



9.7 Potential impacts

The potential for impacts to terrestrial flora and vegetation resulting from the Proposal are summarised in Table 9-11.

Table 9-11: Potential impacts

Potential impacts	Context
ASDP site	
Clearing of native vegetation	The ASDP site contains 24 ha of native vegetation in varying condition which will be impacted.
Disturbance or clearing of PECs	Native vegetation within the ASDP site (24 ha) comprises a PEC which may be impacted.
Fragmentation of vegetation	The clearing of native vegetation may lead to the fragmentation of habitat and increased edge effects.
Spread of declared pest species or dieback	The clearing of vegetation and excavation and handling of soil may lead to the spread of weeds and dieback.
Changes to groundwater level or flow impacting GDEs	Construction and dewatering activities may impact groundwater flow and level impacting vegetation dependent on it.
Pipeline DAF	
Clearing of native vegetation	The pipeline DAF contains 38 ha of native vegetation in varying condition which may be impacted.
Disturbance or clearing of TECs and PECs	The pipeline DAF contains 24 ha of TECs and PECs which may be impacted.
Disturbance or clearing of <i>Bush Forever</i> sites	The pipeline DAF intersects 20 ha of <i>Bush Forever</i> sites which may be impacted.
Disturbance of wetlands	The pipeline DAF intersects 4.6 ha of a CCW which may be impacted by clearing and impacts to groundwater. The corridor also intersects five wetlands which may be impacted by the construction of the pipeline through impact to groundwater.
Fragmentation of vegetation	The clearing of native vegetation may lead to the fragmentation of habitat and increased edge effects.
Spread of declared pest species or dieback	The clearing of vegetation and excavation and handling of soil may lead to the spread of weeds (including declared pest species) or dieback.
Changes to groundwater level or flow impacting GDEs	Construction and dewatering activities may impact groundwater flow and level impacting vegetation dependant on it.

9.8 Assessment of impacts

As assessment has been undertaken of the direct and indirect impacts of the Proposal using the results of vegetation and condition mapping outlined in Section 9.3. Impacts have been described separately for the ASDP site and the pipeline DAF. The assessment of impacts within the pipeline DAF has been considered in corridor sections, identifying the key environmentally sensitive features in each.



9.8.1 ASDP site

Clearing of native vegetation

The Proposal will result in the direct loss of vegetation and flora as a result of clearing. At a complex level, vegetation is well-represented in the region with all but one vegetation complex having more than 30% of the pre-European extent remaining. The Karrakatta complex has 23% of its extent remaining. The Proposal could reduce the current extent of this vegetation complex by 0.3%.

At an association level, three associations (949, 998 and 1007) have more than 30% of their pre-European extent remaining at both a State and local level and are therefore, considered to be of least concern. The remaining vegetation association (6) has less than 30% of its pre-European extent remaining at 23%. The Proposal could reduce the current extent of this vegetation complex by 0.12%.

The Proposal will result in the loss of 24 ha of native vegetation associated with the 'Acacia shrublands on taller dunes of the southern Swan Coastal Plain' PEC (Priority 3) in 'Good' and 'Good to Very Good' condition.

Acacia shrublands on taller dunes PEC occurs along the Swan Coastal Plain coastal strip for 170 km from Seabird to Yalgorup National Park; however, the mapped extent is not known. Reservation and conservation status of this PEC was described by Gibson et al (1994) as poorly reserved and susceptible (a community of concern due to evidence that it can be modified or destroyed by human activities or would be vulnerable to new threatening processes).

Whilst 24 ha of native vegetation will be cleared within the ASDP site, the PEC is not restricted in extent given its known range. Furthermore, the site is surrounded by native vegetation which is considered to be similar in nature and condition, significant portions of which are reserved in conservation areas. Given this, the Proposal is not expected to significantly impact on the conservation status of this PEC.

Introduction and spread of dieback and introduced weeds

No declared pest species were identified in the ASDP site.

Dieback assessments have been inconclusive in relation to the presence of dieback. The potential remains for the spread of dieback from infested to uninfested areas from clearing, construction and maintenance activities associated with the Proposal. However, given the calcareous nature of soils within the DAF the likelihood of dieback occurrence is considered very low.

Construction activities will be guided by the TCEMF, and appropriate weeds and dieback controls will be embedded within the document to guide activities to ensure weeds and dieback are not spread.

Through the implementation of appropriate management and control the potential impacts of the Proposal to adjacent vegetation through the spread of weeds and dieback is considered to be low.



Fragmentation of vegetation

The ASDP site is in an area which is subject to existing clearing and fragmentation. The site is located adjacent to the existing WWTP and utilises existing cleared areas and tracks to the extent possible.

With the exception of the existing access road and the pipeline corridor, the Proposal retains a north-south linkage of remnant vegetation between Marmion Avenue and the coast.

The interface between the Proposal and the adjacent areas of native vegetation will be managed during construction through the TCEMF.

The additional fragmentation resulting from the Proposal are expected to be highly localised and no significant residual impact is anticipated.

Groundwater dependent ecosystems

Construction of the ASDP site, including dewatering activities for the intake and outfall onshore shafts, have the potential to impact vegetation through reduced groundwater level and flow. This is further considered under Section 13 (Inland Waters).

9.8.2 Pipeline

Clearing of native vegetation

The pipeline DAF contains 38 ha of native vegetation. A large proportion (33%) of this native vegetation is in a 'Degraded' and 'Completely Degraded' condition (12.5 ha). The pipeline DAF is 30 m wide; however, the actual construction corridor impacted is expected to be from 12 m to 16 m depending on the constraints present at each location (refer to Section 3.4.4).

The pipeline route has been designed with specific consideration to the avoidance of private land and property, sensitive ecological areas and native vegetation. Most of the pipeline will be constructed in road reserves (approximately 22 km or 68% of the length), with the remainder in land owned by Water Corporation (4 km or 12%), Department of Planning, Lands & Heritage (5 km or 16%) and LandCorp/Main Roads Western Australia (1.5 km or 5%).

As discussed previously, at a complex level, vegetation is well-represented in the region with all but one vegetation complex having more than 30% of the pre-European extent remaining. The Karrakatta complex has 23% of its extent remaining. The Proposal could reduce the current extent of this vegetation complex by 0.3%.

At an association level, three associations (949, 998 and 1007) have more than 30% of their pre-European extent remaining at both a State and local level and are therefore, considered to be of least concern. The remaining vegetation association (6) has less than 30% of its pre-European extent remaining at 23%. The Proposal could reduce the current extent of this vegetation complex by 0.12%.

Specific impacts in sections of the pipeline DAF as defined in the route assessment discussion paper (GHD 2018) are described below, including an assessment of the impacts on any TECs, PECs and *Bush Forever* sites as relevant. Page numbers presented against each section refer to the pages of Figure 9-1, Figure 9-2 and Figure 9-3.



