

# MOOREBANK PRECINCT EAST – OPERATIONAL FACILITY

## Annual Flora and Fauna Monitoring Report

26 MAY 2022



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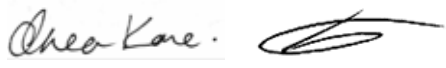


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# MOOREBANK PRECINCT EAST – OPERATIONAL FACILITY

## Annual Monitoring Report

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<b>Report No</b>	1.0	
<b>Date</b>	26/05/2022	
<b>Revision Text</b>	B	

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## REVISIONS

Revision	Date	Description	Prepared by	Approved by
A	12/05/2022	Draft report	TBH TK	NB
B	26/05/2022	Final report	TBH	NB

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# 1 INTRODUCTION

Arcadis were commissioned to undertake monitoring inspections and deliver the annual flora and fauna monitoring report for the operation of the Moorebank Precinct East (MPE) facility. The requirement to monitor biodiversity values within the MPE operational facility and biodiversity values related to the approval of the project is specified in the following Conditions of Consent (CoC) and Conditions of Approval (CoA):

- Moorebank Precinct East EPBC Concept Approval (EPBC 2011/6229)
- Ministers Conditions of Consent (CoC) (SSD 6766; SSD 7628)

Additional requirements to monitor biodiversity values are included in the following project documents:

- Moorebank Precinct East – Stage 1 (SSD 6766) and Moorebank Precinct East – Stage 2 (SSD 7628) Environmental Impact Statements (EIS)
- Riparian Vegetation Management Plan for SIMTA Intermodal Terminal Facility – Stage 1 (Hyder 2015)
- SIMTA Intermodal Terminal Facility – Stage 1. Riparian Vegetation Management Plan – 2017 Updated (AMBS 2017)
- Operational Flora and Fauna Management Plan for Moorebank Logistics Park – East Precinct (Arcadis 2020a)
- Threatened Flora Offset Management Plan (Arcadis 2020b)
- Nest Box Management Strategy. Moorebank Precinct East Stage 1 – Rail Link (CPB 2017)
- Moorebank Precinct West Stage 2. Koala Management Plan (Cumberland Ecology 2020)

## 1.1 Moorebank Precinct East background

The Moorebank Logistics Park (MLP) is an integral component of the Freight, Ports and Transport strategies of both the NSW and Commonwealth governments to help manage the challenges of an expected tripling of freight volumes at Port Botany by 2031.

The MLP aims to streamline the freight logistics supply chain from port to store, deliver savings to businesses and consumers, and help service the rapidly growing demand for imported goods in south-west Sydney. It is located approximately 27 kilometres south-west of the Sydney Central Business District and approximately 26 kilometres west of Port Botany within the Liverpool Local Government Area. The MLP is divided into an East Precinct and a West Precinct, located east and west of Moorebank Avenue respectively.

The main features of MPE include:

- An Import Export (IMEX) Terminal. The IMEX Terminal comprises:
  - Truck processing, holding and loading areas with an entrance and exit from Moorebank Avenue
  - Rail loading and container storage areas serviced by container handling equipment
- An Administration facility and associated car parking with light vehicle access from Moorebank Avenue
- An Operational Rail Link connecting the IMEX terminal and the Southern Sydney Freight Line (SSFL) traversing Moorebank Avenue, Anzac Creek, Georges River and Glenfield Waste Facility
- Associated ancillary infrastructure including signage, lighting, landscaping, water management
- Warehouse and distribution facilities including warehousing up to 21 metres in height, typically ranging in size from 20,000 meters squared to 62,000 meters squared
  - Office and administration facilities
  - Amenities

- Car parking
- Truck loading/unloading docks
- Internal parking for pick-up and delivery vehicles (PUD)
- Specialised sortation and conveyor equipment
- Hardstand areas that provide trailer parking spaces, external PUD parking spaces, vehicle manoeuvring areas and access to the main internal site road
- Signage for business identification purposes, including backlit illuminated signage on each warehouse
- Internal fitout, comprising racking and storage
- A freight village including a mix of retail, commercial and light industrial spaces typically up to 15 metres in height and varying in size and design
- An internal road network to enable efficient movement of vehicles, dispatch of freight from the warehouses and transport of containers between the IMEX Terminal and warehouse and distribution facilities

In addition to the constructed assets of the MPE development there are several other areas which have been included within the MPE operational facility for the purpose of flora and fauna monitoring. These include:

- Five designated offset sites for EPBC listed threatened flora species within Wattle Grove offset area
- Lands adjoining (within 10 meters of) the Rail Link
- Riparian vegetation management sites at Anzac Creek and Georges River
- Nest box locations within Moorebank and Wattle Grove offset areas

## 1.2 Monitoring objectives

Management of flora and fauna values within the MPE operational facility and associated lands is reviewed on an annual basis following a series of detailed monitoring surveys. The core objectives of flora and fauna monitoring are to:

- Monitor protected threatened flora species
- Monitor protected vegetated areas adjacent to the operational facility (including EPBC offset areas)
- Monitoring to minimise harm to fauna and maintain habitat offsets (nest boxes)
- Monitor works to protect and improve riparian and aquatic environments
- Monitor for weed occurrence and recruitment within operational site

The results of flora and fauna monitoring across the MPE operational facility is the subject of this report. A series of recommendations are included to rectify any management issues identified during monitoring and enhance the biodiversity values within the MPE operational facility.

The methodologies and results of nest box and EPBC offset site surveys has not been included in the body of this report. Both of these monitoring components have been described in separate documents which have been included as appendices to this report:

- Appendix D. EPBC offset sites - Annual monitoring report
- Appendix H. Nest box monitoring report (Spring 2021)
- Appendix I. Nest box corrective action report



Figure 1-1. MPE operational facility and adjacent biobank site

### **1.3 Requirements for monitoring**

The requirements to monitor biodiversity values during operation of the MPE facility are summarised below in Table 1-1.



Table 1-1. MPE operational facility flora and fauna monitoring requirements

Subject	Approval condition	Requirement	Where addressed
Weed and feral animal monitoring	CoC B110 (SSD 7628)	<p><i>B110. Prior to operation, the Applicant must prepare an Operational Flora and Fauna Management Plan (OFFMP) in consultation with OEH. The OFFMP must form part of the OEMP required by condition C3 and must include measures to ensure biodiversity values not intended to be impacted are protected, including but not limited to:</i></p> <ul style="list-style-type: none"> <li><i>i. Weed control</i></li> <li><i>ii. Feral animal control</i></li> <li><i>iii. Pathogen management procedures</i></li> <li><i>iv. Monitoring</i></li> <li><i>v. Rehabilitation actions.</i></li> </ul>	<p>Sections:2.3, 3.3, 4.3 (weeds) 2.4.3, 3.4.3, 4.4.3 (feral animals)</p>
	CoC B127 (SSD 7628)	<p><i>The Applicant must:</i></p> <ul style="list-style-type: none"> <li><i>a. take all reasonable steps to manage pests and vermin on the site;</i></li> <li><i>b. manage declared noxious weeds on the site in accordance with the requirements of the Noxious Weeds Act 1993;</i></li> <li><i>c. inspect the site on a regular basis, no less than every 3 months, to ensure that these measures are working effectively, and that pests, vermin or noxious weeds are not present on site in sufficient numbers to pose an environmental hazard, or cause the loss of amenity in the surrounding area</i></li> </ul>	
	CoA 5(h) (EPBC 2011.6229)	<p><i>For the better protection of EPBC listed flora &amp; the environment on Commonwealth land, the person taking the action must engage a suitably qualified expert to prepare a Flora and Fauna Management Plan (FFMP) for the approval of the Minister. The FFMP must include (but need not be limited to):</i></p> <ul style="list-style-type: none"> <li><i>h) measures to safeguard flora and fauna from the threat of weeds, fire, pathogens and unauthorised access, including (but not limited to) the commitments outlined in section 7.4.1 of the EIS (and summarised at Annexure A)</i></li> </ul>	
Riparian rehabilitation and management	CoC C21, E9 (SSD 6766)	<p><i>C21. The Georges River Bridge shall be designed to ensure fauna movement within the riparian corridor is maintained. The bridge shall be designed in consultation with DPI Water and DPI Fisheries and approved by the Certifying Authority. A copy of the final design shall be submitted to the Secretary for information and made available on the Project Website.</i></p>	<p>Sections: 2.1.2, 3.1.2, 4.1.2</p>

Subject	Approval condition	Requirement	Where addressed
		<i>E9. All activities taking place in, on or under waterfront land, as defined in the Water Management Act 2000 should be conducted generally in accordance with the NSW Office of Water's Guidelines for Controlled Activities.</i>	
	CoC B110 (i) (v) (SSD 7628)	<i>B110 (i),(v). See above.</i> Riparian vegetation monitoring will be conducted within the riparian management areas identified within the original MPE Stage 1 Riparian Vegetation Management Plan (Hyder 2015) and updated version (AMBS 2017). The monitoring requirements are also set out in these documents.	
EPBC threatened flora offsets	EPBC CoA 6(e)	<i>6(e). measures for regular monitoring of the status of individuals of Nodding Geebung and Small-flower Grevillea and their habitat as measured against the baseline population and distribution, including:</i> <i>i. fluctuations in population size and distribution; and</i> <i>ii. response to disturbances and/or management actions.</i>  Monitoring of threatened flora species (Nodding Geebung and Small-flowered Grevillea) within the EPBC offset areas will be completed in accordance with the Threatened Flora Offset Management Plan (Arcadis 2020).	Appendix B
Monitoring condition of threatened flora and vegetation adjacent to the Rail Link, within BA341 lands	EPBC CoA 5(i)	<i>ongoing monitoring to inform the adaptive management of native vegetation adjoining the rail easement</i> Monitoring of threatened flora and vegetation condition adjoining the Rail Link will be conducted in accordance with the OFFMP (Arcadis 2020a) and the BA341 Biobanking Agreement (OEH 2019) requirements.	Sections: 2.1.1, 2.2.1, 3.1.1, 3.2.1, 4.1.1, 4.2.1
Koala management	CoC B152 (SSD 7709)	<i>B152. Prior to clearing of native vegetation, a Koala Management Plan (KMP) must be prepared by a suitably qualified person in consultation with OEH and be submitted to the Planning Secretary for approval. KMP must:</i> <i>a. identify habitat corridors, of adequate dimension to provide Koala habitat corridors as supported by Koala specialist, to provide connectivity both within the Intermodal Precinct area and with other core koala habitat areas (i.e. to the south and to the west along Georges River);</i> <i>b. include details of structures to eliminate barriers to movement (presented by fences, roads, drainage culverts or pits, rail lines and the like) for koalas and other native fauna likely to use the site of habitat corridor;</i>	Sections: 2.4.2, 3.4.2, 4.4.2

Subject	Approval condition	Requirement	Where addressed
		<p><i>c. include other measures to minimise the risk of harm to koalas.</i></p> <p>Koala fencing is to be installed along the interface of the occupied habitat (Wattle Grove offset area) and the MPE operational site. Annual monitoring of the fencing will be conducted to ensure it is functional and in agreement within the Koala Management Plan (Cumberland Ecology 2020).</p>	
Nest Boxes	EPBC CoA Annexure A – Summary of mitigation measures	<i>Consider the installation of nest boxes in woodland vegetation in the rail corridor that may offer alternative nesting habitat to hollow dependent species recorded in the study area.</i>	Appendix H Appendix I
	CoC E34(d)(ii)(b) (SSD 6766)	<p><i>The identification of areas to be cleared and details of management measures to avoid residual habitat damage or loss and to minimise or eliminate time lags between the removal and subsequent replacement of habitat such as:</i></p> <ul style="list-style-type: none"> <li>- <i>clearing procedures (including nest box plan)</i></li> </ul> <p>Requirements for nest box monitoring have been documented with the approved Nest Box Management Strategy for Moorebank East Precinct Stage 1 – Rail Link (CPB 2017)</p>	
	CoC B108 (a) (b (SSD 7628))	<p><i>B108. Prior to clearing of native vegetation, the Applicant must prepare a Construction Flora and Fauna Management Plan (CFFMP) in consultation with OEH. The CFFMP must form part of the CEMP required by condition C1 and must include the following:</i></p> <ul style="list-style-type: none"> <li><i>a. measures to minimise the loss of key fauna habitat, including tree hollows;</i></li> <li><i>b. measures to minimise the impacts on fauna on site, including conducting fauna pre-clearance surveys prior to vegetation clearing and building demolition</i></li> </ul>	



## 2 METHODOLOGY

This annual monitoring report summarises the findings of field surveys conducted across the MPE operational facility and provides an assessment of the management actions being implemented. This report contains the results of surveys and site inspections undertaken during the monitoring period (May 2021 – May 2022), including details of:

- Date, time and location
- Nature of the inspection
- Name of the person conducting the inspection
- Weather observations.

Table 2-1 itemises the dates of survey including the monitoring actions completed and the prevailing weather conditions from the nearest weather station at Holsworthy Aerodrome AWS {station 066161} (BOM 2021).

