 Mitigation

The City of Gosnells propose a range of measures to mitigate the potential impacts of the future implementation of the proposed scheme amendments (through subdivision, development and supporting infrastructure works) on inland waters. This includes impact avoidance, minimisation and rehabilitation measures, consistent with the EPA mitigation hierarchy. The planning mechanisms and the associated stages of the land use planning process applicable to each mitigation measure are also outlined below.

4.2.9.1 Avoid

Measures to avoid impacts to inland water values within the site include the provision of future environmental retention areas for key environmental values, and also the implementation of a contemporary drainage and water management strategy. The future environmental retention areas reflect the proposed future Biodiversity Asset POS reserves shown in the draft MKSEA Structure Plan, which will provide for the future retention of inland water values, once they are established through the future subdivision and development process.

The future environmental retention areas will avoid clearing impacts to:

- **Greater Brixton Street Wetlands**. The proposed amendments and associated future development footprint do not propose any change in land use or development within the GBSW. All future development will occur outside of the GBSW and the existing zoning and tenure of the GBSW will be maintained as is for conservation purposes. In addition, a 50 m buffer zone along the south-eastern boundary of GBSW will be introduced, which will result in the relocation of Boundary Road (and removal of the existing road bitumen).
- **Yule Brook**. The waterway, as well as its proposed foreshore area, will be retained within a future foreshore reserve within the site, outside of the future development footprint. The foreshore reserve incorporates buffer zones, floodplain areas and riparian vegetation associated with Yule Brook.
- **Conservation category wetlands**. All CCWs (as mapped by Emerge Associates (2022b)) within private lots within the site are proposed to be retained and provided with buffer zones. All CCW values within the Boundary Road reserve will also be maintained, as the road reserve will be converted to a buffer area (with removal of the road pavement).

Wetland buffer zones have been assessed through a site-specific buffer assessment (**Appendix G**) and discussed in **Section 4.2.4**.

4.2.9.2 Minimise

Minimisation of impacts to inland water values will be provided through the following mitigation measures:

- Preparation and implementation of a LWMS as part of the structure planning process, the purpose of which is to define the water management strategy for the proposed future development. An LWMS has been prepared for each precinct of the site as part of the draft MKSEA Structure Plan, provided in **Appendix D** and **Appendix E**. The two LWMS propose the following water management strategies which will minimise potential impacts of the proposed scheme amendments on inland water values:
  - Maintaining existing flow regimes to wetlands and sensitive environments within the site so that the existing hydrology feeding these is maintained.
  - Avoiding changes to existing groundwater controls so that groundwater conditions are maintained.
  - Avoiding the need for significant imported fill that could potentially alter catchment hydrology.
  - Utilisation of reticulated scheme water and wastewater.
  - Treatment of small event runoff as close to source as possible, to mimic natural hydrological regimes.
  - Upgrade of existing roadside swale network to a contemporary swale network utilising WSUD design and techniques, to improve quality of stormwater runoff flowing into sensitive environmental receptors (GBSW, Yule Brook, CCWs).
  - Utilisation of the proposed swale network, multiple use corridor and Yule Brook foreshore reserve to adequately convey and detain flows from rainfall events such that all water is conveyed while maintaining (and not exceeding) peak flow rates.
  - Providing adequate storage capacity in stormwater infrastructure to accommodate flows from major flood events, to reduce the risk of overflows and associated public safety risks.

  The LWMS documents will need to be finalised as part of the approval process for the draft MKSEA Structure Plan following completion of the EPA assessment.

- Preparation and implementation of Urban Water Management Plan/s to support future subdivision and development applications, which will outline how the proposed water management strategies identified in the approved LWMS documents will be implemented as part of subdivisional and/or development works.
- Preparation and implementation of a Conservation Area Management Strategy as part of the structure planning process, the purpose of which is to define a consistent approach to the short and long-term management of Biodiversity Asset POS areas (and their associated environmental values including wetlands, foreshore areas and associated buffer zones) identified within the draft Structure Plan layout. A Conservation Area Management Strategy has been prepared for the site as part of the draft MKSEA Structure Plan and is provided in the respective EAMS documents for each precinct, provided in **Appendix B** and **Appendix C**. This will need to be finalised as part of the approval process for the draft MKSEA Structure Plan following completion of the EPA assessment.
- Preparation and implementation of Conservation Area Management Plan/s for all Biodiversity Asset POS areas (which include retained CCWs and Yule Brook foreshore), which will be required to detail how the areas will be managed to maintain and enhance existing inland water values in line with the above mentioned Management Strategy. These plans will be prepared and implemented at the subdivision and development stage. Management plans will be required to be consistent with the City of Gosnells Policy CP 6.2.2 and the associated Guidelines. In relation to the Yule Brook foreshore, due to the varied land ownership in this area, it will not be possible to prepare and implement a single plan from the outset. Instead, as incremental subdivisional and development occurs, a series of lot specific short-term plans will be prepared. Once a sufficient amount of the foreshore area is within Crown ownership, a long-term plan will be prepared and implemented by the long-term management authority.
- Preparation and implementation of an Acid Sulfate Soils Management Plan, where applicable, which will detail how ASS will be managed during subdivision and development works. These plans will be prepared and implemented at the subdivision and development stage, as a condition of subdivision approval.

The above requirements will be implemented through application of the proposed local scheme provisions listed in **Section 2.2.3**, which include:

- Subdivision and development are to be in accordance with an approved Structure Plan, which shall be prepared in accordance with *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 Part 4. The approved Structure Plan together with all approved amendments shall apply in relation to the land within the area of the Structure Plan. The zones designated in the Structure Plan and the permissibility of uses within those zones shall be given due regard when determining applications within the Structure Plan area.
- The Structure Plan must provide for the protection and enhancement of the following environmental values within Biodiversity Asset public open space areas:
  - Conservation category wetlands within private lots and buffers
  - Threatened ecological communities within private lots and buffers
  - Yule Brook and a determined foreshore reserve.
- Prior to the approval of the Structure Plan, a Conservation Area Management Strategy shall be prepared and approved by the City of Gosnells. The purpose of the strategy is to define a consistent approach to the short and long-term management of Biodiversity Asset public open space areas identified within the Structure Plan.
- Where subdivision applications affect land that contains environmental values identified in the Structure Plan, the local government will recommend to the WAPC that a condition of

subdivision approval be imposed, requiring a Conservation Area Management Plan to be prepared for any applicable Biodiversity Asset public open space areas, which will detail how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.

- Development applications on land that contains environmental values identified in the Structure Plan, shall be accompanied by a Conservation Area Management Plan (unless an existing Conservation Area Management Plan already applies to the land), that details how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Prior to the approval of the Structure Plan, a Local Water Management Strategy shall be prepared and approved for each MKSEA precinct included within the Structure Plan area. The purpose of each strategy is to define the water management strategy for future development proposed in the Structure Plan area.
- Prior to commencement of subdivision or development works, an Urban Water Management Plan shall be prepared and approved. The purpose of the plan is to detail how the water management strategy documented in the Local Water Management Strategy will be implemented as part of subdivision or development works.

Monitoring program

EPA task 22 requires the preparation of a monitoring program, the purpose of which is to monitor that the EPA objective is being met. Based on consultation with DWER, it was confirmed that a strategic monitoring approach is required, with the key parameters requiring monitoring being water levels and water quality (nutrient levels), with the ER to include a description of the nature and extent of monitoring proposed, including:

- Broad objectives of the monitoring program
- Location of monitoring sites
- Frequency of monitoring
- That the City of Gosnells will be responsible for collecting, analyzing and reporting the data.
- Measures to be adopted in cases of non-compliance.

The proposed post-development monitoring program is documented in Section 10 of each respective LWMS (**Appendix D** and **Appendix E**). **Table 12** summarises the key elements of the proposed monitoring program, however the LWMS documents should be read in conjunction with this. Overall the proposed monitoring program is consistent with that proposed in the LWMS, except for some minor modification to the proposed frequency of monitoring, which is incorporated below.

Table 12: Summary of proposed monitoring program

Monitoring element	Summary of proposed monitoring program
Broad objectives of the monitoring program	To ensure that implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site does not result in an unacceptable decline of the GBSW and Yule Brook due to reduction in water quality or water levels.

Monitoring element	Summary of proposed monitoring program
Parameters to be measured as part of monitoring	• Groundwater levels • Groundwater quality (In situ pH, EC, temperature. Sample TN, TKN, ammonium (NH4), NOX, TP, FRP) • Surface water quality (In situ pH, EC, temperature. Sample total suspended solids, TN, TKN, NH4, NOX, TP, FRP) • Surface water levels and flow rates
Location of monitoring sites	Proposed groundwater and surface water monitoring locations are shown on **Figure 11**. However, many of these proposed monitoring locations are located within land which is currently under private ownership, but which will ultimately be reserved for conservation and public land uses as future subdivision and development progresses. As such, whilst use of some monitoring locations will be subject to land access permission in the short term, the number of monitoring locations on public land will increase over time.
Frequency of monitoring	Groundwater and surface water monitoring frequency proposed as follows; Post-development monitoring (first two years): quarterly (typically Jan, April, July, Oct) Ongoing monitoring: bi-annually.
Responsibilities	The City will be responsible for collecting, analysing and reporting the data.
Measures to be adopted in cases of non-compliance.	The monitoring program sets out the proposed trigger values for each water quality parameter. If monitoring determines trigger values are exceeded, the LWMS documents a contingency action plan which will be implemented. This is summarised as follows: • Resampling to remove the potential for sampling error. • Comparison of upstream (incoming) quality levels to downstream (outgoing) quality levels. • If levels are greater than 20% higher downstream, then a review of nutrient application practices and surveillance of the area is required to identify the source, which should then be removed if possible (fertiliser input, etc.). • If upstream and downstream levels are similar, then conduct a site-specific review of background data to determine if trigger values require modification, in consultation with DWER. • Following this, complete resampling. If similar exceedances are observed, then this will trigger the installation of additional monitoring locations. If additional monitoring locations are sampled and produce similar exceedances, then City of Gosnells will work with DWER to determine if the results are representative of a broader catchment issue, and whether additional contingency actions are needed.

4.2.9.3 Rehabilitate

In the context of the ER, rehabilitation measures are taken to relate to rehabilitation of areas that may be temporarily impacted as a result of implementing the scheme amendments. Areas impacted by the scheme amendment will be those associated with the development of permanent industrial land uses, which are not temporary and therefore any such impacts are not possible to directly rehabilitate. As such no specific rehabilitation mitigation measures are proposed directly as part of the proposed scheme amendments.

4.2.10 Residual impact

If commercial and industrial subdivision development proceeds in accordance with the mitigation measures, the following residual impacts and benefits are anticipated:

- A 3.87% increase in total annual water flows through the GBSW (primarily via surface flows conveyed by the Yule Brook tributary that traverses the GBSW). The existing peak flow rates will

not be exceeded, however it is anticipated that a longer hydroperiod will be experienced across an annual period whereby flows will be more frequent and/or last longer periods of time across the course of a year.
- A 1.8% increase in total annual water flows in Yule Brook. The existing peak flow rates will not be exceeded.
- A reduction in nutrients (74% total nitrogen reduction and 72% total phosphorus reduction).
- Loss of up to 0.7 ha of CCW values within the road reserve of Brook Road, due to the required road upgrades. These upgrades are required to widen the carriageway to be a safe width for the anticipated industrial traffic types and volumes, which will consequently also require modification (and likely shifting) of the existing roadside drains to maintain and provide the necessary drainage functionality. This will also provide an opportunity to construct and vegetate new road swales which achieve WSUD standards.

The residual impacts to 0.7 ha of CCW values within the road reserve of Brook Road are likely to be significant, and as such trigger an offset requirement. This is discussed in **Section 5**.

Both the GBSW and Yule Brook are large and regionally significant inland water features which have been subject to significant change in hydrology over the long term. Ecosystem health and function has demonstrated a level of resilience to these changes in water quantity and quality. Relatively, the anticipated changes in water quantity are small compared to historic long-term changes and will contribute to counter-acting part of the negative long term trend of drying. Overall, the residual impacts to these inland waters values are not considered to be significant. The following considerations have informed this conclusion:

- The context of historical and future climate change is an important consideration. The south-west of Western Australia has experienced a long-term drying trend since around the 1970s, which has seen a decrease in rainfall and increase in temperature, a trend which is predicted to continue into the future. The water inputs to GBSW and Yule Brook, which are dependent on surface water runoff and expressions of perched groundwater (both of which are primarily influenced by rainfall) have been declining over the long-term and this trend will likely continue into the future.
- In this context, the residual impacts will result in a small net increase (relative to total existing water volumes) in water availability for water-dependent ecosystems such as the GBSW and Yule Brook over an annual period, which will contribute to counter-acting part of this long-term drying trend.
- A key consideration to ensure that the increase in available water over an annual period does not negatively impact the GBSW or Yule Brook is to not exceed existing peak flow rates and to provide sufficient treatment of water quality, both of which will be achieved through the proposed mitigation measures (specifically through application of the WSUD water management strategies proposed in the LWMS documents).
- The relative change (net increase) in total water/flow volumes anticipated for the GBSW and Yule Brook over an annual period are small compared to existing total water volumes and long-term average flows, particularly when the predicted effects of future climate change are also factored in. The magnitude of change is less than that which has already occurred as a result of climate change to date (for example, the Yule Brook has experienced a 15% decline in flows between the long-term and short-term (10 year) average, whereas the anticipated increase in annual flows in the post-development scenario is approximately 1.8% of the long-term average, including consideration of climate change).
- Both the GBSW and Yule Brook are large and regionally significant inland water features which have been subject to significant change in their hydrology over the long term, demonstrating a

level of resilience to changes in water volumes and flows. The anticipated increases in total water volumes and flows are comparatively small to historical long-term changes, and will increase water availability over an annual period rather than decrease it.

4.2.11 Predicted outcome

It is important to note that the existing hydrological regimes and quality of groundwater and surface water within the site are highly disturbed from their natural state, as a result of historical and existing rural land uses. In this context, future development of the site provides an opportunity to reduce existing environmental impacts associated with the current roadside drain network and absence of water quality controls, through implementation of a contemporary water management strategy incorporating infrastructure with water sensitive urban design.

In this context, the scheme amendments and associated future commercial and industrial subdivision and development of the site can be implemented in a manner which achieves the EPA objective. This will require implementation of the proposed water management strategy, which is not anticipated to result in significant residual impacts. Notwithstanding, some impacts to existing hydrological regime and quality are anticipated, which will contribute to counter-acting part of the long-term drying trend for the GBSW and Yule Brook, in addition to improvements to the existing water quality through implementation of contemporary water management infrastructure.

The identified likely significant residual impact to CCW values are limited to clearing within the public road reserve for Brook Road and can be counterbalanced through offsets, as discussed in **Section 5**.

In conclusion the impacts on inland waters can be managed to an acceptable level, subject to implementation of mitigation measures including the LWMS, Urban Water Management Plans, the proposed monitoring program, Conservation Management Strategy and Plans. Subject to the development and implementation of these plans, the EPA's objective can be achieved.

4.3 Key Environmental Factor: Flora and vegetation

4.3.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

4.3.2 Relevant policy and guidance

Table 13: Relevant policy and guidance for the flora and vegetation environmental factor

Policy and Guidance	Consideration for the proposed amendments
Statement of Environmental Principles, Factors and Objectives (EPA 2020a)	Referred to in the identification and assessment of potential impacts for each key environmental factor.
Environmental Factor Guideline - Flora and vegetation (EPA 2016b)	Consulted in the consideration of potential impacts to flora and vegetation as a result of the proposed amendments.
Technical Guidance: Flora and vegetation surveys for environmental impact assessment (EPA 2016d)	The flora and vegetation assessments conducted over the site utilise the survey methodologies outlined in the EPA Technical Guidance. Historical surveys conducted prior to 2016 follow methodology from the preceding guidance documentation: *Guidance Statement No. 51 - Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (EPA 2004).*
Environment Protection and Biodiversity Conservation Act 1999 and approved conservation advices on any relevant MNES	**Section 4.3.3.2** outlines the survey methodology utilised for assessing EPBC Act listed TECs occurring within the site, based on the criteria provided in this guidance.
Department of Agriculture, Water and the Environment (DAWE now DCCEEW) Survey guidelines for Australia's threatened species: Various Guidelines for surveying for species listed as threatened under the EPBC Act	The flora and vegetation assessments conducted over the site refer to the guidelines and methodologies for surveying conservation significant flora species and threatened ecological communities.

4.3.3 Receiving environment

4.3.3.1 Studies and investigations

The City of Gosnells (and other parties) have undertaken a range of studies and investigations related to flora and vegetation across MKSEA (including the site), as summarised in **Table 14**. These studies and investigations have informed the current baseline conditions of the site, as well as the environmental impact assessment of the proposed scheme amendments.

Many of the studies and investigations completed to date have informed previous stages of the strategic land use process for MKSEA, including preparation of local planning policies, MRS amendments and structure plans.

Table 14: Flora and vegetation studies and investigations applicable to the site

Investigation	Author	Survey date/s	Scope	Spatial coverage
MKSEA Environmental Review: Flora, Vegetation, Fauna and Wetlands	Cardno BSD (2005)	October 2004	'Level 1' flora and vegetation survey.	Entire MKSEA boundary (excluding GBSW). Includes the site.
The Flora, Vegetation and Wetlands of MKSEA	Tauss and Weston (2010)	Multiple site visits over 2007 to 2009	'Level 2' detailed flora and vegetation survey.	Entire MKSEA boundary (excluding GBSW). Includes the site.
Flora and Vegetation Assessment - Maddington Kenwick Strategic Employment Area Precinct 3	Emerge Associates (2015)	7 and 9 December 2015	'Level 1' flora and vegetation survey.	MKSEA Precincts 3A and 3B. Survey includes part of the site (Precinct 3B).
Flora, Vegetation and Wetland Assessment - Maddington Kenwick Strategic Employment Area Precincts 2 and 3B (**Appendix H**)	Emerge Associates (2022b)	30 May, 3 July, 31 August, 15 September, 6 October and 27 October 2017.	Reconnaissance and a detailed flora and vegetation survey, a targeted flora survey and wetland survey/assessment.	MKSEA Precincts 2 and 3B. Includes the site.
Flora and Vegetation Assessment - Maddington Kenwick Strategic Employment Area Precincts 2 and 3B Road Reserves (**Appendix I**)	Emerge Associates (2022a)	6 and 14 December 2022	Addendum to 2018 survey to assess road reserves.	MKSEA Precincts 2 and 3B road reserves. Includes the site.

Information presented herein on the flora and vegetation values within the site is based on the findings of the most recent *Flora, Vegetation and Wetland Assessment - Maddington Kenwick Strategic Employment Area Precincts 2 and 3B* (Emerge Associates 2022b) and the *Flora and Vegetation Assessment - Maddington Kenwick Strategic Employment Area Precincts 2 and 3B Road Reserves* (Emerge Associates 2022a) survey, as these are the most contemporary available information prepared in accordance with *Technical Guidance: flora and vegetation surveys for environmental impact assessment* (EPA 2016), whilst also incorporating the findings of historical surveys.

Due to varied land ownership, Emerge Associates (2022b) were not permitted direct access to all private land parcels within the site during the survey. The lots which could not be directly accessed are identified in Figure 5 of the survey report, provided in **Appendix H**.

Notwithstanding, the survey provides a comprehensive study of the site by utilising information adapted from previous surveys (Cardno BSD 2005; Tauss and Weston 2010 and Emerge Associates 2015) and DBCA datasets to supplement information for inaccessible lots.

A review of the land parcels which were unable to be visited has indicates there is not a significant risk that they contain significant vegetation and particularly significant vegetation expected to be cleared as part of future development. This conclusion is based on the following:

- Lots which were unable to be visited by Emerge Associates (2022b) that contain significant vegetation were directly visited and sampled (with quadrats or relevés) by Tauss and Weston (2010), which involved a comprehensive and intensive survey effort that is considered to remain

current. Tauss and Weston (2010) also sampled many other lots and concluded they did not contain significant vegetation.

- The remainder of the site is highly modified and cleared and it is considered unlikely that additional undetected significant vegetation occurs, as there has been significant survey effort applied across the site (Cardno BSD 2005; Tauss and Weston 2010; Emerge Associates 2015 and Emerge Associates 2022). Vegetation has been mapped across all lots and areas not identified as comprising significant vegetation have been based on informed conclusions from observations from adjacent land parcels, road reserves, high resolution aerial imagery and the results of previous surveys.
- All areas of significant vegetation within private lots (i.e. excluding public road reserves) identified in consideration of the results of surveys (Cardno BSD 2005; Tauss and Weston 2010; Emerge Associates 2015 and Emerge Associates 2022) have been identified for retention as part of future development.

Overall a suitable level of survey has been undertaken to date to inform this ER. Notwithstanding this, and to address any residual concerns of the EPA, the following scheme provision is proposed:

> Where subdivision applications affect land, which has not been directly surveyed for flora and vegetation or terrestrial fauna, suitable surveys are to be undertaken to support the application to determine if significant flora, vegetation and fauna values occur. If such values are identified, then they must either be protected or necessary environmental approvals must be attained if they are to be impacted (including the provision of offsets where required).

In addition to investigations completed solely over the site, various stakeholders have completed a range of flora and vegetation studies and investigations within the GBSW, as summarised in **Table 15**.

Table 15: Flora and vegetation studies and investigations applicable to GBSW and Yule Brook

Investigation	Author	Spatial coverage
Vegetation of the Yule Brook Reserve near Perth Western Australia	Speck and Baird (1984)	GBSW (Alison Baird Reserve, east of Bickley Road). Excludes the site.
Report on the Biological Survey of Lots 48 and Pt 35 Brixton Street Kenwick	Goble-Garratt (1991)	GBSW (between Brixton Street and Bickley Road). Excludes the site.
Flora and Vegetation. Boundary and Brook Roads, Kenwick	Mattiske Associates (1992)	GBSW (east of Alison Baird Reserve to Tonkin Highway). Excludes the site.
Flora (in Keighery (ed.) 1995, Knowing and Managing the Brixton Street Wetlands)	Keighery and Keighery (1995)	GBSW (west of Brixton Street). Excludes the site.
The Greater Brixton Street Wetlands Management Guidelines, Natural History and Research	Marshall (2000)	GBSW. Excludes the site.
Vegetation, Flora and Conservation Values of Lot 106 Wanaping Road, Kenwick in the Greater Brixton St Wetlands	Keighery and Tauss (2008)	GBSW (between Brixton Street and Bickley Road, limited to Lot 106 Wanaping Road). Excludes the site.
GBSW updated vegetation condition mapping (unpublished)	DBCA (2016)	GBSW. Excludes the site.
Threatened and Conservation-Listed Plant Communities in the Proposed Yule Brook Regional Park (in Lambers (ed.) 2019, A Jewel in the Crown of a Global Biodiversity Hotspot)	Keighery *et al.* (2019)	GBSW. Excludes the site.

Investigation	Author	Spatial coverage
A New Look at the Flora and Vegetation Patterns of the Yule Brook and the Greater Brixton Street Wetlands (in Lambers (ed.) 2019, A Jewel in the Crown of a Global Biodiversity Hotspot)	Tauss *et al.* (2019)	GBSW. Excludes the site.

Historical flora and vegetation assessments of the GBSW have had variable sampling intensity and spatial coverage. Marshall (2000) compiled the results of a number of studies (Speck and Baird 1984; Goble-Garratt 1991; Mattiske Associates 1992; Keighery and Keighery 1995) to produce consolidated vegetation unit mapping for the whole of GBSW, which is presented in this ER.

DBCA undertook vegetation condition mapping of the GBSW in 2016, which has been provided for use in this ER where the mapping extends over publicly owned land.

Tauss *et al.* (2019) completed a comprehensive flora and vegetation investigation over all of the GBSW (as defined by the Bush Forever Site 387 boundary), which involved sampling between 2008 – 2011 at 122 sample locations. The National Heritage Trust provided a grant to undertake this study, which was prepared for the Friends of Brixton Street Wetlands. The study aimed to update the GBSW flora inventory; floristically classify vegetation; map vegetation communities at a fine-scale and map surface water channels within GBSW. The results of this study provide a contemporary and detailed account of the flora and vegetation values within the GBSW, and are referred to in this ER. Plant community mapping from Tauss *et al.* (2019) is not replicated in this ER due to copyright, but has been considered in the ER in relation to the vegetation units defined by Marshall (2000).

4.3.3.2 Survey Methods

The 'level 2' targeted flora and vegetation survey Emerge Associates (2022b) conducted over the site is consistent with current EPA policy and guidance; *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016d).

The survey included detailed sampling of selected vegetation and targeted flora surveys and wetland assessments. Two botanists undertook spring surveys over the site on 31 August, 15 September, 6 October and 27 October 2017. Detailed sampling of vegetation was undertaken using non-permanent quadrats, established over a 10 x 10 m area using stakes and a measuring tape. A total of 24 quadrats were surveyed, with at least one quadrat located within each plant community where vegetation was considered suitably intact to warrant formal sampling. Vegetation condition was assigned at each quadrat and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994).

Areas of suitable habitat for threatened and priority flora species with potential to occur in the site were identified and searched. Multiple surveys were undertaken of some patches of vegetation to ensure the full suite of potential species and variation in flowering time was accounted for. In addition, vegetation supporting previous records of threatened and/or priority flora (from DBCA search results and/or Tauss and Weston (2010)) was surveyed again to confirm the presence of the species and number of individuals.

The locations of TECs and/or PECs within the site according to the DBCA database and previous surveys (Tauss and Weston 2010) were reviewed using recent aerial photography and, where

possible, site visits. Areas of native vegetation potentially representing a TEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds provided in the following documents:

- *Approved Conservation Advice for Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain* (DoEE 2017a)
- *Approved Conservation Advice for Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain* (DoEE 2017d)
- Approved Conservation Advice for Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain (DoEE 2017b)
- Interim Recovery Plan 2012-2017 for Banksia attenuata and/or Eucalyptus marginata woodlands of the eastern side of the Swan Coastal Plain (Swan Coastal Plain community type 20b – Gibson et al. 1994) (DEC 2012)
- *Approved Conservation Advice for shrublands and woodlands of the eastern Swan Coastal Plain* (DoEE 2017c)
- *Approved Conservation Advice for clay pans of the Swan Coastal Plain* (TSSC 2012a)
- *Commonwealth Listing Advice on clay pans of the Swan Coastal Plain* (TSSC 2012b).

Emerge Associates (2022a) completed an additional survey of the road reserves within MKSEA Precincts 2 and 3B in December 2022. The survey area solely comprised public road reserves and was therefore freely accessible.

Further details regarding survey and sampling procedures are outlined in the *Flora, Vegetation and Wetland Assessment* (Emerge Associates 2022b) (**Appendix H**).

4.3.3.3 Regional context

The site is located within the Perth subregion of the Swan Coastal Plain, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of tuart, jarrah and marri on less leached soils (Beard *et al.* 2013). This subregion forms part of south-west Australia global biodiversity hotspot (Gioia and Hopper 2017) and contains a wide variety of endemic flora and vegetation types.