From ADSP site to Marmion Avenue (p 1)

The pipeline DAF commences at the ASDP site, then follows the existing access road to the WWTP and Brindabella Parkway through to Marmion Avenue.

The construction corridor will be located within previously cleared areas and therefore no clearing of native vegetation is required along this section of the pipeline DAF.

Marmion Avenue (p 1)

Within this section of the pipeline DAF the route follows the Marmion Avenue road reserve south. There are existing buried services in the road reserve along this section.

No clearing of native vegetation will be required along this section of the pipeline construction corridor. It is likely that the pipeline would need to be installed under the road pavement to avoid disturbance to the existing services.

Whilst the preferred route from the ASDP site towards Carabooda Tank follows Marmion Avenue and Romeo Road, it is recognised this route remains at risk due to various developments in the area. An alternative route has also been identified, in consultation with LandCorp, where the pipeline deviates to the north from approximately the midpoint of Romeo Road (see Figure 3-4).

This route locates the pipeline within a future road reserve, referred to as 'NS2', prior to heading west along the southern side of the Alkimos City Centre commercial zone cadastral boundary. Due to the presence of various development proposals within the Alkimos City Centre zone, by several proponents including LandCorp, Metronet and MRWA, it is recognised that these developments remain subject to environmental approval assessments.

Romeo Road from Marmion Avenue to Wanneroo Road (p 2)

From Marmion Avenue, the pipeline DAF follows the existing Romeo Road reserve. The road reserve will be required to host several services and will likely need to be widened to accommodate the planned future Romeo Road upgrade works. Clearing of native vegetation may be required in this section, if works are completed in advance of the Romeo Road upgrade works.

The section contains 5.1 ha of native vegetation in varying condition from 'Very Good' to 'Degraded' interspersed with sections of 'Cleared' and 'Completely Degraded' land. The following environmentally sensitive features are intersected:

- 0.02 ha of 'Banksia woodland of the Swan Coastal Plain' TEC in 'Good' condition
- 4.0 ha of 'Coastal shrublands on shallow sands, southern Swan Coastal Plain' and 'Acacia shrublands on taller dunes – Southern Swan Coastal Plain' PEC in 'Good' and 'Good to Very Good' condition
- 0.6 ha of 'Northern Spearwood Shrubland and Woodlands' PEC in 'Good – Degraded' condition
- 0.8 ha of *Bush Forever* site 383 in 'Good – Degraded' condition.



It is expected that the small area of Banksia woodland TEC and the Northern Spearwood shrubland and woodlands PEC within this section can be avoided by following existing cleared areas. Therefore, no impacts on this TEC and PEC are anticipated within this section of the pipeline DAF.

The construction of the pipeline in this section has the potential to result in the loss of up to 4.0 ha of Acacia shrubland PEC in 'Good' and 'Good to Very Good' condition. The extent of this PEC is not known; however, its range is not restricted occurring along the coast from Seabird to Yalgorup National Park (a distance of 170 km).

McLennan Drive from Wanneroo Road to Carabooda Tank site (p 3)

The pipeline DAF within this section follows an existing water utility route along Karoborup Road, Water Corporation easements/property and McLennan Drive, which is unmade in this section. From McLennan Drive, the pipeline runs north to the Carabooda Tank site following an existing Water Corporation easement.

Some clearing of native vegetation may be required in this section, most likely between Gibbs Road and Godel Road. The section contains 4.5 ha of native vegetation, the majority of which is in a 'Degraded' condition, with some patches in 'Good Condition'. The following environmental features are present:

- 0.9 ha of '*Melaleuca huegelii* – *Melaleuca acerosa* shrublands on Limestone Ridges / Northern Spearwood Shrublands and Woodlands' TEC in 'Good' condition
- 0.5 ha of 'Northern Spearwood Shrubland and Woodlands' PEC in 'Completely Degraded' condition (0.1 ha) and 'Good' condition (0.4 ha)
- 3.1 ha of 'Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain' PEC, the majority in 'Degraded' condition (2.7 ha) with the remainder in 'Good' condition.

The small area of TEC is mapped as being in 'Good' condition and will be avoided where possible. The PECs are in 'Degraded' or 'Completely Degraded' condition. Impact to these PECs are unlikely to be avoidable and will be minimised to the extent possible. The area of impact represents is a very small proportion of the remaining extent.

McLennan Drive to Wesco Road (p 3)

This section of pipeline DAF aligns with McLennan Road, which is sealed at this point. The pipeline will either be installed along the northern road verge to avoid the mapped PEC or under the exiting road surface to avoid the requirement to clear roadside vegetation.

At the end of McLennan Drive, the pipeline DAF runs south along the western boundary of State Forest and *Bush Forever* site 290. This route was selected to avoid private property and mining tenements. The pipeline DAF intersects approximately 3.3 ha of State Forest and *Bush Forever* site 290. The route follows existing cleared areas and track where possible, however, up to 5.5 ha native vegetation clearing will be required, of which 3.3 ha occurs within State Forest and *Bush Forever* site 290. Most of the vegetation at this location is in 'Very Good' to 'Excellent' condition.



This section of the pipeline DAF also contains:

- 2.3 ha of the '*Melaleuca huegelii* – *Melaleuca acerosa* shrublands on Limestone Ridges / Northern Spearwood Shrublands and Woodlands' TEC in 'Very Good' and 'Excellent' condition
- 0.3 ha of 'Northern Spearwood Shrubland and Woodlands' PEC in 'Very Good' condition.

It is expected that the impacts to the TEC, PEC and native vegetation in State Forest and *Bush Forever* can be avoided or the impact minimised by following cleared areas and by using restricted construction corridor methods (i.e. a construction width of 12 m).

Wesco Road to Old Yanchep Road (p 4)

The pipeline along this section of the pipeline DAF will be installed within the existing road reserve. The road reserve is relatively clear of native vegetation (6.4 ha), and that which is present is in a 'Degraded' condition.

However, the section between Lisbon Road and Old Yanchep Road contains 2.5 ha of vegetation in a 'Good' (1.2 ha), 'Very Good' (1.0 ha) and 'Excellent' (0.3 ha) condition, which may require clearing.

This section of the pipeline DAF also contains:

- 1.5 ha of 'Banksia woodland' TEC in 'Very Good' and 'Good' condition
- 1.7 ha of '*Melaleuca huegelii* – *Melaleuca acerosa* shrublands on Limestone Ridges / Northern Spearwood Shrublands and Woodlands' TEC in 'Excellent' (0.3 ha), 'Good' (0.7 ha) and 'Degraded' (0.7 ha) condition.