Table 2-1. Timings and weather conditions on survey dates

Date	Survey Type	Temperature		Rain (mm)
		Min (°C)	Max (°C)	
12.04.2021	Weed monitoring of operational facility and Rail Link	6.9	20	0
16.06.2021	Weed monitoring of operational facility and Rail Link	4.1	18.5	0
17.08.2021	Weed monitoring of operational facility and Rail Link	7.7	18.6	0
8.09.2021	EPBC offset site monitoring (Nodding Geebung) Nest box monitoring	6.2	22.4	0.2
9.09.2021	EPBC offset site monitoring (Nodding Geebung) Nest box monitoring Remote camera monitoring for feral animals (deployment)	4.7	26.9	0
16.09.2021	EPBC offset site monitoring (Nodding Geebung)	6.2	18.1	0
17.09.2021	EPBC offset site monitoring (Nodding Geebung) Remote camera monitoring for habitat connectivity (deployment)	5.0	22.1	0
30.09.2021	Nest box monitoring	13.8	23.6	1.8
1.10.2021	Nest box monitoring	13.1	26.0	0.6
8.10.2021	EPBC offset site monitoring (Small-flower Grevillea) Nest box monitoring	13.1	21.4	0
18.10.2021	Weed monitoring of operational facility and Rail Link	8.7	26.7	0
22.10.2021	EPBC offset site monitoring (Nodding Geebung) Monitoring BA341 lands adjoining Rail Link	12.6	24.7	0
25.10.2021	Monitoring BA341 lands adjoining Rail Link Remote camera monitoring for habitat connectivity (collection)	9.7	22.4	0
03.11.2021	Remote camera monitoring for feral animals (collection)	13.0	25.3	0
15.11.2021	Monitoring of Georges River management site in accordance with RVMP	8.9	20.8	0.6
29.11.2021	Monitoring BA341 lands adjoining Rail Link	13.0	23.8	0.2
7.12.2021	Weed monitoring of operational facility and Rail Link	15.9	29.2	0

Date	Survey Type	Temperature		Rain (mm)
		Min (°C)	Max (°C)	
17.02.2022	Weed monitoring of operational facility and Rail Link	15.7	34.7	0
14.03.2022	Monitoring of Georges River management site in accordance with RVMP	13.9	25.1	0
23.03.2022	Nest box corrective action works	17.3	25.5	0
24.03.2022	Nest box corrective action works	17.0	19.9	2.2
20.04.2022	Monitoring BA341 lands adjoining Rail Link	11.9	23.5	11.0

## 2.1 Native vegetation monitoring

The methodologies applied to monitoring native vegetation at riparian vegetation management sites and in the lands adjoining the Rail Link are discussed below.

### 2.1.1 Lands adjoining Rail Link

Native vegetation adjoining the Rail Link was assessed to determine whether management actions (or lack of) within the Rail Link is having an impact on its condition. Surveying was restricted to native vegetation adjoining (within 10 metres) the Rail Link. Monitoring of this vegetation is a requirement of the EPBC Condition of Approval (CoA) 5(i) (Table 1-1).

Vegetation condition was monitored by conducting 10 x 40 metre vegetation quadrats. Vegetation quadrats followed the Biodiversity Assessment Method (BAM) (DPIE EES 2020) however focused on composition rather than function; structural data was not collected. Vegetation quadrats were conducted in the same location as the previous survey events to allow accurate comparison of changes to composition across monitoring years. The location of vegetation quadrats was demarcated with a metal star picket.

The following composition attributes were quantitatively assessed within vegetation quadrats:

- Percent foliage cover of canopy species
- Percent foliage cover of shrub species
- Percent foliage cover of ground cover species
- Percent foliage cover of exotic species

### 2.1.2 Riparian vegetation management

Riparian vegetation monitoring is required to measure the success of bush regeneration works and track the regeneration and condition of native vegetation at Georges River and Anzac Creek management areas. Results are compared annually against the performance criteria identified in the Riparian Vegetation Management Plan (Table 4, Riparian vegetation management monitoring report Hyder 2015) to determine whether works are on track to achieving the RVMP objectives, which are to:

- Restore, conserve, and enhance the riparian vegetation in the Georges River and Anzac Creek site that fall within the SIMTA Rail Corridor
- Long term eradication of weed species from the management sites
- Maintain an adequate width of riparian vegetation adjoining Georges River and Anzac Creek
- Protect and enhance fauna habitat connectivity along the Georges River and Anzac Creek riparian zone.

In April 2018, the Anzac Creek riparian management area was burned in a bushfire. Following the bushfire, asbestos was identified within the area, and since then, no bush regeneration works have been conducted within the Anzac Creek management zone. Subsequently, monitoring was not conducted by Arcadis to review bush regeneration activities within this management area. Anzac Creek riparian management area will not be reviewed further in this report.

Six 5 x 5 metre monitoring plots were established across the Georges River management zones during the baseline survey in June 2018 (AMBS 2017). Two additional plots were established before works began on the western bank of the Georges River in September 2019 (AMBS 2017). These permanent monitoring plots were established to monitor changes in vegetation composition as well as monitor the success of plantings. The locations of each plot are detailed in Table 2-2.

At each monitoring plot the following actions were conducted:

- Plots were divided into four segments, numbered 1 to 4 from the south east corner of the plot in a clockwise direction to the north-east corner of the plot.

- Vegetation attributes were assessed and recorded for each segment:
  - Percentage cover of weed species – percent cover in each segment was estimated for each weed species present and a mean value for each species was calculated
  - Percentage cover of native species – percent cover in each segment was estimated for each structural layer (ground, mid and canopy) and a mean value for each structural layer was calculated
  - Naturally occurring (non-planted) native species – a list of all naturally occurring native species within the plot was recorded.
- Photographs of each plot were taken from the permanent stake

Previously, the number of planted natives and naturally occurring natives were recorded separately, however due to difficulty in distinguishing between now established planted and naturally occurring native vegetation, the methodology has been updated to exclude this delineation.

*Table 2-2 Riparian vegetation monitoring plot details*

Management zone	Plot Number	Zone	Easting	Northing
GZ1	MR09	56	307302	66239796
GZ1	MR10	56	307310	6239809
GZ1	MR11	56	307296	6239829
GZ2	MR12	56	307261	6239813
GZ2	MR13	56	307249	6239834
GZ2	MR15	56	307245	6239769
GZ4	MR14	56	307229	6239815
GZ4	MR16	56	307222	6239778
GZ2	MR18	56	307152	6239797
GZ5	MR19	56	307158	6239818

## 2.2 Threatened flora monitoring

Threatened flora species were monitored on lands adjoining the Rail Link. The methodologies used to monitor threatened flora are discussed below.

### 2.2.1 Lands adjoining Rail Link

Monitoring of threatened flora in the areas adjoining (within 10 metres) the Rail Link was conducted to assess whether management actions (or lack of) within the Rail Link is having an impact on threatened species occurrence or individual condition.

Monitoring for threatened flora species occurrence was conducted by walking parallel field transects at three metre spacings, marking the location of any threatened species on an Arc-GIS enabled iPad. Notes were collected on the health of plants, including whether individuals were seeding, budding or flowering.

## 2.3 Weed monitoring

Weed monitoring has been conducted by an ecologist on a bi-monthly basis over the 2021/2022 monitoring period: during the months of April, June, August, October, December and February.

The methodology employed to monitor weeds across the operational facility and in the Rail Link corridor is described in the bi-monthly reports which have been included in Appendix A.

A summary of the changes to weed cover across the MPE operational facility and Rail Link for the monitoring year has been summarised in section 3.3 and ongoing recommendations to manage weed included in section 4.3.

## 2.4 Fauna monitoring

Surveys were undertaken to assess fauna habitat connectivity, determine feral animal presence and review the effectiveness of fauna habitat features relevant to the operation of the MPE facility. The surveys conducted have been discussed below.

### 2.4.1 Habitat connectivity monitoring

Anzac Creek culvert and the expanse beneath the Rail Link bridge (on the eastern side of Georges River) was monitored using remote cameras to determine whether native fauna are using the areas to move between patches of habitat. At each location four remote infra-red cameras were deployed for approximately five weeks to photograph animals moving between patches of habitat. The locations of cameras is described in Table 2-3.

*Table 2-3 Location of remote cameras monitoring habitat connectivity*

Description of location	Number of cameras
Northern bank of Anzac Creek facing downstream	1
Northern bank of Anzac Creek facing upstream	1
Southern bank of Anzac Creek facing downstream	1
Southern bank of Anzac Creek facing upstream	1
Northern side of bridge facing south	2
Southern side of bridge facing north	2

The captured view of deployed cameras at each survey location are presented in Table 2-4.

*Table 2-4. Examples of remote camera deployment at Anzac Creek management site to monitor habitat connectivity*



**Remote camera: Downstream South**



**Remote camera: Upstream North**

Table 2-5. Examples of remote cameras deployed to assess the connectivity value of Georges River management site



Following collection of remotes cameras captured photographs were reviewed for animal presence. The species captured, date and time of the photograph were recorded.

2.4.2 Koala management monitoring

Arcadis ecologists made a visual inspection of fencing and Koala structures Wattle Grove offset area from the MPE site. Koala fencing, bridges and culverts were assessed for installation and condition in accordance with *Figure 9. Location of Koala Grids and Bridges* of the Moorebank Precinct West Stage 2 Koala Management Plan (KMP) (Cumberland Ecology, 2020).


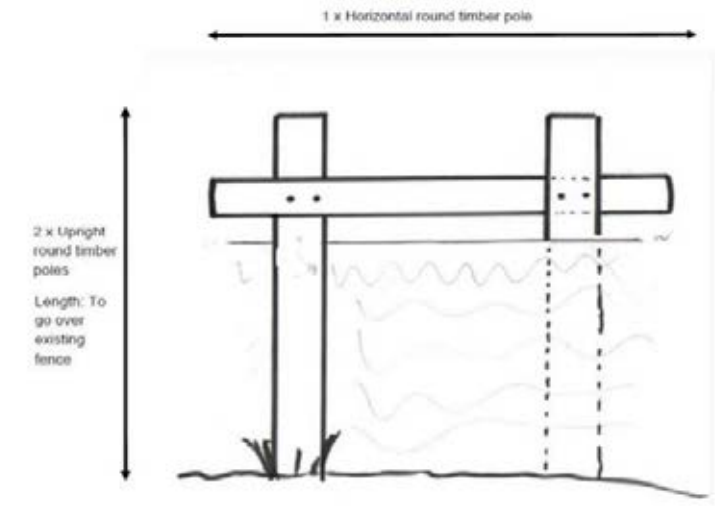
Visual inspections included an assessment of:

- The level of intactness of fences, identifying damage, holes, points of entry, and areas of collapse or corrosion
- Presence and condition of koala bridges across cyclone fencing
- Presence and condition of koala gates and grids at management access points Wattle Grove offset area (Table 2-6)

Where issues were identified photographs were captured and locations recorded using an Arc-GIS enabled iPad.



Table 2-6. Koala structures to be constructed along perimeter fencing

	
Koala grids	Koala bridges

2.4.3 Feral animal monitoring

Feral animal presence was investigated within the MPE operational facility through the deployment of remote cameras. Six remote infra-red cameras were set up along the access roads that follow the boundary fence of MPE where it interfaces Wattle Grove offset area. Cameras were left at a single location for approximately two months to detect feral animal activity, following which, the captured images were reviewed and processed. A species list for each camera was documented.

Cameras were placed in areas which had evidence of feral species presence (burrows and animal trails) and along access trails, internal roads and connecting passages that are likely to be used by feral animals when moving across the landscape. Examples of the captured views of deployed cameras is presented in Table 2-7.

Table 2-7. Examples of feral animal remote camera deployment

	
Remote camera focusing on animal trail parallel to Rail Link corridor fence	Remote camera focusing on access road within Wattle Grove offset area

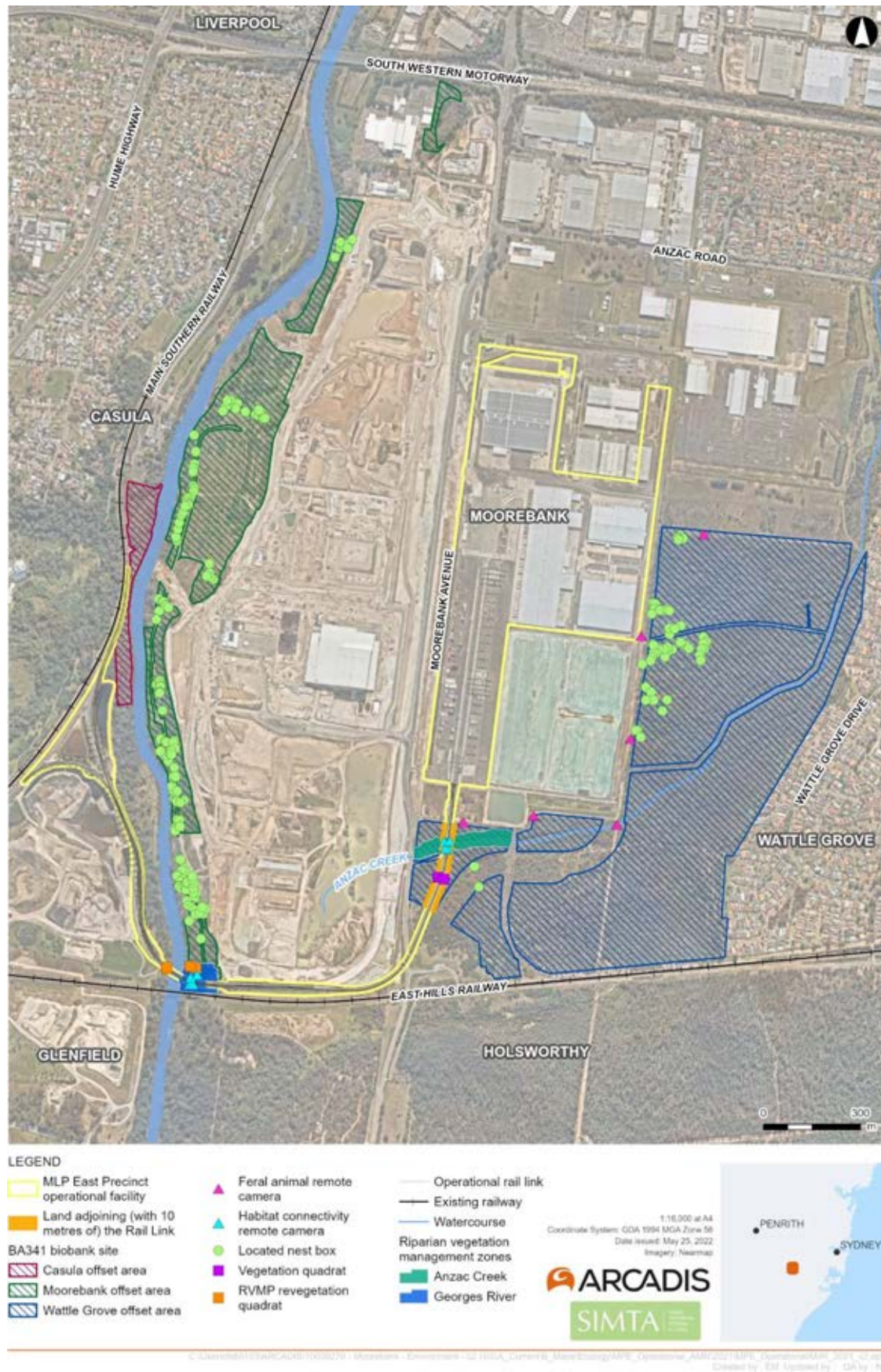


Figure 2-1. Monitoring surveys conducted across MPE operational facility



### 3 RESULTS

The results of the monitoring surveys undertaken to assess the condition of the biodiversity values within the MPE operational facility are discussed below.