Heddle *et al.* (1980) regional vegetation complex mapping delineates the various vegetation types which would have occurred across the Swan Coastal Plain prior to European settlement. Based on this mapping, the site occurs within the Guildford complex, which have been subject to significant historical agricultural development and associated land clearing since European settlement, resulting in approximately 5.1% of its original extent currently remaining (**Table 16**).

Table 16: Status of Guildford vegetation complex (Heddle et al. 1980) (Government of Western Australia 2019)

Guildford complex description	Pre-European extent (ha)	2018 extent[1](ha)	2018 extent[1] (%)
A mixture of open forest to tall open forest of *Corymbia calophylla - Eucalyptus wandoo – Eucalyptus marginata* and woodland of *Eucalyptus wandoo* (with rare occurrences of *Eucalyptus lane-poolei*). Minor components include *Eucalyptus rudis - Melaleuca rhaphiophylla.*	90,513	4,608	5.1%

The EPA (2008) considers that remnants of vegetation complexes where less than 10% of the complex remains within 'constrained areas' (areas where there is a reasonable expectation that

development will be able to proceed, such as the eastern side of the Swan Coastal Plain) are of high conservation significance and are a priority for protection.

The site comprises a highly modified environment, containing a mixture of cleared areas and remnant patches of native vegetation, some of which remain structurally intact (primarily where they contiguous with the GBSW). Native vegetation extends over 34.69 ha (16%) of the site and is generally characterised by species representative of the Guildford complex, including *Corymbia calophylla* (marri), *Banksia spp., Eucalyptus rudis* (flooded gum) and *Melaleuca spp* (Emerge Associates 2022b).

The site has been highly modified over time due to historical land clearing and agricultural land-uses (Emerge Associates 2022b). Ongoing disturbance from cattle grazing and cropping activities have resulted in the fragmentation of native vegetation into isolated patches and the general dominance of non-native vegetation.

Whilst the site does not contain any conservation areas or Bush Forever (BF) Sites, several occur within a 1 km radius, including the GBSW (BF Site 387), Hartfield Park (BF Site 320), Welshpool Road Bushland (BF Site 50) and the Clifford Street Bushland (BF Site 53), as shown in **Figure 3.**

4.3.3.4 Flora and vegetation of the Greater Brixton Street Wetlands

In contrast to the site, the GBSW remain largely intact and have not been subject to significant historical clearing (in contrast the majority of MKSEA). Flora and vegetation studies of the GBSW undertaken to date have observed a high level of floristic diversity, with Tauss *et al.* (2019) identifying 611 native plant taxa within the GBSW. Approximately 51% of these taxa are wetland species, with the remainder occurring outside of wetland areas on low ridges and dunes.

For comparison, the GBSW BF 387) covers an area of 176 ha and contains over double the number of flora species that are known to occur within Kings Park (BFSite 317), which covers an area of 321 ha and is known to contain at least 293 native taxa. The high biodiversity of the GBSW is likely due to the wide range of available habitats due to variation in soil types and hydrological conditions, as well as the rich species pool of the region (Zemunik 2019).

The GBSW also provide habitat for range of conservation significant flora species. Of the 611 native flora recorded by Tauss *et al.* (2019) within the GBSW, 39 are listed as 'threatened' or 'priority' flora species, as outlined in **Table 17**.

Table 17: Conservation significant flora species within GBSW (Tauss et al. 2019)

Species	Level of significance	
	State	EPBC Act
Grevillea thelemanniana	Threatened	Critically Endangered
Ptilotus pyramidatus	Threatened	Critically Endangered
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Threatened	Critically Endangered
Andersonia gracilis	Threatened	Endangered
Austrostipa bronwenae	Threatened	Endangered
Calytrix breviseta subsp. breviseta	Threatened	Endangered
Diuris purdiei	Threatened	Endangered

Species	Level of significance	
	State	EPBC Act
Eremophila glabra subsp. chlorella	Threatened	Endangered
Lepidosperma rostratum	Threatened	Endangered
Conospermum undulatum	Threatened	Vulnerable
Eleocharis keigheryi	Threatened	Vulnerable
Calandrinia sp. Piawaning (A.C. Beauglehole 12257)	Priority 1	-
Schoenus sp. Beaufort (G.J. Keighery 6291)	Priority 1	-
Comesperma griffinii	Priority 2	-
Comesperma rhadinocarpum	Priority 2	-
Diuris brevis	Priority 2	-
Isotropis cuneifolia subsp. glabra	Priority 2	-
Lepyrodia curvescens	Priority 2	-
Schoenus loliaceus	Priority 2	-
Babingtonia urbana	Priority 3	-
Byblis gigantea	Priority 3	-
Chamaescilla gibsonii	Priority 3	-
Cyathochaeta teretifolia	Priority 3	-
Eryngium pinnatifidum subsp. palustre (G.J. Keighery 13459)	Priority 3	-
Eryngium subdecumbens (G.J. Keighery 5390)	Priority 3	-
Isopogon drummondii	Priority 3	-
Myriophyllum echinatum	Priority 3	-
Schoenus benthamii	Priority 3	-
Schoenus capillifolius	Priority 3	-
Schoenus pennisetis	Priority 3	-
Schoenus sp. Waroona (G.J. Keighery 12235)	Priority 3	-
Stylidium aceratum	Priority 3	-
Stylidium longitubum	Priority 3	-
Aponogeton hexatepalus	Priority 4	-
Drosera occidentalis	Priority 4	-
Hydrocotyle lemnoides	Priority 4	-
Ornduffia submersa	Priority 4	-
Schoenus natans	Priority 4	-
Verticordia lindleyi subsp. lindleyi	Priority 4	-

DBCA manage the majority of the GBSW and have completed extensive floristic sampling of the GBSW, culminating in the preparation of a field herbarium guide (DBCA 2018). The field guide describes the complex sequence of different flora species which occur across different seasons within the claypan habitats which dominate the GBSW:

- When the claypans are inundated with winter rains and are full, they support a range of native aquatic plants.
- As water levels begin to drop, a series of annual and perennial herbs grow and flower.
- Once the claypans dry-out in early summer, different species then emerge, such as sundews and trigger plants.

Flat areas surrounding the claypans also support various native herbs, sedges and rushes, whilst upland areas and sandy rises are characterised by marri and banksia woodland with native understoreys (DBCA 2018).

Marshall (2000) identifies the following broad habitat types for flora within the GBSW (**Figure 12**):

- Water filled depressions, may be claypans or humus rich or combinations of both (wetland)
- Mixed shrublands on seasonally waterlogged or inundated flats or edges of depressions (wetland)
- Mixed low shrublands on dry flats, occasionally waterlogged (intermediate areas, occasionally waterlogged)
- Banksia woodlands (upland)
- Marri woodlands (upland).

DBCA (2016) vegetation condition mapping (**Figure 13**) shows the majority of the GBSW remain highly intact with little disturbance, with much of the GBSW in 'excellent' vegetation condition.

Keighery *et al.* (2019) reviewed the floristic community types (FCTs) and associated threatened and priority ecological communities which occur within the GBSW, which are detailed in **Table 21**.

Table 18: Threatened and priority ecological communities recorded within GBSW (Keighery et al. 2019)

FCT	TEC name	Level of significance	
		State	EPBC Act
FCT 3a	*Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain	Critically Endangered	Endangered
FCT 7 FCT 8 FCT 9 FCT 10a	Clay pans of the Swan Coastal Plain^	Vulnerable (FCTs 7, 8, 9) Endangered (FCT 10a)	Critically Endangered
FCT 21c	Low lying *Banksia attenuata* woodlands or shrublands	Priority 3	Endangered
FCT 21c FCT 23a	*Banksia* Dominated Woodlands of the Swan Coastal Plain IBRA Region	Priority 3	Endangered

^Incorporates four State-listed TECs: FCT 7 'herb rich saline shrublands in clay pans', FCT 8 'herb rich shrublands in clay pans', FCT 9 'dense shrublands on clay flats', FCT 10a 'shrublands on dry clay flats'

4.3.3.5 Flora

Emerge Associates (2022b) recorded a total of 182 native and 43 non-native (weed) species within the site, representing 54 families and 137 genera. The dominant families containing native taxa were Myrtaceae (25 native taxa and two weed taxa) and Cyperaceae (20 native taxa). The most common genera were *Melaleuca* (eight native taxa), *Drosera* (seven native taxa), *Schoenus* (six native taxa) and *Hakea* (six native taxa). The floristic biodiversity of the site is significantly less than the adjacent GBSW, within which 611 native species have been identified.

Of the 43 weed species identified, three are listed as declared pests pursuant to the *Biosecurity and Agriculture Management Act 2007*; **Asparagus asparagoides* (bridal creeper), **Moraea flaccida* (one-leaf cape tulip) and **Zantedeschia aethiopica* (arum lily). DCCEEW also list bridal creeper as a 'weed of national significance'.

4.3.3.6 Plant communities

Emerge Associates (2022b, 2022a) identified 26 native plant communities within the site. However, due to the prevalence of rural-residential land uses, the majority of land (approximately 86%) is characterised by heavily disturbed areas comprising non-native grasses with occasional native shrubs and trees and planted vegetation, which does not comprise a native plant community.

The site supports three general categories of native plant communities:

- 10.6 ha of woodland and forest type plant communities, characterised by a canopy of *Corymbia calophylla* (marri), *Eucalyptus decipiens* and *Melaleuca preissiana/rhaphiophylla*, with an understorey ranging from a native shrubland and forbland to non-native grassland.
- 11.3 ha of wetland plant communities, comprising seasonally inundated shrublands with a low to medium shrub layer, as well as some communities with a tall shrub layer. These communities generally have a diverse and dense layer of native sedges, rushes and herbs.
- 13.5 ha of riparian plant communities, generally associated with areas in proximity to Yule Brook.

The description and total extent of each plant community within the site are provided in **Table 19** and shown in **Figure 12**.

Table 19: Plant communities identified within the site (Emerge Associates 2018b)

Plant community	Description	Area (ha)
ErCo	Low open woodland of Eucalyptus rudis and Casuarina obesa over shrubland of Melaleuca lateritia. NB: previously referred to as T9 (Tauss and Weston 2010)	0.17
MACp	Tall shrubland *Melaleuca* spp., *Acacia* spp., and *Callitris pyramidalis* over mixed sedges, rushes and herbs. NB: previously referred to as SL3 and ST6 (Tauss and Weston (2010)	2.67
MEr	Low woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* over closed non-native forbland often dominated by **Cenchrus macrourus*	3.79
MrErCp	Occasional Eucalyptus rudis over tall shrubland *Melaleuca* spp. and *Callitris pyramidalis* over closed forbland *Watsonia meriana* var. *bulbillifera.* NB: incorporates ST1 and T4 from Tauss and Weston (2010)	6.84
Riparian communities sub-total		**13.47**
AlHa	Low shrubland *Acacia lasiocarpa* and *Hypocalymma angustifolium* over rushland of *Leptocarpus canus* (or layer absent in degraded areas) over non-native grassland **Eragrostis curvula* over mixed forbland. NB: incorporates RS1 and SL6 from Tauss and Weston (2010)	3.39
CpM	Shrubland *Melaleuca* spp. and *Callitris pyramidalis* over rush and sedgeland *Chaetanthus aristatus* and *Leptocarpus canus* and mixed forbland	0.26
HaBtCa	Tall open shrubland of Viminaria juncea over shrubland of Hypocalymma angustifolium, Melaleuca spp. and Banksia telmatiaea over sedge/rushland Chaetanthus aristatus, Leptocarpus canus and Mesomelaena tetragona	0.53
MHa	Shrubland *Melaleuca* spp. over low shrubland *Acacia* spp and *Hypocalymma angustifolium* over mixed forbs, sedges and rushes (understorey dominated by weeds in degraded areas). NB: incorporates ST3 and ST4 from Tauss and Weston (2010)	5.09
MsHaKm	Shrubland of Melaleuca seriata, Hypocalymma angustifolium and Kunzea micrantha over diverse sedges, rushes and herbs. NB: previously referred to as SL2 (Tauss and Weston (2010)	0.75

Plant community	Description	Area (ha)
PeHa	Open tall shrubland of *Viminaria juncea* over low shrubland *Pericalymma ellipticum* and *Hypocalymma angustifolium* over diverse sedges and forbs	0.12
TiC	Low shrubland *Tecticornia indica* subsp. *bidens* over forbland *Centrolepis* spp., **Moraea flaccida* and **Eragrostis* curvula	0.62
VjAlLc	Open to closed shrubland of *Viminaria juncea* over low shrubland *Acacia lasiocarpa* and *Hypocalymma angustifolium* over forbland *Stylidium* spp.	0.46
VjLl	Open shrubland of *Viminaria juncea* over sedgeland of *Lepidosperma longitudinale* and open herbland. NB: previously referred to as ST2 (Tauss and Weston (2010)	0.05
Wetland communities sub-total		**11.27**
BAc	Low woodland *Banksia* spp. and occasional *Nuytsia floribunda* and *Allocasuarina fraseriana* over open shrubland *Adenanthos cygnorum* and *Xanthorrhoea preissii* over non-native open grassland. NB: incorporates T11 from Tauss and Weston (2010)	1.34
Cc	Woodland to open forest *Corymbia calophylla* over closed grassland of introduced species NB: incorporates T3 from Tauss and Weston (2010)	2.74
CcEd	Woodland of *Eucalyptus decipiens* and *Corymbia calophylla* over open shrubland *Xanthorrhoea preissii* over open sedge and forbland with grassland of introduced species	0.57
CcXp	Open woodland *Corymbia calophylla* with scattered *Nuytsia floribunda* over open shrubland *Xanthorrhoea preissii* over forbland and introduced grassland	1.46
CpMKaXp	Shrubland of *Melaleuca* spp., *Callitris pyramidalis, Viminaria juncea* and occasional emergent *Nuytsia floribunda* over *Xanthorrhoea preissii* and *Kingia australis* over native and introduced forbland	0.05
Erc	Low open forest of *Eucalyptus rudis* and *Eucalyptus camaldulensis* (and hybrids) over low open shrubland of *Pericalymma ellipticum*, *Verticordia densiflora* and open sedge/forbland over grassland introduced species	0.22
KaXp	Sparse woodland of *Nuytsia floribunda* over shrubland *Xanthorrhoea preissii* and *Kingia australis* over native and introduced forbland	0.28
MLc	Shrubland Melaleuca rhaphiophylla and M. viminea subsp. viminea over low rushland Leptocarpus canus and grassland Eragrostis curvula	0.22
MpDs	Low open forest of *Melaleuca preissiana* over sedgeland of *Dielsia stenostachya* and open herbs. NB: previously referred to as T7 (Tauss and Weston (2010)	0.89
MpLl	Open woodland *Melaleuca preissiana* (some occurrences also with *M. rhaphiophylla*) over open sedge and rushland *Lepidosperma longitudinale*, *Schoenus rigens* and *Cyathochaeta teretifolia* and sparse herbs (understorey dominated by weeds in degraded areas) NB: previously referred to as T5, T6 and T8 from Tauss and Weston (2010)	2.49
MpNf	Low woodland of *Melaleuca preissiana* and *Nuytsia floribunda* over *Melaleuca* spp. closed predominantly non-native grass land and forbland	0.09
MpPcAc	Low open woodland Melaleuca preissiana over shrubland Pericalymma ellipticum, Adenanthos cygnorum and Hypocalymma angustifolium over sedges, rushes and forbs	0.28
Woodland/forest communities sub-total		**10.63**
Non-native/ hardstand	Heavily disturbed areas comprising weeds with occasional native shrubs and planted vegetation or areas of hardstand or bare ground or road pavement	219.39

4.3.3.7 Vegetation condition

The site has been subject to significant historical disturbance, with the majority (86%) of the site no longer supporting a native vegetation community. Historical and existing land uses within the site are generally incompatible with the conservation of local biodiversity, due to the occurrence of a range of disturbance activities such as unauthorised vegetation clearing, burning, grazing, de-watering and filling of wetlands, general soil disturbance, indiscriminate driving of vehicles through bushland, rubbish dumping and weed invasion.

Native vegetation extends over 35.4 ha (14%) of the site ranging from 'degraded' to 'excellent-very good' condition. The remaining 219.4 ha of the site supports primarily non-native vegetation in 'completely degraded' condition or hardstand. Approximately 14.7 ha (6%) of the site was assessed to contain intact native vegetation of 'good' or better condition (Keighery 1994) and is therefore considered to represent intact patches of the overarching Guildford vegetation complex. The extent of vegetation by condition category is detailed in **Table 20** and shown in **Figure 13.**

Table 20: Extent of vegetation condition categories within the site (Emerge Associates 2018)

Condition category	Total Area (ha)
Pristine	-
Excellent	-
Excellent – very good	0.53
Very Good	5.24
Very Good - good	0.17
Good	8.79
Good - degraded	0.20
Degraded	20.44
Completely Degraded	219.39

4.3.3.8 Threatened and Priority Ecological Communities

Emerge Associates (2018b) identified three threatened ecological communities (TECs) within the site:

- 1.95 ha of *Corymbia calophylla – Kingia australis* woodlands on heavy soils of the SCP
- 5.16 ha of clay pans of the Swan Coastal Plain (which incorporates 'herb rich saline shrublands in clay pans', 'herb rich shrublands in clay pans' and 'shrublands on dry clay flats' TECs)
- 8.59 ha of shrublands and woodlands on Muchea limestone.
- 0.09 ha of Banksia woodlands of the Swan Coastal Plain.

No additional TECs or priority ecological communities (PECs) are considered likely to occur (Emerge Associates 2018b).

Figure 14 and **Table 21** detail the identified TECs within the site.

Table 21: TECs recorded within the site.

Plant community	TEC name	Level of significance		Area (ha)
		State	EPBC Act	
CcXp, HaBtCa, KaXp	*Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain	Critically Endangered	Endangered	1.95
AlHa, CpM, MHa, MsHaKm, PeHa, VjAlLc	Clay pans of the Swan Coastal Plain^	Vulnerable (FCTs 7, 8) Endangered (FCT 10a)	Critically Endangered	5.16
AlHa, CcEd, MACp, Mer, MHa, MrErCp, VjLl	Shrublands and woodlands on Muchea limestone of the Swan Coastal Plain	Endangered	Endangered	8.59
BAc	Banksia woodlands of the Swan Coastal Plain	Priority 3	Endangered	0.09

^Incorporates three State-listed TECs: FCT 7 'herb rich saline shrublands in clay pans', FCT 8 'herb rich shrublands in clay pans', FCT 10a 'shrublands on dry clay flats'

4.3.3.9 Ecological water requirements of significant vegetation

The three TECs identified as occurring within the site are considered to represent 'significant vegetation' and their ecological water requirements are summarised below.

Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain

The *Corymbia calophylla – Kingia australis* woodlands on heavy soils of the Swan Coastal Plain TEC occurs on flat landforms which are saturated due to an underlying impervious soil layer (such as a claypan or hardpan) which acts as a barrier to drainage of water through the soil, causing waterlogging. The community requires a relatively shallow (approximately 0.5 to 3 m) depth to groundwater, and occurrences can become inundated in the wetter months due to rainfall and surface flows (DoEE 2017a).

The community is considered sensitive to alterations in the height of the local water table and/or altered surface water flows, which may change the length of the period or the depth of any ponding.

Clay pans of the Swan Coastal Plain

The Clay pans of the Swan Coastal Plain TEC occurs when a clay substrate forms an impermeable layer close to the surface and impedes water movement vertically enabling water to collect on the surface. The TEC relies on rainfall and/or local surface flow to fill the clay pan landform and are less likely to be influenced by groundwater (DSEWPaC 2012a). The TEC is reliant on the local catchment sustaining poorly drained flats, i.e. fresh surface water pooling over a confining layer.

The community is sensitive to changes to the natural hydrology, given this can result in alteration to the composition of the underlying clay pan (which are dependent on the timing of filing and drying at appropriate times of the year).

Shrublands and woodlands on Muchea limestone

The Shrublands and woodlands on Muchea limestone TEC occurs on palusplain soils locally mapped as Muchea Limestone comprising limestone, clay and sand. The community can occur as a wetland or terrestrial environment that accesses groundwater at depth with sustained saturation which allows plants to access stored water. Muchea limestone and other palusplain vegetation types are generally likely to be ground water dependent ecosystems (that is, ecosystems that access water at depth, albeit potential shallow depth) (DoEE 2017d).

Based on the high level of interaction with the groundwater, the community is considered sensitive to alterations in the height of the local water table. Altered periods or depths of ponding may affect the timing of growth of herbs in the understorey and may also affect the species composition of the community by favouring different plant species.

4.3.3.10 Threatened and priority flora

Table 22 details the threatened and priority flora species within the site identified by:

- Emerge Associates (2022b, 2022a) and;
- Tauss and Weston (2010); where these records are situated within land parcels which were inaccessible during the Emerge Associates (2018b) survey and therefore could not be confirmed (and subsequently reflected in the Emerge Associates dataset), but were still considered likely to occur. The number of populations recorded for each species is provided in **Table 22**, as opposed to the number of individuals recorded (given this is not specified by Tauss and Weston (2010)).

Figure 14 shows the recorded locations of threatened and priority flora within the site.

Both surveys were unable to directly access some of the privately-owned land parcels within the site, resulting in limitations to the results of both surveys. As such, additional and currently unknown occurrences of priority or threatened flora species may occur in lots which were not directly accessed as part of the 2010 or 2018 surveys. Notwithstanding, both surveys were able to directly access the majority of lots containing intact native vegetation, which provide the most likely habitat for threatened and priority flora species, given the remainder of the site have been historically cleared and subject to significant historical disturbance.

Further information regarding the occurrence of threatened or priority flora species within the site is provided in **Appendix H.**

Table 22: Threatened and priority flora recorded or likely to occur within the site

Species	Level of significance		Total (no.)
	State	EPBC Act	
Emerge Associates (2022b, 2022a) – number of recorded individuals			
Grevillea thelemanniana	CR	CR	355
Calytrix breviseta subsp. *breviseta*	EN	EN	2
Conospermum undulatum	VU	VU	68
Babingtonia urbana	P3	-	1
Schoenus benthamii	P3	-	1
Verticordia lindleyi subsp. *lindleyi*	P4	-	3

Species	Level of significance		Total (no.)
	State	EPBC Act	
Tauss and Weston (2010) – number of recorded populations			
Grevillea thelemanniana	CR	CR	4
Calytrix breviseta subsp. *breviseta*	EN	EN	1
Eremophila glabra subsp. *chlorella*	EN	EN	1
Lepidosperma rostratum	EN	EN	4
Babingtonia urbana	P3	-	4
Cyathochaeta teretifolia	P3	-	1
Schoenus pennisetis	P3	-	4
Verticordia lindleyi subsp. *lindleyi*	P4	-	1

Figure 14 also shows DBCA records of threatened and priority flora from their regional databases. The majority of DBCA records within the site were confirmed and more accurately recorded and mapped by Tauss and Weston (2010) or Emerge Associates (2018b). The other DBCA records within the site are considered unreliable given the following:

- They are old records from between the 1970s and the 1990s.
- Due to their age, their locations were manually interpreted by DBCA based on broad descriptions of location in relation to local roads or other general features, rather than more reliable and accurate methods such as GPS locations. Many of the locational descriptions provided do not appear to align with their recorded location. As such, these records are unlikely to be located accurately enough to enable proper consideration in an environmental impact assessment process.
- The recorded locations are within highly disturbed and cleared areas, which are less likely to provide suitable habitat for the majority of priority and threatened flora species, compared to remnant vegetation. Therefore, it is unlikely that the species occurs in this location and the record/s may no longer be applicable.

Given the above, the locations of priority and threatened flora recorded by Emerge Associates (2022b, 2022a) or Tauss and Weston (2010) have been used for the purpose of the environmental impact assessment presented in this ER. Notwithstanding, the DBCA records have been provided to provide local and regional context to the occurrences of threatened and priority flora species, with a significant number of records located within the adjacent GBSW, as discussed in **Section 4.2.3.3**.

4.3.4 Potential environmental impacts

Implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site has potential to directly and indirectly impact on flora and vegetation. As outlined in the ER Instructions, potential impacts (direct, indirect and cumulative) on the environmental values for this factor in a local and regional context include:

- Direct loss through clearing
- Loss of fauna habitat (vegetation loss) short and long term
- Impacts to wetland and riparian vegetation and ground water dependent ecosystems through changes to hydrology
- Spread or intensification of weeds and *Phytophthora* dieback
- Increased fire risk to significant flora and vegetation within and adjacent to the site including the GBSW
- Fragmentation.

4.3.5 Assessment of impacts

The 'future development footprint' and 'future environmental retention areas' (**Figure 6**) have been used to quantify and assess the potential impacts of future implementation of the proposed scheme amendments on flora and vegetation.

4.3.5.1 Direct loss through clearing

Plant communities

Up to 9.56 ha (27%) of native vegetation (within native plant communities) occurs within the future development footprint and therefore may be cleared as part of future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works (**Table 23**). This includes:

- 2.9 ha (21%) of riparian vegetation
- 2.5 ha (22%) of wetland vegetation
- 4.2 ha (39%) of woodland/forest vegetation.

Additionally, 175.8 ha (80%) of 'non-native/hardstand' areas occur within the future development footprint and are anticipated to be cleared. These are heavily disturbed areas primarily comprising cleared areas or non-native species, however, do contain some occasional native species such as trees and shrubs (but not enough to warrant identification within a native plant community).

The development footprint has been designed to avoid intact native vegetation where possible, with impacts primarily associated with areas of 'non-native/hardstand' vegetation.

No direct loss of flora and vegetation through clearing will occur within the GBSW.

Table 23: Potential impacts to vegetation (by plant community)

Plant community	Within site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Riparian communities				
ErCo	0.17	0.17	-	100%
MACp	2.67	0.17	2.50	6%
MEr	3.79	0.76	3.03	20%
MrErCp	6.84	1.76	5.08	26%
Subtotal	**13.47**	**2.86**	**10.61**	**21%**
Wetland communities				
AlHa	3.39	1.22	2.17	36%
CpM	0.26	-	0.26	0%
HaBtCa	0.53	-	0.53	0%
MHa	5.09	0.59	4.50	12%
MsHaKm	0.75	-	0.75	0%
PeHa	0.12	-	0.12	0%
TiC	0.62	0.62	-	100%
VjAlLc	0.46	0.09	0.37	20%
VjLl	0.05	-	0.05	0%
Subtotal	**11.27**	**2.52**	**8.75**	**22%**
Woodland/forest communities				
BAc	1.34	0.73	0.61	54%
Cc	2.74	2.03	0.71	74%
CcEd	0.57	-	0.57	0%
CcXp	1.46	-	1.46	0%
CpMKaXp	0.05	-	0.05	0%
Erc	0.22	0.19	0.03	86%
KaXp	0.28	-	0.28	0%
MLc	0.22	0.09	0.13	41%
MpDs	0.89	0.89	-	100%
MpLl	2.49	0.21	2.28	8%
MpNf	0.09	-	0.09	0%
MpPcAc	0.28	0.03	0.25	11%
Subtotal	**10.63**	**4.17**	**6.46**	**39%**
Non-native/ hardstand	219.39	174.75	44.64	80%

Vegetation condition

With respect to native vegetation condition, the development footprint intersects (**Table 24**) 1.1 ha (7%) of intact native vegetation in 'good' or better condition, which therefore may be cleared as part of future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works.