This section of the pipeline DAF intersects a small portion of *Bush Forever* sites 290 (0.7 ha), 136 (1.9 ha) and 293 (2.7 ha). Vegetation condition within the affected portions of *Bush Forever* sites 290 and 136 are predominately in 'Completely Degraded' to 'Degraded' condition. The portion of *Bush Forever* site 293 impacted is in 'Good' to 'Very Good' condition.

Impacts to native vegetation within these *Bush Forever* sites will be minimised to the extent possible by maximising the use of degraded areas and existing cleared tracks. There is potential for the loss of up to 1.5 ha of Banksia TEC which represents less than 0.001% of the known extent in the SCP. Impacts to the Northern Spearwood Shrubland and Woodlands' a PECs is small at 1.7 ha, representing 0.178% of the known extent.

It is expected that these conservation areas can be avoided or the impact minimised by following cleared areas and by using restricted construction corridor methods (i.e. a construction width of 12 m).

Old Yanchep Road between Wesco Road and Wattle Avenue East (p 5)

The pipeline DAF will follow Old Yanchep Road south, most likely in the western road verge, which is free of existing services. This section contains 4.4 ha of native vegetation, all of which is in 'Degraded' condition.



Wattle Avenue East between Old Yanchep Road and Nowergup Tank site (p 5)

This section contains approximately 7.0 ha of native vegetation. Between Old Yanchep Road and Orchid Road, the pipeline DAF follows the northern verge of the existing access road to Barbagallo Raceway. This section of the alignment is adjacent to several *Bush Forever* sites (0.2 ha site 444; 0.3 ha site 457) and contains:

- 1.2 ha of 'Banksia Woodlands of the Swan Coastal Plain' TEC and PEC.

Clearing impacts will be avoided in this section by using already cleared areas and a restricted construction corridor.

From Orchid Road, the pipeline DAF follows the southern road verge of the Barbagallo Raceway access road. This section is relatively clear of vegetation and clearing can be avoided.

From Barbagallo Raceway, the pipeline DAF follows an existing unsealed track through a vegetated area, part of which comprises *Bush Forever* site 293 (2.2 ha). Most of the native vegetation within this section is in 'Good' condition.

Vegetation in this section comprises:

- 4.7 ha of '*Melaleuca huegelii* – *Melaleuca acerosa* shrublands on Limestone Ridges / Northern Spearwood Shrublands and Woodlands' TEC in 'Excellent' condition
- 0.43 ha of 'Northern Spearwood Shrubland and Woodlands' PEC in 'Excellent' condition.

Whilst 4.7 ha of the TEC represents approximately 3% of the known extent on the SCP, it is expected that the area that will be required to be cleared will be significantly lower due to the use of a restricted construction corridor and already cleared tracks.

Old Yanchep Road between Wattle Avenue East and Pederick Road (p 5)

After the deviation to the Nowergup Tank site, the pipeline DAF continues south along Old Yanchep Road reserve. There is limited native vegetation along this section with wide road verges available for the installation of the pipeline. Given this, no clearing will be required along this section.

Old Yanchep Road between Pederick Road and Flynn Drive (p 6)

This small section of pipeline (approximately 550 m) is constrained by the presence of overhead powerlines and will align with the western road verge adjacent to Wanneroo Golf Club. This road verge is vegetated (2.0 ha), and therefore some clearing will be required.

The vegetation here comprises:

- 2.0 ha of 'Banksia Woodlands of the Swan Coastal Plain' TEC and PEC.

The vegetation is in a 'Good' and 'Very Good' condition. Whilst 2.0 ha of the Banksia woodland TEC represents less than 0.001% of the known extent in the SCP. It is also expected that the area that will be required to be cleared will be significantly lower due to the use of a restricted construction corridor and already cleared tracks.



Old Yanchep Road and Greenvale Place between Flynn Drive and Coogee Road (p 6)

The pipeline will be installed in the eastern road verge within this section. The northern portion of this section (Old Yanchep Road) is adjacent to a subdivision under construction and the southern section (Greenvale Place) runs through an established residential area. Restricted corridor construction methods are expected to be used in this area. Only small pockets of native vegetation remain on the western edge of this section which will be avoided.

Therefore, no clearing of native vegetation is required along this section of the alignment.

Coogee Road and Rousset Road to Rome Road (pp 6-8)

From Greenvale Place, the pipeline will follow the less densely populated Coogee Road west where it will be installed in the verge opposite overhead and underground services (northern then southern). Less than 0.4 ha of native vegetation is present in this area, which is mostly 'Completely Degraded' and therefore any clearing impacts are expected to be minimal.

From Coogee Road, the pipeline will follow Rousset Road south. The first section towards Townsend Road is unsealed with a wide cleared track and no existing services. Sufficient capacity exists along the road reserve adjacent the sealed portion to Townsend Road and such no clearing is required along this portion.

Beyond Townsend Road to Rome Road, the route is significantly constrained by overhead and underground services and contains small amounts of native vegetation. At this location, it is most likely that the pipeline will be installed under the existing road surface using a restricted construction corridor, thereby avoiding any clearing impacts.

This section of pipeline also runs adjacent to numerous wetlands (multiple use, resource enhancement and conservation category); however, no clearing of vegetation is required. Other potential impacts to be managed during construction are discussed in Section 13, Inland Waters.

Rome Road to Wanneroo Reservoir (p 8)

The end section of pipeline DAF aligns with the southern verge of Rome Road, which is wide and already cleared. The alignment terminates in the Wanneroo Reservoir site.

Summary of impacts

The Proposal will result in the potential direct loss of native vegetation through clearing for construction of some sections of the pipeline as described above. These maximum clearing impacts are based on the 30 m wide pipeline DAF are described in Table 9-12 (columns headed A).

The actual clearing impacts are expected to be significantly lower than presented once the final pipeline position is established and the pipeline construction corridor is established. As a minimum, Water Corporation will adopt a restricted pipeline construction corridor (12 m wide) in sections where clearing is required. This will reduce the amount of vegetation required to be cleared, as shown in Table 9-12 (columns headed B).