#### 3.1 Native vegetation

The result of monitoring native vegetation at riparian vegetation management sites and in the lands adjoining the Rail Link are discussed below.

##### 3.1.1 Lands adjoining Rail Link

Native vegetation either side of the Rail Link is the Plant Community Type (PCT) 883 Castlereagh Scribbly Gum woodland. Assemblages either side of the Rail Link have a good condition with low levels of weed occurrence and a diversity of native plant species. Both patches of native woodland are fully structured, including trees, shrubs and groundcover vegetation. No signs of natural dieback were observed during monitoring surveys nor were any signs observed to suggest that management activities within the Rail Link are having a negative impact on native vegetation.

Two vegetation quadrats were conducted within the lands adjoining the Rail Link; one on the eastern side and one on the western side. A summary of the results of quadrat monitoring is presented in Table 3-1.

Table 3-1. Results of vegetation quadrat monitoring

Vegetation attribute	Monitoring quadrat on western side of Rail Link (Q1)	Monitoring quadrat on eastern side of Rail Link (Q2)
Native canopy cover (%)	22	13.1
Native shrub cover (%)	44.3	16.3
Native groundcover (%)	14.5	19.9
Total native cover (%)	80.9	49.7
Total exotic cover (%)	0.4	0.4
High threat exotic cover (%)	0.1	0.1

Five species of exotic plant were recorded during quadrat monitoring including *Senecio madagascariensis* (Fireweed), *Trifolium repens* (White Clover), *Secale cereale* (Rye Grass), *Conyza sumatrensis* (Guernsey fleabane) and *Plantago lanceolata* (Lambs Tongue). Exotic species accounted for a low cover across both quadrats; equating to 0.4 percent in each quadrat. Exotic species were mainly restricted to disturbed areas immediately adjacent to the Rail Link. Weeds are mostly present in areas which were disturbed during construction of the rail link rather than in areas of intact native vegetation that did not experience disturbance.

No other notable infestations of weeds were observed in native vegetation adjacent to the Rail Link during the inspection.

##### 3.1.2 Riparian vegetation management

The results of monitoring riparian vegetation at Georges River management site is discussed below.

#### Weed and native species cover

Weed and native species cover are shown in Table 3-3 and Table 3-4 below. The results show that weed cover increased at the majority of monitoring quadrats, with the largest increase in weed cover observed at MR18, which increased from 14% to 51.75% between March 2020 and November 2021. Lowest weed cover was recorded at MR12, which has decreased from 104.3% in June 2018 to 2.5% during current surveys.

Native species cover increased at the majority of monitoring quadrats, with the exception of MR11, MR14 and MR19. The largest increase in native species cover was recorded at MR13, which increased from 24.8% to 45.0% between March 2020 and November 2021. Vegetation at this quadrat consisted of dense stands of *Lomandra longifolia* (Spiny-headed Mat Rush) and had an established canopy of *Eucalyptus botryoides*. Quadrat MR16 recorded the highest proportion of native plants of all monitored quadrats. Vegetation at this quadrat included a high diversity of native species, including *Pteridium esculentum* (Bracken Fern), Spiny-headed Mat Rush and *Themeda triandra* (Kangaroo Grass).

Photo points for MR18 and MR16 have been included in Table 3-2. Photo points for all monitoring quadrats are included in Appendix F.

Table 3-2. Examples of photo points captured at each vegetation quadrat



Photo point at monitoring quadrat MR18



Photo points at monitoring quadrat MR16

*Table 3-3 Comparison of weed cover percentages for each vegetation quadrat across monitoring events (June 2018 – November 2022)*

Quadrat identifier	Zone	Jun '18	Sep '18	Dec '18	Mar '19	Jun '19	Sep '19	Dec '19	Mar '20	Nov '21
MR09	GZ1	10.1	4.8	3.9	5.8	5.4	3	3.9	19.3	6.25
MR10	GZ1	23.8	0.3	2.8	1.3	2	2.4	0.3	2.8	4
MR11	GZ1	43.8	2	13.1	10.5	13.1	18.9	13.9	17.6	39.75
MR12	GZ2	104.3	8.5	1.8	2	0	0.4	0.2	0.1	2.5
MR13	GZ2	82.1	38.5	2	1.1	0	0.9	1.3	2	20
MR14	GZ4	89.1	49.8	50.5	32.3	2	7.5	10.6	14.1	48.75
MR15	GZ2	79.6	69.8	12.3	7.9	0.1	4.4	6.2	6.3	14.25
MR16	GZ4	28.9	20.8	24	14	0.5	2.3	3.1	3.9	27.25
MR18	GZ2	-	-	-	-	-	47.6	1.2	14	51.75
MR19	GZ5	-	-	-	-	-	11.3	0.1	0.4	6.43
Average		-	57.7	24.3	13.8	9.4	8.9	9.9	4.1	22.09

*Table 3-4 Comparison of native cover percentages for each vegetation quadrat compared across monitoring events (June 2018 – November 2022)*

Quadrat identifier	Zone	Jun '18	Sep '18	Dec '18	Mar '19	Jun '19	Sep '19	Dec '19	Mar '20	Nov '21
MR09	GZ1	15.4	16.8	20.3	18	32.5	21.8	29.8	42.8	44.0
MR10	GZ1	24.5	21.8	16	23.5	28.5	24.8	26.5	40.5	41.5
MR11	GZ1	12.5	12.3	18.3	12.5	31.3	26	23.5	37.3	25.9
MR12	GZ2	1	0.3	0.3	1.5	6	8.3	4	23	32.3
MR13	GZ2	3.6	5.5	4.8	4.6	9.5	7.8	7.8	24.8	45.0
MR14	GZ4	30.8	38.8	80	63	26.3	13.3	7.8	26	12.9
MR15	GZ2	3.8	1.8	0.1	0	8.5	4	6.3	23.2	35.0
MR16	GZ4	11.3	28.5	16.3	14.5	10.8	9.8	13	39.8	45.8
MR18	GZ2	-	-	-	-	-	11.5	3.8	22	22.6
MR19	GZ5	-	-	-	-	-	0	0.5	6.5	2.6
Average		12.8	15.7	19.5	17.2	17.1	12.7	12.3	28.6	30.8

## Revegetation

The 2021 survey marked the third time monitoring has occurred for plantings on the eastern side of the Georges River management site. Plantings on the western side of the Georges River were monitored for the first time to provide a baseline data set and photographs to compare against in future monitoring periods.

Plantings for the Georges River management site were selected based on species included in the River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (RFEFCF) Endangered Ecological Community (EEC). Ongoing monitoring of the revegetation areas focused on reviewing the survival and presence of planted species commensurate with the EEC. A suite of shrub and groundcovers species were recorded which are characteristic of RFEFCF including *Acacia Parramattensis* (Parramatta Wattle), *Bursaria Spinosa* (Native Blackthorn), *Echinopogon ovatus* (Forest Hedgehog Grass) and *Melaleuca styphelioides* (Prickly-leaved Tea Tree). A comparison of the species recorded during plot monitoring with species characteristic of the RFEFCF EEC is included in Appendix E.

Plantings have displayed significant growth over the past year. Individual plantings are now indistinguishable from one another; rather the revegetated areas have contiguous patches of native groundcovers. Plot locations which monitor revegetated areas has marked a significant increase in native cover and reduction in weed cover over the past three years.

For example, plots MR12 and MR13 sample areas which have been subject to weed removal and revegetation with native tubestock plantings. Prior to works commencing these plots recorded a native cover score of 1 and 3.6 percent and a weed cover of 104.3 and 82.1 percent, respectively. Following weed removal works and planting, during the November 2021 survey these plots recorded a native cover score of 32.3 and 45 percent and weed covers of 2.5 and 20 percent. Overall, the areas monitored by MR12 and MR13 has seen a great increase in vegetation condition.

An inventory of flora species and covers recorded within the fixed monitoring quadrats has been included in Appendix E and photo points included in Appendix F.

## 3.2 Threatened flora

The results of monitoring threatened flora are discussed below.

### 3.2.1 Lands adjoining Rail Link

Threatened species transects identified four threatened plant species within 10 metres of the Rail Link corridor fencing. Of the four species, three species had been recorded during previous monitoring surveys:

- *Acacia bynoeana* (Bynoe's Wattle)
- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea)
- *Hibbertia puberula* subsp. *puberula*

One individual of *Persoonia nutans* (Nodding Geebung) was identified at the northern-eastern extent of the survey area, which marks the first occurrence of this species within 10 metres of the Rail Link.

Nodding Geebung, Bynoe's Wattle and Small-flower Grevillea were observed to be sparsely scattered, whereas *Hibbertia puberula* subsp. *puberula* was observed in high numbers particularly at the southern extent of the survey area on the eastern side of the Rail Link. The locations of threatened plants has been presented in Figure 3-1.

Table 3-5 provides the listing status for the threatened plant species located and a count for the number of individuals found.

Table 3-5. Threatened plant species identified within lands adjoining the operational Rail Link

Species	Listing status	Number of individuals identified
<i>Acacia bynoeana</i> (Bynoe's Wattle)	BC Act: Endangered EPBC Act: Vulnerable	3
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> (Small-flower Grevillea)	BC Act: Vulnerable EPBC Act Vulnerable	2
<i>Hibbertia puberula</i> subsp. <i>puberula</i>	BC Act: Endangered EPBC Act: Not listed	126
<i>Personia nutans</i> (Nodding Geebung)	BC Act: Endangered EPBC Act Endangered	1

Individuals of the threatened plant species Small-flower Grevillea, Nodding Geebung and *Hibbertia puberula* subsp. *puberula* appeared to be in a healthy condition with some bearing flowers and seed. Individuals of Bynoe's Wattle did not appear to be in a healthy condition. Of the three Bynoe's Wattle located, two were found to be in poor condition and one was found to be in a moderate condition. Two individuals appeared to have signs of grazing by herbivores. The Bynoe's Wattle which was identified as being moderately impacted by herbicide overspray during last years monitoring event was unable to be re-found and is thought to have perished over the 2021/2022 monitoring year.





Figure 3-1. Results of monitoring lands adjoining the operational Rail Link

### 3.3 Weed monitoring

The results of each bi-monthly weed monitoring survey are included in Appendix A. A review of the findings of weed monitoring surveys across the monitoring year has been summarised below.

Seven priority weed species as listed for the Greater Sydney Local Land Services Region were identified on the MPE operational facility and Rail Link during the monitoring year including *Alternanthera philoxeroides* (Alligator Weed), *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Ludwigia peruviana* (Ludwigia), *Nassella neesiana* (Chilean Needle Grass), *Olea europaea* subsp. *cuspidate* (African Olive) and *Senecio madagascariensis* (Fireweed). Priority weeds were sparsely scattered, mainly located within the Rail Link corridor.

Weed cover across the MPE operational facility was generally low throughout the monitoring year. Minor changes in weed cover and exotic species diversity was observed in landscaped areas around warehousing units, within trunk drainage infrastructure running along the western boundary, and in drainage swales at the north-eastern extent of the site. Ongoing, periodic weed control works carried out in these areas was observed to be sufficient in maintain a low weed cover and promoting an increase in cover of native species like *Daviesia ulicifolia* (Gorse Bitter Pea), *Acacia falcata* (Sickle Wattle), *Persicaria discephala* (Slender Knotweed), *Typha orientalis* (Bulrush) and *Ficinia nodosa* (Nobby Club Rush) (Table 3-6).

Table 3-6. Photographs captured during the February 2022 inspection showing low weed cover and established native plants observed on soft batters surrounding the basins and drainage channel at the north-eastern extent of the operation facility



**Drainage channel with high cover of Bulrush and scattered occurrences of Slender Knotweed**

**Soft batters surrounding drainage basin with low weed cover and regenerating native species like Sickle Wattle.**

The Rail Link experienced a fluctuation in weed cover across the monitoring year. A large-scale remediation project commenced in early spring 2020 in the Rail Link to remove weeds from soft landscaped areas and revegetate with native plant species. Bi-monthly surveys over the past year have monitored the progress of this remediation project and provided ongoing assessment on the cover of weeds and striking of native seeds. Generally, an increase in the cover of exotic plant species has been observed since the initial clearing/weed removal event with native seedlings only becoming apparent in summer 2021/2022. The biomass of weeds greatly out ways that of native seedlings.

A suite of exotic grasses, herbaceous and woody weeds have been recorded in the Rail Link including *Acacia saligna* (Golden Wreath Wattle), *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Love Grass), *Briza maxima* (Quaking Grass), *Cirsium vulgare* (Spear Thistle) and *Trifolium michelianum* (Bolansa Clover). Efforts to control/suppress weeds were focused on species which were identified as having a detrimental impact on native seedlings; mainly aggressive exotic grass species. Targeted weed control works were conducted in December 2021 and February 2022 and included herbicide spraying slashing. Although these management actions reduced the cover of focus weed species, other common herbaceous weed species continued to increase in cover (Plate 3-1).





Plate 3-1. Increasing cover of ‘non focus’ weeds in the Rail Link following initial weed removal event.

Despite the increasing cover or exotic species within the Rail Link corridor, native seedlings were observed during the December 2021 and February 2022 surveys, including species such as *Cymbopogon refractus* (Barbed Wire Grass), Sickie Wattle, *Lachnagrostis filiformis* (Blown Grass), *Cynodon dactylon* (Couch Grass), *Themeda triandra* (Kangaroo Grass) and *Chloris truncata* (Windmill Grass). Examples of native seedlings observed is displayed in Table 3-7. It is anticipated by the contractor undertaking the remediation works that native seedlings will continue to germinate and establish with weeds being present, provided that focus aggressive weed species are controlled on a regular basis.