The future development footprint specifically targets historically cleared and impacted areas, with approximately 175 ha (95%) of the future development footprint comprising areas in 'completed degraded' condition.

Table 24: Potential impacts to vegetation (by condition rating)

Vegetation condition	Total within site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Pristine	-	-	-	N/A
Excellent	-	-	-	N/A
Excellent – very good	0.53	-	0.53	0%
Very Good	5.24	-	5.24	0%
Very Good - good	0.17	-	0.17	0%
Good	8.79	1.07	7.72	12%
Good - degraded	0.20	0.02	0.18	10%
Degraded	20.44	8.47	11.97	41%
Subtotal	**35.37**	**9.56**	**25.81**	**27%**
Completely Degraded	219.39	174.75	44.64	80%

Guildford Vegetation Complex

Up to 1.1 ha (7%) of native vegetation representative of the Guildford complex (i.e. native vegetation in 'good' or better condition, of which 13.7 ha occur in total across the site boundary) occurs within the future development footprint and therefore may be cleared as part of future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works (**Table 25**).

As discussed in **Section 4.3.3.3**, the EPA consider vegetation representative of the Guildford complex of high conservation significance and a priority for protection, given less than 10% of the complex remains within 'constrained areas'. The majority (93%) of vegetation representative of the Guildford complex is identified within future retention areas, which is consistent with the policy intent.

Table 25: Potential impacts to Guildford complex vegetation

	Guildford complex
Swan Coastal Plain extent	
Pre-European extent	90,513 ha
2018[1] extent remaining on Swan Coastal Plain	4,608 ha
Percentage of pre-European extent remaining on Swan Coastal Plain	5.1%
Within the site	
'Good' or better condition vegetation within future development footprint	1.1 ha
'Good' or better condition vegetation within future environmental retention area	13.7 ha
Percentage of 'Good' or better condition vegetation impacted	7%

[1] most recent data published by DBCA

Threatened Ecological Communities

Table 26 outlines potential clearing impacts to TECs within the site. All known occurrences of TECs within existing private land parcels have been strategically included within future environmental retention areas in order to avoid clearing. The areas of TEC identified within the future development footprint occur within public road reserves, which are likely to be impacted by future road widening and upgrade works.

Table 26: Potential impacts to threatened ecological communities

TEC	Total within the site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain (SCP 3a)	1.95	-	1.95	0%
Clay pans of the Swan Coastal Plain	5.16	-	5.16	0%
Shrublands and woodlands on Muchea limestone of the Swan Coastal Plain	8.59	1.00	7.59	12%
Banksia woodlands of the Swan Coastal Plain	0.09	0.07	0.02	78%

Threatened and priority flora

Table 29 outlines potential clearing impacts to threatened and priority flora within the site. All known occurrences of threatened and priority flora within existing private land parcels have been strategically included within future environmental retention areas in order to avoid impacts.

Clearing impacts to *Grevillea thelemanniana* are anticipated, as this species is prevalent throughout the road reserves within the site. The loss of up to 206 individuals, located within the public road reserves for Brook Road and Brentwood Road is anticipated, given these roads will require future road widening and upgrade works.

Table 27: Potential impacts to threatened and priority flora

Species	Status	Total within the site	Future development footprint	Future environmental retention areas	Impact (%)
Emerge Associates (2018b) – number of specimens					
Grevillea thelemanniana	CR	355	206	149	58%
Calytrix breviseta subsp. *breviseta*	EN	2	-	2	0%
Conospermum undulatum	VU	68	-	68	0%
Babingtonia urbana	P3	1	-	1	0%
Schoenus benthamii	P3	1	-	1	0%
Verticordia lindleyi subsp. *lindleyi*	P4	3	-	3	0%
Tauss and Weston (2010) – number of populations					
Grevillea thelemanniana	CR	4	-	4	0%
Calytrix breviseta subsp. *breviseta*	EN	1	-	1	0%
Eremophila glabra subsp. *chlorella*	EN	1	-	1	0%
Lepidosperma rostratum	EN	4	-	4	0%
Babingtonia urbana	P3	4	-	4	0%
Cyathochaeta teretifolia	P3	1	-	1	0%
Schoenus pennisetis	P3	4	-	4	0%
Verticordia lindleyi subsp. *lindleyi*	P4	1	-	1	0%

4.3.5.2 Loss of fauna habitat (vegetation loss short and long term)

In the short-term, implementation of the proposed scheme amendments and associated future development has the potential to result in the immediate displacement of fauna as a result of clearing vegetation (fauna habitat) during construction activities. However, for any subdivision or development applications the City of Gosnells will require or recommend to the WAPC that, in line with the *Model Subdivision Conditions Schedule* (WAPC 2020) environmental conditions, a Wildlife Protection Management Plan (or similar) is to be prepared and implemented prior to any on-ground works being undertaken which may impact upon or involve the clearing of potential or known fauna habitat. This would mitigate the risk of short term impacts to fauna due to the removal of vegetation, as it would require implementation of a fauna trapping and relocation program prior to vegetation and associated fauna habitat being cleared.

In the long-term, implementation of the scheme amendment has the potential to contribute to the overall reduction in the extent of flora and vegetation that provides habitat to native fauna species, at a local and regional scale. This is discussed In **Section 4.4.5**.

4.3.5.3 Wetland and riparian vegetation and ground water dependent ecosystems

The majority of wetland (78%) and riparian (79%) vegetation within the site is proposed to be retained within Biodiversity Asset POS areas. These vegetation types are water dependent and as such, alteration to the existing hydrological regime has the potential to impact these values. These values are largely driven by surface water inputs and perched groundwater expressions, rather than interactions with groundwater from underlying regional aquifers, due to the prevalence of impermeable clay layers across the site.

As outlined in **Section 4.2.5** a key principle of the proposed water management strategy is to maintain the existing flow regime to wetlands and sensitive environments, such as areas of wetland and riparian vegetation, within the site so that the hydrology feeding these is maintained. This is proposed to be achieved through WSUD stormwater infrastructure that will treat, convey and detain stormwater runoff prior to entering wetlands and waterways, such that existing peak flow rates are not exceeded in the post-development scenario.

As outlined in **Section 4.2.6**, it is anticipated that there will be a net increase in total available surface water within the site across an annual period, as a result of implementation of future development (and increased impermeable areas), the majority of which will be in the form of surface water runoff conveyed through the proposed swale network, multiple-use corridor and natural watercourses (such as Yule Brook through Precinct 3B, as shown in **Figure 11**).

Due to the anticipated increased availability of water, areas of retained wetland and riparian vegetation which convey stormwater runoff (such as along Yule Brook or the Yule Brook tributary traversing the GBSW) are anticipated to be subject to a greater total volume of surface water runoff over an annual period. However, existing peak flow rates at internal and external stormwater discharge points (primarily existing culverts) will be maintained, such that the peak rate of surface water flow does not increase. This will ensure sensitive areas of flora and vegetation are not exposed to increased peak rates of flow, which have the potential to cause flooding, erosion, transport of sediments and loss of vegetation. Notwithstanding, wetland and riparian vegetation in these areas may experience varied seasonal timing for the emergence and growth of different flora species (for example, within claypan communities), which can be directly influenced by the availability of water and the period of waterlogging after winter rains.

As outlined in **Section 2.6.3**, Perth's climate is changing, which has already resulted in a long-term reduction in rainfall and increase in temperature; trends which are projected to continue. Given this, and given water dependent ecosystems within the site are largely dependent on surface water runoff or expressions of perched groundwater (both of which are primarily influenced by rainfall), it is reasonable to conclude that these areas of wetland and riparian vegetation would have been subject to declining water inputs over the long-term, and that this trend will likely continue into the future. In this context, the anticipated total increase in available water over an annual period that is anticipated to be received by these values would contribute to counter-acting this long-term drying trend. Whilst this has the potential to affect the flowering cycles of some vegetation in these areas due to changes in the period which areas remain waterlogged, such communities experience annual variation in this respect as a result of varied rainfall patterns and exhibit resilience to this variation. In addition, it is likely these conditions have been experienced historically prior to more recent drying trends.

4.3.5.4 Spread or intensification of weeds and *Phytophthora* dieback

Weeds are prevalent throughout the majority of the site, due to the high level of historical land clearing and disturbance associated with historical and existing land uses. Emerge Associates (2018b) recorded 43 non-native (weed) species within the site, of which three species are listed as declared pests pursuant to the *Biosecurity and Agriculture Management Act 2007*, including:

- *Asparagus asparagoides (bridal creeper)

- **Moraea flaccida* (one-leaf cape tulip)
- **Zantedeschia* aethiopica (arum lily).

Weeds have the potential to outcompete and displace native vegetation if introduced or conditions are altered to favour their growth. Weeds may be spread and/or introduced by poor hygiene practices on vehicles and equipment, resulting in soil and weed vegetative material or seeds being transported around site, or into or offsite.

Historical clearing of the site to facilitate rural land uses has been a significant factor in the spread and intensification of weeds within the site to date. Given a range of weed species are already prevalent across the site, it is unlikely that the future development activities will result in an introduction or intensification of weeds. Furthermore, future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works provides an opportunity to remove the majority of weeds (and associated weed seedbank) from the site, through the clearing of weed dominated areas as part of future bulk earthworks. Future environmental retention areas will also provide locations where weed management measures can be targeted to achieve more effective results, which would be difficult to maintain if surrounding rural land uses were maintained.

Dieback, caused by the plant pathogen *Phytophthora cinnamomi*, affects at least 40% of native flora species within in the south-west of Western Australia. It is a soil-borne pathogen that affects the root system of plants, restricting the absorption of water and nutrients, which can lead to plant death. The pathogen is spread through the movement of soil and water. There is no known cure to dieback.

Dieback is known to occur in Jarrah forest areas along the Darling Scarp, east of the site. Due to the low-lying nature of the site and the presence of significant surface water features (such as Yule Brook and the GBSW) which are reliant on upstream catchments originating in the Darling Scarp, there is a risk that the site may already be exposed to dieback.

Future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works will involve the movement of soil, which has the potential to spread dieback and weeds. Construction management protocols and hygiene requirements can be implemented to minimise the risk of spreading dieback, as well as the use of clean soils where imported fill is required for earthworks or planting mix for landscaping works, to ensure weed species and pathogens such as dieback are not introduced.

4.3.5.5 Increased fire risk to significant flora and vegetation

Due to the increased presence of people and machinery in the area during and following implementation of the proposed scheme amendments, there is a potential risk of accidental fires, which could affect significant flora and vegetation within and adjacent to the site including within the GBSW.

In the short-term (i.e. during construction), implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works will involve the use of construction machinery and the movement of potential fuels (such as building debris, waste, cleared vegetation, etc.), which presents a risk of accidental fire ignition that has the potential to impact

significant flora and vegetation within and adjacent to the site (including the GBSW). To mitigate this risk:

- The Department of Fire and Emergency Services (DFES) declares total fire bans for the City of Gosnells on days where a 'severe' Fire Danger Rating applies, pursuant to Section 24C of the *Bush Fires Act 1954*. Such declarations prohibit hot works such as welding, or operation of any engine, vehicle, plant, equipment or machinery in the area likely to cause a bushfire or contribute to the spread of a bushfire.
- Proponents of future development can prepare and implement a Construction Environmental Management Plan (or similar), which would set out construction management requirements to reduce the risk of igniting a bushfire. Such measures could include limiting the types of machinery used in different weather conditions, limiting where different types of machinery can be used and stockpiling of materials can occur, specifying the time of year that certain activities can be undertaken, provision of suitable water supplies to extinguish any ignitions, amongst other considerations. This could be a condition of subdivision or development approval.

In the long-term, any future commercial and industrial land uses established within the site may introduce new potential fire ignition or fuel sources (for example, petrol stations, industries involving the storage of flammable materials, land uses involving the frequent use of 'hot works'), which have the potential to ignite fires which could impact adjacent areas of significant flora and vegetation. However, there are statutory planning requirements to address the bushfire risk of any such land uses where they occur within bushfire prone areas (including areas within 100 m of stands of vegetation, such as that within the GBSW). State Planning Policy 3.7 *Planning in Bushfire Prone Areas* requires any subdivision and development proposal located within a bushfire prone area to:

- Prepare a Bushfire Management Plan, which examines the likely long-term bushfire risk (following development) and the risk mitigation measures that will ensure the land is suitable for its intended purpose.
- Where a 'high-risk' land use is proposed (for example a land use that has an increased risk of igniting a fire), the preparation of a Risk Management Plan is also required, which outlines mitigation measures to manage any increased risk of fire ignition associated with the land use.

These statutory requirements apply to new subdivision and development proposals, and are not retrospectively applied to existing land uses. In this context, continuation of the existing rural land uses within the site (the 'do nothing' scenario) presents an ongoing risk of fire impacting existing flora and vegetation values within and adjacent to the site, given such land uses are not subject to these contemporary planning mechanisms to mitigate bushfire risk. Furthermore, existing rural-land uses also result in ongoing bushfire hazards being present within the site, given the majority of land parcels within the site comprise grass, weed, pasture and/or general vegetation cover, which require routine and ongoing maintenance by landowners to minimize bushfire fuel loads, which may not always occur. Due the low passive surveillance of the area currently, there is also a heightened risk of deliberate arson, which would decrease as the area is developed and more passive surveillance is introduced to the area.

4.3.5.6 Fragmentation

Within the site, native vegetation is subject to a high degree of existing fragmentation as a result of historical clearing and disturbance associated with the rural land uses currently present. As such, remnant native vegetation within the site occurs within predominantly isolated patches of varying

size, with limited connectivity between patches. The exception to this is some patches of vegetation which abut and therefore have some connectivity with the GBSW (albeit separated by existing road carriageways), in addition to vegetation which fringes the Yule Brook and provides a riparian corridor extending throughout Precinct 3B. It is not anticipated that implementation of the proposed scheme amendments would result in further fragmentation of intact native flora and vegetation values, given the future environmental retention areas include the vast majority of patches of native vegetation within the site, as discussed in **Section 4.3.6.1**.

Within the GBSW, intact native vegetation occurs in large, contiguous patches between the two amendment areas. Implementation of the proposed scheme amendments will not fragment flora and vegetation within the GBSW. Remnant vegetation within the site that is adjacent to, or contiguous with, the GSBW is likely to have importance in providing a buffering function to GBSW. These patches may provide a vegetated corridor for the interchange of flora and fauna species and align with future environmental retention areas.

Generally, the larger, more intact patches of remnant vegetation within the site have been identified within the future environmental retention areas, outside of the future development footprint. As such, future clearing is anticipated to be limited to smaller, isolated and more disturbed patches of vegetation which are not representative of intact remnant native vegetation, which is unlikely to increase fragmentation across the site such that it would be considered a significant impact to flora and vegetation values.

4.3.6 Mitigation

The City of Gosnells propose a range of measures to mitigate the potential impacts of the future implementation of the proposed scheme amendments (through subdivision, development and supporting infrastructure works) on flora and vegetation values. This includes impact avoidance, minimisation and rehabilitation measures, consistent with the EPA mitigation hierarchy. The planning mechanisms and the associated stages of the land use planning process applicable to each mitigation measure are also outlined below.

4.3.6.1 Avoid

The primary measure proposed to avoid impacts to flora and vegetation values within the site is the identification of future environmental retention areas. These areas reflect the proposed future Biodiversity Asset POS reserves shown in the draft MKSEA Structure Plan, which will provide for the future retention of flora and vegetation values once POS areas are established through the future subdivision and development process. The future environmental retention areas will avoid impacts to:

- Up to 25.8 ha (73%[1]) of native vegetation (within native plant communities), including:
  - 10.6 ha (79%) of riparian vegetation
  - 8.8 ha (78%) of wetland vegetation
  - 6.5 ha (61%) of woodland/forest vegetation.
    An additional 44.6 ha (20%) of 'non-native/hardstand' vegetation is also avoided.
    The 25.8 ha of native vegetation also includes:

[1] Percentages listed are based on the percentage of the relevant environmental value (for example vegetation type, vegetation condition rating, etc.) across the entire sites.

- 0.5 ha (full extent) of 'excellent – very good' condition vegetation.
- 5.2 ha (full extent) of 'very good' condition vegetation.
- 0.2 ha (full extent) of 'very good - good' condition vegetation.
- 7.7 ha (88%) of 'good' condition vegetation.
- 0.2 ha (90%) of 'good – degraded' condition vegetation.
- 12.0 ha (59%) of 'degraded' condition vegetation.

- All occurrences of TECs within private lots (i.e. excluding road reserves) within the site, including:
  - 1.95 ha (full extent) of *Corymbia calophylla – Kingia australis* woodlands on heavy soils of the Swan Coastal Plain TEC.
  - 5.16 ha (full extent) of Clay pans of the Swan Coastal Plain TEC.
  - 7.59 ha (88%) of Shrublands and woodlands on Muchea limestone TEC
- All occurrences of threatened and priority flora species identified within private lots (i.e. excluding road reserves) with respect to clearing. In addition, 149 individuals of *Grevillea thelemanniana* (42% of total occurrence) will be avoided within the decommissioned Boundary Road.

4.3.6.2 Minimise

Minimisation of impacts to flora and vegetation will be provided through the following mitigation measures:

- Preparation and implementation of a Conservation Area Management Strategy as part of the structure planning process, the purpose of which is to define a consistent approach to the short and long-term management of Biodiversity Asset POS areas identified within the draft MKSEA Structure Plan layout. A Conservation Area Management Strategy has been prepared for the site as part of the draft MKSEA Structure Plan and is provided in the respective EAMS documents for each precinct, provided in **Appendix B** and **Appendix C**, which may require further update prior to approval following the EPA assessment process**.** The objectives of the Conservation Area Management Strategy include:
  - In relation to retained wetlands, wetland buffers and associated Biodiversity Asset POS areas:
    - Separate the wetland from the adjacent land use(s) that might threaten its desired values, through either spatial separation or the use of physical barriers.
    - Preserve and protect the existing conservation values of the wetlands.
    - Prevent any activity that may lead to further loss or degradation.
    - Restore ecological integrity and function through revegetation of degraded areas.
    - Manage and maintain ecological values.
    - Transfer the public open space containing the wetlands and buffers into public ownership and reserve this land for 'Local Open Space' under the City of Gosnells TPS No. 6.
  - In relation to Yule Brook and associated Biodiversity Asset POS areas;
    - The brook needs to be kept ecologically sound and healthy and any degraded areas within the foreshore area rehabilitated.
    - No loss of the waterway function or any breech of agreed water quality criteria should occur as a result of the development of Precinct 3B.
    - Land use activities and development all located outside the foreshore area.
    - Provide hard edges to the foreshore area, for example, roads and pathways to enable public surveillance, deter vandalism and help control the spread of weeds and grass.
- Where subdivision applications affect land which has not been directly surveyed for flora and vegetation or terrestrial fauna, suitable surveys are to be undertaken to support the application to determine if significant flora, vegetation and fauna value occur. If such values are identified,

then they must either be protected or necessary environmental approvals must be attained if they are to be impacted (including the provision of offsets where required).

- Preparation and implementation of Conservation Area Management Plan/s for the proposed future Biodiversity Asset public open space areas where the retention of environmental values is proposed, which will be required to detail how the areas will be managed to maintain and enhance existing fauna habitat values in line with the above mentioned Management Strategy. These plans will be prepared and implemented at the subdivision and development stage. Management plans will be required to be consistent with the City of Gosnells Policy CP 6.2.2 and the associated Guidelines.
- Preparation and implementation of a Construction Environmental Management Plan, which will detail how construction processes will be managed to reduce the risk of introducing or spreading disease (dieback) and weeds. The management plan will be prepared and implemented by individual proponents at the subdivision and development stage.
- Preparation and implementation of a Bushfire Management Plan and Risk Management Plan, where applicable, which will detail bushfire risk management measures that will minimise the risk of fire impacts to flora and vegetation values within the site. The management plan will be required under SPP 3.7 *Planning in Bushfire Prone Areas* and will be prepared and implemented by individual proponents at the subdivision and development stage

The proposed Conservation Area Management Plans will establish the management actions required to ensure retained areas of vegetation (including within adjacent areas, such as the GBSW) are maintained and not directly or indirectly adversely impacted as part of future commercial and industrial development. In consultation with DBCA and DWER, these management plans will be prepared as part of future stages of the land use planning process and shall be approved by the City of Gosnells.

The above requirements will be implemented through application of the proposed local scheme provisions listed in **Section 2.2.3**, which include:

- Subdivision and development are to be in accordance with an approved Structure Plan, which shall be prepared in accordance with *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 Part 4. The approved Structure Plan together with all approved amendments shall apply in relation to the land within the area of the Structure Plan. The zones designated in the Structure Plan and the permissibility of uses within those zones shall be given due regard when determining applications within the Structure Plan area.
- The Structure Plan must provide for the protection and enhancement of the following environmental values within Biodiversity Asset public open space areas:
  - Conservation category wetlands within private lots and buffers
  - Threatened ecological communities within private lots and buffers
  - Yule Brook and a determined foreshore reserve.
- Prior to the approval of the Structure Plan, a Conservation Area Management Strategy shall be prepared and approved by the City of Gosnells. The purpose of the strategy is to define a consistent approach to the short and long-term management of Biodiversity Asset public open space areas identified within the Structure Plan.
- Where subdivision applications affect land, which has not been directly surveyed for flora and vegetation or terrestrial fauna, suitable surveys are to be undertaken to support the application to determine if significant flora, vegetation and fauna values occur. If such values are identified, then they must either be protected or necessary environmental approvals must be attained if they are to be impacted (including the provision of offsets where required).

- Where subdivision applications affect land that contains environmental values identified in the Structure Plan, the local government will recommend to the WAPC that a condition of subdivision approval be imposed, requiring a Conservation Area Management Plan to be prepared for any applicable Biodiversity Asset public open space areas, which will detail how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Development applications on land that contains environmental values identified in the Structure Plan, shall be accompanied by a Conservation Area Management Plan (unless an existing Conservation Area Management Plan already applies to the land), that details how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Prior to the commencement of subdivisional or development works, a Construction and Environmental Management Plan shall be prepared by the proponent and approved by the local government. The plan shall outline the construction management actions to be implemented and is to be consistent with the management actions identified in any applicable Conservation Area Management Plan.

Monitoring program

The proposed monitoring program for the site is outlined in **Section 4.2.9.2**. The program targets monitoring of water quality (nutrient levels) and water levels, which were identified as the key parameters which should be targeted for monitoring in consultation with DWER. Whilst the proposed monitoring is directly related to the inland waters factor, is it also related to the flora and vegetation factor, particularly in relation to the residual impacts associated with changes to the total annual water volumes experienced by retained wetland and riparian vegetation. The proposed monitoring program incorporates monitoring locations within or in proximity to these areas and may assess factors such as significant vegetation structure and condition.

Additional flora and vegetation monitoring requirements apply to any site-specific rehabilitation and revegetation programs, in accordance with the Conservation Area Management Strategy (CAMS), prepared as part of the draft MKSEA Structure Plan (documented in the respective EAMS documents for each precinct, provided in **Appendix B** and **Appendix C**). In summary, the CAMS requires individual Conservation Area Management Plans to include a monitoring program for retained native vegetation and any revegetation and rehabilitation works, to inform reporting and subsequent in-fill planting program(s), and to demonstrate achievement measured against agreed success criteria. Preparation and implementation of individual Conservation Area Management Plans and their associated monitoring requirements will be the responsibility of individual proponents of future development, rather than the City of Gosnells.

Once each Biodiversity Asset POS reserve (as shown in the draft MKSEA Structure Plan) are established, and any required revegetation and rehabilitation works are implemented, and their management is vested with the City of Gosnells, then the City of Gosnells will take on the ongoing monitoring of all vegetation within these reserves.

This monitoring (initially by individual proponents of development and then by the City of Gosnells following handover) will relate to the flora and vegetation factor through monitoring of any required revegetation areas within Biodiversity Asset POS reserves, in addition to the terrestrial fauna factor through monitoring of fauna habitat associated with the revegetation areas.

The City of Gosnells expects that DBCA and UWA will continue to monitor environmental values within the GBSW as landowners.

4.3.6.3 Rehabilitate

In the context of the ER, rehabilitation measures are taken to relate to rehabilitation of areas that may be temporarily impacted as a result of implementing the scheme amendments. Areas impacted by the scheme amendment will be those associated with the development of permanent industrial land uses, which are not temporary and therefore any such impacts are not possible to directly rehabilitate. As such no specific rehabilitation mitigation measures are proposed directly as part of the proposed scheme amendments.

4.3.7 Residual impact

The following residual impacts are anticipated as a result of implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site, once mitigation measures have been applied:

- The loss of up to 1.1 ha of native vegetation representative of the Guildford complex (i.e. native vegetation in 'good' or better condition).
- The loss of up to 1.0 ha of the Shrublands and woodlands on Muchea limestone of the Swan Coastal Plain TEC within public reserves, due to the required road upgrades.
- The loss of up to 0.07 ha of the Banksia Woodlands TEC within public road reserves, due to the required road upgrades.
- The loss of up to 206 individuals of threatened flora species *Grevillea thelemanniana* within public road reserves, due to the required road upgrades.
- Areas of retained wetland and riparian vegetation which convey stormwater runoff (such as along Yule Brook or the Yule Brook tributary traversing the GBSW) may experience varied seasonal timing for the emergence and growth of different flora species.

In relation to the residual impacts relating to road upgrades; these upgrades are required to widen the carriageway to be a safe width for the anticipated industrial traffic types and volumes, which will consequently also require modification (and likely shifting) of the existing roadside drains to maintain and provide the necessary drainage functionality. This will also provide an opportunity to construct and vegetate new road swales which achieve WSUD standards.

The residual impacts to 1.0 ha of Muchea limestone TEC and 206 *Grevillea thelemanniana* threatened flora individuals are likely to be significant, and as such trigger an offset requirement. This is discussed in **Section 5**.

Overall, the remaining residual impacts to flora and vegetation are not considered to be significant. The following considerations have informed this conclusion:

- 13.7 ha (93%) of the total occurrence of vegetation representative of the Guildford complex within the site has been avoided and will be retained. The residual impact is only a small

component (7%) of the total area of such vegetation within the site, and comprises relative small and typically isolated remnants.