Table 9-12: Clearing impacts

Pipeline corridor section	Native vegetation (ha)		Banksia woodland TEC (ha)		Melaleuca shrublands on limestone ridges TEC (ha)		Coastal shrublands PEC (ha)		Tuart woodlands of the SCP PEC (ha)		Northern Spearwood Shrubland and Woodlands PEC (ha)		Bush Forever(ha)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Romeo Road from Marmion Avenue to Wanneroo Road	5.1	2.0	0.02	0.0			4.0	1.6			0.6	0.2	0.8	0.3
McLennan Drive from Wanneroo Road to Carabooda Tank site	4.5	1.8			0.9	0.4			3.1	1.2	0.5	0.2		
McLennan Drive to Wesco Road	5.5	2.2			2.3	0.9					0.3	0.1	3.3	1.3
Wesco Road to Old Yanchep Road	6.4	2.6	1.5	0.6	1.7	0.7								
Old Yanchep Road between Wesco Road and Wattle Avenue East	4.4	1.8											5.3	2.1
Wattle Avenue East between Old Yanchep Road and Nowergup Tank site	7.0	2.8	1.2	0.5	4.7	1.9					0.4	0.2	2.7	1.1



Pipeline corridor section	Native vegetation (ha)		Banksia woodland TEC (ha)		Melaleuca shrublands on limestone ridges TEC (ha)		Coastal shrublands PEC (ha)		Tuart woodlands of the SCP PEC (ha)		Northern Spearwood Shrubland and Woodlands PEC (ha)		Bush Forever(ha)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Old Yanchep Road between Pederick Road and Flynn Drive	2.0	0.8	2.0	0.8										
Coogee Road and Rousset Road to Rome Road	0.4	0.2												
Total	35.3	14.1	4.7	1.9	9.6	3.9	4.0	1.6	3.1	1.2	1.8	0.7	12.1	4.8



Based on the use of a restricted pipeline construction corridor, the following likely impacts are anticipated:

- 14.1 ha of native vegetation, which is present in sections of the pipeline DAF where clearing may be required
- 1.9 ha of native vegetation associated with 'Banksia Woodlands of the Swan Coastal Plain' TEC, which is less than 0.002% of the known extent in the SCP. The majority of the TEC represented is in a 'Good' to 'Very Good' condition
- 3.9 ha of '*Melaleuca huegelii* – *Melaleuca acerosa* shrublands on Limestone Ridges / Northern Spearwood Shrublands and Woodlands' TEC, which is less than 2.5% of the known extent in the SCP. The majority of the TEC represented is in 'Excellent' and 'Very Good' condition
- 0.7 ha of 'Northern Spearwood Shrubland and Woodlands' PEC, which is less than 0.4% of the known extent in the SCP. The majority of the PEC represented is in a variety of condition from 'Completely Degraded' to 'Excellent'
- 1.2 ha of 'Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain' PEC, which is 0.02% of the known extent in the SCP. The majority of the PEC represented is in 'Degraded' condition
- 1.6 ha of 'Coastal shrublands on shallow sands, southern Swan Coastal Plain / Acacia shrublands on taller dunes, southern Swan Coastal Plain' PEC, which is a known to occur from Guilderton to Mandurah. The majority of the PEC represented is in 'Good to Very Good' condition
- 4.8 ha of *Bush Forever* sites, the majority of which is in 'Good' to 'Excellent' condition.

In addition to the use of restricted pipeline construction corridor, the following specific mitigation measures will also be implemented to further minimise to the maximum extent possible the area of vegetation that will require clearing:

- use of existing cleared tracks and verges where possible to avoid clearing
- pre-construction surveys of construction corridor to delimit clearing requirements
- rehabilitation of cleared areas to the maximum extent possible, noting the requirement to maintain a 5 m wide maintenance strip.

The most likely sections of the pipeline DAF that will require some clearing of native vegetation are the section of McLennan Drive that runs alongside State Forest towards Wesco Road; the section from Barbagallo Raceway to the Nowergup Tank site; and the small section of Old Yanchep Road between Pederick Road and Flynn Drive (verge adjacent to Wanneroo Golf Club).

The above areas of clearing represent a small proportion of the total 139 ha pipeline DAF and do not represent a significant loss of vegetation, especially when considering the quantity and condition of similar vegetation surrounding the DAF and the mapped extent of the vegetation types impacted in the region and local area (refer to Table 9-5).



Indirect impacts

Wetlands

The section of pipeline from Coogee Road to Rome Road runs adjacent to numerous multiple use and resource enhancement wetlands (Figure 9-4) and the assessment corridor intersects 4.6 ha of CCW boundary at the top section of Old Yanchep Road and Old Yanchep Road before Pederick Road. At these points, the pipeline DAF will follow Old Yanchep Road, most likely in the western road verge, which is free of existing services. Native vegetation in this section is in 'Degraded' condition. Therefore, no direct impacts to wetlands are anticipated due to the location of the pipeline in less sensitive areas.

Potential indirect impacts resulting from construction activities will be managed through the implementation of the TCEMF. The potential impacts of the construction and operation of the pipeline are further assessed in Section 13 Inland Waters.

Introduction and spread of dieback, declared pest species and introduced weeds

The spread of dieback from infested to uninfested areas has been identified as a potential risk along the DAF because of clearing, and construction and maintenance activities associated with the Proposal.

Due to the presence of both infested areas and significant areas of uninfested vegetation, there is a risk of the pathogen being vectored within the landscape during ground disturbance activities (AECOM 2017; Ecoscape 2018).

Construction activities will be guided by the TCEMF, and appropriate dieback controls will be embedded within the document to guide activities to ensure dieback is not spread along the DAF.

The construction of the pipeline also has the potential to spread of weeds, with two declared pest species identified in the assessment corridor. The spread of weeds may have impacts on the biodiversity values, including competition with native flora and the prevention of seedling recruitment.

Weed management measures will also be addressed in the TCEMF, which will address vehicle hygiene, access and monitoring during construction.

Fragmentation of vegetation

Fragmentation caused by linear clearing of vegetation can lead to the increased risk of 'edge effects' such as weed invasion, disease spread, fire, dust and erosion.

The pipeline will be constructed in an already fragmented landscape and the additional fragmentation of native vegetation has been avoided or minimised as described above by using careful route selection, road reserve, cleared tracks and areas of degraded vegetation.

Residual fragmentation effects on vegetation are expected to be highly localised and no significant impact is anticipated.



Groundwater dependent ecosystems

Construction of the pipeline, including dewatering activities if required, have the potential to impact vegetation through reduced water flow and water quality. This is assessed under Section 13 Inland Waters.

9.9 Mitigation

Water Corporation has applied the mitigation hierarchy to the Proposal to protect terrestrial flora and vegetation so that biological diversity and ecological integrity are maintained. Mitigation measures are summarised in Table 9-13.