Table 3-7. Native seedlings observed colonising soft batters following seeding event



Sickie Wattle (left) and Barbed Wire Grass (right) observed in the Rail Link during February 2022 surveys

Based on what has been observed over the past year in areas which currently support native species it is anticipated that overtime native cover will increase provide ongoing weed control works occur. Existing plantings, with support from bush regenerators, will colonise surrounding areas outcompeting annual common herbaceous weeds. A high-level review of the Rail Link revegetation project was completed by Arcadis in March 2022 which outlined the progress observed and on-going management recommendations required to support an increase in native species cover. This review has been included in Appendix B. Letter - Review of MPE Rail Link revegetation.



3.4 Fauna

The results of monitoring fauna habitat connectivity, feral animals and the effectiveness of fauna habitat features across the MPE operational area is discussed below.

3.4.1 Habitat connectivity

Remote infra-red cameras captured a suite of native and introduced fauna utilising the Anzac Creek culvert to move between patches of bushland within Wattle Grove offset area. Native fauna recorded included Eastern Grey Kangaroo (*Macropus giganteus*), Common Wallaroo (*Macropus robustus*), Swamp Wallaby (*Wallabia bicolor*) and Common Ringtail Possum (*Pseudocheirus peregrinus*) (Table 3-8). Introduced fauna recorded included Red Fox (*Vulpes vulpes*), Black Rat (*Rattus rattus*) and Domestic Cat (*Felis catus*).

Table 3-8. Fauna captured on remote cameras moving between patches of bushland using Anzac Creek culvert

	
Common Ringtail Possum	Common Wallaroo

Three terrestrial fauna species were recorded on remote cameras moving beneath the Rail Link bridge (on the eastern side of Georges River) including two native species, Short-beaked Echidna (*Tachyglossus aculeatus*) and Swamp Wallaby and one pest species, Red Fox. Multiple Swamp Wallabies were captured moving over placed logs suggesting they may be utilising the debris to assist in crossing beneath the bridge. Photographs captured on remote cameras are displayed in Table 3-4.

Table 3-9. Fauna recorded crossing the ballast under the Rail Link

	
Swamp Wallaby	Red Fox

A complete list of fauna recorded on remote cameras at Anzac Creek culvert and beneath the Rail Link bridge has been included in Appendix C.



### 3.4.2 Koala management

Arcadis ecologists traversed the fence line separating the Wattle Grove offset area from the MPE operational facility on 14 March 2022.

No Koala bridges or grids (Table 2-6) have been constructed as per the MLP Koala Management Plan (KMP) (Cumberland Ecology 2020), were recorded during the inspection. Fauna ramps were located at Anzac Creek culvert which may provide connectivity between patches of bushland for Koala. Fauna ramps were observed to be in good condition, however had moved slightly with recent heavy rain flooding the area.

The condition of perimeter fencing, separating the Wattle Grove offset area from the MPE operation facility, is similar to what was observed during the previous year's monitoring event. The fencing had a good structure and was observed to be intact along most of its alignment. Over the 2021/2022 monitoring year a number of sections along the perimeter fence and at access gates, which were identified to have holes or facilitating Koala access to the MPE operational facility, were reinforced with additional lengths of Cyclone fencing. Cyclone fencing was approved by Koala expert Dr. Phillips for being suitable Koala exclusion fencing at the MLP site (Cumberland Ecology 2020).

Fencing inspection identified two locations which had gaps of approximately 15 centimetres between the ground and fence (Figure 3-2). While the gaps are too small currently for Koala to move through, these areas should be monitored to ensure erosion or use by other species does not increase the size in gaps over time.

A Koala was recorded using internal access roads on several remote cameras deployed to detect feral species within the Wattle Grove offset area. Four cameras captured a Koala, each on different nights between 22 September and 26 October 2021. Additional to this, a Koala was observed incidentally within the Wattle Grove offset site on 3 November, 8 December 2021 and 14 December 2021, all times in trees on the edge of internal access tracks.



Figure 3-2. Locations of Koala fencing issues







3.4.3 Feral animals

Remote camera monitoring identified five feral animal species within Wattle Grove offset area, immediately adjacent to the MPE operational facility. Feral animals recorded Brown Hare (*Lepus europaeus*), Domestic Cat (*Felis catus*), Red Fox (*Vulpes vulpes*) and Black Rat (*Rattus rattus*) (Table 3-10). It is anticipated that these feral animals are using the MPE operational facility when moving around the local landscape.

Remote cameras were deployed at six locations along the north and western boundaries of Wattle Grove offset area, nearest to the operational facility. Red Fox was captured on all but one camera. The four remote cameras deployed at Anzac Creek assessing connectivity also all captured Red Fox and Domestic Cat. Domestic Cat and Red Fox were captured on camera with prey species (i.e native wildlife). These feral animals are having a direct impact on native wildlife within adjacent bushland areas.

A complete list of fauna recorded on remote cameras has been included in Appendix C.

Table 3-10. Feral animal species within the MPE operational facility

	
European Hare	Domestic Cat
	
Red Fox	Black Rat

## 4 DISCUSSION AND RECOMMENDATIONS

An assessment of the various monitoring requirements for the MPE operation facility has been discussed below. Where necessary, recommendations have been included to improve or enhance the management of biodiversity values.

### 4.1 Native vegetation

#### 4.1.1 Lands adjoining Rail Link

Castlereagh Scribbly Gum woodland (PCT 883) vegetation adjacent to the Rail Link was in good condition and showed low levels of weed occurrence. There was a high diversity of native plant species within the area, with the native woodland assemblage being fully structured, including trees, shrubs and native groundcover vegetation.

Native vegetation cover decreased within the western quadrat from 87 percent to 80.9 percent between monitoring periods. Similarly, native cover also decreased on the eastern side, from 61.1 percent to 49.7 percent between survey periods. The reduction in native vegetation cover may represent a natural equilibration of vegetation cover within the area as the vegetation begins to regulate native biomass following a large surge in post-fire recruitment following the 2018 wildfires. The change in native cover is not concerning at this time, given that both areas either side of the Rail Link remain in a good condition with a relatively low cover of exotic species and recruitment of native vegetation being observed.

Both monitoring quadrats recorded low levels of exotic species coverage (0.4 percent within monitoring quadrat Q1 and 0.1 percent within monitoring quadrat Q2). This increased from 0.1 percent exotic cover from two exotic species across both quadrats during the previous monitoring period, to 0.4 in each quadrat of five exotic species in the current monitoring event. The additional species recorded during the current surveys were observed to be encroaching from weed infestations within the Rail Link which have begun to spread to a small strip of land along the fence line between the Wattle Grove offset area and the operational Rail Link. It is noted that the spread of these exotic species into the BA341 Lands were restricted to areas of disturbed soil.

Future management of native vegetation adjacent to the Rail Link corridor should focus on minimising impacts from within the rail corridor, including weed infiltration and management activities (i.e weed control works). The management contractor for the Wattle Grove offset site should be made aware of potential weed encroachment from the Rail Link and be procured to undertake targeted weed control works to remove any colonising weeds and improve the condition of native vegetation within the 10 metre corridor.

*Table 4-1. Recommended management actions to maintain/enhance the condition of native vegetation adjacent to the Rail Link*

Identified Issue	Recommended action
Impacts to native vegetation immediately adjacent to areas which are subject to ongoing management activities including weed control works.	<p>Hi-volume spraying of herbicide within the Rail Link in areas adjacent to native vegetation (specifically the BA341 biobank site) should not be conducted.</p> <p>Weed control works within these areas should include manual removal or spot spraying with herbicide. Spot spraying with herbicide should only be undertaken during optimal conditions to avoid spray drift.</p> <p>If there is risk of overspray or off target poisoning to native vegetation (particularly threatened flora) then targeted granular herbicide such as Furophanate granular herbicide should be adopted.</p> <p>Prior to commencing weed control works with the Rail Link contractors should be supplied with sensitive area mapping which identifies the location of threatened species and the BA341 biobank site.</p>
Increased cover of weeds immediately outside to the rail corridor fencing, on areas disturbed during construction of the Rail Link.	These areas should be subject to on-going monitoring to determine whether weeds from the Rail Link are infiltrating and degrading the condition of native vegetation.

Identified Issue	Recommended action
Potential for these weeds to infiltrate the adjacent native vegetation.	The management contractor for the Moorebank biobank site should be made aware of potential weed encroachment from the Rail Link and be procured to undertake targeted weed control works to remove any colonising weeds.

### 4.1.2 Riparian vegetation management

No bush regeneration works have been conducted within the Georges River management site during the current monitoring period. Previous regeneration works were conducted by Toolijooa environmental restoration up until June 2020. Previous works were undertaken with the objective of re-establishing the vegetation community River-Flat Eucalypt Forest on Coastal Floodplain throughout areas impacted by the MPE Stage 1 Rail Access Link Package (RALP) project.

Revegetated areas were observed to continue to increase in native species cover. In most monitored quadrats, planted species had grown so prolifically that planted individuals were indistinguishable from naturally occurring plants.

Works within the management site have been compared against a series of Key Performance Indicators (KPIs) (Hyder 2015) in Table 4-3. It is evident that bush regeneration works have progressed well and that majority of the KPI's are being achieved. Recommendations for revegetation, weed control and connectivity enhancement are included in Table 4-2.

*Table 4-2. Recommended actions to increase the ecological value of the Georges River management site*

Identified Issue	Recommended action
Increased weed coverage within revegetation areas	Bush regenerators should commence weed control works within the Georges River management site immediately. Weed control works should aim to support natural regeneration through removal of scattered weeds and weeds encroaching from infested areas adjacent to the management site.
Encroachment of weed species from adjacent areas of infested bushland	The installation of a sediment fence to limit the amount of weed seed being transported into the revegetated site should be considered if encroachment is continuing despite routine weeding exercises.
Bare patches between plantings on eastern side of Georges River	Encourage natural recruitment of native species by maintaining low levels of weeds in bare areas between plantings.
Infill planting through bare areas on the western side of Georges River.	Infill planting with native tube stock should be conducted in bare areas beneath the Rail Link bridge. Plantings should be commensurate with species present in the RFEFCF vegetation community.

Table 4-3. Key Performance Indicators (KPIs) for RVMP works

Key Performance Indicator	Status		Comments
	Georges River	Anzac Creek	
Certification that all plant stock used for revegetation are of local botanical provenance	Not applicable	Not applicable	No revegetation activities have occurred over the 2021/2022 monitoring year.
Gradual improvement of native plant establishment with the aim of achieving 80 percent cover of native vegetation after five years following initial planting	Achieving	Not applicable	<p>Quadrat monitoring of revegetated areas identified on average a native plant coverage of 30.8 percent, as identified in <b>Table 3-4</b>. It should be noted that this average includes areas which were not subject to revegetation, rather bush regeneration practices to enhance the condition of existing native vegetation.</p> <p>Although the entire site has not achieved an 80 percent native vegetation cover, several area of bare earth were observed which are anticipated to be increasingly colonised by native species over the coming years, with support from bush regenerators.</p> <p>It is recommended that instead of installing additional plants in this area to make up shortfalls in native percent cover, bush regeneration activities should aim to reduce exotic species cover and encourage natural recruitment of bare areas by native species that are already present.</p>
Gradual reduction in weed density to 5 percent of total area of each management site (eastern bank of Georges River and Anzac Creek only)	Achieving	Not applicable	<p>Fixed monitoring quadrats conducted within revegetated areas recorded an average weed cover of 22.09 percent as identified in <b>Table 3-4</b>.</p> <p>Weed species cover has increased since previous monitoring periods from 4.1 percent in March 2020. Weed control works have not been conducted at the management site since June 2020. Native plants are showing signs of being outcompeted by exotic species at many of the monitored quadrats.</p> <p>It is recommended that weed control works are commenced immediately within the management site on the eastern bank of the Georges River to support natural regeneration and further colonisation by native species. Weed control works should remove scattered weeds from revegetated areas and remove weeds encroaching from infested areas adjacent to the management site</p>
Reduction in weed density to 5 percent of total area of management site 5 years after construction (western bank of Georges River only)	Achieving	Not applicable	Weed cover is low across the site with a moderately high species richness of exotic plants. Average exotic cover across monitored quadrats was 22.09 percent, however this is not indicative of total weed cover across the site, which was observed to be lower.



Key Performance Indicator	Status		Comments
	Georges River	Anzac Creek	
			It is recommended that weed control works are commenced immediately within the management site on the western bank of Georges River to support recent plantings and encourage natural regeneration and colonisation by native species. Weed control works should remove scattered weeds from revegetated areas and remove weeds encroaching from infested areas adjacent to the management site
Gradual extension of native plant cover in each management site through natural regeneration	Achieving	Not applicable	Evidence of natural regeneration was observed at the eastern side of the Georges River management site. Bare areas between plantings are showing signs of increasing colonisation by native species including <i>Cassytha glabella</i> (Slender Devil's Twine), <i>Commelina cyanae</i> (Scurvy Weed), <i>Entolasia marginata</i> (Bordered Panic Grass), Kangaroo Grass and <i>Dichelachne micrantha</i> (Short-hair Plume Grass).
Stability of riparian banks including maintenance or reduction of erosion within management sites	Achieving	Not applicable	<p>Groundcover and shrubs species installed amongst coir mesh on steep slopes on the eastern side of Georges River management site have established and are providing stabilisation to the substrate. Natural regeneration of native species was observed on slopes which will increase stabilisation of the slope across the monitoring year.</p> <p>Coir mesh has been installed and secured with intermittent planting of groundcover and shrubs species on exposed sections of river bank at the western side of the Georges River management site. As plantings mature they will offer increased stabilisation of soils.</p> <p>Several major flooding events were experienced along the Georges River system during the 2021/2022 monitoring year. High floodwaters inundated the lower floodplain on the site, completely submerging revegetated areas. Following receding of the floodwaters revegetation areas were observed to be in a good condition and had acted to stabilise soils and previously exposed banks.</p>
Re-establish and maintain connectivity for fauna habitat, particularly in the Georges River management site.	Scope of rehabilitation changed	Not applicable	<p>Habitat connectivity is not consistent the approved habitat connectivity strategy as documented within the RVMP produced by Hyder (2015) and other project related documents. Changes to habitat connectivity beneath the Rail Link bridge and the potential impacts this is having on dispersal of native species is discussed in more detail in Sections 4.1.1.</p> <p>Habitat connectivity across the Georges River management site, linking bushland within the MLP site with bushland to the south, currently consists of large logs placed on rock ballast with small piles of thin course wood debris assembled either side.</p>

Key Performance Indicator	Status		Comments
	Georges River	Anzac Creek	
			A total of three fauna species were captured on remote cameras traversing the area beneath the Rail Link bridge including Red Fox ( <i>Vulpes vulpes</i> ), Short-beaked Echidna ( <i>Tachyglossus aculeatus</i> ) and Swamp Wallaby ( <i>Wallabia bicolor</i> ).