- The area of Banksia Woodland TEC which is expected to be lost is small (0.07 ha). These areas are located within the public road reserves and comprise the outer edges of an existing larger patch of Banksia woodland TEC (approximately 9 ha in size), which is protected within the GBSW. As such, the clearing will not sever or fragment an existing patch into smaller patches, and nor will it compromise the ongoing viability of the retained larger patch.
- Whilst areas of retained wetland and riparian vegetation which convey stormwater runoff (such as along Yule Brook or the Yule Brook tributary traversing the GBSW) are likely to experience a greater total volume of water over an annual period due to increases in water availability, existing peak flow rates at internal and external stormwater discharge points (primarily existing culverts) will be maintained, such that the peak rate of surface water flow does not increase. This will ensure sensitive areas of flora and vegetation are not exposed to increased peak rates of flow, which have the potential to cause flooding, erosion, transport of sediments and loss of vegetation.
- Additionally, the context of historical and ongoing climate change resulting in a long-term drying trend is important to consider, discussed in detail in **Section 4.2.10**. Given this, and given water dependent ecosystems within the site are largely dependent on surface water runoff or expressions of perched groundwater (both of which are primarily influenced by rainfall), it is reasonable to conclude that these values have been subject to declining water inputs over the long-term, and that this trend will likely continue into the future. In this context, the anticipated increase in total available water over an annual period would contribute to counter-acting this long-term drying trend. Whilst this has the potential to affect the flowering cycles of some vegetation in these areas due to changes in the period which areas remain waterlogged, such communities experience annual variation in this respect as a result of varied rainfall patterns and exhibit resilience to this variation. In addition, it is likely these conditions have been experienced historically prior to more recent drying trends.

4.3.8 Predicted outcome

The EPA objective for flora and vegetation is '*to protect flora and vegetation so that biological diversity and ecological integrity are maintained*'.

The scheme amendments and associated future commercial and industrial subdivision and development of the site can be implemented in a manner which achieves the EPA objective. Specifically, the draft MKSEA Structure Plan prepared by the City of Gosnells provides for a future Biodiversity Asset POS network which will enable future retention and enhancement of significant environmental values within the site. The identified significant residual impacts are limited to clearing within public road reserves and can be counterbalanced through offsets, as discussed in **Section 5**.

4.4 Key Environmental Factor: Terrestrial Fauna

4.4.1 EPA objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

4.4.2 Relevant policy and guidance

Table 28: Relevant policy and guidance for the terrestrial fauna environmental factor

Policy and Guidance	Consideration for the proposed amendments
Statement of Environmental Principles, Factors and Objectives (EPA 2020a)	Referred to in the identification and assessment of potential impacts for each key environmental factor.
Environmental Factor Guideline - Terrestrial Fauna (EPA 2016a)	Consulted in the consideration of potential impacts to terrestrial fauna as a result of the proposed amendments.
Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020b)	The terrestrial fauna assessments conducted over the site utilise survey methodologies consistent with that outlined in the EPA Technical Guidance documents, where applicable.
Technical Guidance: Sampling of short range endemic invertebrate fauna (EPA 2016e)	
Relevant recovery plans, conservation advices and/or threat abatement plans for conservation significant species that are known to occur, or are likely to occur in the vicinity of the amendment area.	The terrestrial fauna assessments conducted over the site refer to the following recovery plans: • Carnaby's Cockatoo (*Calyptorphynchus latirostris)* Recovery Plan (DPaW 2013) • Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksia naso*) Recovery Plan (DEC 2008) • EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo, Baudin's cockatoo and Forest red-tailed black cockatoo (DSEWPaC 2012b)
DAWE Survey guidelines for Australia's threatened species: various Guidelines for surveying for species listed as threatened under the EPBC Act.	The terrestrial fauna assessments conducted over the site refer to the guidelines and methodologies for surveying threatened fauna species.

4.4.3 Receiving environment

4.4.3.1 Studies and investigations

The City of Gosnells (and other parties) have undertaken a range of studies and investigations related to terrestrial fauna across MKSEA (including the site), as summarised in **Table 29**. These studies and investigations have informed the current baseline conditions of the site, as well as the environmental impact assessment of the proposed scheme amendments.

Table 29: Terrestrial fauna studies and investigations applicable to the site

Investigation	Author	Survey date/s	Scope	Spatial coverage
MKSEA Environmental Review: Flora, Vegetation, Fauna and Wetlands	Cardno BSD (2005)	November 2004	'Level 1' fauna assessment	Entire MKSEA boundary (excluding GBSW). Includes the site.

Investigation	Author	Survey date/s	Scope	Spatial coverage
Black Cockatoo Survey - MSKEA Precinct 2 & 3A/3B	360 Environmental (2012)	24 and 25 July 2012	Targeted black cockatoo survey	MKSEA Precincts 2, 3A and 3B only. Includes the site.
Fauna Assessment Report - MKSEA Precinct 3	Harewood (2016)	9 December 2015	'Level 1' fauna assessment and targeted black cockatoo survey	MKSEA Precincts 3A and 3B only. Includes part of the site (Precinct 3B).
Fauna Assessment Report - MKSEA Precinct 2 & 3B (**Appendix J)**	Harewood (2018)	23-26 October 2017, 14 November 2017 and 19 February 2018	'Level 1' fauna assessment and targeted black cockatoo survey	MKSEA Precincts 2, 3B, including part of GBSW. Includes the site.
Short Range Endemic Invertebrate Assessment of MKSEA, Kenwick (**Appendix K**)	Invertebrate Solutions (2022)	8 and 17 September 2021	Shore range endemic (SRE) desktop assessment and field survey. Conservation significant invertebrate fauna desktop assessment.	MKSEA Precincts 2 and 3B. Includes the site.

Information presented herein regarding terrestrial fauna values within the site is primarily based on the findings of the most recent assessment completed by Harewood (2018) (**Appendix J**), given it is the most recently completed and comprehensive fauna assessment of the site (whilst also incorporating the findings of historical surveys), and adopts a methodology consistent with EPA *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020b). An exception to this approach is where SRE fauna are discussed, which primarily relies on the assessment completed by Invertebrate Solutions (2022) (**Appendix K**).

4.4.3.2 Regional context

As discussed in **Section 4.3.3.3**, the site is located on the eastern margin of the Swan Coastal Plain, which is characterised by areas historically largely cleared of remnant vegetation to facilitate rural land uses, resulting in reduced fauna habitat values. Notwithstanding, the locality surrounding the site still supports some larger remnants of native vegetation and associated fauna habitat, including the GBSW and other Bush Forever sites including Hartfield Park (BF Site 320), Welshpool Road Bushland (BF Site 50) and the Clifford Street Bushland (BF Site 53).

Ecological linkages represent areas of native vegetation which provide a corridor or linkage between patches of vegetation to allow movement of flora and fauna and their genetic material through the landscape, helping to maintain metapopulations. Ecological linkages are often continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

Two regional ecological linkages are mapped across part of the site, intersecting MKSEA Precinct 2, but primarily aligning with the extent of the GBSW between the two amendment areas, as shown in **Figure 16**. These ecological linkages were identified in a study completed as part of the Perth Biodiversity Project, which maps ecological linkages across the Perth metropolitan region. In addition, the Yule Brook corridor may provide some value as an ecological linkage, however its

capacity to provide a corridor for wildlife movement is diminished through fragmentation of habitat (Harewood 2018).

4.4.3.3 Terrestrial fauna of the Greater Brixton Street Wetlands

Limited fauna surveys have been undertaken within the GBSW. Harewood (2018) surveyed the site (which is directly adjacent to the GBSW), but also included some camera trap and bat calling sampling within the GBSW. Harewood (2018) concluded a range of native fauna species, including some conservation significant species, are likely to occur within the GBSW, based on results from the literature review and observations made during the field assessment.

Potentially suitable habitat for the three conservation significant species of black cockatoo (Carnaby's black cockatoo, Forest red-tailed black cockatoo and Baudin's black cockatoo) occurs within the GBSW, primarily associated with areas of marri (*Corymbia calophylla*) woodland over sandy flats. Whilst Harewood (2018) did not conduct a targeted black cockatoo survey over the GBSW and the species' presence is unconfirmed, the GBSW contains vegetation which has the potential to provide foraging, roosting and breeding habitat for black cockatoos.

In addition, DBCA databases contain records of the following conservation significant species being observed within the GBSW:

- *Glossurocolletes bilobatus* (unnamed Bee) state-listed as a Priority 2 species, recorded in 1981. Harewood (2018) concluded it may occur within the GBSW based on the historical record, but its current status in the area is unknown.
- *Leioproctus douglasiellus* (unnamed Bee) listed as a Priority 2 species at a state level and Critically Endangered under the EPBC Act. The species was recorded within the GBSW in 2006. Harewood (2018) concluded it may occur within the GBSW based on the historical record, but its current status in the area is unknown.
- *Isoodon fusciventer* (Quenda) listed as a Priority 4 at a state level. This species is known to persist within paddocks with dense grasses and bush remnants with dense groundcover including within the GBSW. This species was recorded at several locations on camera traps within the GBSW during the survey period. It has also previously been recorded along Yule Brook and in highly degraded sections of vegetation external to the site which contained dense grass (Harewood 2018).

Davis and Douglas (2019) and Bradshaw (2019) reviewed the results of various surveys and fauna databases to determine bird and mammal species considered likely to still occur within the GBSW and the wider locality. The conservation-significant fauna species listed in **Table 30** were identified.

Table 30: Conservation significant birds and mammals considered likely to still occur within GBSW (Davis and Douglas 2019; Bradshaw 2019)

Species	Common name	Listing status	
		State	EPBC Act
BIRDS			
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU
Calyptorhynchus latirostris	Carnaby's black cockatoo	EN	EN
Tringa nebularia	Common greenshank	MI	MI
Actitis hypoleucos	Common sandpiper	MI	MI
Falco peregrinus	Peregrine Falcon	OS	-
MAMMALS			
Dasyurus geoffroii	Chuditch	VU	VU
Isoodon fusciventer	Quenda	P4	-

4.4.3.4 Fauna habitat

Harewood (2018) used the vegetation communities identified by Emerge Associates (2018) within the site as a basis for a classification of areas into broad fauna habitat types supplemented with observations made during the fauna assessment. A total of three main fauna habitat types were identified within the site as outlined in **Table 34** and shown in **Figure 15**. Notwithstanding, the site predominantly comprises non-native vegetation and hardstand areas offering limited fauna habitat values.

Table 31: Fauna habitats identified within the site

Fauna habitat	Description	Area (ha)
Riparian habitat	Open to closed woodland/forest of *Eucalyptus rudis* and *Melaleuca preissiana/rhaphiophylla* associated with Yule Brook comprising plant communities ErCo, MACp, MEr and MrErCp as described in **Appendix H**	13.5
Wetland habitat	Closed low, medium or tall shrubland, often with a diverse understorey of native sedges, rushes and herbs comprising plant communities AlHa, CpM, CpMKaXp, HaBtCa, MHa, MsHaKm, PeHa, TiC, VjAlLc and VjLl as described in **Appendix H**.	11.3
Woodland/forest habitat	Open woodland/forest of *Corymbia calophylla*, *Eucalyptus decipiens, E. rudis*, *Banksia* spp. and *Melaleuca preissiana/rhaphiophylla* comprising plant communities BAc, Cc, CcEd, CcXp, Erc, KaXp, MpDs, MLc, MpLl, MpNf and MpPcAc as described in **Appendix H**.	10.7
Non-native/hardstand	Heavily disturbed areas comprising weeds with occasional native shrubs and planted vegetation or areas of hardstand/bare ground.	219.4

Harewood (2018) made the following conclusions regarding the fauna habitat values of the site:

- Fauna habitat values have been severely compromised by the removal of most of the original native vegetation and the degradation of remnant patches.
- Most of the site lacks any natural attributes and is now only utilised by generally common and widespread fauna species with non-specific requirements which allow them to persist in

disturbed/highly disturbed habitats. As a result, the fauna diversity is well below levels present prior to historical disturbances having occurred.

- Notwithstanding the lack of diversity within the site, it retains some value for some species of conservation significance, in particular black cockatoos and quenda.
- Individual remnant native trees and groves of trees, while limited in extent, support the primary fauna habitat value although these areas vary in quality, with most areas being totally degraded and lacking significant native groundcover/shrubs and microhabitats such as hollow logs.
- Yule Brook is also highly degraded but has some value as an ecological linkage which provides a corridor for wildlife movement (albeit tenuous at some points).
- Habitat within the site has been degraded as a result of historical clearing, altered fire regimes and the presence of introduced predators, which is likely to have had a significant effect on species diversity in the remaining remnants of fauna habitat. Because of these factors most of the site has very little conservation significance to fauna in general.

4.4.3.5 Conservation-significant species

Harewood (2018) identified 147 native vertebrate fauna species to potentially occur within the site, as summarised in **Table 32**. Of these species, 51 were observed during the field surveys.

Table 32: Summary of native vertebrate fauna species potentially occurring within the site (Harewood 2018)

Native taxon	No. species potentially occurring	Observed onsite during fieldwork
Fish	2	-
Amphibians	8	-
Reptiles	25	2
Birds	102	45
Non-volant mammals	2	1
Bats	8	3
TOTAL	**147**	**51**

Of these 147 native vertebrate fauna species potentially occurring within the site, 26 are listed under State and/or Commonwealth legislation (as a 'threatened', 'priority' or 'migratory' species) and are therefore considered conservation significant, as summarised in **Table 33**. Harewood (2018) assessed these species to determine their likelihood of occurrence within the site, utilising the following categories:

- **Known to occur:** The species was positively identified as being present within the site during the field survey or from recent literature records.
- **Possible to occur:** Potentially suitable habitat for the species was identified but of marginal quality and/or extent. The amendment site is within or close to the species known distribution.
- **Unlikely to occur:** Individuals of some species may occur occasionally as vagrants/transients especially if suitable habitat is located nearby, but the site lie outside of the known distribution of the species and/or no suitable habitat was identified.
- **Would not occur:** The site lie outside of the known distribution of the species and/or no suitable habitat was identified within the site.
- **Locally extinct:** Populations no longer occur within a small part of the species' natural range, in this case within 10-20 km of the site. However, populations still persist elsewhere.

Of the identified 26 conservation significant vertebrate fauna species;

- Four species are known to occur within the site, including three species of black cockatoo (Forest red-tailed black cockatoo, Baudin's black cockatoo and Carnaby's black cockatoo) and one mammal species (Quenda). With respect to quenda, whilst Harewood (2018) identified suitable habitat within the site, no observations of the species were recorded outside of the GBSW.
- One species was considered to possibly occur within the site (Peregrine Falcon).
- Four species were considered unlikely to occur within the site.
- Twelve species were considered not to occur within the site.
- Five species were considered to be locally extinct.

Table 33: Conservation significant vertebrate fauna potentially occurring within the site (Harewood 2018)

Species	Common name	Listing status		Likelihood of Occurrence	Habitat present	Recorded*
		State	EPBC Act			
BIRDS						
Apus pacificus	Fork-tailed Swift	MI	MI	Unlikely to occur	Yes	No
Botaurus poiciloptilus	Australasian Bittern	EN	EN	Would not occur	No	No
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Known to occur	Yes	Yes
Calyptorhynchus baudinii	Baudin's black cockatoo	EN	EN	Known to occur	Yes	Yes
Calyptorhynchus latirostris	Carnaby's black cockatoo	EN	EN	Known to occur	Yes	Yes
Falco peregrinus	Peregrine Falcon	OS	-	Possible to occur	Yes	No
Leipoa ocellata	Malleefowl	VU	VU	Locally extinct	No	No
Motacilla cinerea	Grey Wagtail	MI	MI	Would not occur	No	No
Oxyura australis	Blue-billed Duck	P4	-	Unlikely to occur	No	No
Pandion haliaetus	Osprey	MI	MI	Would not occur	No	No
Plegadis falcinellus	Glossy Ibis	MI	MI	Unlikely to occur	No	No
Rostratula benghalensis	Painted Snipe	-	EN;MI	Would not occur	No	No
REPTILES						
Acanthophis antarcticus	Southern Death Adder	P3	-	Would not occur	No	No
Ctenotus delli	Darling Range Heath Ctenotus	P4	-	Would not occur	No	No
Ctenotus ora	Coastal Plains Skink	P3	-	Would not occur	No	No
Lerista lineata	Perth Lined Lerista	P3	-	Would not occur	No	No
Neelaps calonotos	Black-striped Snake	P3	-	Would not occur	No	No

Species	Common name	Listing status		Likelihood of Occurrence	Habitat present	Recorded*
		State	EPBC Act			
MAMMALS						
Bettongia penicillata ogibyi	Woylie	CR	EN	Locally extinct	No	No
Dasyurus geoffroii	Chuditch	VU	VU	Would not occur	No	No
Hydromys chrysogaster	Water Rat	P4	-	Would not occur	No	No
Isoodon fusciventer	Quenda	P4	-	Known to occur	Yes	Yes (GBSW)
Macropus irma	Western Brush Wallaby	P4	-	Would not occur	No	No
Myrmecobius fasciatus	Numbat	EN	EN	Locally extinct	No	No
PhasCity of Gosnells ale tapoatafa wambenger	Brush-tailed PhasCity of Gosnells ale	CD	-	Unlikely to occur	No	No
Pseudocheirus occidentalis	Western Ringtail Possum	CR	CR	Locally extinct	No	No
Setonix brachyurus	Quokka	VU	VU	Locally extinct	No	No

* Recorded as occurring within the site during site inspection completed by Harewood (2018), with the exception of Isoodon fusciventer (quenda) which was observed only within the GBSW.

Based on the results of the fauna assessment (Harewood 2018):

- Three species of conservation significant black cockatoo (Carnaby's black cockatoo, Forest red-tailed black cockatoo and Baudin's black cockatoo) were positively identified as utilising the site for some purpose. The site was found to contain potential foraging, roosting and breeding habitat, discussed in **Section 4.4.3.6**.
- The quenda was positively identified as occurring within the GBSW, directly adjacent to the site. The relevance of the site to the quenda is discussed in **Section 4.4.3.7**.
- The peregrine falcon is a migratory bird listed in Western Australia as an 'other specially protected' species. This species was considered to potentially utilise some sections of the site as part of a much larger home range. However, no evidence of nesting within the site was observed, and it is considered very unlikely the species would breed onsite (Harewood 2018). The species is known to occur across Australia, as well as parts of Europe, Asia, Africa and the Americas. The species have a very large range and typically nests in coastal and inland cliffs or open woodlands near water, but is also known to nest on high city buildings such as skyscrapers. The site would provide potential habitat to the species consistent with all other open peri-urban areas across the Swan Coastal Plain that contain open ground that prey may be found in. The species would only occur on rare occasions when flying across the locality in search of prey.

All remaining conservation significant vertebrate fauna were considered to be 'unlikely to occur', 'would not occur' or 'locally extinct' within the site. As such these species are not considered further in the ER, but are discussed further in the *Fauna Assessment Report* (Harewood 2018) provided in **Appendix J**.

4.4.3.6 Black cockatoos

Due to the local and regional conservation significance of black cockatoos and their known occurrence in the local area, a targeted black cockatoo survey was conducted across the site by Harewood (2018). This involved a search for potential black cockatoo breeding, roosting and foraging habitat. Further discussion regarding the survey methodology is detailed in the *Fauna Assessment* (**Appendix J**).

Regional context

The site is located within the modelled and known range of all three species of black cockatoo. However, the site is located in the western margin of Baudin's black cockatoo's modelled range, with the species having a strong preference for the Darling Scarp and the south-west region but has been known to move out onto the eastern edge of the Swan Coastal Plain. Of the three species, Baudin's are the least likely to occur within MKSEA and the least likely to breed within the local area (Harewood 2018).

Regional habitat data for Carnaby's black cockatoo (DEC 2011; Johnstone *et al.* 2011) and regional black cockatoo roosting surveys published by Birdlife Australia indicate that the site contains areas of potential Carnaby's black cockatoo foraging and roosting habitat, and is located in proximity to a number of roosting and breeding areas, the majority of which are located in the Darling Range to the east of the site.

Foraging habitat

The nature and extent of potential foraging habitat present within the site was assessed by Harewood (2018), based on the dominant flora species and vegetation types documented in the *Flora, Vegetation and Wetland Assessment* (Emerge Associates 2018b). Searches for secondary evidence of black cockatoo foraging (such as chewed marri nuts or banksia cones) were undertaken within the site and allocated to a species where possible.

Harewood (2018) concluded the site supports approximately 6.19 ha of potential black cockatoo foraging habitat, the extent of which is shown in **Figure 16** . The primary black cockatoo foraging species observed within the site were marri and banksia trees. Jarrah, tuart, flood gum, sheoak and grass trees also provide a black cockatoo foraging resource within the site, however these species are generally foraged upon less frequently compared to marri and banksia and were observed in lower numbers. As such, the areas of identified foraging habitat are mainly represented by areas containing marri trees. Marri trees provide a primary foraging resource for all three species of black cockatoo. All mapped potential foraging habitat is considered to represent high quality foraging habitat.

Foraging debris left by black cockatoos was observed at several locations within the site during the survey, all in the form of chewed marri fruits. This foraging activity was attributed to all three species based on the nature of chew marks on the marri fruits (Harewood 2018).

Breeding habitat

The site is outside of the known breeding range for Baudin's black cockatoo, but within the breeding range of Carnaby's black cockatoo and forest red-tailed black cockatoo.

Harewood (2018) identified 84 potential black cockatoo breeding habitat trees within the site, as shown in **Figure 16**. Of these trees, two contained one or more hollows deemed unsuitable for black cockatoo nesting, with the remainder not observed to contain any hollows. 70 of the potential black cockatoo habitat trees were marri trees, with the remaining comprising tuart, flooded gum and jarrah trees. An inventory of potential habitat trees recorded within the site is provided in **Appendix J**.

Based on these results, no hollows suitable for black cockatoo nesting were observed within the site. While trees within the site have the potential to form hollows in the future, it will likely take many years for hollows to form such that they are suitable for use by black cockatoos.

Not all land parcels within the site could be directly accessed during the fauna assessment and as such the black cockatoo potential breeding habitat trees recorded by Harewood (2018) do not represent a complete account of all such habitat trees across the site. Notwithstanding, the majority of land parcels within the site which supported vegetation likely to contain potential black cockatoo habitat trees (for example, marri, jarrah, flooded gum and tuart trees) were able to be accessed, such that the fauna assessment had suitable coverage over the site.

Roosting habitat

Black cockatoo roosting habitat typically comprises large stands of native trees, close to water and foraging resources.

Birdlife Australia undertakes annual monitoring of black cockatoo roost sites across the south-west of WA, as part of the 'Great Cocky Count'. Two Great Cocky Count monitoring locations are located within MKSEA, one within the adjacent Precinct 3A (ID 'GOSKENR001') and one within Precinct 3B (within the site) (ID 'GOSKENR002'). The two locations were first surveyed as part of the Great Cocky Count in 2017 and 2018 respectively, and their locations are shown on **Figure 16**.

Both locations have been confirmed to support forest red-tailed black cockatoo roosting (**Table 34**). No records of Carnaby's black cockatoo or Baudin's black cockatoo roosting have been recorded at either location (**Table 35**).

Table 34: Great Cocky Count roost survey results within MKSEA - forest red-tailed black cockatoo

Birdlife roost ID	Year			
	2017	2018	2019	2020
GOSKENR001	51	334	35	Not surveyed
GOSKENR002	Not surveyed	72	0	Not surveyed

Table 35: Great Cocky Count roost survey results within MKSEA – Carnaby's or Baudin's black cockatoo

Birdlife roost ID	Year			
	2017	2018	2019	2020
GOSKENR001	0	0	0	Not surveyed
GOSKENR002	Not surveyed	0	0	Not surveyed

360 Environmental (2012) assessed black cockatoo roosting habitat within MKSEA. This assessment did not include dusk surveys (direct survey of roosting activity), but was based on secondary evidence associated with black cockatoo roosting activity (large amounts of bird scat in a specific area and/or significant amounts of small broken branches on the ground, typically in areas containing extensive amounts of foraging evidence). Based on this assessment, 360 Environmental (2012) identified three potential forest red-tailed black cockatoo roosting locations within the site, all of which were in Precinct 3B **(Figure 16**). Two of the roosting sites were located either side of Grove Road and generally align with the 'GOSKENR002' roosting location, with the third site located approximately 100 m to the north-east within an adjacent land parcel. Given their proximity, the roosting locations could be described collectively as comprising a single roost site.

Harewood (2018) also assessed black cockatoo roosting habitat within MKSEA. This assessment was also based on secondary evidence associated with black cockatoo roosting activity rather than dusk roosting surveys and targeted areas outside of those previously assessed by 360 Environmental (2012). This assessment did not identify evidence of any other black cockatoo roosting activity within the site.

The above roost surveys were undertaken across the whole of the site, and given black cockatoos are known to roost in both native and non-native trees, roosting observations made as part of these surveys involved consideration and observations of both native and non-native trees.

Emerge Associates have undertaken 23 dusk roost surveys at 'GOSKENR001' (on behalf of the proponent of the adjacent MKSEA Precinct 3A development), typically every two months, over a three year period between April 2018 and January 2021. 16 of the 23 surveys have recorded forest red-tailed black cockatoo roosting (with the number of birds ranging between 2 to 335), indicating the site is routinely used for roosting by the species. Emerge Associates also completed five additional dusk roost surveys of 'GOSKENR002' (between April 2018 and April 2019), four of which recorded forest red-tailed black cockatoo roosting. Based on these results and those of the Great Cocky Count, both roost sites are likely to remain actively used by forest red-tailed black cockatoos. Carnaby's black cockatoo and Baudin's black cockatoo have not been recorded during any of the dusk surveys at either location.

Overall, the site contains a number of previously recorded black cockatoo roosting locations, within Precinct 3B, which are considered likely to remain in use intermittently by black cockatoos (most predominantly forest red-tailed black cockatoos).

4.4.3.7 Quenda

The quenda (*Isoodon fusciventer*) is a non-volant mammal species which is not listed as threatened under State or Commonwealth legislation, however, it is identified as a 'Priority 4' species at a State level. The site is located in the northern Swan Coastal Plain, within the known distribution of the species. Suitable habitat for the species includes dense scrubby, often swampy, vegetation with dense cover up to 1 m high (Harewood 2018). The species often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.

Harewood (2018) recorded the species at several locations on camera traps within the GBSW (adjacent to the site). No opportunistic observations of the species were recorded within the site

(noting no camera traps were setup outside of the GBSW). The species has previously been recorded along Yule Brook and in highly degraded areas of MKSEA Precinct 3A (north-west of the site) which contained dense grass. As such, Harewood (2018) concluded quenda are likely to persist in paddocks with dense grasses and bush remnants with dense groundcover within the site, but noted:

- Quenda habitat within the site appears largely marginal in quality.
- Where remnants of native vegetation occur within the site, most are of a very small size and have a high degree of fragmentation (excluding Yule Brook).
- The majority of the site is unsuitable for quenda to use as habitat.

Harewood (2018) does not define the extent of quenda habitat within the site. However, given quenda habitat requirements are typically related to density of vegetation cover, all areas comprising a native vegetation community within the site are considered to represent potential quenda habitat, with the exception of 'non-native/hardstand' areas given these areas are typically sparsely vegetated and also comprise sections of hardstand and bare ground. On this basis, it is estimated that the site contain 35.4 ha of quenda habitat, as shown in **Figure 16**.