Table 9-13: Mitigation hierarchy to potential impacts on flora and vegetation

Potential impacts	Avoid	Minimise	Monitoring and management
ASDP site			
Clearing of native vegetation	Existing conservation areas immediately surrounding the ASDP site will remain largely intact, including the TEC vegetation identified to the north of the ASDP site (area 10a).	Rehabilitation of approximately 11 ha of landscaped and cleared areas to achieve a pre-development native vegetation community.	Implementation of a TCEMF
Disturbance or clearing of PECs			
Fragmentation of vegetation			
Spread of declared pest species or dieback	No declared pest species were identified on site.	Weed and dieback surveys can be completed prior to construction to ensure impacts can be minimised.	
Pipeline			
Clearing of native vegetation	The requirement for clearing of native vegetation has been avoided along large sections of the pipeline by following road reserves and already cleared areas and tracks.	The clearing of vegetation has been minimised by using a restricted and slightly-restricted pipeline construction corridor (12 m to 16 m width). The pipeline construction corridor will be rehabilitated to the pre-construction land use, including revegetation with native species where appropriate. A 5 m wide cleared strip will be maintained for Water Corporation access. The Proposal alignment has been developed to utilise existing linear infrastructure (i.e. road reserve) where possible, significantly reduce the fragmentation of vegetation	
Disturbance or clearing of TECs and PECs			
Disturbance or clearing of <i>Bush Forever</i> sites			
Disturbance of wetlands			
Fragmentation of vegetation			
Spread of declared pest species or dieback	-	-	



9.9.1 Mitigation strategies

Environmental monitoring and management will be outlined in further detail in a TCEMF to guide construction activities and provide environmental performance standards, including management measures such as:

- vegetation retention where possible
- clearing and access control measures (such as demarcation of clearing boundaries)
- rehabilitation of temporary construction areas
- weed hygiene plan
- Dieback management plan
- topsoil management.

9.10 Predicted outcome

Based on the scale and nature of impacts, the location away from sensitive areas, and the mitigation to be implemented, the Proposal is not expected to result in a significant impact on flora and vegetation, and biological diversity and ecological integrity will be maintained. The Proposal is unlikely to alter the conservation status of any impacted vegetation communities.

Impacts to TECs are less than 5% of the existing known extent. The Proposal will impact on less than 0.2% of the mapped extents (where known) of PECs present. The TECs and PECs that will be impacted are known to occur across a large range and are well represented in conservation areas in the local and regional area.

Accordingly, it is expected that the EPA's objective for flora and vegetation will be met.



10. Terrestrial Fauna

10.1 EPA objectives

The EPA's environmental objective for terrestrial fauna is:

“To protect terrestrial fauna so that biological diversity and ecological integrity are maintained” (EPA 2016n).

10.2 Policy and guidance

Relevant EPA policy and guidelines, and the scope of each of these relevant to the Proposal are presented in Table 10-1.

Table 10-1: Policies and guidelines

Policy or guidance	Scope
Technical Guide - Terrestrial Fauna Surveys (EPA 2016o)	Surveys for the Proposal were carried out in accordance with the requirements for environmental surveying as outlined in this technical guide.
Factor Guideline, Terrestrial Fauna (EPA 2016n)	Fauna surveys for the Proposal were carried out in accordance with the requirements as set out in this guideline.
Environmental Protection Bulletin No. 20 – Protection of Naturally Vegetated Areas through Planning and Development (EPA 2013)	Given the Proposal is located in an urban area, this bulletin was considered in the development of the Proposal. The EPA's objectives for terrestrial fauna have been considered in the design of the Proposal and in avoiding, minimising and mitigating potential impacts.

10.3 Overview of studies

Several environmental studies have been conducted in the DAF to determine the terrestrial fauna values present. Descriptions of the studies undertaken for the Proposal are presented in Table 10-2.

Table 10-2: Terrestrial fauna studies undertaken for the Proposal

Investigation	Scope
Alkimos Waste Water Treatment Plant (Bamford Consulting Ecologists 2018; Appendix J)	Bamford Consulting Ecologists conducted a Level 1 fauna assessment (desktop review and site inspection) for the area surrounding the Alkimos WWTP. A substantial portion of this survey area intersects the ASDP site.
Eglinton Groundwater Investigations (Ecoscape 2018; Appendix I)	Water Corporation commissioned Ecoscape to conduct a Level 1 fauna survey and a Black Cockatoo survey of a number of pipeline options and sites for a Groundwater Treatment Plant and pump station. The survey area intersects with the current DAF. As part of the survey, Ecoscape facilitated Traditional Owner attendance.



Investigation	Scope
Alkimos SDP Investigations – Integration, Alkimos to Wanneroo Reservoir (AECOM 2017; Appendix F)	Water Corporation required biological investigations to define and map the environmental values for a linear infrastructure corridor between Yanchep and Wanneroo. Results of this survey have been used in defining the preferred route of the pipeline.
Ecological Assessment – Alkimos SDP Pipeline Integration (AECOM 2018; Appendix G)	Water Corporation required further biological investigations to define and map environmental values for a linear infrastructure corridor in Alkimos. A targeted Black Cockatoo and Level 1 fauna survey were conducted in July and August 2018.

The results from the above desktop assessments and surveys have been used to describe the fauna and fauna habitat values within the DAF in the following sections.

10.4 Receiving environment

10.4.1 ASDP site

Bamford Consulting Ecologists (2018) undertook a Level 1 fauna assessment of the area around the existing Alkimos WWTP (approximately 221 ha) including the DAF for the ASDP site. The report provides information on the fauna values of the survey area, particularly for significant species, and an overview of the ecological function of the ASDP site in a local and regional context.

No conservation significant fauna species were recorded during the survey and no evidence of Black Cockatoos roosting or nesting was observed.

10.4.2 Pipeline

Three fauna surveys have been conducted across the pipeline DAF (Ecoscape 2018; AECOM 2017, 2018); which have been used to inform the final design of the pipeline route. The surveys identified 37 fauna species; six of which were identified as conservation significant species known to, or likely to, occur within the pipeline DAF, as summarised in Table 10-3.

Table 10-3: Conservation significant fauna known or likely to occur

Species	Common name	Conservation status	
		EPBC Act	BC Act
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	Endangered	Endangered
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	Vulnerable	Vulnerable
<i>Macropus Irma</i>	Western Brush Wallaby	-	Priority 4
<i>Isodon obesulus fusciventer</i>	Quenda or Southern Brown Bandicoot	-	Priority 4
<i>Grallina cyanoleuca</i>	Magpie Lark	Listed marine	-
<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo	Listed marine	-

The Magpie Lark and the Shining Bronze-Cuckoo have not been considered further in this assessment as habitat critical to these species does not occur within the DAF.



In addition to the conservation significant species observed, the Rainbow Bee-eater (EPBC Act listed marine) is considered likely to be present within the DAF due to the presence of their preferred habitat. Habitat required for this species is considered wide-spread across Australia and, therefore, this species is not considered further in this assessment.

10.4.3 Black cockatoo

Black cockatoos are long-lived, slow-breeding birds that display strong pair bonds. The species is suffering the effects of population decline and habitat loss. Carnaby's Black Cockatoo breed in hollows that are usually found in trees that are more than 200 years old and are generally known to breed throughout the southwest, to the west of Ravensthorpe in the higher rainfall areas (DSEWPac 2012b).