## 4.2 Threatened flora

### 4.2.1 Lands adjoining the Rail Link

Threatened species transect identified four threatened plant species within 10 metres of the Rail Link corridor fencing, including Bynoe's Wattle, Nodding Geebung, Small-flower Grevillea and *Hibbertia puberula* subsp. *puberula*. These threatened species were mostly observed to be in a good condition, except for Bynoe's Wattle, which had demonstrated a reduction in the numbers of individuals found since the previous survey period, and remaining individuals appeared to be damaged from grazing by herbivores.

The number of Small-flowered Grevillea and *Hibbertia puberula* subsp. *puberula* individuals increased across the monitored area whereas the number of Bynoe's Wattle decreased. Changes to the number of individuals of these threatened plant species is shown below in Table 4-4.

Table 4-4 Changes to numbers of individuals of the three threatened plant species identified on lands adjoining the Rail Link

Species	Number of individuals identified 2020/2021	Number of individuals identified 2021/2022	Change
<i>Acacia bynoeana</i> (Bynoe's Wattle)	6	3	-3
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> (Small-flower Grevillea)	1	2	+1
<i>Hibbertia puberula</i> subsp. <i>puberula</i>	85	126	+41
<i>Persoonia nutans</i> (Nodding Geebung)	0	1	+1

No impacts were observed to native vegetation or threatened species outside of the rail corridor as a result of ongoing management activities within the Rail Link. During the 2020/2021 monitoring event herbicide spraying works conducted within the Rail Link resulted in impacts to adjoining native vegetation and threatened species due to overspray. This did not re-occur over the 2021/2022 monitoring year.

Table 4-5. Recommended management actions to protect threatened flora species in lands adjoining the Rail Link

Identified Issue	Recommended action
Impact to threatened species immediately adjacent to areas which are subject to ongoing management activities including weed control works.	<p>Hi-volume spraying of herbicide within the Rail Link in areas adjacent to threatened species locations (specifically the BA341 biobank site) should not be conducted.</p> <p>Weed control works within these areas should include manual removal or spot spraying with herbicide. Spot spraying with herbicide should only be undertaken during optimal conditions to avoid spray drift.</p> <p>If there is risk of overspray or off target poisoning to threatened flora then targeted granular herbicide such as Flupropanate granular herbicide should be adopted.</p> <p>Prior to commencing weed control works with the Rail Link contractors should be supplied with sensitive area mapping which identifies the location of threatened species and the BA341 biobank site.</p>

Identified Issue	Recommended action
<p>Increased cover of weeds immediately outside to the rail corridor fencing, on areas disturbed during construction of the Rail Link.</p> <p>Potential for these weeds to infiltrate the adjacent native vegetation and degraded threatened species habitat.</p>	<p>These areas should be subject to on-going monitoring to determine whether weeds from the Rail Link are infiltrating and degrading the condition of threatened species habitat.</p> <p>The management contractor for the Wattle Grove offset area should be made aware of potential weed encroachment from the Rail Link and be procured to undertake targeted weed control works to remove any colonising weeds.</p>

### 4.3 Weed occurrence and cover

The following management action remain applicable and are recommended for the MPE operational facility to maintain low weed covers and promote the regeneration of native plant species:

- Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.
- Large patches of African Lovegrass and Rhodes Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events. This will reduce colonisation of these grasses into revegetation areas.
- Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility should be slashed regularly to prevent seeding events.
- Weeds on soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should continue to be suppressed through a combination of herbicide application, slashing and hand weeding.

To support the continued regeneration and colonisation of native species that have been established within the Rail Link through the remediation project the following actions should be implemented:

- on-boarding of a trained bush regeneration contractor to conduct regular ongoing weed control work
- weed control works targeting exotic species listed as 'priority' for the Greater Sydney Local Land Services region and the exotic grass species: *Melinus repens* (Red Natal Grass), *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Love Grass), *Hyparrhenia hirta* (Coolatai Grass) and *Themeda quadrivalvis* (Grader Grass)
- monitoring of rehabilitated areas of the Rail Link to identify areas which may require additional support (i.e. seeding) or any novel exotic species which may be detrimental to the survival of natives

No herbicide spraying should be conducted outside of the Rail Link corridor, specifically adjacent to environmentally sensitive areas south of the MPE operational facility. Manual weed control works in environmentally sensitive areas should not extend beyond the construction envelope of the RALP project. If further clarification is required, the project ecologist should be consulted.

Table 4-6. Recommended actions to achieve/maintain low weed cover across MPE operational area and Rail Link

Identified Issue	Recommended action
Weed growth on soft landscaped areas within the MPE operational facility	<p>Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility should be slashed regularly.</p> <p>Weeds on soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should continue to be suppressed through a combination of herbicide application, slashing and hand weeding.</p>
Weed growth on soft landscaped areas within the Rail Link	<p>Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.</p> <p>Large patches of African Lovegrass and Rhodes Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events.</p>
Low cover of native species on revegetated soft batters in the Rail Link	<p>To support the continued regeneration and colonisation of native species:</p> <ul style="list-style-type: none"> <li>a trained bush regeneration contractor should be onboarded to conduct regular ongoing weed control work targeting exotic species listed as 'priority' for the Greater Sydney Local Land Services region and the exotic grass species: <i>Melinus repens</i> (Red Natal Grass), <i>Chloris gayana</i> (Rhodes Grass), <i>Eragrostis curvula</i> (African Love Grass), <i>Hyparrhenia hirta</i> (Coolatai Grass) and <i>Themeda quadrivalvis</i> (Grader Grass)</li> <li>monitoring of rehabilitated areas of the Rail Link to identify areas which may require additional support to increase native plant cover (i.e. seeding), or any novel exotic species which may be detrimental to the survival of natives</li> </ul>

## 4.4 Fauna

### 4.4.1 Fauna habitat connectivity

Fauna habitat connectivity monitoring identified that several species, both native and invasive, are continuously utilising Anzac Creek corridor to move between patches of native vegetation within the Wattle Grove offset area. The fauna ramps installed at the culvert are being readily used by native fauna and provide access and egress between patches of bushland either side of the operation Rail Link.

During a site inspection in March 2022, the Anzac Creek corridor was unable to be crossed due to high water levels after a sustained period of rainfall. The fauna ramps appeared to have remained in place however it is recommended these be checked for movement once water levels drop. Intermittent monitoring inspections should be made of the culvert to ensure fauna ramps remain in situ and vegetation growth within crossing passages does not begin to obstruct movement or cause an issue to the culvert infrastructure or operation of the Rail Link.

Large logs and coarse woody debris placed on rock ballast remain as the habitat connectivity measure linking riparian vegetation within the MLP precinct with bushland to the south. This alternative habitat connectivity measure was adopted following the placement of ballast in the 20 metre wide gap cleared for the bridge on the eastern side of the Georges River during construction.



*Plate 4-1. Large logs and piles of coarse woody debris placed to facilitate movement of fauna across ballast at Georges River beneath the rail link bridge*

Mobile native species recorded within the Georges River offset site which are likely to move along riparian vegetation corridors include Sugar Glider, Common Ringtail Possum, Common Brushtail Possum, Swamp Wallaby, Short-beaked Echidna, Red-bellied Black Snake and Common Wallaroo. Remote camera monitoring for the Rail Link area identified three species as using the corridor, including Red Fox, Short-beaked Echidna and Swamp Wallaby. Evidently, only a small subset of the native species known to occur within MLP have been recorded using the corridor. Arboreal mammals often will not cross areas with low tree cover (Soanes & van der Ree, 2009), and no evidence of use by these species has been recorded by remote cameras. It is likely that the current habitat connectivity measures in place are not facilitating dispersal for some species along the vegetated Georges river corridor.

Additionally, a six-foot-high cyclone fence with top-lined barbed wire installed to the south of the Georges River management site is likely a barrier to the movement of some fauna species between the MLP site and bushland to the south. Ground-dwelling fauna like macropods are unlikely to be able to pass this cyclone fence, and due to the barbed wire lined top, arboreal fauna are also likely prevented from climbing the fence and dispersing across the landscape. Koala have been recorded in riparian bushland



along the Georges River as well as bushland to the south outside of the MLP precinct. Koalas would readily move along this corridor for various reasons (foraging, dispersal, breeding) and the cyclone fencing may be inhibiting these movements.



*Plate 4-2. Cyclone fence at the southern extent of the management site*

If revegetation works were conducted as per the RVMP (Hyder 2015) and the six-foot-high cyclone fencing was removed a greater diversity of fauna species would likely be recorded using the passage to move along the Georges River riparian corridor. Recommended actions to increase the connectivity value of Georges River management site are identified in Table 4-7. These actions integrate components of the methodology outlined in the RVMP to maintaining and enhancing fauna habitat beneath the Rail Link bridge.

*Table 4-7. Recommended actions to improve habitat connectivity at Anzac Creek culvert and beneath the Rail Link bridge on the eastern banks of the Georges River*

Identified Issue	Recommended action
Vegetation growth within crossing passages on the northern and southern sides of the Anzac Creek culvert.	Intermittent monitoring inspections should be made of the culvert to ensure fauna ramps remain in situ and vegetation growth within crossing passages does not begin to obstruct movement or cause an issue to the culvert infrastructure or operation of the Rail Link
Inadequate habitat connectivity beneath the Rail Link bridge	Review of rock ballast as the necessary means for erosion and sediment control beneath the Rail Link bridge. If rock ballast is not deemed necessary for the entire 20 metre wide gap, it should be removed and replaced with alternative soil stabilisation materials (i.e. coir logs, jute and coir mesh). Planting of native species should be undertaken in conjunction with installation of soft stabilisation materials as per the original habitat connectivity enhancement plan from the RVMP (Hyder 2015). If rock ballast cannot be removed, improvement of current crossing designs should be considered such as installation of crossings to support arboreal mammal dispersal.
Installation of six-foot-high cyclone fence at the southern extent of management site restricting movement of fauna along the Georges River riparian corridor	A review of the fencing location and design should be conducted to determine whether it is necessary and/or whether it can be modified to allow the movement of fauna from the MLP site to bushland south of the site. Fencing design should not include barbed wire, and existing fencing should be modified to improve connectivity.  Considerations should be made for the installation of crossing mechanisms for fauna (i.e. Koala bridges) or replacement of the current Cyclone fence with a rural style fence with wooden bollard and 5 straight wires, as is to be installed around MLP drainage channels.

#### 4.4.2 Koala management monitoring

Cyclone mesh fencing is present along the interface between Wattle Grove offset area and the MPE operational facility restricting movement of Koalas into unsuitable areas. Inspection of the perimeter identified two areas where there was a small gap between the fence and ground. The gaps were a maximum of 15 centimetres which were unlikely to enable a Koala to pass under, however these areas should be checked throughout the year to ensure gaps do not increase in size due to erosion or use by smaller animals such as hares.

Currently no structures (bridges, culverts, refuge posts) have been installed which facilitate the movement of Koala from the Wattle Grove offset area to adjoining areas of suitable habitat. Koala bridges are yet to be installed along the southern boundary of the offset area as per the KPM (Cumberland Ecology 2020) to facilitate Koala movement into bushland areas within the Holsworthy defence area. It is noted in the KPM that prior to installing Koala bridges "Transport for NSW and Department of Defence will need to be consulted...to gain necessary access/permits." Additionally, a series of other actions are required to increase suitability for Koala movement across the rail line as discussed in Section 8.3.5.2 of the KMP (Cumberland Ecology 2020).

As development continues across the MLP site Koala fences, bridges, gates and grids will be installed in accordance with the plans outlined in the KMP (Cumberland Ecology, 2020).

Table 4-8. Recommended management actions to maintain Koala fencing adjacent to the MPE operational facility

Identified Issue	Recommended action
No connectivity between Wattle Grove offset area and bushland in Holsworthy defence area	Discussions should commence with TfNSW and Department of Defence to determine the feasibility of implementing connectivity measures outlined in the KMP (Cumberland Ecology 2020) to allow Koalas and other fauna to move between the Wattle Grove offset area and bushland in the Holsworthy defence area. Barbed wire should not be used in fence design in these areas, except for koala exclusion fencing.

#### 4.4.3 Feral animals

Four feral animal species were captured on remote cameras during monitoring surveys; European Hare (*Lepus europaeus*), Domestic Cat (*Felis catus*), Red Fox (*Vulpes vulpes*) and Black Rat (*Rattus rattus*). The abundance of these species can't be determined based on camera data. Impacts from these species on native biota has been observed in the field as well as on remote camera photographs, however, are mainly occurring the Wattle Grove offset area which falls outside of the MPE operational area.

European Hare can cause significant damage when gnawing the bark of young trees and shrubs and can cause severe damage to revegetation sites (Agriculture Victoria 2021). Ongoing revegetation activities in the Rail Link and onsite detention basins (OSDs) may be at risk from this species.