4.4.3.8 Short range endemic and conservation significant invertebrates

Short range endemics (SREs) are defined as terrestrial and freshwater invertebrate fauna species that have naturally small distributions of less than 10,000 km^2 (EPA 2016e). Given their potential to be restricted at small spatial scales, SRE species are generally at greater risk of changes in conservation status, local population or taxon extinctions than other, more widely distributed taxa. Other invertebrate species may also be of conversation significance, but have a widespread distribution and are therefore not considered SRE species.

Invertebrate Solutions (2022) completed a desktop assessment for SRE species and conservation significant invertebrate species. In addition, a targeted SRE field survey was completed in September 2021 (which also involved opportunistic, but not targeted, searches for conservation significant invertebrates). The survey report is provided **Appendix J**.

With respect to SRE species, a 40,000 ha desktop study area was investigated, which identified four 'confirmed' and four 'likely' SRE species as potentially occurring within the site. All other species identified in the desktop assessment were determined to be widespread and not SRE species. As detailed in **Table 36**, none of the 'confirmed' or 'likely' SRE species were identified as having a high likelihood of occurrence within the site through the desktop assessment, and none of these species were subsequently identified within the site during the targeted SRE field survey.

Table 36: SRE species identified during desktop assessment

Species	Common name	SRE status	Conservation status	Likelihood of occurrence within the site	Identified during field survey
Idiosoma sigillatum	Mygalomorph spider	Confirmed SRE	Priority 3	Moderate	No
Leioproctus (Glossurocolletes) bilobatus	Native bee	Confirmed SRE	Priority 2	Low	No
Idiosoma jarrah	Mygalomorph spider	Confirmed SRE	-	Low	No

Species	Common name	SRE status	Conservation status	Likelihood of occurrence within the site	Identified during field survey
Bothriembryon serpentinus	Land snail	Confirmed SRE	-	Low	No
Buddelundia cinerascens	Slater	Likely SRE	-	Moderate	No
Buddelundia inaequalis	Slater	Likely SRE	-	Moderate	No
Buddelundia opaca	Slater	Likely SRE	-	Moderate	No
Dinocambala ingens	Millipede	Likely SRE	-	Low	No

A database record for *Buddelundia cinerascens* is mapped within the site, however the site-specific SRE field survey did not identify the species as occurring within the site. The species has been recorded to occur at a variety of location across the Swan Coastal Plain, including at Kings Park, Rottnest Island, Cervantes, Lancelin, Guilderton, Yanchep, Ocean Reef and Hillarys. The species has been identified in a variety of habitat types, indicating it is locally widespread and relatively abundant. Given the species has been recorded in a variety of habitats across the Swan Coastal Plain, the most likely potential habitat within the site comprises areas of intact native vegetation. Notwithstanding, targeted SRE field surveys of these areas did not identify the species within the site.

Whilst none of the eight 'confirmed' or 'likely' SRE species identified in the desktop assessment were observed to occur within the site during the targeted SRE field survey, an additional two 'likely' and five 'potential' SRE species were positively identified during the field survey, as detailed in **Table 37**. The recorded locations of these species are shown in **Figure 16**.

Table 37: Additional SRE species identified during field survey

Species	Common name	SRE status	Conservation status	Identified in desktop assessment	Identified during field survey
Pseudodiploexochus sp. 'A'	Armadillid isopod	Likely SRE	-	No	Yes
Pseudodiploexochus sp. 'B'	Armadillid isopod	Likely SRE	-	No	Yes
Spherillo sp.'2'	Armadillid isopod	Potential SRE	-	No	Yes
Paraplatyarthridae sp. indet.	Paraplatyarthrid isopod	Potential SRE	-	No	Yes
Laevophiloscia sp.'1'	Philosciid isopod	Potential SRE	-	No	Yes
Styloniscus sp.'1'	Styloniscud isopod	Potential SRE	-	No	Yes
Olpiidae sp. indet.	Pseudoscorpion	Potential SRE	-	No	Yes

Four of the identified species are currently known only from within the surveyed site:

- *Pseudodiploexochus* sp. 'B' (armadillid isopod) - 'Likely' SRE species
- *Paraplatyarthridae* sp. indet. (paraplatyarthrid isopod) - 'Potential' SRE species
- *Styloniscus* sp.'1' (styloniscud isopod) - 'Potential' SRE species
- *Olpiidae* sp. indet. (pseudoscorpion) - 'Potential' SRE species.

Invertebrate Solutions (2022) concluded that habitat for the *Pseudodiploexochus* genus extends from the SCP both south and east to include the wetter parts of the Jarrah Forest biome and the southern forests, however, due to the absence of a taxonomic framework the full distribution of the genus and this individual species (or other taxa of this genus) in Western Australia is unknown, but is likely extensive through wetter forested regions.

Invertebrate Solutions (2022) outlined that the three 'Potential' SRE species have a tentative assignment of SRE status primarily due to a lack of taxonomic frameworks that are used to classify the taxa, combined with limited distributional data due to limited previous surveys that are able to record these species. Furthermore, Invertebrate Solutions (2022) concluded all three 'Potential' SRE are likely to be distributed in similar habitats throughout the SCP or even more broadly in the greater south west of Western Australia, but these likely distributions based upon vegetation, climatic and spatial data are unconfirmed due to a lack of systematic survey for these species, especially within conservation estate.

Conservation significant invertebrates

Invertebrate Solutions (2022) identified seven conservation significant invertebrate species as having some potential to occur within the site based on the desktop assessment, including six native bee species and one moth species, as detailed in **Table 38**. Whilst not a targeted search for conservation-significant invertebrates, the targeted SRE field survey did not record any opportunistic observations of the seven species.

Table 38: Conservation significant invertebrate species identified during desktop assessment

Species	Common name	Conservation status – EPBC Act	Conservation status - State	Likelihood of occurrence within site	Identified during field survey
Hesperocolletes douglasi [1]	Native bee	Critically Endangered	Critically Endangered	Moderate	No
Leioproctus douglasiellus [1]	Native bee	Critically Endangered	Critically Endangered	Moderate to low	No
Neopasiphae simplicior [1]	Native bee	Critically Endangered	Critically Endangered	Low	No
Leioproctus (Glossurocolletes) bilobatus	Native bee	-	Priority 2	Low	No
Leioproctus contrarius [1]	Native bee	-	Priority 3	Low	No
Hylaeus globuliferus [1]	Native bee	-	Priority 3	High	No
Synemon gratiosa [1]	Graceful sun moth	-	Priority 4	Low	No

[1] species is widespread and not an SRE species.

Five of the species were assessed to have a 'low' or 'moderate to low' likelihood of occurrence within the site. However, two bee species were assessed to have a 'moderate' or 'high' likelihood of occurrence within the site, and are further discussed below.

Native bee species *Hylaeus globuliferus* (Priority 3) was assessed to have a 'high' likelihood of occurring within the site. The species has a wide distribution in Western Australia from north of Eneabba, through the southern Wheatbelt and the Swan Coastal Plain, and east along the south coast to the Fitzgerald River National Park. Most records from the Swan Coastal Plain are historical. The species is associated with *Adenanthos cygnorum* and *Banksia attenuata* amongst other native plants, both of which occur within selected portions of the site and are widespread throughout the south-west of Western Australia. Invertebrate Solutions (2022) considered that the site does not comprise critical habitat for the species. Potential habitat mapping, based on the known distribution of suitable flora species, is provided in **Plate 5**. The site contains approximately 1.7 ha of potential habitat in isolated areas, whilst the adjacent GBSW contain approximately 7.2 ha of potential habitat. Potential habitat across the Swan Coastal Plain is extensive, given the prevalence of the suitable flora species (for example, *Banksia attenuata* commonly occurs through the bioregion, typically wherever Banksia woodland vegetation types occur).

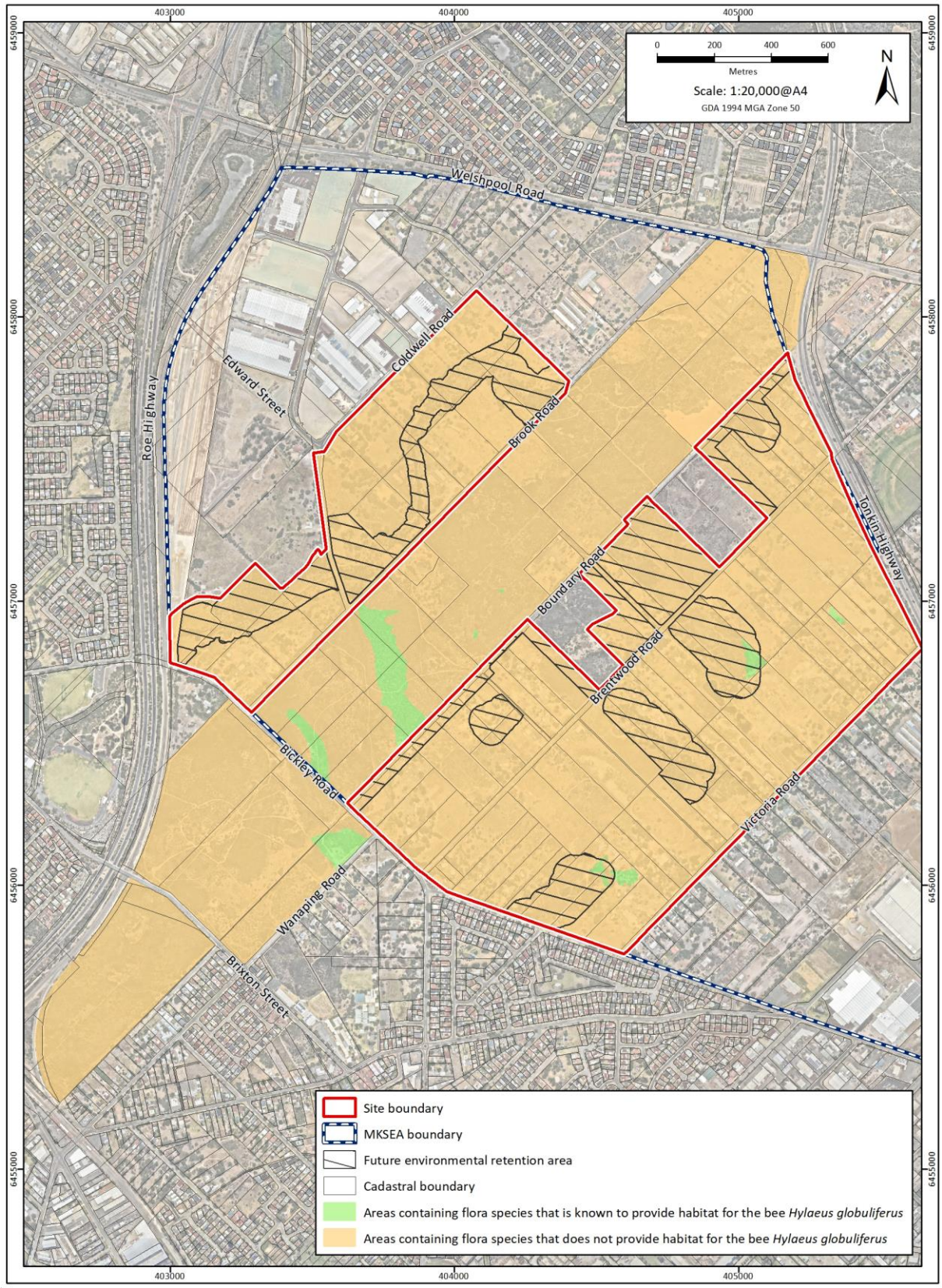

Plate 5: Potential habitat for native bee ***Hylaeus globuliferus (Priority 3)***

Native bee species *Hesperocolletes douglasi* (Critically Endangered) was assessed to have a 'moderate' likelihood of occurring within the site. The species was only previously recorded on Rottnest Island, where it was presumed extinct, until 2015 when another specimen was recorded near Pinjar in the northern Swan Coastal Plain. There is very little known about the species and its habitat preferences are still being determined, with the currently known list including *Philotheca spicata, Patersonia occidentalis*, two species of *Stylidium*, a species of *Scaevola* and the plant families Fabaceae and Myrtaceae (both of which occur extensively across the Swan Coastal Plain).

Invertebrate Solutions (2022) considered that the site does not comprise critical habitat for the species. Potential habitat mapping for the species, based on the extent of flora species known to provide habitat, is provided in **Plate 6**. The site contains approximately 34.9 ha of potential habitat, whilst the adjacent GBSW contain approximately 148 ha of potential habitat. Potential habitat across the Swan Coastal Plain is extensive, given the prevalence of the suitable flora species (for example, Fabaceae and Myrtaceae species).

In addition to the above terrestrial conservation-significant invertebrate species discussed above, one aquatic conservation-significant species has the potential to occur; *Westralunio carteri* (Carter's freshwater mussel), based on a review of DBCA threatened and priority flora records and Commonwealth threatened species searches. Harewood (2018) completed a desktop assessment of the likelihood of occurrence of the species. The species is known to occur between Moore River and Frankland River, and has been previously recorded in the lower reaches of Yule Brook (downstream of the site). The mussel prefers habitat of slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. The portion of Yule brook which occurs within the site was considered by Harewood (2018) unsuitable for the species to persist, given it is too degraded and experiences low water flows in summer. As such, the species is considered unlikely to occur within the site.

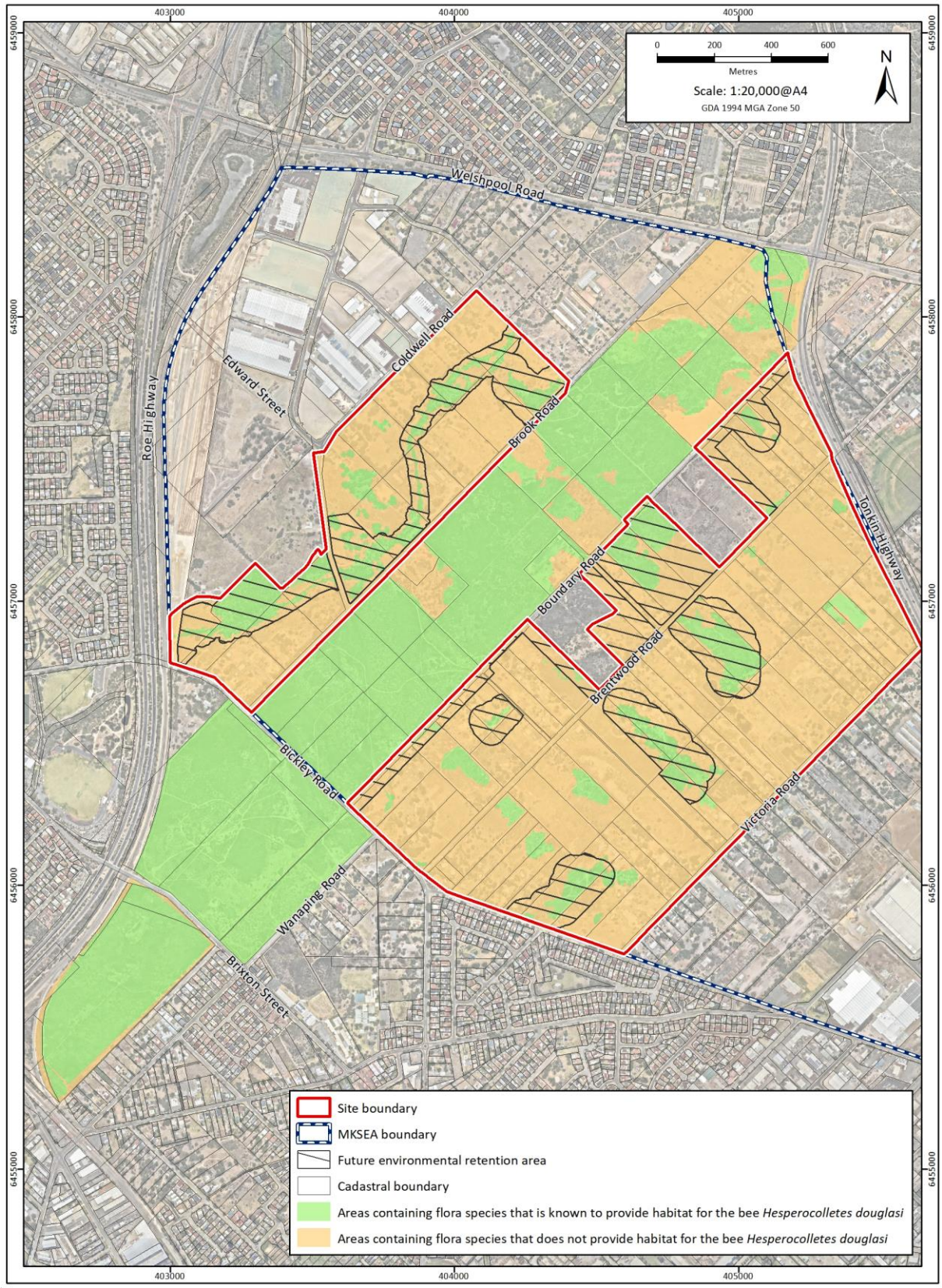

Plate 6: Potential habitat for native bee ***Hesperocolletes douglasi (Critically Endangered)***

4.4.4 Potential environmental impacts

Implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site has potential to directly and indirectly impact on terrestrial fauna. As outlined in the ER Instructions, potential impacts (direct, indirect and cumulative) on the environmental values for this factor in a local and regional context include:

- Fauna mortality as a result of construction activities.
- Loss of significant fauna habitat including black cockatoo habitat - breeding, roosting and foraging.
- Direct or indirect impacts or loss of other significant fauna and fauna habitat found to be present during survey.
- Fragmentation of fauna habitat and loss of ecological connectivity.
- Degradation of fauna habitat and habitat modification from introduction and increased spread of weeds and/or disease, altered surface water flows, altered groundwater and edge effects.
- Disturbance to waterbirds (including migratory species) from impacts to wetlands.
- Altered fauna behaviour due to noise, lighting and human presence.
- Change in feral animal abundance and/or movement.

4.4.5 Assessment of impacts

4.4.5.1 Fauna mortality as a result of construction activities

Implementation of the proposed scheme amendments and associated future development has the potential to result in fauna interactions during construction activities, which could lead to fauna mortality or injury. Such interactions are most likely to occur where construction activities occur adjacent to or within stands of remnant vegetation (compared to areas devoid of native vegetation, such as cleared areas), given their heightened fauna habitat values and increased likelihood of fauna occurrence. The risk of fauna mortality or injury during construction is primarily associated with the use of heavy machinery and other vehicles, potentially leading to accidental vehicle strikes during the vegetation clearing process.

This is a well-known risk of construction activities and can be mitigated through a range of precautionary and construction management measures, including:

- Implementation of a pre-clearing trapping program in areas of remnant bushland to capture and then relocate fauna species out of the construction area prior to the commencement of clearing activities. This typically involves relocation of any captured fauna to nearby bushland or conservation reserves. This would typically not be required within parkland cleared areas due to the absence of understorey fauna habitat, with management measures limited to those listed below.
- Undertaking pre-clearing inspections of fauna habitats (including microhabitats such as logs, leaf litter and tree hollows) to ensure no fauna occur in the clearing area immediately prior to commencing clearing works.
- During clearing works, having a suitably qualified and experienced fauna spotter/handler supervising the clearing activities, to actively search for fauna during clearing, relocate any opportunistically identified fauna, and attend to any injured fauna.
- Stipulating limits on construction vehicle operating speeds and operating times (i.e. within daylight hours), to minimise the chance of vehicle strikes.

- Undertaking clearing in a single direction, typically toward other areas of vegetation, to allow any remaining fauna to move themselves away from the area once works commence.
- Providing training and inductions to construction personnel regarding fauna management.
- Having a protocol in place to manage any fauna which might be injured, for example taking injured fauna to the nearest wildlife or veterinary clinic.

These construction management actions are typically implemented in accordance with an approved Wildlife Protection Management Plan (or a similar document). For any subdivision or development applications within the site, the City of Gosnells will require or recommend to the WAPC that, in line with the *Model Subdivision Conditions Schedule* (WAPC 2020) environmental conditions, a Wildlife Protection Management Plan is to be prepared and implemented prior to any on-ground works being undertaken for sites with remnant bushland or significant trees. This will provide a statutory mechanism to require implementation of these construction management actions to mitigate the risk of fauna mortality or injury as a result of construction activities.

These management actions (as well as the Wildlife Protection Management Plan process) are also regulated by DBCA pursuant to *Biodiversity Conservation Act 2016*, which requires appropriate fauna handling licences to be in place.

4.4.5.2 Loss of black cockatoo habitat - breeding, roosting and foraging

Breeding habitat

Table 39 summarises the potential impacts to identified black cockatoo potential breeding habitat trees as a result of future implementation of the proposed scheme amendments.

Table 39: Potential impacts to black cockatoo potential breeding habitat trees

Black cockatoo potential breeding habitat trees (Harewood 2018)	Within the site (#trees)	Future development footprint (#trees)	Future environmental retention areas (#trees)	Impact (%)
Containing unsuitable hollows	2	0	2	0%
Containing no hollows	82	53	29	64%
Total	84	53	31	58%

As outlined in **Section 4.4.3.6**, Harewood (2018) was not able to directly access all land parcels within the site and as such the figures provided in **Table 39** do not account for all black cockatoo habitat trees occurring within the site. Notwithstanding, the majority of land parcels within the site which supported vegetation likely to contain potential black cockatoo habitat trees (for example, marri, jarrah, flooded gum and planted tuart trees) were assessed by Harewood (2018) and as such the majority of habitat trees are considered to have been assessed.

Roosting habitat

One potential roosting location (identified in 2012 by 360 Environmental) is situated within the future development footprint and therefore may be lost as part of future implementation of the proposed scheme amendments (though this is not guaranteed given future proponent-led detailed design processes for development within the land may incorporate partial or full retention of the

habitat). The remaining roost locations, which comprise three separate records but all generally align with Great Cocky Count roost location 'GOSKENR002', are situated approximately 100 m to the south-west of this roosting location, within a future environmental retention area, and as such are anticipated to be retained as part of future development.

The roosting locations within the site are known to be used by forest red-tailed black cockatoos, with no records of use by Carnaby's black cockatoo or Baudin's black cockatoo. As such, it is likely that any potential impacts associated with the potential future loss of any roosting habitat would be most applicable to forest red-tailed black cockatoos.

The potential future loss of the roosting location will be mitigated through the retention and enhancement of the GOSKENR002 roosting location (located approximately 100 m to the south-west of the potentially impacted roosting habitat). Enhancement of the habitat will include formalisation of the area through fencing and management, as well as implementation of revegetation to plant additional trees known to provide black cockatoo roosting habitat, to increase the overall availability of black cockatoo roosting (as well as foraging and breeding) habitat in the long term. This will be implemented through future Conservation Area Management Plan/s.

In addition, known roosting habitat will continue to be retained elsewhere in the immediate area. This includes the ongoing retention of the nearby 'GOSKENR001' black cockatoo roost site within MKSEA Precinct 3A, which is also known to support routine roosting activity by forest red-tailed black cockatoos. In addition, the nearby Woodlupine Reserve on the western side of Roe Highway has recently been planted with 60 advanced marri trees to provide further black cockatoo habitat. At a more regional context, at least 54 other known black cockatoo roosting sites occur within 12 km of the site, of which 42 are known to have been used for roosting by forest red-tailed black cockatoos and 34 known to have been used for roosting by either Carnaby's black cockatoo or Baudin's black cockatoo.

Foraging habitat

Table 40 summarises the potential impacts to black cockatoo foraging habitat as a result of future implementation of the proposed scheme amendments. Up to 2.75 ha of foraging habitat is located within the future development footprint and is anticipated to be cleared as part of future development. These areas primarily comprise smaller and isolated patches of foraging habitat, compared to more consolidated areas proposed for future retention within the site.

Table 40: Potential impacts to black cockatoo foraging habitat

	Within the site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Black cockatoo foraging habitat	6.19	2.75	3.44	44%

Up to 3.44 ha of black cockatoo foraging habitat is located within future environmental retention areas and is anticipated to be retained as part of future development. This includes the largest and most consolidated area of habitat in the central portion of Precinct 2, within which foraging habitat is primarily provided by marri trees, which are a known primary foraging resource for all three species of black cockatoo.

The 2.75 ha of foraging habitat within the future development footprint represents a small proportion of available habitat across the local and regional area, estimated to comprise less than 0.03% of foraging habitat for all three species of black cockatoos within 12 km of the site. In this respect:

- Approximately 15,130 ha[4] of potential Carnaby's black cockatoo and Baudin's black cockatoo foraging habitat is estimated to occur within 12 km of the site, with over 11,865 ha (78.42%) of this habitat provided a level of protection from clearing through land tenure, reservation or other land use planning mechanisms (for example MRS 'Parks and Recreation' reserves, MRS 'Bush Forever' sites and DBCA managed lands such as National Parks, Regional Parks, Nature Reserves, State Forest and Conservation Parks).
- Approximately 14,371 ha[4] of potential forest red-tailed black cockatoo foraging habitat is estimated to occur within 12 km of the site, with over 11,598 ha (80.71%) of this potential habitat provided a level of protection from clearing.

The majority of potential foraging habitat within 12 km of the site is afforded some protection from clearing, indicating it is more likely to remain in the long-term. Much of this habitat is located along the Darling Scarp and across the Darling Plateau, associated with large areas of protected Jarrah forest. In addition to providing extensive foraging resources for all three species of black cockatoo, these areas also provide roosting and breeding habitat for black cockatoos.

4.4.5.3 Direct or indirect impacts

Fauna habitat types

Up to 9.56 ha (27%) of mapped fauna habitat (based on native vegetation occurrence) occurs within the future development footprint and therefore may be cleared as part of future implementation of the proposed scheme amendments, through subdivision, development and supporting infrastructure works. This includes:

- 2.9 ha (21%) of riparian habitat
- 2.5 ha (22%) of wetland habitat
- 4.2 ha (39%) of woodland/forest habitat.

Additionally, 174.8 ha (80%) of 'non-native/hardstand' areas occur within the future development footprint and are anticipated to be cleared. These are heavily disturbed areas primarily comprising cleared areas or non-native plant species, however, do contain some occasional native species such as trees and shrubs that may provide some isolated fauna habitat values.

The development footprint has been designed to avoid intact native vegetation providing suitable fauna habitat where possible, with impacts primarily associated with areas of 'non-native/hardstand' vegetation.

[4] Calculated using remnant native vegetation data published by the Department of Primary Industries and Regional Development and known black cockatoo foraging species preferences.

Quenda

Harewood (2018) concluded that in addition to black cockatoos, other conservation significant vertebrate fauna species known to occur within the site was limited to quenda. Harewood (2018) recorded the species within the adjacent GBSW, but not directly within the site. Notwithstanding, quenda have historically been observed within the Yule Brook and in highly degraded areas of MKSEA Precinct 3A which contained dense grass. As such, Harewood (2018) concluded quenda are likely to persist in some paddocks with dense grasses and bush remnants with dense groundcover within the site. The extent of native vegetation communities has been used to estimate the extent of quenda habitat within the site, totalling 35.4 ha.

Table 41 summarises the potential impacts to quenda habitat as a result of future implementation of the proposed scheme amendments.