The Level 1 fauna assessment conducted by Bamford Consulting Ecologists (2018) included assessment of Black Cockatoo habitat in the ASDP site to identify potential breeding, roosting and foraging habitat for Carnaby's Black Cockatoos.

The Black Cockatoo habitat assessment for the Pipeline corridor was undertaken by AECOM (2017) and Ecoscape (2018) to identify potential breeding, roosting and foraging habitat for the three threatened Black Cockatoo species that potentially occur within the survey areas (and DAF).

Foraging habitat in the survey area was assessed as being of Very High and High Quality, consisting of mainly Eucalypt (Marri, Tuart and/or Jarrah) and Banksia woodlands suitable for Carnaby's Cockatoo. Very High and High Quality foraging habitat for the Forest Red-tailed Black Cockatoo was also identified; generally consisting of Eucalypt woodlands with Marri, Jarrah and Sheoak. A total of 26.7 ha of Carnaby's Black Cockatoo foraging habitat and 9.7 ha of Forest Red-tailed Black Cockatoo foraging habitat in High and Very High quality was identified in the DAF.

The assessment determined potential breeding trees based on those with a diameter at breast height (DBH) >500 mm, except for *Eucalyptus wandoo* (DBH >300 mm). A total of 634 potential habitat trees were identified in the wider survey area, with 67 potentially supporting breeding hollows. However, many of the hollows were noted as being used by bees. No potential breeding trees or suitable hollows were identified in the ASDP site. Within the pipeline DAF, 191 potential breeding trees, containing 32 potentially suitable breeding hollows, were identified as presented on Figure 10.1.

10.4.4 Western Brush Wallaby

The Western Brush Wallaby is endemic to the southwest of WA and occurs from North of Kalbarri to Cape Arid National Park. It commonly occurs in dry sclerophyll forest, Banksia woodlands and shrublands, typically favouring dense low vegetation that provides dense cover. Western Brush Wallabies tend to rely more on moisture derived from plants than from free-water sources.

Brush Wallabies are solitary, nocturnal but tending to be more active just after sunset and just before sunrise. Recently-burnt areas, at least up to two years post-fire, are favoured for foraging but are not essential, whereas access to dense vegetation for shelter is. Population studies in Whiteman Park have found that males have large home ranges, up to 9.9 ha in a night and 69.2 ha during a year. The male ranges appear to overlap with several females (up to 5.3 ha in a night and 32.5 ha during a year).



The Brush Wallaby is classified as Priority 4, which means that the population has declined and requires monitoring; but it is not currently considered threatened or in need of special protection.

10.4.5 Quenda

Quenda are present through much of the southwest of WA, with more patchy distribution extending to the Great Western Woodlands and Recherche area. They prefer dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeding in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.

Quenda are mostly nocturnal, usually solitary, terrestrial and omnivorous, digging into the soil for invertebrates, fungi, edible plant parts and occasional small vertebrates. Breeding occurs at any season with a peak in spring, nesting in litter-covered depressions concealed under logs, shrubs or debris.

Known threatening processes include fragmentation of habitat, fire in habitat already fragmented, and predation by cats, dogs and foxes. Disturbance of potential nesting sites (logs, shrubs, debris piles and litter) may impact some individuals, and may cause death or injury directly, or through forced relocation resulting in increased intraspecific competition and exposure to predators.

10.4.6 Fauna habitat

The field surveys identified eight fauna habitat types within the DAF based on the vegetation types mapped in the flora and vegetation survey, as presented in Figure 10-1 and Table 10-4. The DAF is surrounded by areas of similar habitat in largely contiguous and intact patches, with over 8000 ha within 4 km of the DAF.

Table 10-4: Fauna habitat types within the DAF

Fauna habitat	Extent within the ASDP site (ha)	Extent within pipeline DAF (ha)	% of DAF	Potential habitat for conservation significant species
Banksia woodland	-	17	12%	<ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo • Carnaby's Black Cockatoo • Quenda • Rainbow Bee-eater
Eucalypt woodland	-	9.7	7%	<ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo • Carnaby's Black Cockatoo • Quenda • Rainbow Bee-eater



Fauna habitat	Extent within the ASDP site (ha)	Extent within pipeline DAF (ha)	% of DAF	Potential habitat for conservation significant species
Wetlands and riparian vegetation	-	1.8	1%	<ul style="list-style-type: none"> Great Egret Quenda Forest Red-tailed Black Cockatoo Carnaby's Black Cockatoo Rainbow Bee-eater
Heath and shrubland	-	7.4	5%	<ul style="list-style-type: none"> Carnaby's Black Cockatoo Quenda Rainbow Bee-eater
Acacia shrubland over mixed low shrubs and weeds on sand	16.0	0.8	12%	<ul style="list-style-type: none"> Carnaby's Black Cockatoo Quenda Western Brush Wallaby
Cleared areas with occasional Eucalypts (planted) over weeds on sand	0.9	-	1%	<ul style="list-style-type: none"> Carnaby's Black Cockatoo Quenda Western Brush Wallaby
Low dense Banksia and/or Melaleuca thicket and mixed shrubland on sand and limestone	5.8	-	4%	<ul style="list-style-type: none"> Carnaby's Black Cockatoo
Scattered Tuart trees over weeds on sand	1.6	-	1%	<ul style="list-style-type: none"> Carnaby's Black Cockatoo
Scattered trees	-	3.3	2%	<ul style="list-style-type: none"> Forest Red-tailed Black Cockatoo Carnaby's Black Cockatoo Rainbow Bee-eater
Pine plantation regrowth	-	2.7	2%	<ul style="list-style-type: none"> Forest Red-tailed Black Cockatoo Carnaby's Black Cockatoo Rainbow Bee-eater
Planted, parkland vegetation and maintained gardens	1.7	8.2	7%	<ul style="list-style-type: none"> Forest Red-tailed Black Cockatoo⁵ Carnaby's Black Cockatoo Rainbow Bee-eater Quenda
TOTAL	26.0	50.8		

⁵ The 'Planted, parkland vegetation and maintained gardens' habitat type contains potential habitat for the Forest Red-tailed Black Cockatoo in the pipeline DAF only.



Five fauna habitats were identified within the ASDP site, including:

- low dense Banksia and/or Melaleuca thicket and mixed shrubland on sand and limestone
- Acacia shrubland over mixed low shrubs and weeds on sand
- scattered Tuart trees over weeds on sand
- cleared areas with occasional Eucalypts
- planted, parkland vegetation and maintained gardens.