Domestic Cat and Red Fox were recorded on remote cameras at five locations on the boundary of the MPE operational facility. It is likely that these species regularly traverse the operational area whilst moving across the landscape. The same single domestic cat was captured repeatedly across the Wattle Grove offset area; however Red Fox individuals were unable to be identified. Two foxes have been recorded together at Anzac Creek in the Wattle Grove offset area, and a mother and cub has been observed multiple times in the adjacent areas. A Red Fox den was also located within the Wattle Grove offset area.

The occurrence of Black Rat within the MPE operational facility is not considered to be a significant issue. This species is common across the landscape. No significant infestations of this species or signs of infestation have been observed across the facility or within the adjacent Wattle Grove offset area. In large numbers this species has potential to impact upon native fauna through predation and competition for resources. One Black Rat was observed inhabiting a nest box during 2021 nest box surveys indicating this species may predate on native bird eggs and/or compete for nesting space with hollow-dependant fauna.

The landholder should support the implementation of a feral animal control program predominately focusing on the control of Red Fox in the bushland immediately adjacent to the operation facility (Wattle Grove offset area). The MPE property manager should communicate with Liverpool City Council and

surrounding landholders (Glenfield Waste Facility, National Intermodal and Holsworthy Army Barracks) to discuss feasibility and willingness to undertake a co-ordinated feral animal control program.

*Table 4-9. Recommended monitoring for feral animals within the MPE operational facility*

Identified Issue	Recommended Corrective Action
Vertebrate pests within the MPE operational facility and surrounds	Ongoing opportunistic monitoring should be conducted through MPE operational facility and surrounds to determine whether populations of European Hare, Red Fox, Black Rat and Domestic Cat are having a negative impact on native biota. Any signs of novel pests within the biobank site should also be recorded.
Increased observation of Red Fox which may indicate an increasing population	Communicate with Liverpool City Council and surrounding landholders (Glenfield Waste Facility and Holsworthy Army Barracks) to discuss feasibility and willingness to undertake a co-ordinated Red Fox control program.

## 4.5 Summary of recommendations

Table 4-10 compiles management issues identified during the 2021/2022 monitoring period within the MPE operational facility and recommends appropriate corrective actions.

*Table 4-10. Compiled list of management issues identified within MPE operational facility and recommended corrective actions*

Identified issue and reference number		Recommended action
<b>Native vegetation: Lands adjoining the Rail Link</b>		
1	Impacts to native vegetation immediately adjacent to areas which are subject to ongoing management activities including weed control works.	<p>Hi-volume spraying of herbicide within the Rail Link in areas adjacent to native vegetation (specifically the BA341 biobank site) should not be conducted.</p> <p>Weed control works within these areas should include manual removal or spot spraying with herbicide. Spot spraying with herbicide should only be undertaken during optimal conditions to avoid spray drift.</p> <p>If there is risk of overspray or off target poisoning to native vegetation (particularly threatened flora) then targeted granular herbicide such as Furophanate granular herbicide should be adopted.</p> <p>Prior to commencing weed control works with the Rail Link contractors should be supplied with sensitive area mapping which identifies the location of threatened species and the BA341 biobank site.</p>
2	<p>Increased cover of weeds immediately outside to the rail corridor fencing, on areas disturbed during construction of the Rail Link.</p> <p>Potential for these weeds to infiltrate the adjacent native vegetation.</p>	<p>These areas should be subject to on-going monitoring to determine whether weeds from the Rail Link are infiltrating and degrading the condition of native vegetation.</p> <p>The management contractor for the Moorebank biobank site should be made aware of potential weed encroachment from the Rail Link and be procured to undertake targeted weed control works to remove any colonising weeds.</p>
<b>Native vegetation: Riparian vegetation management</b>		
3	Increased weed coverage within revegetation areas	Bush regenerators should commence weed control works within the Georges River management site immediately. Weed control works should aim to support natural regeneration through removal of scattered weeds and weeds encroaching from infested areas adjacent to the management site.
4	Encroachment of weed species from adjacent areas of infested bushland	The installation of a sediment fence to limit the amount of weed seed being transported into the revegetated site should be considered if encroachment is continuing despite routine weeding exercises.
5	Bare patches between plantings on eastern side of Georges River	Encourage natural recruitment of native species by maintaining low levels of weeds in bare areas between plantings.
6	Infill planting through bare areas on the western side of Georges River.	Infill planting with native tube stock should be conducted in bare areas beneath the Rail Link bridge. Plantings should be commensurate with species present in the RFEFCF vegetation community.
<b>Threatened flora: Lands adjoining the Rail Link</b>		
7	Impact to threatened species immediately adjacent to areas which are subject to ongoing management activities including weed control works.	<p>Hi-volume spraying of herbicide within the Rail Link in areas adjacent to threatened species locations (specifically the BA341 biobank site) should not be conducted.</p> <p>Weed control works within these areas should include manual removal or spot spraying with herbicide. Spot spraying with</p>

Identified issue and reference number	Recommended action
	<p>herbicide should only be undertaken during optimal conditions to avoid spray drift.</p> <p>If there is risk of overspray or off target poisoning to threatened flora then targeted granular herbicide such as Furophanate granular herbicide should be adopted.</p> <p>Prior to commencing weed control works with the Rail Link contractors should be supplied with sensitive area mapping which identifies the location of threatened species and the BA341 biobank site.</p>
<p>8 Increased cover of weeds immediately outside to the rail corridor fencing, on areas disturbed during construction of the Rail Link.</p> <p>Potential for these weeds to infiltrate the adjacent native vegetation and degraded threatened species habitat.</p>	<p>These areas should be subject to on-going monitoring to determine whether weeds from the Rail Link are infiltrating and degrading the condition of threatened species habitat.</p> <p>The management contractor for the Wattle Grove offset area should be made aware of potential weed encroachment from the Rail Link and be procured to undertake targeted weed control works to remove any colonising weeds.</p>
<b>Weed occurrence in MPE operational facility and Rail Link</b>	
<p>9 Weed growth on soft landscaped areas within the MPE operational facility</p>	<p>Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility should be slashed regularly.</p> <p>Weeds on soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should continue to be suppressed through a combination of herbicide application, slashing and hand weeding.</p>
<p>10 Weed growth on soft landscaped areas within the Rail Link</p>	<p>Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.</p> <p>Large patches of African Lovegrass and Rhodes Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events.</p>
<p>11 Low cover of native species on revegetated soft batters in the Rail Link</p>	<p>To support the continued regeneration and colonisation of native species:</p> <ul style="list-style-type: none"> <li>• a trained bush regeneration contractor should be onboarded to conduct regular ongoing weed control work targeting exotic species listed as 'priority' for the Greater Sydney Local Land Services region and the exotic grass species: <i>Melinis repens</i> (Red Natal Grass), <i>Chloris gayana</i> (Rhodes Grass), <i>Eragrostis curvula</i> (African Love Grass), <i>Hyparrhenia hirta</i> (Coolatai Grass) and <i>Themeda quadrivalvis</i> (Grader Grass)</li> <li>• monitoring of rehabilitated areas of the Rail Link to identify areas which may require additional support to increase native plant cover (i.e. seeding), or any novel exotic species which may be detrimental to the survival of natives</li> </ul>
<b>Fauna: Fauna habitat connectivity</b>	
<p>12 Vegetation growth within crossing passages on the northern and southern sides of the Anzac Creek culvert.</p>	<p>Intermittent monitoring inspections should be made of the culvert to ensure fauna ramps remain in situ and vegetation growth within crossing passages does not begin to obstruct movement or cause an issue to the culvert infrastructure or operation of the Rail Link</p>
<p>13 Inadequate habitat connectivity beneath the Rail Link bridge</p>	<p>Review of rock ballast as the necessary means for erosion and sediment control beneath the Rail Link bridge. If rock ballast is not deemed necessary for the entire 20 metre wide gap, it should be removed and replaced with alternative soil</p>

Identified issue and reference number	Recommended action
	<p>stabilisation materials (i.e. coir logs, jute and coir mesh). Planting of native species should be undertaken in conjunction with installation of soft stabilisation materials as per the original habitat connectivity enhancement plan from the RVMP (Hyder 2015). If rock ballast cannot be removed, improvement of current crossing designs should be considered such as installation of crossings to support arboreal mammal dispersal.</p>
<p>14</p> <p>Installation of six-foot-high cyclone fence at the southern extent of management site restricting movement of fauna along the Georges River riparian corridor</p>	<p>A review of the fencing location and design should be conducted to determine whether it is necessary and/or whether it can be modified to allow the movement of fauna from the MLP site to bushland south of the site.</p> <p>Considerations should be made for the installation of crossing mechanisms for fauna (i.e. Koala bridges) or replacement of the current Cyclone fence with a rural style fence with wooden bollard and 5 straight wires, as is to be installed around MLP drainage channels.</p>
<b>Fauna: Koala management monitoring</b>	
<p>15</p> <p>No connectivity between Wattle Grove offset area and bushland in Holsworthy defence area</p>	<p>Discussions should commence with TfNSW and Department of Defence to determine the feasibility of implementing connectivity measures outlined in the KMP (Cumberland Ecology 2020) to allow Koalas and other fauna to move between the Wattle Grove offset area and bushland in the Holsworthy defence area.</p>
<b>Fauna: Feral animals</b>	
<p>16</p> <p>Vertebrate pests within the MPE operational facility and surrounds</p>	<p>Ongoing opportunistic monitoring should be conducted through MPE operational facility and surrounds to determine whether populations of European Hare, Red Fox, Black Rat and Domestic Cat are having a negative impact on native biota. Any signs of novel pests within the biobank site should also be recorded.</p>
<p>17</p> <p>Increased observation of Red Fox which may indicate an increasing population</p>	<p>Communicate with Liverpool City Council and surrounding landholders (Glenfield Waste Facility and Holsworthy Army Barracks) to discuss feasibility and willingness to undertake a co-ordinated Red Fox control program.</p>



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- Office of Environment and Heritage (OEH) (2019) BioBanking Agreement (BA341) for Moorebank Intermodal Terminal Biobank Site

## **6 APPENDICIES**

**APPENDIX A . WEED MONITORING REPORTS (APRIL 2021 – APRIL 2022)**

**APPENDIX B . LETTER – REVIEW OF MPE RAIL LINK REVEGETATION**

**APPENDIX C . REMOTE CAMERA: FAUNA SPECIES INVENTORY**

**APPENDIX D . EPBC OFFSET SITES - ANNUAL MONITORING REPORT**

**APPENDIX E . RIPARIAN VEGETATION MANAGEMENT – FLORA INVENTORIES**

**APPENDIX F . RIPARIAN VEGETATION MANAGEMENT – PHOTO POINTS**

**APPENDIX G . BA341 LANDS ADJOINING RAIL LINK - QUADRAT MONITORING DATA**

**APPENDIX H . NEST BOX MONITORING REPORT (SPRING 2021)**

**APPENDIX I . NEST BOX CORRECTIVE ACTION REPORT**

## **APPENDIX A. WEED MONITORING REPORTS (APRIL 2021 - APRIL 2022)**

**Date** 11/05/2021  
**To** Fei Chen (Tactical)  
**From** Nathan Banks (Arcadis)  
**Copy to** Ketan Patel (Arcadis)  
**Subject** MPE Operational – Weed Monitoring Report April 2021

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## Introduction

Arcadis have been commissioned by Tactical on behalf of Qube Holdings to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed coverages and the presence of any weeds listed as Priority under the *Biosecurity Act 2015*.

The first monitoring report (April 2020) included a comprehensive baseline assessment of weed coverage within the MPE Operational Area. Subsequent reports, including this report (April 2021), include survey methodology, summarise changes to weed condition and assess weed control actions against previous recommendations listed in Table 2.

## Methodology

Arcadis ecologist Nathan Banks attended the MPE Operational Facility on Monday 12 April 2021. The area surveyed by the attending ecologist is presented in Figure 1.

Monitoring involved traversing the MPE operational area on foot surveying landscaped areas, stormwater infrastructure and areas adjoining the Rail Link for the occurrence of weed species and signs of weed control works. Areas that have previously been flagged as requiring remediation works were prioritised to assess the status of these. The following information was collected where weeds were identified:

- Presence of exotic species, including priority weeds
- Per cent foliage cover of exotic species
- Per cent foliage cover of priority weeds

The coverage of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1.