Table 41: Potential impacts to quenda habitat

	Area within the site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Quenda habitat (estimated)	35.4	9.6	25.8	27%

Approximately 27% of quenda habitat estimated to occur within the site is situated within the future development footprint and is anticipated to be lost as part of future development. The largest and most consolidated areas of habitat occur within future environmental retention areas and are anticipated to be retained and enhanced. These include areas of habitat in proximity to the GBSW, which is known to support a population of quenda and provides significant habitat for the species.

'Likely' and 'Potential' SRE fauna

All areas of vegetation where the 'Likely' and 'Potential' SRE species were recorded during the targeted SRE field survey within the site are within the identified future environmental retention areas, as shown in **Figure 16**, and thus impacts to known occurrences of these species are anticipated to be avoided. Invertebrate Solutions (2022) concluded that the site is not considered to be critical habitat for any SRE species, and given that the majority of native vegetation (which represents potential SRE habitat) is proposed to be retained there is expected to be little to no loss of any potential SRE habitat.

A database record for *Buddelundia cinerascens* intersects the site, however the species was not recorded within the site during the targeted SRE field survey. The species has been recorded in a variety of habitats elsewhere across the Swan Coastal Plain and the most likely potential habitat within the site comprises areas of intact native vegetation. Given intact native vegetation was extensively surveyed for SRE without identifying the species and the majority of this vegetation (i.e. the species potential habitat) is within future environmental retention areas, potential impacts to the species are unlikely, if any.

Native bees

Potential habitat for native bee species *Hylaeus globuliferus* (Priority 3) and *Hesperocolletes douglasi* (Critically Endangered) occurs within the site, noting that both species have habitat types (and associated floristic compositions) which are common across the Swan Coastal Plain.

Table 42 summarises the potential impacts to native bee habitat as a result of future implementation of the proposed scheme amendments.

Table 42: Potential impacts to native bee habitat

	Total within the site (ha)	Future development footprint (ha)	Future environmental retention areas (ha)	Impact (%)
Hylaeus globuliferus habitat	1.7	0.7	1.0	41%
Hesperocolletes douglasi habitat	34.9	8.7	26.2	25%

Invertebrate Solutions (2022) completed a desktop assessment and a field survey including opportunistic observations for conservation significant invertebrate species, however targeted surveys have not been completed. This provides limitations as to predicting the potential impacts to native bee species, given it is unknown whether or not either species actually utilises potential habitat within the site. However, impacts to potential habitat have been considered.

Both species have significantly greater quantities of potential habitat available within the adjacent GBSW, including approximately 7 ha for *Hylaeus globuliferus* and 148 ha for *Hesperocolletes douglasi*. Furthermore, potential habitat for both species is likely to be widespread across the Swan Coastal Plain due to prevalence of suitable flora species.

4.4.5.4 Fragmentation of fauna habitat and loss of ecological connectivity

Fragmentation of fauna habitat due to loss of vegetation reduces the ability of fauna to move freely to access dispersed or temporary resources and potentially reduces gene flow. Habitat fragmentation potentially exacerbates other threats, like predation by feral species, by providing access into habitats that were previously dense and difficult to traverse. The potential for habitat fragmentation is most likely to occur where there is limited extent of a fauna habitat supporting a population of breeding fauna species, or where a particular species is limited to that specific habitat.

With the exception of Yule Brook, the site has been extensively cleared and therefore provides limited contribution to mapped ecological linkages, with fauna habitat generally only comprising small, isolated fragments of native vegetation subject to differing levels of disturbance.

Given the future development footprint excludes the larger, consolidated areas of native vegetation which provide the highest value to fauna and remaining ecological connectively within the site (including the Yule Brook corridor and associated foreshore area), it is unlikely that implementation of the proposed scheme amendments and associated future development will result in significant further fragmentation of habitat, beyond that which already occurs within the site.

4.4.5.5 Introduction of weeds and/or disease, altered surface water flows, altered groundwater and edge effects

<u>Introduction and increased spread of weeds and/or disease</u>

As outlined in **Section 4.3.5.4**, weeds are prevalent throughout the majority of the site. Future development will provide opportunities to remove the weed seed bank from the majority of weed invested areas through earthworks and also enable weed management measures to be targeted in

areas of retained vegetation to reduce weed occurrence. With respect to disease, there is a risk that the site may already be exposed to dieback.

Construction management protocols and hygiene requirements can be implemented through conditions of future subdivision and development approvals to minimise the risk of spreading dieback and weeds, as well as the use of clean soils where imported fill is required for earthworks or planting mix for landscaping works, to ensure weed species and pathogens such as dieback are not introduced or spread. Through implementation of these mitigation measures, significant degradation of fauna habitat due to the introduction and increased spreads of weeds and/or disease is not anticipated.

Edge effects

Areas of remnant vegetation and associated fauna habitat within the site are already highly fragmented and as a result are subject to edge effects. Where areas of existing fauna habitat are identified within future environmental retention areas, these are anticipated to be retained in full and not fragmented into smaller areas, which could expose these areas to additional edge effects. Furthermore, buffer zones are provided surrounding areas of native vegetation and associated fauna habitat anticipated for future retention, which will provide increased protection from edge effects, by providing separation between retained habitat and nearby future development areas and also through enhancement of these areas.

Altered surface water flows and groundwater

As discussed in **Section 4.3.5.3**, wetland and riparian vegetation which occurs in areas which convey stormwater runoff (such as along Yule Brook or the Yule Brook tributary traversing the GBSW) will be subject to a greater total volume of surface water runoff over an annual period. Whilst this has the potential to alter seasonal timing for the emergence and growth of different flora species, this is unlikely result in the degradation of fauna habitat, as existing peak flow rates at internal and external stormwater discharge points (primarily existing culverts) will be maintained, such that the peak rate of surface water flow does not increase. This will ensure sensitive areas of flora and vegetation and associated fauna habitat are not exposed to increased peak rates of flow, which have the potential to cause flooding, erosion, transport of sediments and loss of vegetation and habitat.

4.4.5.6 Disturbance to waterbirds (including migratory species) from impacts to wetlands

Harewood (2018) concluded that no migratory or wetland bird species are considered to occur within or utilise the site, and that whilst some more common species may occur very occasionally at some manmade wetlands or dams the site contain only very marginal habitat for these species.

Notwithstanding the results of Harewood (2018), there remains potential for waterbirds to utilise wetlands within the site at times, particularly wetlands in proximity to GBSW. However, given all CCWs within private lots and the Yule Brook are identified within future environmental retention areas and are proposed to be retained and enhanced, it is not anticipated that disturbances to waterbirds from impacts to wetlands will occur.

4.4.5.7 Altered fauna behaviour due to noise, lighting and human presence

Compared to rural land uses currently occurring across the site, the proposed future industrial and commercial land uses would likely result in increased levels of noise and light emissions, as well as an increased human presence. This has the potential to impact upon fauna species, such as affecting foraging and breeding behaviours (Newport *et al.* 2014).

Potential measures to reduce the impacts of noise, lighting and human presence on fauna include selecting appropriate land uses directly adjacent to areas of habitat and the use of shielding or barriers to reduce acoustic and light emissions into areas of habitat (for example, strategic directional lighting, light covers and dense vegetation screening) (Newport *et al.* 2014).

Within the site, areas directly adjacent to the GBSW are most applicable in this regard, given the GBSW contains large and intact areas of fauna habitat. Where it is practical to realign the existing road network (limited to specific portions of the site due to constraints of the existing external road network), the development footprint has been setback from the south-eastern boundary of the GBSW to provide a buffer zone to proposed industrial and commercial land uses, which will reduce noise and light emissions impacting the GBSW. The treatment of these buffer zones will be determined as part of future stages of the land use planning process, but it is anticipated that some planting of these areas would occur, which would further mitigate these potential impacts. In addition, the City will require the use of LED street lighting nearby to areas of retained fauna habitat to ensure light spill beyond the road is minimised.

4.4.5.8 Change in feral animal abundance and/or movement

Harewood (2018) recorded eight introduced species within the site or adjacent GBSW, with a further five species considered to potentially frequent the area:

- Mammals
  - *Canis lupus familiaris* (dog) – potential to occur
  - *Felis cattus* (cat) – recorded
  - *Mus musculus* (house mouse) – recorded
  - *Oryctolagus cuniculus* (rabbit) – recorded
  - *Rattus rattus* (black rat) – potential to occur
  - *Vulpes vulpes* (red fox) – recorded
- Birds
  - *Anas platyrhynchos* (mallard duck) – potential to occur
  - *Columba livia* (domestic pigeon) – potential to occur
  - *Dacelo novaeguineae* (laughing kookaburra) – recorded
  - *Streptopelia chinensis* (spotted turtle dove) – recorded
  - *Streptopelia senegalensis* (laughing turtle dove) – recorded
  - *Trichoglossus haematodus* (rainbow lorikeet) – recorded
- Fish
  - *Gambusia holbrooki* (mosquito fish) – potential to occur

Harewood (2018) concluded that the presence of introduced predators, amongst other factors, is likely to have had a significant effect on the current reduced diversity of fauna species that remain within the site. Overall, introduced fauna species are already known to occur across the site.

Given the proposed scheme amendments would allow for industrial development, it is unlikely this would result in significant increases in the abundance of feral predators (such as dogs, cats and foxes) within the site, given existing rural-residential land uses (which are conducive to such species) would be removed and replaced with commercial and industrial land uses with predominantly hardstand surfaces. As such, it is likely there will be less domestic animal ownership within the site and less vegetated paddocks and pasture which could be used by such animals for refuge.

Of the conservation significant fauna species known to occur within the site, quenda are the most susceptible to predation by feral animals. Given cats and red foxes were recorded as already occurring within the site, and specifically within the GBSW, quenda are already likely to be subject to predation by such species in the local area. As outlined above, it is unlikely that the proposed scheme amendments would result in a significant increase in the abundance of feral predators such that predation of quenda would significantly increase above existing levels.

In 2020, the City of Gosnells amended the *Cat Local Law 2014* to identify 'cat prohibited areas', which prohibits cats from being within the GBSW (amongst other natural areas within the City of Gosnells). As such, the City of Gosnells will target control of cats (domestic or feral) in this area and will also penalise any owners of domestic cats found to occur within the GBSW. This local law is intended to reduce local impacts of cat predation on native fauna.

4.4.6 Mitigation

The City of Gosnells propose a range of measures to mitigate the potential impacts of future implementation of the proposed scheme amendments (through subdivision, development and supporting infrastructure works) on terrestrial fauna. This includes impact avoidance, minimisation and rehabilitation measures, consistent with the EPA mitigation hierarchy. The planning mechanisms and the associated stages of the land use planning process applicable to each mitigation measure are also outlined below.

4.4.6.1 Avoid

The primary measure proposed to avoid impacts to terrestrial fauna values within the site is the identification of future environmental retention areas. These areas reflect the proposed future Biodiversity Asset POS areas shown in the draft MKSEA Structure Plan, which will provide for the future retention and enhancement of fauna habitat once POS areas are established through the future subdivision and development process. The future environmental retention areas will avoid impacts to:

- Up to 25.8 ha (73%[5]) of fauna habitat associated with native vegetation (within native plant communities), including (**Figure 15**):
  - 10.6 ha (79%) of fauna habitat associated with riparian vegetation
  - 8.8 ha (78%) of fauna habitat associated with wetland vegetation
  - 6.5 ha (61%) of fauna habitat associated with woodland/forest vegetation.

  An additional 44.6 ha (20%) of fauna habitat associated with 'non-native/hardstand' vegetation is also avoided, which may include parkland cleared supporting mature trees.
- With respect to black cockatoo habitat (**Figure 16**);

[5] Percentages listed are based on the percentage of the relevant environmental value (for example fauna habitat type) across the entire site.

  - 3.44 ha (56%) of foraging habitat
  - 31 (36%) black cockatoo habitat trees
  - An existing black cockatoo roosting location (comprising three separate records), which aligns with Great Cocky Count roost location 'GOSKENR002'. This habitat will be retained and enhanced within the Yule Brook foreshore reserve to provide a connected habitat refuge for black cockatoos and other native fauna.
- 25.8 ha (73%) of quenda habitat (**Figure 16**).
- 1.0 ha (59%) and 26.2 ha (75%) of potential habitat for native bee species *Hylaeus globuliferus* and *Hesperocolletes douglasi*, respectively.
- All areas of vegetation where the 'Likely' and 'Potential' SRE species were identified (**Figure 16**).

4.4.6.2 Minimise

Minimisation of impacts to terrestrial fauna values will be provided through the following mitigation measures:

- Preparation and implementation of a Conservation Area Management Strategy as part of the structure planning process, the purpose of which is to define a consistent approach to the short and long-term management of Biodiversity Asset POS areas identified within the draft MKSEA Structure Plan layout. A Conservation Area Management Strategy has been prepared for the site as part of the draft MKSEA Structure Plan and is provided in the respective EAMS documents for each precinct, provided in **Appendix B** and **Appendix C**, which may require further update prior to approval following the EPA assessment process.
- Preparation and implementation of Conservation Area Management Plan/s for the proposed future Biodiversity Asset public open space areas where the retention of environmental values is proposed, which will be required to detail how the areas will be managed to maintain and enhance existing fauna habitat values in line with the above mentioned Management Strategy. These plans will be prepared and implemented at the subdivision and development stage. Management plans will be required to be consistent with the City of Gosnells Policy CP 6.2.2 and the associated Guidelines.
- Preparation and implementation of a Wildlife Protection Management Plan, to support future subdivision and development applications which involve clearing of remnant bushland or significant trees. The purpose of the plan will be to detail the management measures that will be implemented during construction to minimise the risk of fauna injury or mortality, such as pre-clearing fauna trapping programs, pre-clearing inspections of habitat, clearing protocols, construction vehicles speed limits and injured fauna protocols. The management plan will be prepared and implemented by individual proponents at the subdivision and development stage.
- Preparation and implementation of a Tree Protection Management Plan, where subdivision or development applications cover areas containing existing trees. The purpose of the plan will be to encourage the retention of significant trees providing fauna habitat (such as black cockatoo foraging, roosting and breeding habitat) and detail which trees are proposed to be retained versus those proposed to be lost. This requirement will be imposed by the City of Gosnells as a condition of subdivision or development approval.
- The City of Gosnells will require the use of LED street lighting nearby to retained fauna habitat to ensure light spill beyond the road is minimised, to minimise the potential impacts of light emissions on native fauna.

The above requirements will be implemented through application of the proposed local scheme provisions listed in **Section 2.2.3**, which include:

- Subdivision and development are to be in accordance with an approved Structure Plan, which shall be prepared in accordance with *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 Part 4. The approved Structure Plan together with all approved amendments shall apply in relation to the land within the area of the Structure Plan. The zones designated in the Structure Plan and the permissibility of uses within those zones shall be given due regard when determining applications within the Structure Plan area.
- The Structure Plan must provide for the protection and enhancement of the following environmental values within Biodiversity Asset public open space areas:
  - Conservation category wetlands within private lots and buffers
  - Threatened ecological communities within private lots and buffers
  - Yule Brook and a determined foreshore reserve.
- Prior to the approval of the Structure Plan, a Conservation Area Management Strategy shall be prepared and approved by the City of Gosnells. The purpose of the strategy is to define a consistent approach to the short and long-term management of Biodiversity Asset public open space areas identified within the Structure Plan.
- Where subdivision applications affect land, which has not been directly surveyed for flora and vegetation or terrestrial fauna, suitable surveys are to be undertaken to support the application to determine if significant flora, vegetation and fauna values occur. If such values are identified, then they must either be protected or necessary environmental approvals must be attained if they are to be impacted (including the provision of offsets where required).
- Where subdivision applications affect land that contains environmental values identified in the Structure Plan, the local government will recommend to the WAPC that a condition of subdivision approval be imposed, requiring a Conservation Area Management Plan to be prepared for any applicable Biodiversity Asset public open space areas, which will detail how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Development applications on land that contains environmental values identified in the Structure Plan, shall be accompanied by a Conservation Area Management Plan (unless an existing Conservation Area Management Plan already applies to the land), that details how the approved Conservation Area Management Strategy will be implemented within the area subject to the application. The management plan will be required to be consistent with the City of Gosnells Policy CP 6.2.2 *Retention, Rehabilitation and Revegetation of Natural Areas* and the associated Guidelines.
- Prior to the commencement of subdivisional or development works, a Construction and Environmental Management Plan shall be prepared by the proponent and approved by the local government. The plan shall outline the construction management actions to be implemented and is to be consistent with the management actions identified in any applicable Conservation Area Management Plan.

Monitoring program

The proposed monitoring program for the site is outlined in **Section 4.2.9.2**. The program targets monitoring of water quality (nutrient levels) and water levels, which were identified as the key parameters which should be targeted for monitoring in consultation with DWER. Whilst the proposed monitoring is directly and most prominently related to the inland waters factor, is it

indirectly related to the terrestrial fauna factor. Areas of fauna habitat within the site proposed to be retained as part of future development are primarily associated with wetland and riparian vegetation, which is dependent on the maintenance of the existing hydrological regime, which is the focus on the proposed monitoring program.

Additional monitoring related to revegetation areas and associated fauna habitat is outlined in **Section 4.3.6.2**.

The City also participates and assists the community in the annual Great Cocky Count program.

4.4.6.3 Rehabilitate

In the context of the ER, rehabilitation measures are taken to relate to rehabilitation of areas that may be temporarily impacted as a result of implementing the scheme amendments. Areas impacted by the scheme amendment will be those associated with the development of permanent industrial land uses, which are not temporary and therefore any such impacts are not possible to directly rehabilitate. As such no specific rehabilitation mitigation measures are proposed directly as part of the proposed scheme amendments.

4.4.7 Residual impact

The following residual impacts are anticipated as a result of implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site, once mitigation measures have been applied:

- The loss of up to 49 known trees that may provide potential breeding habitat for black cockatoos, none of which contain hollows.
- The loss of trees that may provide roosting for black cockatoos (note this was a roosting location identified by indirect evidence and is not a Great Cocky Count roost site).
- The loss of up to 2.75 ha which may provide foraging habitat for black cockatoos.
- The loss of up to 9.6 ha which may provide suitable habitat for quenda.
- The loss of potential habitat for peregrine falcon, associated with the development of open rural areas and paddocks across the site, within which prey species may occur.
- The loss of up to 0.7 ha and 8.7 ha potential habitat for native bee species *Hylaeus globuliferus* and *Hesperocolletes douglasi*, respectively.

Overall, the residual impacts to terrestrial fauna are not considered to be significant. The following considerations have informed this conclusion:

- No known or potential black cockatoo breeding habitat trees with any hollows are proposed to be cleared. As such, none of the potential black cockatoo habitat trees provided any existing breeding habitat for black cockatoo species. Whilst these trees have the potential to develop suitable hollows in the future, a further 31 potential habitat trees (two of which contain small hollows) are proposed to be retained and may also develop suitable hollows in the future. In addition, significant black cockatoo breeding habitat is available in close proximity to the site associated with extensive areas of Jarrah Forest along the Darling Scarp.
- The trees which black cockatoos may roost in are situated in close proximity to two known and recorded Great Cocky Count roosting sites, which occur within future retention areas and as such will be retained and enhanced (through revegetation and rehabilitation) as part of future development. Enhancement of the habitat will include formalisation of the area through fencing

and management, as well as implementation of revegetation to plant additional trees known to provide black cockatoo roosting habitat, to increase the overall availability of black cockatoo roosting (as well as foraging and breeding) habitat in the long term. This will be implemented through future Conservation Area Management Plan/s. In addition, known roosting habitat will continue to be retained elsewhere in the immediate area, including the ongoing retention of the nearby 'GOSKENR001' black cockatoo roost site within MKSEA Precinct 3A, which is also known to support routine roosting activity by forest red-tailed black cockatoos. In addition, at least 54 other known black cockatoo roosting sites occur within 12 km of the site, of which 42 are known to have been used for roosting by forest red-tailed black cockatoos and 34 known to have been used for roosting by either Carnaby's black cockatoo or Baudin's black cockatoo.

- The 2.75 ha of foraging habitat within the future development footprint represents a small proportion of available habitat across the local and regional area, estimated to comprise less than 0.03% of foraging habitat for all three species of black cockatoos within 12 km of the site. In addition, 3.44 ha of foraging habitat will be retained across the site, to provide an ongoing foraging resource in the immediate area.
- The majority (25.8 ha, 73%) of quenda habitat within the site will be retained, providing ongoing local habitat for the species. In addition, the species is known to commonly utilise the adjacent GBSW and was recorded on numerous occasions in this area during site surveys. Given no impacts to habitat within the GBSW are proposed, ongoing use of this habitat by local species is not anticipated to be affected. The largest and most consolidated areas of habitat occur within future environmental retention areas and will be retained and enhanced.
- With respect to peregrine falcon, the species occurs across all of Australia with a large home range. The potential habitat within the site associated with open areas of semi-rural land that the species may rarely fly over as part of a much larger search radius for potential prey is common and extensive across the locality and Swan Coastal Plain. Additionally, the species was not observed within the site and is very unlikely to breed within the site.
- With respect to potential native bee habitat, the residual impacts are minimal when compared to the areas of potential habitat avoided within future environmental retention areas. In addition, the flora species which provide habitat for each species are common and widespread across the Swan Coastal Plain.

4.4.8 Predicted outcome

The EPA objective for terrestrial fauna is *'to protect terrestrial fauna so that biological diversity and ecological integrity are maintained'.*

The scheme amendments and associated future commercial and industrial subdivision and development of the site can be implemented in a manner which achieves the EPA objective. Specifically, the draft MKSEA Structure Plan prepared by the City of Gosnells provides for a future conservation area network which will enable future retention of the majority of intact native fauna habitat, including that for conservation significant species such as black cockatoos and quenda. Some confirmed black cockatoo roosting habitat occurs within the future development footprint and therefore may be lost as part of future development, however other confirmed roosting habitat will be retained in close proximity and POS areas will be revegetated and enhanced with species suitable for black cockatoos, to provide additional roosting habitat, whilst other nearby known roost locations nearby to the site will continue to provide roosting habitat in the locality. Overall, no significant impacts to terrestrial fauna are anticipated.

4.5 Key Environmental Factor: Social Surroundings

4.5.1 EPA objective

To protect social surroundings from significant harm.

4.5.2 Relevant policy and guidance

Table 43: Relevant policy and guidance for the social surroundings factor

Policy and Guidance	Consideration for the proposed amendments
Statement of Environmental Principles, Factors and Objectives (EPA 2020a)	Referred to in the identification and assessment of potential impacts for each key environmental factor.
Environmental Factor Guideline - Social Surroundings (EPA 2016c)	Consulted in the consideration of potential impacts to flora and vegetation as a result of the proposed amendments.
Aboriginal Heritage Due Diligence Guidelines (DAA 2013)	The Aboriginal heritage surveys completed across MKSEA and the site considered these Guidelines.

4.5.3 Receiving environment

4.5.3.1 Aboriginal heritage desktop assessment

The Aboriginal Heritage Inquiry System (AHIS) is maintained by the Department of Planning, Lands and Heritage (DPLH), and contains information on Registered Aboriginal Heritages Sites listed under the *Aboriginal Heritage Act 1972* (AH Act) and Other Heritage Places known to occur within Western Australia.

In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2020) was undertaken. The results of this search indicated four registered Aboriginal heritage sites are mapped as occurring within the site, in addition to three other heritage places, as shown in **Figure 17** and detailed in **Table 44**.

Of the seven Aboriginal sites recorded on the AHIS, DPLH has determined that five are spatially unreliable, meaning the physical location of these sites cannot be conclusively confirmed or relied upon as being accurately mapped. Three sites are identified as 'other heritage places' which includes 'lodged sites' (where information has been received in relation to the place, but an assessment has not been completed to determine if it meets the criteria to a Registered site under the AH Act) and 'stored data/not a site' (where the place has been assessed as not meeting the criteria of a Registered site under the AH Act).

Table 44: Aboriginal heritage sites and other heritage places within the site (DPLH 2021)

Name	DPLH ID	Precinct	Description	Status	Location Data	Type
Boundary Road, Wattle Grove	3624	Precinct 2	Aboriginal Site	Registered	Reliable	Artefacts / scatter
Brentwood Road, Quarry	4342	Precinct 2	Aboriginal Site	Registered	Unreliable	Artefacts / scatter, quarry
Brentwood Road, Swamp	4343	Precinct 2	Aboriginal Site	Registered	Unreliable	Artefacts / scatter
Yule Brook Mandoorn	36929	Precinct 3B	Aboriginal Site	Registered	Unreliable	Mythological
Wattle Grove, Perth	3312	GBSW	Other Heritage Place	Lodged	Unreliable	Artefacts / scatter, camp
Brentwood Road NW	4341	Precinct 2	Other Heritage Place	Lodged	Unreliable	Artefacts / scatter
Yule Brook Farm 02	24785	Precinct 3B	Other Heritage Place	Lodged	Reliable	Artefacts / scatter, arch deposit

4.5.3.2 Aboriginal heritage surveys

A *Preliminary Investigation of Aboriginal Heritage* was conducted by Australian Cultural Heritage Management (ACHM) in May 2009 (**Appendix L**. The scope of this desktop investigation extended across the entirety of the MKSEA precincts and involved an assessment of all available information on Aboriginal heritage values, including a review of previously completed archaeological and ethnographic surveys, as listed below.

- Working document to identify Aboriginal Heritage Issues to facilitate risk management strategies for stage 5 of the Dampier to Bunbury Natural Gas Pipeline Duplication Project (Australian Interaction Consultants)
- Results of an Aboriginal cultural heritage survey of the Yule brook flow reduction dam site, Kenwick (Peter Gifford)
- Report on an Archaeological Investigation for Aboriginal Sites Gosnells Bridge Works (Quartermaine Consultants)
- Report on a Survey for Aboriginal Sites at the Proposed Homestead Road Sewerage Pipeline, Gosnells. Aug. 1989. (R O'Connor)
- Australian Research Grants Scheme: Final Report on the Project the Swan Coastal Plain, Western Australia (S Hallam)
- Aboriginal Sites in the Perth Metropolitan Area: A Management Scheme. June 1987, Revised 1988 (L Strawbridge)
- Aboriginal Heritage issues and cable crossings: upper Canning River downstream from Nicholson Road traffic bridge adjacent downstream from Canning Bridge and Narrows bridge utilizing internal bridge structure Swan River adjacent upstream to Causeway (B Machin)

Previous surveys indicated the majority of Aboriginal sites are small in size and low in artefact density. The most common stone artefact material is quartz, with fossiliferous chert, chert and dolerite being the remaining stone types. The ACHM (2009) survey concluded additional Aboriginal heritage survey work was required to inform a management strategy prior to development

occurring. Further studies were also recommended for 'Boundary Road, Wattle Grove' (ID 3624) and 'Yule Brook Farm 02' (ID 24785). In addition, the Yule Brook was recommended as an 'Aboriginal Site' under Section 5 of the *Aboriginal Heritage Act 1972* based on the Gifford (2007) Aboriginal cultural heritage survey results.