Acacia shrubland (16 ha) represents the most extensive fauna habitat within the ASDP site. This habitat may be used by Carnaby's Black Cockatoo, Quenda and Western Brush Wallaby. This fauna habitat type was assessed as having low to medium foraging habitat value for Black Cockatoos (Bamford Consulting Ecologists 2018). No evidence of roosting or foraging of Black Cockatoos was recorded in the ASDP site.

Eight fauna habitats were identified within the pipeline DAF. Of these, Banksia woodland (17 ha) represents the most extensive habitat type. This habitat is likely to be used by many of the common fauna species that occur in the area, as well as by conservation significant species such as the Forest Red-tailed Black Cockatoo and Carnaby's Black Cockatoo (breeding, roosting and foraging habitat), and potentially Quenda.

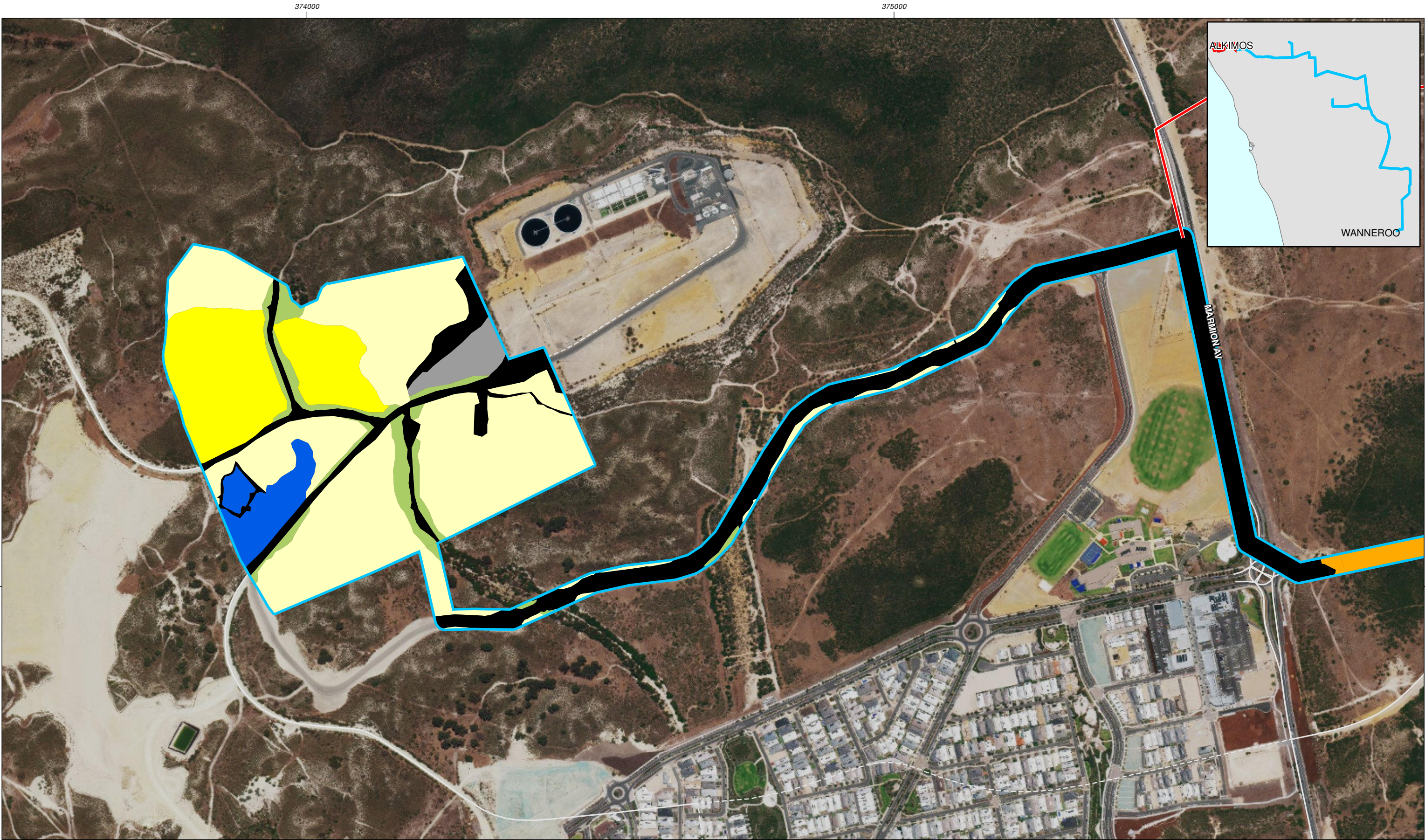


Figure 10-1: Fauna Habitat

Scale 1:6,000 at A3

0 100 m

Legend

- Development Area Footprint
- Black Cockatoo Breeding Trees
- Northern Route Option
- Minor Road
- Track

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/03/2019

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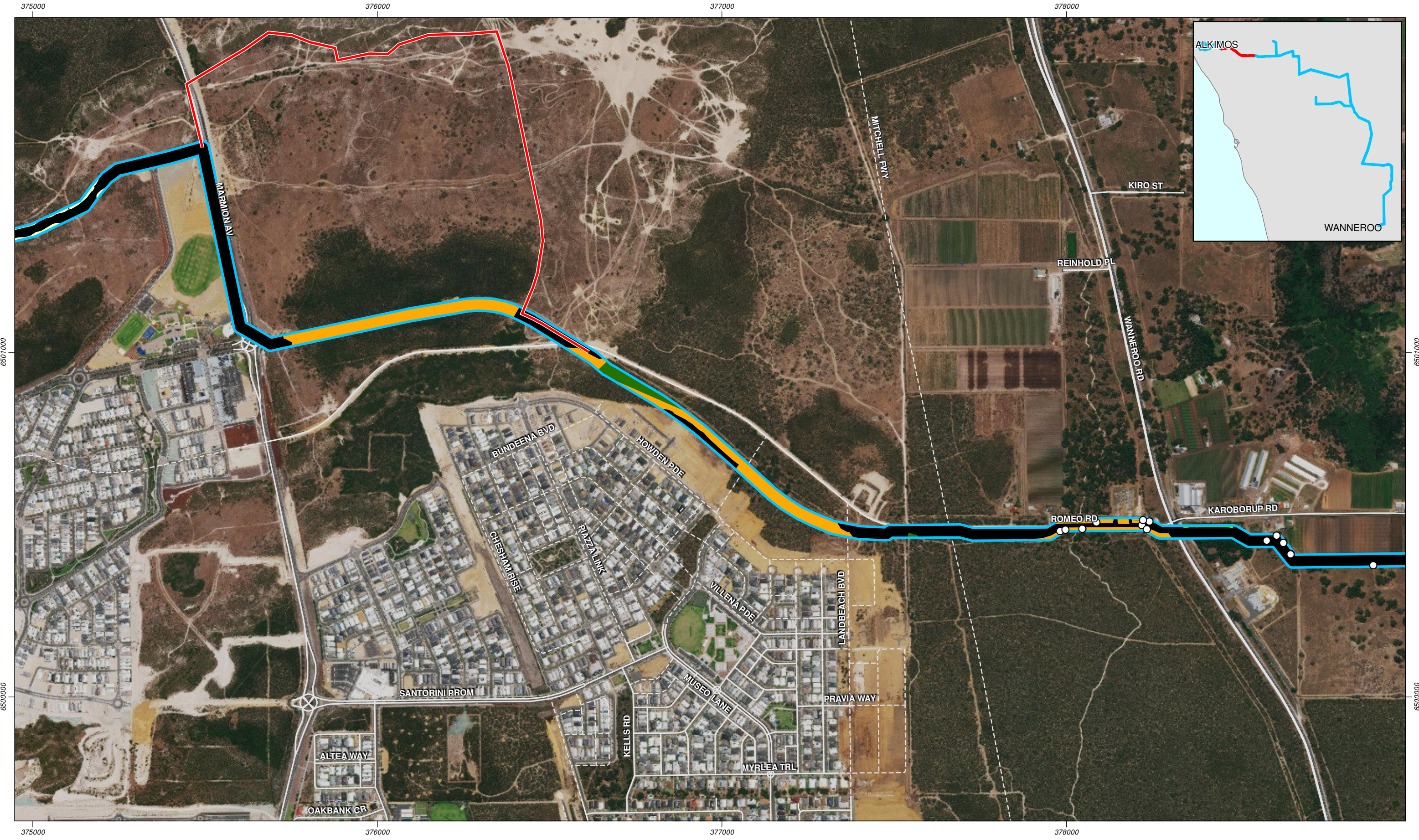