Table 1. Categories to describe percent coverage of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	0 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

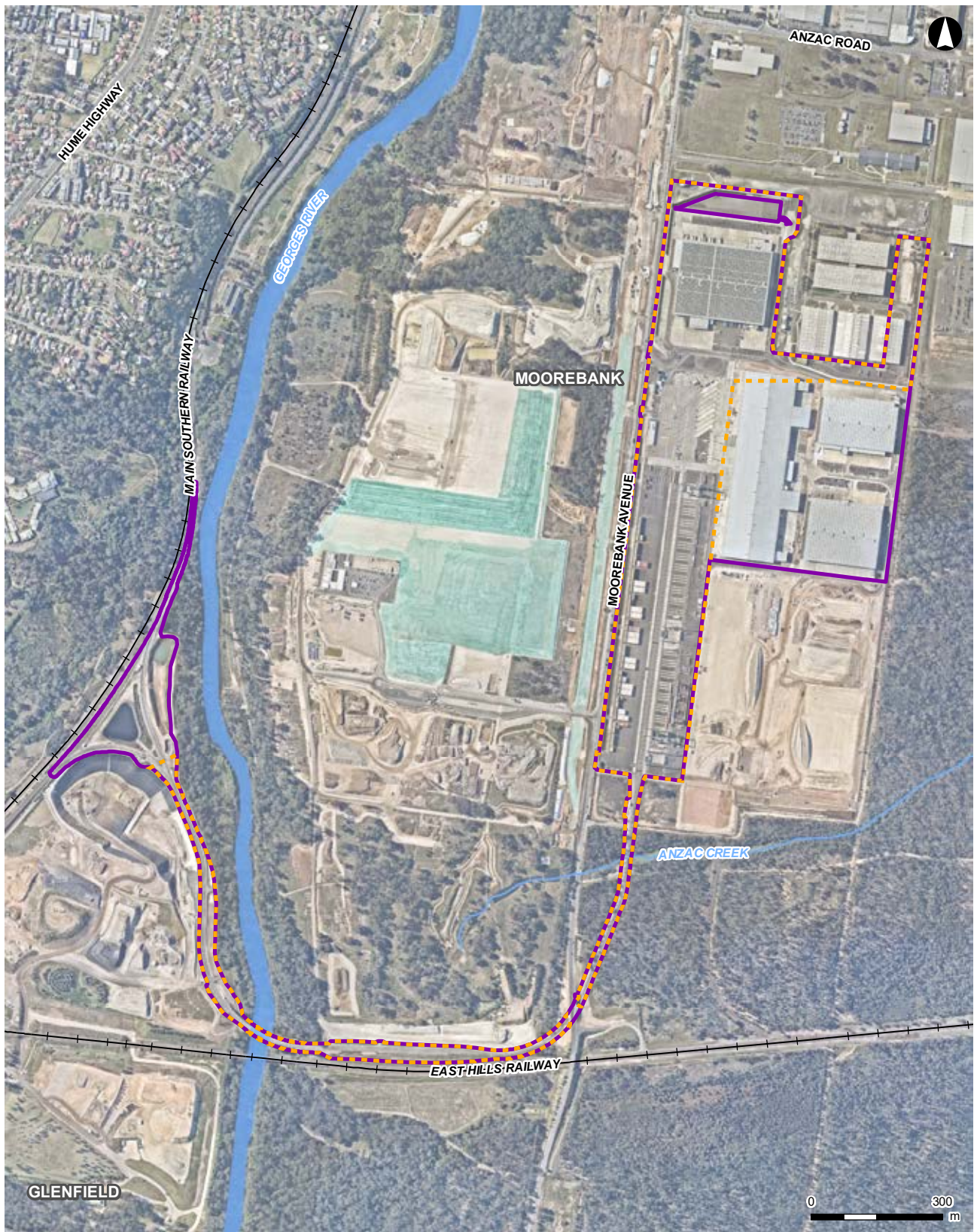
The weather on the day of survey was sunny with a maximum temperature of 20°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2020).

## Study Limitations

The data presented within this report is restricted to what was observed and recoded by the attending Arcadis ecologist during the site assessment on the 12 April 2021.

Monitoring of weeds was restricted to operational areas; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologist was not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys will require the attendance of a PO to access these areas.

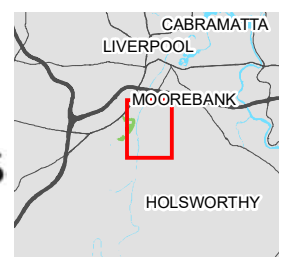


#### LEGEND

- - - Weed monitoring survey extent
- - - MPE operational boundary
- Watercourse
- +— Existing railway

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 Coordinate System: GDA 1994 MGA Zone 56  
 Aerial imagery supplied by nearmap (Oct. 2020)

1:13,000 at A4





## Results

Observations made by the attending ecologist during the April 2021 weed monitoring survey are summarised below.

### Weeds

Survey of the MPE operation facility did not identify any significant weed infestations that require immediate attention. Weed levels on soft batters within the trunk drainage system along the western boundary remain low. Invasive grasses are present however are providing stabilisation for the batter and herbaceous weeds are sparsely scattered. The planted garden bed adjacent to the Target warehouse is in good condition with a suit of native species and little to no weed occurrence.

Weed levels at the north-eastern extent of the facility surrounding drainage basins and swales has reduced since the February 2021 survey. The patch of *Ludwigia peruviana* previously identified has been removed from the drainage swale and herbaceous weeds and exotic grasses surrounding the basins have been managed through a combination of slashing, hand weeding and spot spraying. The management of weeds in this area will promote the growth and regeneration of native species including *Acacia falcata* (Sickle Wattle), *Cynodon dactylon* (Couch grass) and *Paspalum distichum* (Water couch).



Plate 1. Slashing and spot spraying around drainage lines and water retention basins at the north-eastern extent of MPE

Since the previous weed monitoring inspection further remediation works have been undertaken throughout the Rail Link. Dead weed within remediated areas have been removed and all areas have been hydromulched with a seed mix comprised of a sterile cover crop and native seed palette commensurate with the MPE UDLP (Arcadis 2020). Progress photos of the remediation works have been included in Appendix B. The remediated areas are mostly weed free however along the soft batters on the southern side of the Rail Link tussocks of the exotic grass species *Eragrostis curvula* (African Love Grass) were observed. African Lovegrass is an aggressive invasive grass which readily colonises areas outcompeting other species if not adequately controlled.





*Plate 2. African Lovegrass tussocks (dark green grass tussocks) colonising remediated areas within Rail Link*

On the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor significant weed infestations exists, including invasive grasses, herbaceous and woody weeds. This area poses a risk to the recently remediated areas. Consideration should be given to management of these areas to reduce the risk of encroachment of weeds into recently remediated areas.



*Plate 3. Area between the operational boundary and the East Hills line rail corridor supporting weeds*



A sparse scattering on priority weeds remain with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)

The location of these Priority weeds as well as the percent coverages of weeds across the MPE operational area is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the April 2021 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 2).

Table 2. Weed control works tracking

Priority	Action	Action description	April '21 performance assessment
1	Eradicate Priority weeds	Target Priority weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	The priority weed <i>Ludwigia peruviana</i> was removed from a drainage line at the north-eastern extent of the MPE operational facility.  Three priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive) and <i>Lantana camara</i> (Lantana) (Figure 2 - Figure 6). These should be removed.
2	Removal of notable weed species	Notable weed species including Moth Vine, Castor Oil Plant and Grader Grass should be removed from operational areas using a combination of manual and herbicide control.	Scattered individuals of Golden Wreath Wattle, Grader Grass, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into recently remediated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of environmental weeds adjacent to biobank areas and natural bushland environments. Manual removal should be adopted in areas adjacent to threatened flora locations.	No weeds were observed encroaching on the biobank site and other natural bushland environments.
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African Love Grass through regular mowing or slashing.	All weeds within remediated areas of the Rail Link have been removed and revegetation has commenced.  Slashing, hand weeding and spot spraying has been conducted at

Priority	Action	Action description	April '21 performance assessment
			the north-eastern extent of the MPE operational facility to reduce the extent and coverage of exotic grasses, herbaceous and woody weeds.
5	Reduce percent coverage of environmental weeds within the Rail Link	Reduction in percent coverage of environmental weed infestations by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	<p>Weeds have been removed from all operational areas within the Rail Link. Weeds have been removed from soft batters and revegetation of areas has commenced.</p> <p>Areas between the operational boundary and the East Hills line rail corridor support significant weed infestations This area poses a risk to the recently remediated areas and should be considered for management (slashing and spot spraying).</p>
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	<p>Herbaceous weeds and woody weeds have been maintained at low levels within the trunk drainage infrastructure.</p> <p>Weed control works were conducted at the north-eastern extent of the MPE operational facility to reduce the extent and coverage of exotic grasses, herbaceous and woody weeds.</p>

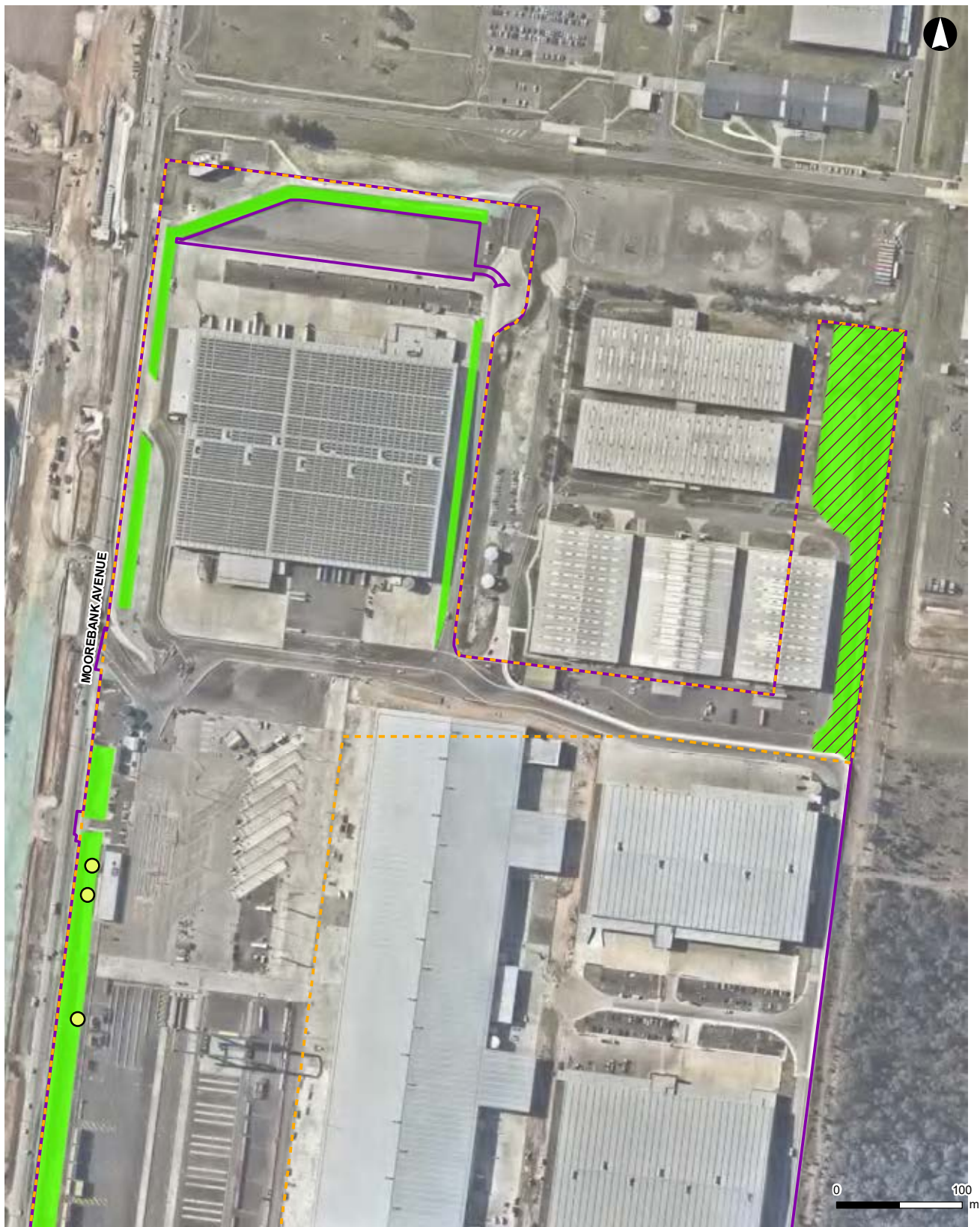
## Erosion

Periods of heavy rainfall since the February surveys has resulted in slipping of sections of recently remediated soft batters within the Rail Link corridor (Plate 4). The location of the two areas where batter slipping was observed is presented in Figure 4 and Figure 5.



*Plate 4. A section of soft batter within the Rail Link which has slipped following periods of high rainfall*



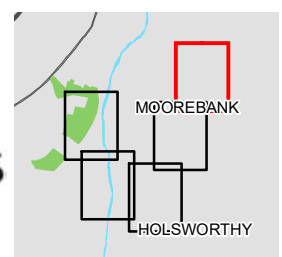


- MPE operational boundary
- Weed monitoring survey extent

- Weed coverage Low
- Works recently conducted
- Weed slashing and spraying

- Priority and notable weeds**
- Golden Wreath Wattle

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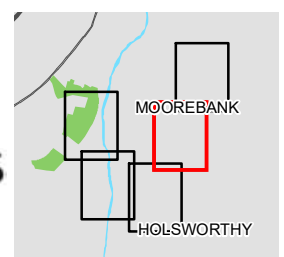
- MPE operational boundary
- Weed monitoring survey extent
- Remediated batters (weed removal & coir mesh)
- Watercourse

- Weed coverage**
- Low
- Works recently conducted**
- Hydromulching with native seed mix

- Priority and notable weeds**
- Golden Wreath Wattle

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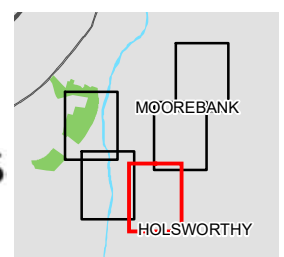
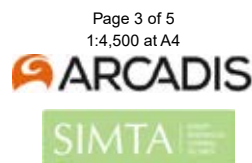


- MPE operational boundary
- Weed monitoring survey extent
- Remediated batters (weed removal & coir mesh)
- Watercourse
- Existing railway