An *Aboriginal Cultural Heritage Impact Assessment* was subsequently conducted by ACHM in October 2018 (**Appendix M**) to investigate the aboriginal heritage values of the site. Site inspections of mapped heritage places were undertaken in October 2018 with a team consisting of one ACHM archaeologists, between six and eight Whadjak Noongar representatives and three City of Gosnells representatives. Additionally, areas comprising remnant bushland within the site were also inspected to identify any unrecorded Aboriginal heritage places.

ACHM (2018) assessed all mapped Aboriginal heritage places within the site (outlined in **Table 45**). The results of ACHM (2018) in relation to each Aboriginal heritage place are summarised in **Table 45**.

Table 45: Summary of ACHM (2018) survey conclusions in relation to Aboriginal heritage places

Aboriginal heritage place	ACHM (2018) results and conclusions
DPLH 4341 'Brentwood Road NW'	• Recorded in 1973 and comprises a small artefact scatter consisting of ~50 artefacts (49 quartz and one chert). • Onsite inspection by ACHM (2018) observed the area to be heavily disturbed by historical clearing, with building rubble and built-up earthworked soil observed. The remaining area containing remnant vegetation was inspection in detail, with no cultural material identified. • ACHM (2018) concluded that given the evident disturbance it is unlikely that any cultural materials present would be in their original depositional context, with the site integrity being 'very poor'. As such, ACHM (2018) considered that it is **unlikely this heritage place would constitute an Aboriginal heritage site** under Section 5 of the *Aboriginal Heritage Act 1972.*
DPLH 4342 'Brentwood Road, Quarry'	• Recorded in 1973 and comprises a small to moderate artefact scatter/quarry consisting of ~48 artefacts (40 quartz, seven fossilised chert and one chert). • Onsite inspection by ACHM (2018) observed the area to be heavily disturbed and situated directly adjacent to Tonkin Highway and an associated drainage culvert. • ACHM (2018) concluded that given the evident disturbance it is probable that any cultural materials present would not be in their original depositional context, with the site integrity being 'very poor'. As such, ACHM (2018) considered that it is **unlikely this heritage place would constitute an Aboriginal heritage site** under Section 5 of the *Aboriginal Heritage Act 1972.*
DPLH 4343 'Brentwood Road, Swamp'	• Recorded in 1973 and comprises a small to moderate artefact scatter consisting of ~42 artefacts (32 quartz and 10 fossilised chert). • ACHM (2018) noted that both DPLH 4342 and DPLH 4343 are listed by the DPLH at the same coordinates, indicating the sites may overlap. • Given the sites comprise the same location, the results of the assessment were the same as for DPLH 4342, being that ACHM (2018) considered that it is **unlikely this heritage place would constitute an Aboriginal heritage site** under Section 5 of the *Aboriginal Heritage Act 1972*.
DPLH 3312 'Wattle Grove, Perth'	• Recorded in 1973 and comprises a small artefact scatter consisting of three quartz flakes. • A previous investigation completed by Czerwinski (2009) reported that all three artefacts were previously collected and therefore DPLH 3312 **may be considered no longer a site** under Section 5 of the *Aboriginal Heritage Act 1972*.
DPLH 3624 'Boundary Road, Wattle Grove'	• Recorded in 1970 and comprises a small artefact scatter consisting of one quartz flake, one dolerite flake and one glass. • Onsite inspection by ACHM (2018) observed the area to be heavily disturbed by pastoral activities, with horses grazing at the recorded location. The area was observed to have formed a natural wetland and was largely underwater, which restricted access to the exact site

Aboriginal heritage place	ACHM (2018) results and conclusions
	location and as such further investigation would be required to determine the presence of cultural materials, condition and intactness of the site. • Notwithstanding, ACHM (2018) concluded that given the evident disturbance it is unlikely that any cultural materials present would be in their original depositional context, with the site integrity being 'very poor'. As such, ACHM (2018) considered that it **is unlikely this heritage place would constitute an Aboriginal heritage site** under Section 5 of the *Aboriginal Heritage Act 1972.*
DPLH 24785 'Yule Brook Farm 02'	• Recorded in 2007 and comprises a small artefact scatter consisting of 24 quartz artefacts. • Access to the land was not available, with observations made from adjacent areas (<50 m away). Winter grasses covered the area, meaning ground visibility was low. As such, ACHM (2018) concluded further investigation would be required to determine the presence of cultural materials, condition and intactness of the site. • Notwithstanding, ACHM (2018) concluded that given the evident disturbance it is unlikely that any cultural materials present would be in their original depositional context, with the site integrity being 'very poor'.
DPLH 36929 'Yule Brook Mandoorn'	• Whilst this site was not formally listed on the AHIS at the time of the survey, ACHM (2018) did survey the extent of Yule Brook and did not identify any archaeological heritage sites. • ACHM (2018) considered the ethnographic heritage values of Yule Brook, with Whadjak Noongar traditional owners identifying it was a place of importance to past lifeways and daily life. Traditional owners requested further opportunity to have a suitably qualified anthropologist conduct further ethnographic consultation regarding Yule Brook. • It is considered that additional ethnographic consultation should be undertaken prior to the finalisation and approval of a structure plan over the area. • **The heritage place has since been registered** under the *Aboriginal Heritage Act 1972* due to its mythological heritage values.

Detailed inspections of areas within Precinct 2 and Precinct 3B where remnant bushland occurred did not identify any new Aboriginal heritage places (ACHM 2018).

Based on the results of ACHM (2018), DPLH heritage places 4341, 4342, 4343, 3312 & 3624 are unlikely to constitute an Aboriginal heritage site under Section 5 of the *Aboriginal Heritage Act 1972*. With respect to the two other Aboriginal heritage places within the site:

- DPLH 36929 'Yule Brook Mandoorn' is a registered Aboriginal heritage site of ethnographic significance. Whilst initial consultation with traditional owners has been completed, further consultation specific to Yule Brook should be undertaken prior to the finalisation and approval of a structure plan over the area.
- DPLH 24785 'Yule Brook Farm 02' is a lodged Aboriginal heritage place which, whilst considered by ACHM (2018) to be unlikely to contain any cultural materials in their original depositional context, with the site integrity being 'very poor', would require further investigation to confirm its status.

4.5.3.3 Non-indigenous cultural heritage values

In order to determine the actual or potential presence of sites or features of non-indigenous heritage significance within the site, a review of readily available information at a federal, state and local government level was undertaken to determine if any of the following occur within the site.

- World Heritage Sites
- National Heritage Places
- Commonwealth Heritage Places

- Sites listed in the State Register of Heritage Places
- Sites listed in the City of Gosnells Municipal Heritage Register.

A review of the above registers did not identify any non-indigenous heritage features as being mapped within the site.

Whilst not within the site, the adjacent GBSW is included on the City of Gosnells Municipal Heritage Register as a 'Category 2' listing, which is defined as 'a *place of considerable cultural heritage significance to City of Gosnells with a high degree of integrity/authenticity that is worthy of recognition and protection through provisions of the City of Gosnells Town Planning Scheme. Planning application needs to be submitted to the City of Gosnells for any proposed development. Recommend: Conservation of the place is highly desirable. Any alterations or extensions should reinforce the significance of the place.*'

This is largely associated with the significant biodiversity known to be supported by the wetland system. This has led to the formation of a local volunteer 'friends' group for the GBSW in 1994, as well as the establishment of the Alison Baird Reserve over part of the GBSW which is managed by the University of Western Australia and used for conservation and educational purposes. DBCA manage the majority of the balance of the GBSW, with general public access largely restricted to preserve the biodiversity of the area. The wetlands were vested in the Conservation Commission of Western Australia as a nature reserve in 2004 and Landgate designated the reserve in 2007.

4.5.3.4 Amenity (noise, odour and dust)

Future commercial and industrial development of the site may result in the introduction of land uses which could emit noise, odour or dust emissions. Such emissions, if not suitably managed, have the potential to impact upon the amenity of nearby sensitive land uses.

The site is located adjacent to the following land uses:

- Existing light industrial and commercial land use to the south in the suburb of Maddington.
- Existing rural land uses to the east in the suburbs of Wattle Grove and Orange Grove.
- Reserves, primarily being the GBSWs which are situated between the two amendment areas.
- Existing areas of commercial and industrial development to the immediate north (MKSEA Precinct 3A) and south (MKSEA Precinct 1).
- A series of major roads which bound MKSEA, including Roe Highway, Welshpool Road East, Tonkin Highway and Bickley Road.
- A freight railway line to the west (adjacent to Roe Highway).
- Suburban residential areas to the north, west and south in the suburbs of Wattle Grove, Kenwick and Beckenham, respectively.

4.5.4 Potential environmental impacts

Implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site has potential to directly and indirectly impact on social surroundings. As outlined in the ER Instructions, potential impacts (direct, indirect and cumulative) on the environmental values for this factor in a local and regional context include:

- Disturbance to Aboriginal heritage places and/or cultural association within the area.
- Changes to environment which may impact on Aboriginal heritage places.

- Impacts to the natural and historical heritage values of the GBSW.
- Impacts to the amenity; noise, odour and dust (temporary or permanent).

4.5.5 Assessment of impacts

4.5.5.1 Disturbance to Aboriginal heritage places and/or cultural association within the area

As outlined in **Section 4.5.3.2**, Aboriginal heritage surveys completed to date have confirmed the following Aboriginal heritage places are applicable to the site and proposed scheme amendments:

- DPLH 36929 'Yule Brook Mandoorn', which is a registered Aboriginal heritage site of ethnographic significance.
- DPLH 24785 'Yule Brook Farm 02', which is a lodged Aboriginal heritage place which, whilst considered by ACHM (2018) to be unlikely to contain any cultural materials in their original depositional context, with the site integrity being 'very poor', would require further investigation to confirm its status. The heritage place is yet to be considered by the Aboriginal Cultural Materials Committee to determine whether it represents an Aboriginal heritage site under Section 5 of the *Aboriginal Heritage Act 1972*.

Other Aboriginal heritage places previously mapped within the site have been assessed through onsite surveys and consultation with traditional owners, which concluded they are unlikely to be representative of Aboriginal heritage sites under Section 5 of the *Aboriginal Heritage Act 1972*.

<u>DPLH 36929 'Yule Brook Mandoorn'</u>

Yule Brook and its associated foreshore area have been identified within a future environmental retention area. This will provide for the future retention and enhancement of Yule Brook within a future foreshore reserve. Fundamentally, this will provide for the protection of the Aboriginal heritage values associated with Yule Brook. Whilst initial consultation with traditional owners has been completed, further consultation specific to Yule Brook should be undertaken prior to the finalisation and approval of a structure plan over the area.

<u>DPLH 24785 'Yule Brook Farm 02'</u>

Further investigation is necessary to confirm whether this lodged heritage place represents an Aboriginal heritage sites under Section 5 of the *Aboriginal Heritage Act 1972*. Notwithstanding, the artefact scatter site is located within and directly adjacent to the Yule Brook watercourse, and as such is expected to be retained through incorporation into the future foreshore reserve. As such, it is not anticipated that future development will impact or disturb this potential Aboriginal heritage place.

Some disturbance to the Yule Brook waterway and foreshore area may occur through the proposed enhancement of the foreshore area (for example revegetation works or installation of WSUD drainage infrastructure), which therefore may require consent under Section 18 of the *Aboriginal Heritage Act 1972* to proceed.

4.5.5.2 Changes to environment which may impact on Aboriginal heritage places

Both Aboriginal heritage places relevant to the site are associated with the Yule Brook waterway. Changes to the environment as a result of implementing the proposed scheme amendments that could impact Yule Brook relate to an anticipated increase in the amount of surface water runoff conveyed by Yule Brook in the post-development scenario. This change in itself is not anticipated to alter the alignment of Yule Brook or fundamentally impact its function, given Yule Brook has historically supported higher flows prior to the current long-term drying trend. As such, such changes to the environment are unlikely to impact the Aboriginal heritage values associated with Yule Brook.

As outlined in **Section 4.2.5**, the proposed water management strategy involves the installation of WSUD stormwater management infrastructure in proximity to Yule Brook, to increase its capacity to safely detain flood flows during major rainfall events to ensure public safety. This may involve disturbance to the Yule Brook or adjacent areas to install the associated detention areas, which could result in impacts to the Aboriginal heritage values of Yule Brook. If this is the case, consent under Section 18 of the *Aboriginal Heritage Act 1972* may be required to undertake such works.

The section of Yule Brook that passes through privately owned land within Precinct 3B is presently inaccessible to the public. The future establishment of a foreshore reserve, with in an area of Biodiversity Asset Public Open Space, will enable Aboriginal people to access Yule Brook and their associated heritage. The ability for Aboriginal people to reconnect will their heritage is considered to be a positive impact of the MKSEA.

4.5.5.3 Impacts to the natural and historical heritage values of the Greater Brixton Street Wetlands

No impacts to the natural and historical heritage values of the GBSW are anticipated. The proposed amendments and associated future development footprint do not propose any change in land use or development within the GBSW. All future development will occur outside of the GBSW and the existing zoning and tenure of the GBSW will be maintained as is.

Implementation of the proposed amendment and associated future development will not diminish the existing cultural values of the GBSW, and will not preclude the ongoing use of the GBSW for cultural purposes, such as existing groups, activities and land uses. Implementation of the proposed amendments through future development of the adjacent areas will also provide opportunities to formalise and enhance existing interfaces between the GBSW and adjacent areas. This could include the provision of fencing, interpretive signage and walking tracks, along the development and GBSW interface.

4.5.5.4 Impacts to the amenity; noise, odour and dust (temporary or permanent)

This section has been considered with respect to potential amenity impacts to people within adjacent sensitive land uses. Impacts of noise and light emissions on terrestrial fauna are considered in **Section 4.4.5.7**.

Sensitive land uses adjacent to the site within which a person's amenity has the potential to be impacted by noise, odour or dust emissions include;

- Suburban residential areas to the north, west and south in the suburbs of Wattle Grove, Kenwick and Beckenham, respectively.
- Existing rural land uses to the east in the suburbs of Wattle Grove and Orange Grove.
- Reserves, primarily being the GBSWs which are situated between the two amendment areas.

It is not anticipated that any future light industrial and commercial land uses established within the site would emit noise, odour or dust emissions of a sufficient magnitude such that it would significantly impact the amenity of adjacent sensitive land uses. The proposed light industrial and commercial land uses do not typically result in significant noise, odour or dust emissions, which are more commonly produced by heavy or noxious industrial land uses (which are not proposed within the site). Any future development applications within the site that propose to establish a land use which may result in significant noise, odour or dust emissions, such that they are likely to significantly impact on nearby sensitive land uses, would be subject to additional regulation under Part V of the *Environmental Protection Act 1986* to suitably control such emissions, including;

- Conformance with the requirements of the Environmental Protection (Noise) Regulations 1997.
- Requirements to attain a works approval and operating license for the proposed land uses. To attain such approvals, any proposal would need to demonstrate how emissions can be suitably mitigated to avoid significant impacts to existing sensitive land uses nearby.

As such, permanent impacts to amenity due to noise, odour and dust emissions are unlikely to occur based on the proposed land uses.

Temporary impacts to the amenity of nearby sensitive land uses due to noise, odour and dust emissions may occur during the construction stage, but can be suitably mitigated through implementation of a Construction Environmental Management Plan.

4.5.6 Mitigation

The City of Gosnells propose a range of measures to mitigate the potential impacts of the future implementation of the proposed scheme amendments (through subdivision, development and supporting infrastructure works) on social surroundings. This includes impact avoidance, minimisation and rehabilitation measures, consistent with the EPA mitigation hierarchy. The planning mechanisms and the associated stages of the land use planning process applicable to each mitigation measure are also outlined below.

4.5.6.1 Avoid

The primary measure proposed to avoid impacts to social surroundings within the site is the identification of future environmental retention areas. These areas reflect the proposed future Biodiversity Asset POS areas shown in the draft MKSEA Structure Plan, which will provide for the future retention of social surrounding values once such areas are established through the future subdivision and development process.

The future environmental retention areas will provide for the avoidance of impacts to Aboriginal heritage sites associated with Yule Brook. The waterway, as well as its foreshore area, will be retained within a future foreshore reserve within the site, outside of the future development footprint. The foreshore reserve incorporates buffer zones, floodplain areas and riparian vegetation

associated with Yule Brook. As such, the Aboriginal heritage values associated with Yule Brook will be maintained, and access to them improved.

In addition, the heritage and cultural values of GBSW will be maintained by avoiding any changes in land use or development within the GBSW. All future development will avoid and occur outside of the GBSW and the existing zoning and tenure of the GBSW will be maintained as is.

4.5.6.2 Minimise

Minimisation of impacts to social surroundings will be provided through the preparation and implementation of a Construction Environmental Management Plan/s, which will detail how construction processes will be managed to reduce any noise, dust and odour emissions which could temporarily affect the amenity of nearby sensitive land uses. Such plans will be prepared and implemented by individual proponents at the subdivision and development stage.

In addition, impact minimisation measures will be provided as a result of other statutory requirements including:

- Section 18 consent under the *Aboriginal Heritage Act 1972*, if disturbance to a Registered Aboriginal heritage site is anticipated. This may involve works associated with or in proximity to Yule Brook.
- Part V regulation under the *Environmental Protection Act 1986*, if any land uses are proposed to be established which may result in significant noise, odour or dust emissions, such that they are likely to significantly impact on nearby sensitive land uses.
- *Environmental Protection (Noise) Regulations 1997,* noise emissions from any land uses will need to conform with the assigned levels stipulated in these regulations.

4.5.6.3 Rehabilitate

In the context of the ER, rehabilitation measures are taken to relate to rehabilitation of areas that may be temporarily impacted as a result of implementing the scheme amendments. Areas impacted by the scheme amendment will be those associated with the development of permanent industrial land uses, which are not temporary and therefore any such impacts are not possible to directly rehabilitate. As such no specific rehabilitation mitigation measures are proposed directly as part of the proposed scheme amendments.

4.5.7 Residual impact

No residual impacts are anticipated as a result of implementation of future commercial and industrial subdivision and development, as well as the provision of associated infrastructure, within the site, once mitigation measures have been applied.

4.5.8 Predicted outcome

The EPA objective for social surroundings is '*to protect social surroundings from significant harm.*'

The scheme amendments and associated future commercial and industrial subdivision and development of the site can be implemented in a manner which achieves the EPA objective. Specifically, the draft MKSEA Structure Plan prepared by the City of Gosnells provides for a future Biodiversity Asset POS network which will enable future retention of all significant Aboriginal and

cultural heritage values within and adjacent to the site (including Yule Brook and GBSW), and improve access to them. Impacts to the amenity of adjacent sensitive land uses are not anticipated to be significant and can be suitably mitigated during construction and through Part V of the EP Act, if required.

5 Offsets

5.1 Significant residual impacts

The ER has identified the following significant residual impacts:

- Loss of up to 1.0 ha of Muchea Limestone TEC
- Loss of up to 206 *Grevillea thelemanniana* (spider-net grevillea) threatened flora individuals
- Loss of up to 0.7 ha of CCW values.

The significant residual impacts are anticipated as a result of the implementation of the draft MKSEA Structure Plan and specifically the required future widening and upgrades to Brook Road and Brentwood Road, as these environmental values occur within the existing road reserves (and specifically within existing roadside drains).

Based on the outcomes of the environmental impact assessment within this ER document and consideration of the mitigation hierarchy including the proposed mitigation (impact avoidance, minimisation and rehabilitation) measures to be implemented, offset/s will be required to counterbalance these significant residual impacts.

A residual impact significance model (RISM), based on the format provided in the *WA Environmental Offset Guidelines* (WA Government 2014), is provided in **Table 46**.

Table 46: Residual impact significance model

Part IV Environmental Factors	Flora and vegetation					Inland waters	Terrestrial fauna	Social surroundings	All factors
	Rare flora	TECs	Remnant vegetation	Conservation areas	High biological diversity	Wetlands & waterways	Habitat for fauna		Other
Residual impact that is **environmentally unacceptable or cannot be offset**	No residual impacts are considered to meet this criteria.								
Significant residual impacts that **will require an offset** – All significant residual impacts to species and ecosystems protected by statute or where the cumulative impact is already at a critical level	Loss of up to 206 spider-net grevillea individuals within the road reserves of Brook and Brentwood Roads, as a result of required road widening and upgrades. **Significant residual impact will trigger an offset.**	Loss of up to 1.0 ha of the Muchea limestone TEC within the road reserves of Brook and Brentwood Roads, as a result of required road widening and upgrades. **Significant residual impact will trigger an offset.**	No residual impacts are considered to meet this criteria.	No residual impacts are considered to meet this criteria.	No residual impacts are considered to meet this criteria.	Loss of up to 0.7 ha of CCW values within the road reserves of Brook Road, as a result of required road widening and upgrades. **Significant residual impact will trigger an offset.**	No residual impacts are considered to meet this criteria.	No residual impacts are considered to meet this criteria.	No residual impacts are considered to meet this criteria.
Residual impacts that **may require an offset** – Any residual impact to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed	No residual impacts are considered to meet this criteria.								
Residual impacts that are not significant and **do not require an offset**.	No residual impacts are considered to meet this criteria.	Loss of 0.07 ha of Banksia Woodlands TEC within the road reserves of Brook Road, as a result of required road widening and upgrades. **Residual impact is not significant and will not trigger offset.**	• Loss of up to 1.1 ha of Guildford complex vegetation in 'good' or better condition. • Areas of retained wetland and riparian vegetation which convey stormwater runoff (such as along Yule Brook or the Yule Brook tributary traversing the GBSW) may experience varied seasonal timing for the emergence and growth of different flora species. **Residual impacts are not significant and will not trigger offset.**	Refer to 'wetlands & waterways' in relation to residual impacts to GBSW.	Refer to 'wetlands & waterways' in relation to residual impacts to GBSW.	• 3.87% increase in total annual water flows across the GBSW (primarily via surface flows conveyed by the Yule Brook tributary that traverses the GBSW) • 1.8% increase in total annual water flows in Yule Brook. • 74% total nitrogen reduction and 72% total phosphorus reduction. **Residual impacts are not significant and will not trigger offset.**	• Black cockatoos: loss of up to 49 potential habitat trees, 2.75 ha of potential foraging habitat and trees that may provide roosting habitat. • Quenda: loss of up to 9.6 ha which may provide suitable habitat. • Peregrine falcon: loss of potential habitat (open rural areas and paddocks) • The loss of up to 0.7 ha and 8.7 ha potential habitat for two native bee species respectively. **Residual impacts are not significant and will not trigger offset.**	No residual impacts are considered to meet this criteria.	No residual impacts are considered to meet this criteria.

5.2 Key characteristics of matters requiring offsets

5.2.1 Muchea limestone TEC

Section 4.3.3.8 provides a summary of the occurrence of the Muchea limestone TEC within the site.

The approved conservation advice for the Muchea limestone TEC (DoEE 2017d) was prepared with the objective to mitigate the risk of extinction (or collapse) and help recover its biodiversity and function, through protecting it as a matter of national environmental significance under Commonwealth environmental law.

Known threats to the Muchea limestone TEC that are considered relevant to the proposed amendments and future industrial and commercial development within the site area include:

- Clearing of vegetation for development purposes such as road widening and/or upgrades
- Weed and disease introduction and invasion
- Hydrological changes and erosion by wind and water.

The approved conservation advice (DoEE 2017d) and *Interim Recovery Plan No. 57 Shrublands and Woodlands on Muchea Limestone* (DCLM 2000) outline the appropriate recovery principles and required recovery actions for the Muchea limestone TEC, which include:

- Protect the ecological community to prevent further loss of extent and condition
- Restore the ecological community within its original range by active abatement of threats, regeneration and revegetation and other conservation initiatives
- Communication - engage with and support people to increase understanding of the value and function of the ecological community and encourage their effort in its protection and recovery
- Research and monitoring to improve our understanding of the ecological community and methods for restoration and protection over the long term.

5.2.2 Spider-net grevillea

Section 4.3.3.10 provides a summary of the occurrence of spider-net grevillea within the site.

Whilst no recovery plan exists for this species, the species conservation advice (TSSC 2017) highlights the following known threats to the species relevant to the scheme amendment and future industrial and commercial development within the site:

- Vegetation clearing for maintenance of boundary and internal firebreaks
- Vegetation clearing for urban, rural and industrial uses
- Vegetation clearing for and maintenance of road reserves

5.2.3 Conservation category wetlands

Section 4.2.3.10 provides a summary of the occurrence of CCWs within the site.

No conservation advice or recovery plans exist for CCWs, however given the Muchea Limestone TEC and spider-net grevillea occur as part of and within CCW wetland features, the threats and recovery principles applicable to these matters (as outlined in the respective recovery plans and conservation advice) are considered to also have some application to CCWs.

5.3 Proposed offset approach

5.3.1 On-ground management offset

An on-ground management offset approach, incorporating revegetation and rehabilitation, is proposed to counterbalance the significant residual impacts to all three matters.

A key threat for the relevant matters is vegetation clearing, which contributes to the trend of a decline in the remaining extent of known occurrences. An on-ground management offset has the potential to contribute to addressing this declining trend, through the recovery of degraded or cleared areas to establish new or improved quality occurrences of such matters. Overall, a net gain in total area of each matter can be achieved through such an offset.

All three matters are known to occur in multiple locations across the site. It is also considered likely that prior to historical rural development and associated land clearing, additional occurrences of all three matters would have been present within the site, given:

- The vast majority of the site comprises a wetland landform, which prior to historical wholescale vegetation clearing, would have been commensurate with a CCW classification. All three matters occur on a wetland landform.
- The presence of Muchea limestone substrate.
- Spider-net grevillea is only known to occur in the local area and has a strong association with the Muchea Limestone TEC as a key indicator species. As such, the species is likely to have co-occurred within historical areas of Muchea Limestone TEC across the site.

As such, the majority of wetland landform areas within the site are considered to provide suitable habitat and geomorphology for revegetation and rehabilitation works for all three impacted matters.

The draft MKSEA Structure Plan provides for the retention of all occurrences of Muchea Limestone TEC, and CCWs and populations of spider-net grevillea where these occur on private lots. These areas will be retained and provided buffer zones, with the total area protected within future Biodiversity Asset POS areas. The proposed on-ground management approach is to revegetate and rehabilitate newly created buffer zones, which currently comprise highly degraded and cleared rural land. The offset areas will be located within new buffer zones established around existing and retained occurrences of the Muchea limestone TEC, CCWs and spider-net grevillea within the site, given:

- Retained occurrences of the Muchea Limestone TEC are also identified as CCWs and a number of patches contain retained populations of spider-net grevillea.
- This allows existing occurrences of retained Muchea Limestone TEC, CCWs and spider-net grevillea, to be expanded, increasing the total area of occurrence/population size.
- This will therefore contribute to the offset requirements for all three matters collectively.
- It is logical to co-align revegetation next to existing occurrences as it increases the likelihood that the underlying substrate and geomorphology are suitable.
- These areas will ultimately be within secure public land tenure, once they are established as Biodiversity Asset POS areas and transferred to the City of Gosnells following establishment.
- The revegetated areas will provide protection for the known occurrence (i.e. the area being buffered) from adjacent threatening processes.
- The revegetated areas may ultimately be included in an expanded GBSW and Bush Forever site, following establishment of the Biodiversity Asset POS area network.