Figure 10-1: Fauna Habitat

N

Scale 1:10,000 at A3

0 100 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/03/2019

Legend

Development Area Footprint

Black Cockatoo Breeding Trees

Northern Route Option

Major Road

Minor Road

Track

Fauna Habitat

Acacia shrubland over mixed low shrubs and weeds on sand

Banksia Woodlands

Cleared

Eucalypt Woodlands

Heath and Shrubland

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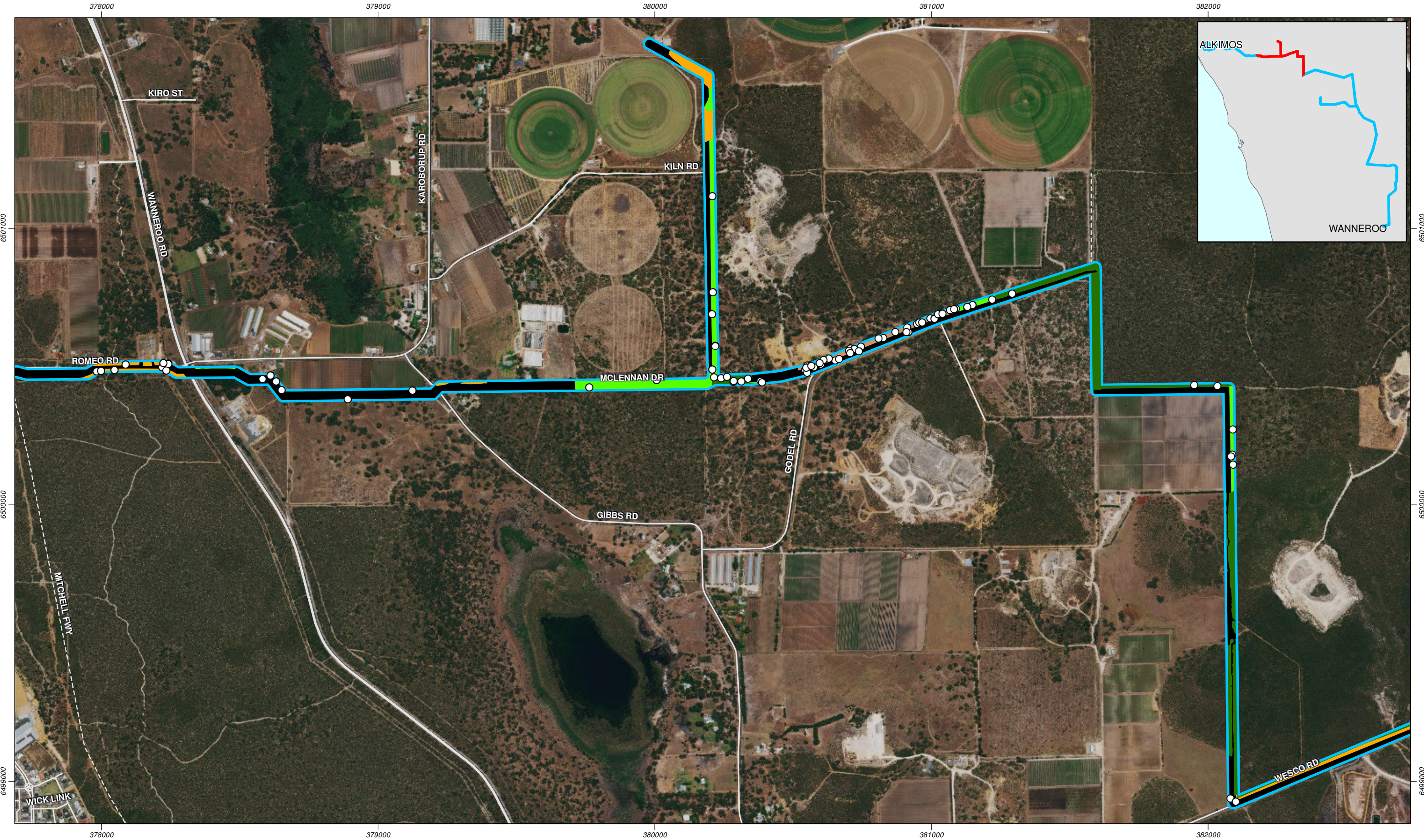


Figure 10-1: Fauna Habitat

Scale 1:12,500 at A3

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 50
Date: 18/03/2019

Legend

Development Area Footprint
 Black Cockatoo Breeding Trees
 Major Road
 Minor Road

Track

Fauna Habitat

 Banksia Woodlands
 Cleared

Eucalypt Woodlands
 Heath and Shrubland
 Scattered Trees

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Figure 10-1: Fauna Habitat

Scale 1:10,500 at A3

0 100 m

Legend

- Development Area Footprint
- Black Cockatoo Breeding Trees
- Minor Road
- Track

Fauna Habitat

- Banksia Woodlands
- Cleared
- Eucalypt Woodlands
- Heath and Shrubland
- Pine Plantation Regrowth
- Scattered Trees

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