As part of the proposed on-ground management offset approach and considering the recovery plan and approved conservation advice for the Muchea limestone TEC and spider-net grevillea, revegetation within the proposed offset areas will utilise the use of locally collected seeds and cultivation of existing plants (where required to be removed) where possible. This approach would further ensure the existing genetic diversity of the area will be maintained within future offset areas and minimise the impact on existing vegetation.

The proposed offset approach will require further detail and refinement as part of developing an offset strategy. It is envisaged that the offset strategy may be incorporated into an updated and finalised version of the Conservation Area Management Strategy, which would be completed prior to and support approval of the draft MKSEA Structure Plan. This would then be implemented through each required Conservation Area Management Plan, where spatially applicable.

To evaluate the acceptability and suitability of the proposed offset approach, an assessment has been completed against the following:

- Applicable recovery plans and conservation advice (**Section 5.4.1**)
- The WA offset policy framework (**Section 5.4.2**).

This has included completion of a preliminary assessment of the offset approach using the *WA Offsets Metric* (**Section 5.4.2.3**).

5.3.2 Consideration of averted loss offset

It is noted that an averted loss offset approach has also been considered, however was not progressed as an on-ground management offset approach was considered to be more appropriate and achievable.

For context, it is considered that averting the loss of a protected matter or its habitat delivers a conservation gain where there is an immediate threat of destruction or degradation. The risk of loss of the protected matter and/or its habitat can be averted by securing its future for conservation purposes, such as by transferring the ownership and management of an area of land containing habitat from a private entity to a public entity, application of a conservation covenant on the title of land, which serves to reduce the risk that habitat may be completely lost in the future, or to avert a gradual decline in the quality over time.

For the Muchea Limestone TEC and spider-net grevillea, averted loss offsets are likely to be challenging to achieve as the limited amount of known remaining occurrences of the Muchea limestone TEC and spider-net grevillea populations (which are also predominantly geographically restricted to the local area) will restrict the ability to identify potentially suitable offset properties. This limitation is less applicable to CCWs, as they are relatively abundant across the Swan Coastal Plain. On this basis, collectively it was considered that an on-ground management was more appropriate and achievable and therefore was progressed as the primary offset approach.

It is noted that significant impact avoidance outcomes for all three matters have been facilitated across the site based on the future environmental retention areas. Whilst this avoidance cannot be factored into offset calculations for significant residual impacts, it is important to acknowledge as it demonstrates the implementation of the scheme amendments and the draft MKSEA Structure Plan

will increase the area/number of these matters protected within public ownership and conserved for conservation purposes, which would otherwise not occur in a 'do nothing' scenario.

5.4 Evaluation of proposed offset approach

5.4.1 Conservation advice and recovery plans

The proposed offset strategy was developed cognisant of conservation advice and/or recovery plan for the Muchea limestone TEC and the spider-net grevillea.

The recovery aim and criteria of the Muchea limestone TEC as outlined in the Interim Recovery Plan No. 57 *Shrublands and Woodlands on Muchea Limestone* (DCLM 2000) is to:

'maintain or improve the overall condition of the Muchea limestone community and reduce the level of threat with the aim of reclassifying it from critically endangered to endangered.'

The management actions of the proposed offset approach are consistent with the recovery actions of Interim Recovery Plan No. 57 and the Muchea limestone TEC conservation advice.

Table 47 includes a summary of the priority recovery actions outlined in the approved conservation advice, which align with the recovery aims and criteria of the Interim Recovery Plan No.57, and how these can be addressed through the proposed offset approach.

There is no recovery plan for the spider-net grevillea (or CCWs). However, given the association between the three matters, the assessment against the recovery actions and principles of the conservation advice and Interim Recovery Plan No. 57 for the Muchea limestone TEC is considered to be applicable to all three matters.

Table 47: Consistency of proposed offset approach with the approved conservation advice and Interim Recovery Plan No. 57.

Item #	Recovery actions of approved conservation advice and Interim Recovery Plan No.57	How the recovery action would be addressed in the offset proposal
1	Protect the ecological community to prevent further loss of extent and condition	The mitigation hierarchy has been applied throughout the planning process for the proposed amendments and associated draft MKSEA Structure Plan. This has included avoidance of impacts through the provision of Biodiversity Asset POS area to enable the future retention of: • 7.59 ha of Muchea limestone TEC (88% of total occurrence within site) • 149 spider-net grevillea plants (42% of total occurrence within the site) • All areas of CCWs within privately owned lots, in addition to CCW values along Boundary Road which will be decommissioned as a road. Notwithstanding, some unavoidable impacts are predicted. To implement the draft MKSEA Structure Plan, existing major roads (including Brook Road and Brentwood Roads) will require upgrading and/or widening to support future industrial land uses. The existing road network is presently not sufficient nor safe to provide suitable transport and general commute opportunities in the area required for the proposed future industrial land use. These upgrades will result in the unavoidable significant residual impacts to the three matters, however these can be counterbalanced by the proposed offset approach.

Item #	Recovery actions of approved conservation advice and Interim Recovery Plan No.57	How the recovery action would be addressed in the offset proposal
2	Restore the ecological community within its original range by active abatement of threats, regeneration and revegetation and other conservation initiatives	The proposed on-ground management offset approach is based on revegetation and rehabilitation works to restore the three matters within areas where they would have likely previously occurred. Implementation of the proposed offset approach will result in a net increase in the total area of each matter within the site. The on-ground management offset approach will additionally include other conservation initiatives which will further aid in the abatement of threats to the matters such as: • Hygiene controls to prevent the spread of invasive weeds and diseases into the offset area and the broader GBSWs • Utilising seeds and cuttings from removed flora such as spider-net grevillea for cultivation in the offset areas to maintain the genetic diversity within the area • Fence installation to prevent unauthorised access into the revegetated and rehabilitated offset areas • Access track establishment to aid in on-ground management • General weed control expected to be undertaken several times a year • Watering of tubestock and juvenile plants during hot summer months • Mulch application to prevent moisture evaporating • Feral animal control • Maintenance and monitoring of offset objective success.
3	Communication- engage with and support people to increase understanding of the value and function of the ecological community and encourage their effort in its protection and recovery	The proposed offset areas/ revegetation areas will be part of the local conservation reserve, that the local community can enjoy through controlled access (where appropriate). Community involvement in revegetation and rehabilitation works is anticipated (this may include groups such as Friends of Brixton Street Wetlands).
4	Research and monitoring to improve our understanding of the ecological community and methods for restoration and protection over the long term	Monitoring of the rehabilitation and revegetation actions and outcomes will be required by the Conservation Area Management Plan for the relevant future environmental retention areas including the proposed offset areas. Monitoring will ensure offset targets and objectives are on track and can be achieved, whilst contingency actions can be applied when required.

5.4.2 Assessment against the WA Offset Policy Framework

5.4.2.1 WA Environmental Offset Policy

A summary of how the *WA Environmental Offset Policy* principles apply to the proposed offset approach is provided in **Table 48**.

Table 48: Application of the WA Environmental Offset Policy Principles

Principle	Application
Environmental offsets will only be considered after avoidance and mitigation options have been pursued.	The mitigation hierarchy has been applied throughout the planning process for the proposed amendments and associated draft MKSEA Structure Plan. This has included avoidance of impacts through the provision of Biodiversity Asset POS area to enable the future retention of: • 7.59 ha of Muchea limestone TEC (88% of total occurrence within site) • 149 spider-net grevillea plants (42% of total occurrence within the site) • All areas of CCWs within privately owned lots, in addition to CCW values along Boundary Road which will be decommissioned as a road. A range of impact minimisation measures are also proposed. Offsets are only proposed for the significant residual impacts which are unavoidable and could not be mitigated.
Environmental offsets are not appropriate for all projects.	Offsets are considered appropriate for the project given: • All three matters are able to readily offset through on-ground management techniques. • The proposed offset approach aligns with the relevant conservation advice and recovery plan. • Offsets will be implemented by the City of Gosnells, who will be responsible for the management of Biodiversity Asset POS areas in the long-term, which is where the offsets will be located. • The City of Gosnells is a public organisation and can be relied upon to achieve the offset outcomes in the long-term.
Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental values being impacted.	The on-ground management offset is relevant to the impacts, as it targets the same environmental values being impacted (Muchea limestone TEC, spider-net grevillea and CCW values). The proposed offset would also be proportionate to the residual impacts, as it would counterbalance 100% of the significant residual impacts of the proposal, as determined through the application of the *WA Environmental Offset Guidelines.*
Environmental offsets will be based on sound environmental information and knowledge.	Design of the on-ground management offset is anticipated to be detailed within an Offset Strategy and would be based on site-specific baseline environmental information. The *Approved Conservation Advice for Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain* (DoEE 2017d), the *Shrubland and Woodlands on Muchea Limestone Interim Recovery Plan 2000-2003* (DBCA 2000) and the *Conservation Advice Grevillea thelemanniana Spider Net Grevillea* (TSSC 2017) would provide guidance on on-ground management best practices. Additionally, the on-ground management may be guided by a range of technical advisory stakeholders who are experienced in on-ground management within the local area and the nearby GBSW.
Environmental offsets will be applied within a framework of adaptive management.	The proposed on-ground management offset approach would incorporate adaptive management (i.e. monitoring would be completed to inform management and to achieve offset objectives and targets). Furthermore, the offset approach would include a range of contingency measures which will allow for adaptive management during implementation of the offset to ensure the offset objectives and targets are met by reducing any risks.
Environmental offsets will be focussed on longer term strategic outcomes.	The proposed offset approach is to utilise land within future Biodiversity Asset POS areas, which once created will exist in perpetuity under public ownership and management by the City of Gosnells. The proposed Biodiversity Asset POS area network is envisaged to ultimately form part of the broader GBSW and Bush Forever site in the long-term.

5.4.2.2 WA Environmental Offset Guidelines

A summary of how the key concepts and requirements of the *WA Environmental Offsets Guidelines* have been considered in the development of this proposed offset approach and is provided in **Table 49**.

Table 49: Application of the WA Environmental Offset Guidelines

Concept	Application
Type of offset	On-ground management is proposed, including revegetation (re-establishment of native vegetation in degraded areas) and rehabilitation (repair of ecosystem processes).
In proximity to the area of impact	The offset site would be located within the proposed future environmental retention areas within the site, which are located directly adjacent to the development footprint.
Provides similar or better vegetation condition than area impacted	The three matters occur in variable condition throughout the site. The proposed on-ground management offset targets would improve degraded and completely degraded vegetation to achieve at least 'good' or better condition through revegetation and rehabilitation.
Provides similar habitat structure to undisturbed examples of impacted vegetation type	The proposed offset approach intends to provide 'like for like' and improved habitat types to those where a significant residual impact occurs. The structural components of the revegetation will be confirmed through the future offset strategy, however will ensure: • Target vegetation structure aligns the Muchea limestone community • Planting palette includes spider-net grevillea • Will occur on a wetland landform Reference sites can be established to guide design of the revegetation program such that it is similar to undisturbed examples of the matters.
Has a better area to perimeter ratio than the impacted site	The impacted matters occur within long and relatively thin road reserves. This results in the matters currently being subject to a low area to perimeter ratio. The proposed offset approach will consolidate on-ground management in areas adjacent to existing occurrences of the Muchea limestone TEC and will have a much greater area to perimeter ratio than the impacted occurrences within road reserves.
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site	A variety of conservation significant flora are known to occur across the local area. Where possible and appropriate, these will be included in the revegetation palette. Introduction of additional native vegetation within the site through the on-ground management offset will also increase the availability of suitable habitat for such species, encouraging natural dispersal and establishment of such species in this area.
Close to or contiguous with an existing conservation area (e.g. Bush Forever)	The proposed offset areas would be located directly abutting Bush Forever Site 387 (GBSW) as part of the future environmental retention areas. It is noted that portions of the future environmental retention areas, particularly along Boundary Road, are anticipated to ultimately consolidate with the GBSW area.

5.4.2.3 WA Environmental Offsets Metric

The *WA Environmental Offset Guidelines 2014* and *Environmental Offset Metric* have been applied to determine the quantity of offset features and area required to counterbalance the significant residual impact on the three matters resulting from the proposed scheme amendment and future industrial development.

Based the results of applying the *Environmental Offset Metric*, the following offset quantum is required to counterbalance 100% of the significant residual impact for each matter:

- 1.15 ha of Muchea limestone TEC
- 409 spider-net grevillea plants
- 1.21 ha of CCW.

There is sufficient land available within buffer zones adjacent to Muchea limestone TEC occurrences, which exist on a wetland landform, to accommodate the required offset areas.

Separate offset metric calculations have been undertaken for each matter, which are provided in **Appendix N**. The rationale for the offset calculator inputs are provided in the below tables.

Table 50: Rationale for offset calculator score used for Muchea limestone TEC.

Calculation/element	Score (feature)	Rationale
Conservation significance		
Description	The Shrublands and Woodland on Muchea Limestone of the Swan Coastal Plain TEC (Muchea limestone TEC)	As described in **Section 4.3.3.8** and shown in **Figure 14**.
Type of environmental value	Ecological community	
Conservation significance or environmental value	Endangered	
Significant impact		
Significant impact (ha)	1.0 ha	Extent of clearing required to upgrade the roads. An additional 7.59 ha of Muchea limestone TEC (88% of total occurrence within site) is proposed for retention.
Quality (Number)	5	The impacted vegetation is located within the road shoulders and varies in condition between 'degraded' and 'good' and has a low area to perimeter ratio. It is of a lower quality compared to larger and more consolidated occurrences within the site.
Offset		
Proposed offset (area in ha)	1.15	1.15 ha is the minimum area required to be offset and revegetated to satisfy 100% of the offset requirements, based on the other parameter values used.
Current quality of offset site	0	The offset area within the future environmental retention areas will comprise a predominantly cleared area in completely degraded condition.

Calculation/element	Score (feature)	Rationale
Future quality WITHOUT offset	0	Without implementation of on-ground management, the offset area would remain in its current condition.
Future quality WITH offset	7	On-ground management will reintroduce and establish native vegetation within the offset areas which would ultimately meet the characteristics of the Muchea limestone TEC. It is anticipated that with on-ground management activities such as weed management and monitoring, native vegetation would ultimately achieve 'very good' condition.
Time until ecological benefit (years)	10	A timeframe of 10 years has been assumed as a conservative assessment of the time required for the revegetation to achieve an intact vegetation community that would meet the characteristics of the Muchea limestone TEC in 'very good' condition.
Confidence in offset result (%)	70%	A value of 70% has been selected as there is moderate to high probability that the revegetation and rehabilitation works will success achieve a Muchea limestone TEC community. The confidence in result has been determine conservatively due to the uncertainty included in any rehabilitation and revegetation program, in particular in regard to revegetation and species survival success during the first years of on-ground management.
Duration of offset implementation (maximum 20 years)	20	The maximum value of 20 years has been selected as the revegetation is expected to remain in perpetuity after the offset is complete.
Time until offset secured (years)	5	It is anticipated that it may take up to 5 years for the offset site to be created (as a Biodiversity Asset POS area), due to the staged nature in which industrial development of the site is likely to occur.
Risk of future loss WITHOUT offset (%)	0	The offset area will comprise an area cleared of vegetation. As such there are no values at risk of loss.
Risk of future loss WITH offset (%)	0	The offset area will comprise an area cleared of vegetation. As such there are no values at risk of loss.

Table 51: Rationale for offset calculator score used for Grevillea thelemanniana

Calculation/element	Score (feature)	Rationale
Conservation significance		
Description	*Grevillea thelemanniana*	As described in **Section 4.3.3.10** and shown in **Figure 14**.
Type of environmental value	Species (flora)	
Conservation significance or environmental value	Rare/threatened species – critically endangered	
Significant impact		
Significant impact (feature)	206	Extent of clearing required to upgrade the roads. An additional 149 spider-net grevillea plants (58% of total occurrence within site) are proposed for retention.

Calculation/element	Score (feature)	Rationale
Offset		
Start number (of type of feature)	0	The offset area within the future environmental retention areas will comprise a predominantly cleared area in completely degraded condition, with no existing occurrences of spider-net grevillea
Future number WITHOUT offset	0	Without implementation of on-ground management, the offset area would remain in its current condition.
Future number WITH offset	409	409 is the minimum number required to be planted to satisfy 100% of the offset requirements, based on the other parameter values used.
Time until ecological benefit (years)	5	A timeframe of 5 years has been assumed for the ecological benefits as it was determined that this period would be sufficient to undertake on-ground management associated with the revegetation and rehabilitation of the offset areas and allow for the plants to become well established.
Confidence in offset result (%)	70%	A value of 70% has been selected as there is moderate to high probability that the revegetation and rehabilitation of the proposed offset areas within the future environmental retention areas would be an effective and strong measure to achieve net gain in the population of spider-net grevillea. The confidence in result has been determine conservatively due to the uncertainty included in any rehabilitation and revegetation program in particular in regard to revegetation and species survival success during the first years of on-ground management.

Table 52: Rationale for offset calculator score used for CCW values

Calculation/element	Score (feature)	Rationale
Conservation significance		
Description	CCW values within the Brook Road reserves	As described in **Section 4.2.3.10** and shown in **Figure 11**.
Type of environmental value	Ecological community	
Conservation significance or environmental value	Endangered	
Significant impact		
Significant impact (ha)	0.7 ha	Extent of impacted CCW values to upgrade the roads. All other CCWs within the site are proposed for retention.
Quality (Number)	6	The CCW values occur either side of the existing Brook Road, which comprise Muchea limestone TEC vegetation in 'degraded' and 'good' condition. The presence of an existing road carriageway through the centre of the wider CCW significantly reduces the function and quality of the wetland feature.
Offset		
Proposed offset (area in ha)	1.21	1.21 ha is the minimum area required to be offset and revegetated to satisfy 100% of the offset requirements, based on the other parameter values used.

Calculation/element	Score (feature)	Rationale
Current quality of offset site	2	The offset area within the future environmental retention areas will comprise a predominantly cleared area in completely degraded condition. Notwithstanding, the area will still support the underlying wetland landform and associated function, hence a score of 0 has not been used.
Future quality WITHOUT offset	0	Without implementation of on-ground management, the offset area would remain in its current condition.
Future quality WITH offset	7	On-ground management will reintroduce and establish native vegetation within the offset areas which would ultimately meet the characteristics of the Muchea limestone TEC. It is anticipated that with on-ground management activities such as weed management and monitoring, native vegetation would ultimately achieve 'very good' condition. New occurrences of spider-net grevillea threatened flora will also be established. Collectively this will restore the degraded wetland areas to a 'CCW' classification.
Time until ecological benefit (years)	10	A timeframe of 10 years has been assumed as a conservative assessment of the time required for the revegetation to achieve an intact vegetation community such that a CCW classification could be achieved.
Confidence in offset result (%)	70%	A value of 70% has been selected as there is moderate to high probability that the revegetation and rehabilitation works will success achieve a CCW classification. The confidence in result has been determine conservatively due to the uncertainty included in any rehabilitation and revegetation program, in particular in regard to revegetation and species survival success during the first years of on-ground management.
Duration of offset implementation (maximum 20 years)	20	The maximum value of 20 years has been selected as the revegetation is expected to remain in perpetuity after the offset is complete.
Time until offset secured (years)	5	It is anticipated that it may take up to 5 years for the offset site to be created (as a Biodiversity Asset POS area), due to the staged nature in which industrial development of the site is likely to occur.
Risk of future loss WITHOUT offset (%)	0	The offset area will comprise an area cleared of vegetation. As such there are no values at risk of loss.
Risk of future loss WITH offset (%)	0	The offset area will comprise an area cleared of vegetation. As such there are no values at risk of loss.

5.5 Conclusion

Impacts have been avoided to the greatest extent practicable. Unavoidable significant residual impacts trigger the requirement for offsets, that is losses of Muchea Limestone TEC, *Grevillea thelemanniana* (spider-net grevillea) and CCW values. Offsets can be provided on-site through revegetation and restoration that counterbalance the residual significant impacts and meet the requirements of the relevant recovery plan, conservation advice and WA offset framework.

6 Holistic Impact Assessment

This holistic assessment considers the whole environment, including discussion of the connections and interactions between the parts of the environment (environmental factors) and the predicted outcomes in relation to the environmental principles and the EPA's environmental objectives.

6.1 Potential risks

The broader MKSEA contains important environmental values and areas. The most notable environmental feature is the GBSW and Yule Brook which flows into the Swan and Canning Rivers. Outside of the GBSW but within the site boundary are wetlands, waterways and remnant native vegetation and associated fauna habitat. The correlation, linkages and connections are demonstrated when examining hydrological features or inland waters (**Figure 11**), vegetation condition, conservation significance of flora and vegetation (**Figure 13** and **Figure 14**) and conservation significance of fauna habitat or terrestrial fauna (**Figure 16**).

If the draft MKSEA Structure Plan proposes clearing of native vegetation and development this would be a direct impact – where clearing will diminish flora and vegetation and in-turn remove in part or whole fauna habitat and wetlands/waterways. Likewise it may be more likely that clearing could disturb Aboriginal heritage places and reduce amenity values.

While the draft MKSEA Structure Plan does not propose to develop (directly impact) any part of the GBSW there may be potential indirect impacts that relate to all the environmental factors and might equally apply to proposed areas for retention and conservation. These potential indirect impacts on the GBSW are of primary concern to the EPA, City of Gosnells, stakeholders and community.

While the threatening processes associated with surrounding rural use such as uncontrolled access, rubbish dumping, weed incursion, fire risk, vermin and nutrient rich run-off will be managed or removed as part of the draft MKSEA Structure Plan implementation, and therefore alleviated some indirect impacts, the most relevant potential new indirect impact is likely to be changes in hydrology.

While the hydrology of the area has been altered significantly historically and rainfall has reduced due to climate change, further changes in hydrology might include changes in inundation and flooding of GBSW, changes in surface or sub-surface flow paths, changes in local or regional groundwater levels, and increased nutrients and other pollutants in surface water. These changes have the potential to arise because of groundwater abstraction, subsoil drainage, increased impervious surfaces and increased peak flows and inundation, which may be laden with pollutants.

These kind of changes in hydrology have the potential to impact flora and vegetation, terrestrial fauna and inland waters. Impacts could vary from complete loss of vegetation and fauna habitat value to subtle but important changes in ecology and species composition, viability and diversity.

6.2 Assessment

6.2.1 Direct impacts

The draft MKSEA Structure Plan has been developed to ensure development is compatible with the retention and protection of important environmental values. Avoiding direct impacts to environmental values has been fundamental.

The draft MKSEA Structure Plan aims to provide for the expansion of the GBSW, beyond the boundary of Bush Forever site 387. This will be accomplished because the draft MKSEA Structure Plan has been developed using three important design principles:

- No development within the GBSW (Bush Forever site 387).
- Avoid development of wetlands, waterways and their buffers/foreshore, native vegetation and fauna habitat in 'good' or better condition (where possible) outside the GBSW.
- Focus development in areas which are 'degraded' or 'completely degraded'.

As a result, the draft MKSEA Structure Plan will provide for over a quarter of the amendment areas to be included in Biodiversity Asset POS areas (transferring them from private to public ownership), with potential for this land to be included in an expanded GBSW and therefore provide an approximate 50% increase in the size of the original GBSW Bush Forever site. Implementation of the draft MKSEA Structure Plan will result in this land being acquired or ceded free of cost and protected via reservation.

175 ha of 'completely degraded' predominantly non-native vegetation is proposed for development. Only 0.4% of the amendment areas, or 1.1 ha, contains 'good' or better condition native vegetation that is proposed to be cleared. Overall implementation of amendments 166 and 169 through the draft MKSEA Structure Plan will almost entirely avoid the clearing of valuable native vegetation, wetlands and fauna habitat. On this basis direct impacts to the interconnected environmental factors of flora and vegetation, terrestrial fauna and inland waters has largely been avoided and certainly minimised to the greatest extent practical.

Despite best efforts some impacts are unavoidable, that is the loss of up to 206 individual spider-net grevillea, 1.0 ha of the Muchea limestone TEC and 0.7 ha of CCW values due to the required widening and upgrading of Brook and Brentwood Roads. This unavoidable impact in existing road reserves is considered a significant residual impact and triggers the need to provide offsets. A preliminary assessment using the WA Offset Guidelines (Government of Western Australia 2014) has been undertaken and an offset area of 1.15 ha is required for the Muchea limestone TEC, 1.21 ha required for CCW values, and planting of 409 spider-net grevillea. These offsets will easily be achieved through restoration and revegetation within retained Biodiversity Asset POS areas and implemented through Conservation Area Management Plans for each applicable future retention area.

6.2.2 Indirect impacts

To mitigate the risk of significant changes in hydrology a best practice approach to stormwater management will be adopted, through implementation of Local Water Management Strategies which adopt a WSUD approach. To mimic the natural water cycle, the stormwater strategy has been designed so the post-development peak flow rates within Yule Brook and the tributary traversing the GBSW will not exceed pre-development peak flow rates. Stormwater management uses a treatment train approach, and is proposed to be detained, treated and infiltrated within private lots, then within road reserves and finally within open spaces, all within the site and prior to any discharge. Subsoil drainage will not be used to lower groundwater levels, and the existing controls that are in place are proposed to be retained, which will mitigate the extent of change to the GBSW and other downstream environments. Further, the proposed approach to developing the land sets a side a large multiple use corridor and other green spaces that can potentially be used to adaptively manage the hydrological regime in the future, in the event that climate change results in reduced rainfall and other conditions which affect the hydrology of the amendment areas and GBSW.

Compared to the current rural land use, development will result in a significant reduction in sediments, total nitrogen (74%) and phosphorus (72%) and contribute to a reduction in nutrients ultimately entering the Swan and Canning River system. The drainage scheme will also be designed to trap litter.

A small increase in total annual water volume flowing into Yule Brook (1.8%) and the tributary that traverses the GBSW (3.9%) is predicted, accounting for predicted future climate change, and not expected to have significant environmental impacts.

For storms up to the 1% Annual Exceedance Probability (AEP), the Yule Brook tributary that traverses the GBSW will not experience any increase in peak flows rates and therefore there will be no new breakout flows or ponding as a result. It is noted that the primary inputs/drivers to the hydrology of the GBSW will be maintained, and rainfall will remain the dominant contributor to the GBSW ecosystem.

6.3 Summary and conclusion

The proposed scheme amendments and draft MKSEA Structure Plan has been developed based on sound sustainable development and best practice environmental management principles and will almost entirely avoid direct environmental impacts. New areas of open space will likely become part of a larger GBSW reserve.

Best practice stormwater design will ensure indirect impacts are avoided and mitigated, so that the existing hydrological regime which supports the GBSW ecosystem is maintained.

Best practice stormwater design will ensure indirect impacts are avoided and mitigated, so that the existing hydrological regime which supports the GBSW ecosystem is maintained.

From a holistic perspective the implementation of the proposed scheme amendments and associated draft MKSEA Structure Plan will not only meet all the EPA's environmental objectives it may also achieve a net environmental benefit and provides for positive environmental, heritage, cultural, community and scientific outcomes.

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Figures