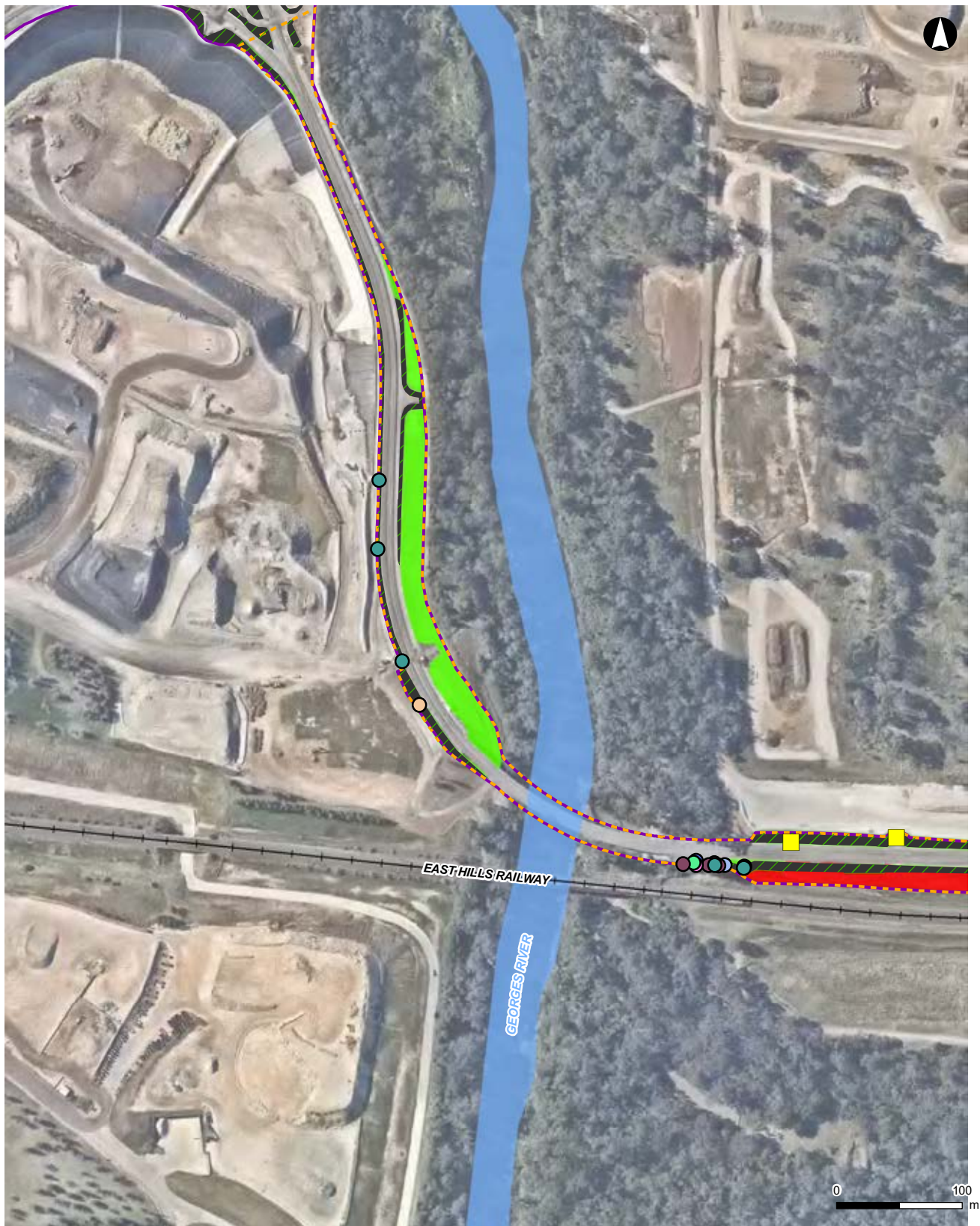
- Weed coverage**
- High
- Low
- Works recently conducted**
- Hydromulching with native seed mix
- Erosion issue**
- Slumping batter

- Priority and notable weeds**
- Golden Wreath Wattle
- Grader Grass
- Moth Vine

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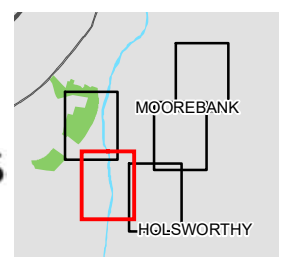
- MPE operational boundary
- Weed monitoring survey extent
- Remediated batters (weed removal & coir mesh)
- Existing railway

- Weed coverage**
  - High
  - Low
- Works recently conducted**
  - Hydromulching with native seed mix
- Erosion issue**
  - Slumping batter

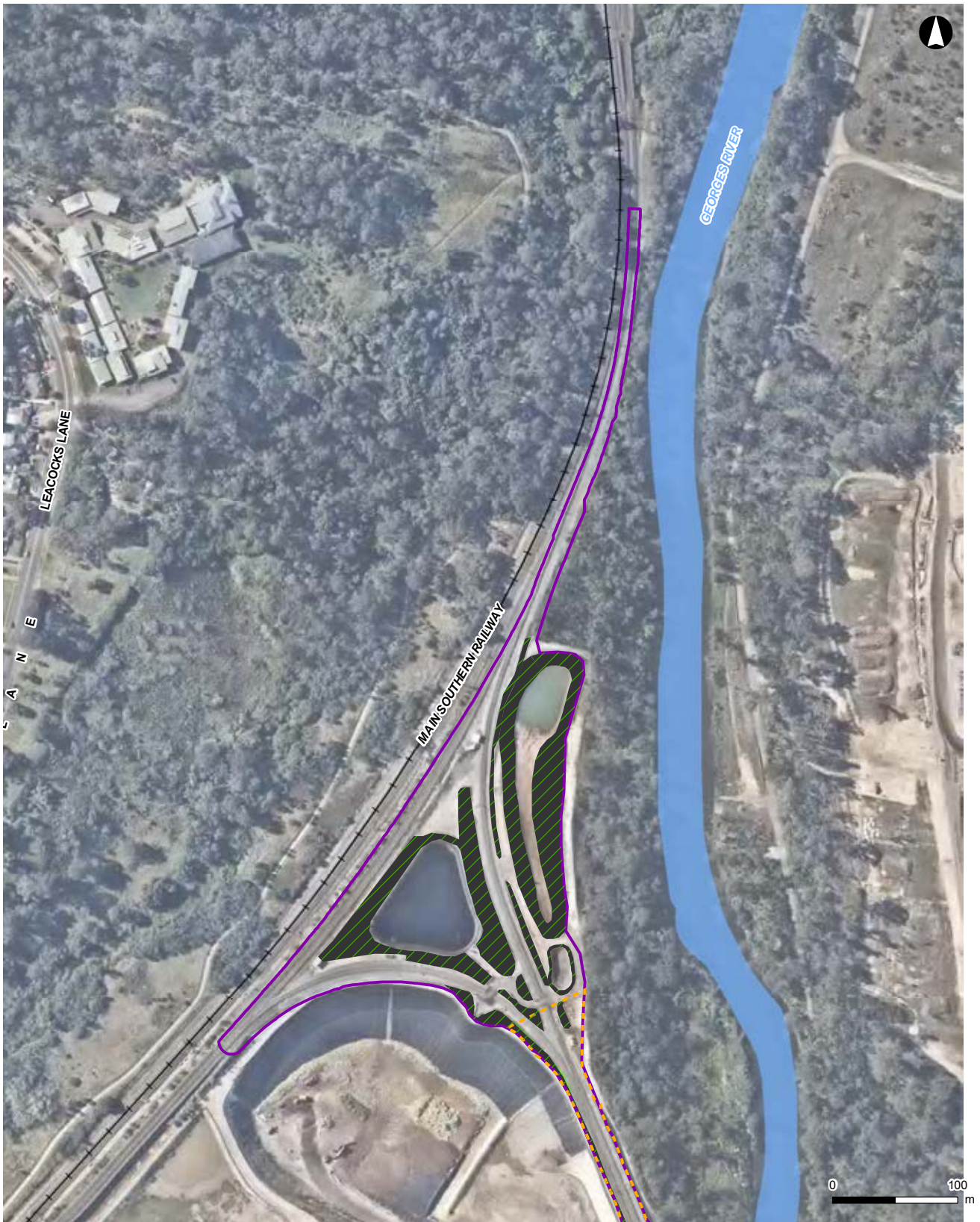
- Priority and notable weeds**
  - African Olive
  - Bridal Creeper
  - Castor Oil Plant
  - Fireweed
  - Grader Grass
  - Lantana
  - Narrow-leaf Privet

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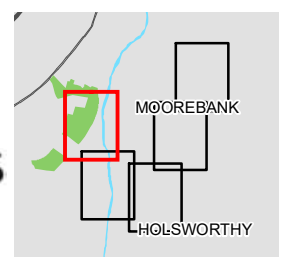




- MPE operational boundary
- Weed monitoring survey extent
- Remediated batters (weed removal & coir mesh)
- Existing railway
- Weed coverage Low
- Works recently conducted
- Hydromulching with native seed mix

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## Recommendations

Recommended weed control actions resulting from the previous weed monitoring surveys are included in Appendix A: Recommended Actions Catalogue. The catalogue has been reviewed and updated to reflect works undertaken since the February surveys.

The following actions are recommended based on observations made during the April survey:

- Remove all occurrence of *Acacia saligna* (Golden Wreath Wattle), *Araujia sericifera* (Moth Vine), *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Themeda quadrivalvis* (Grader Grass), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ricinus communis* (Castor Oil Plant) within the Rail Link.
- Spot spraying with herbicide should be conducted throughout remediated areas within the Rail Link targeting the exotic grass species African Love Grass. Herbicide application should be conducted in accordance with the approved Weed Management Plan.
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Application of herbicide within the Rail Link, in areas adjacent to the Moorebank biobank site and threatened flora locations, should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. Priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate Priority weeds species including Bridal Creeper, Chilean Needle Grass, Alligator Weed, Lantana, Ludwigia and African Olive	Commenced	Lantana, African Olive and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove notable weed species including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine within Rail Link	Commenced	Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE Operational Facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Weeds outside of the Rail Link corridor fencing should be removed following a pre-clearing inspection by an ecologist to search for threatened flora, specifically <i>Hibbertia fumana</i> .
December 2020	Remove exotic grasses and herbaceous weeds in areas not remediated within the Rail Link.	Commenced	All areas within the operation bounds of the Rail Link have been remediated with weeds being removed and revegetation being commenced.
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Not started	

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



August 2020



October 2020



April 2021



August 2020



October 2020



April 2021





August 2020



October 2020



April 2021



June 2020



October 2020



April 2021





June 2020



October 2020



April 2021



June 2020



October 2020



April 2021



June 2020



October 2020



April 2021



## APPENDIX C. PRIORITY WEED PROFILES



Chilean Needle Grass (*Nassella neesiana*)



Pampas Grass (*Cortaderia selloana*)



Lantana (*Lantana camara*)



Fireweed (*Senecio madagascariensis*)



Alligator Weed (*Alternanthera philoxeroides*)



African Olive (*Olea europaea* subsp. *cuspidata*)



Bridal Creeper (*Asparagus asparagoides*)



Peruvian Primrose (*Ludwigia peruviana*)

## APPENDIX D. WEED SPECIES INVENTORY

Scientific Name	Common name	Status
<i>Acacia saligna</i>	Golden Wreath Wattle	
<i>Acetosa sagittata</i>	Rambling Dock	
<i>Alternanthera philoxeroides</i>	Alligator Weed	Priority
<i>Anagallis arvensis</i>	Scarlet Pimpernel	
<i>Araujia sericifera</i>	Moth Vine	
<i>Asparagus asparagoides</i>	Bridal Creeper	Priority
<i>Bidens pilosa</i>	Cobbler's Pegs	
<i>Cardiospermum grandiflorum</i>	Balloon Vine	
<i>Chenopodium album</i>	Fat Hen	
<i>Chloris gayana</i>	Rhodes Grass	
<i>Cirsium vulgare</i>	Spear Thistle	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	
<i>Cortaderia selloana</i>	Pampas Grass	Priority
<i>Cyperus eragrostis</i>	Umbrella Sedge	
<i>Echinochloa crus-galli</i>	Barnyard Grass	
<i>Eragrostis curvula</i>	African Lovegrass	
<i>Foeniculum vulgare</i>	Fennel	
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	
<i>Hyparrhenia hirta</i>	Coolatai Grass	
<i>Hypochaeris radicata</i>	Catsear	
<i>Ipomoea purpurea</i>	Common Morning Glory	
<i>Lantana camara</i>	Lantana	Priority
<i>Ligustrum sinense</i>	Small-leaved Privet	
<i>Ludwigia peruviana</i>	Peruvian Primrose	Priority
<i>Modiola caroliniana</i>	Red-flowered Mallow	
<i>Nassella neesiana</i>	Chilean Needle Grass	Priority
<i>Olea europaea subsp. cuspidata</i>	African Olive	Priority
<i>Paspalum dilatatum</i>	Paspalum	
<i>Paspalum urvillei</i>	Vasey Grass	
<i>Pennisetum clandestinum</i>	Kikuyu Grass	
<i>Pennisetum setaceum</i>	Fountain Grass	
<i>Phytolacca octandra</i>	Inkweed	
<i>Plantago lanceolata</i>	Lamb's Tongues	
<i>Ricinus communis</i>	Castor Oil Plant	
<i>Secale cereale</i>	Cereal Rye	

Scientific Name	Common name	Status
<i>Senecio madagascariensis</i>	Fireweed	Priority
<i>Senna pendula</i>	Cassia	
<i>Setaria pumila</i>	Pale Pigeon Grass	
<i>Sida rhombifolia</i>	Paddy's Lucerne	
<i>Solanum nigrum</i>	Black-berry Nightshade	
<i>Solanum sisymbriifolium</i>		
<i>Sonchus oleraceus</i>	Common Sowthistle	
<i>Tagetes minuta</i>	Stinking Roger	
<i>Themeda quadrivalvis</i>	Grader grass	
<i>Trifolium repens</i>	White Clover	
<i>Verbena bonariensis</i>	Purpletop	
<i>Vicia sativa</i>	Common vetch	

**Date** 14/07/2021  
**To** Fei Chen (Tactical)  
**From** Nathan Banks (Arcadis)  
**Copy to** Ketan Patel (Arcadis)  
**Subject** MPE Operational – Weed Monitoring Report June 2021

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## Introduction

Arcadis have been commissioned by Tactical on behalf of Qube Holdings to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed coverages and the presence of any weeds listed as Priority under the *Biosecurity Act 2015*.

The first monitoring report (April 2020) included a comprehensive baseline assessment of weed coverage within the MPE Operational Area. Subsequent reports, including this report (June 2021), include survey methodology, summarise changes to weed condition and assess weed control actions against previous recommendations listed in Table 2.

## Methodology

Arcadis ecologist Nathan Banks attended the MPE Operational Facility on Wednesday 16 June 2021. The area surveyed by the attending ecologist is presented in Figure 1.

Monitoring involved traversing the MPE operational area on foot surveying landscaped areas, stormwater infrastructure and areas adjoining the Rail Link for the occurrence of weed species and signs of weed control works. Areas that have previously been flagged as requiring remediation works were prioritised to assess the status of these. The following information was collected where weeds were identified:

- Presence of exotic species, including priority weeds
- Per cent foliage cover of exotic species
- Per cent foliage cover of priority weeds

The coverage of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1.



Table 1. Categories to describe percent coverage of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

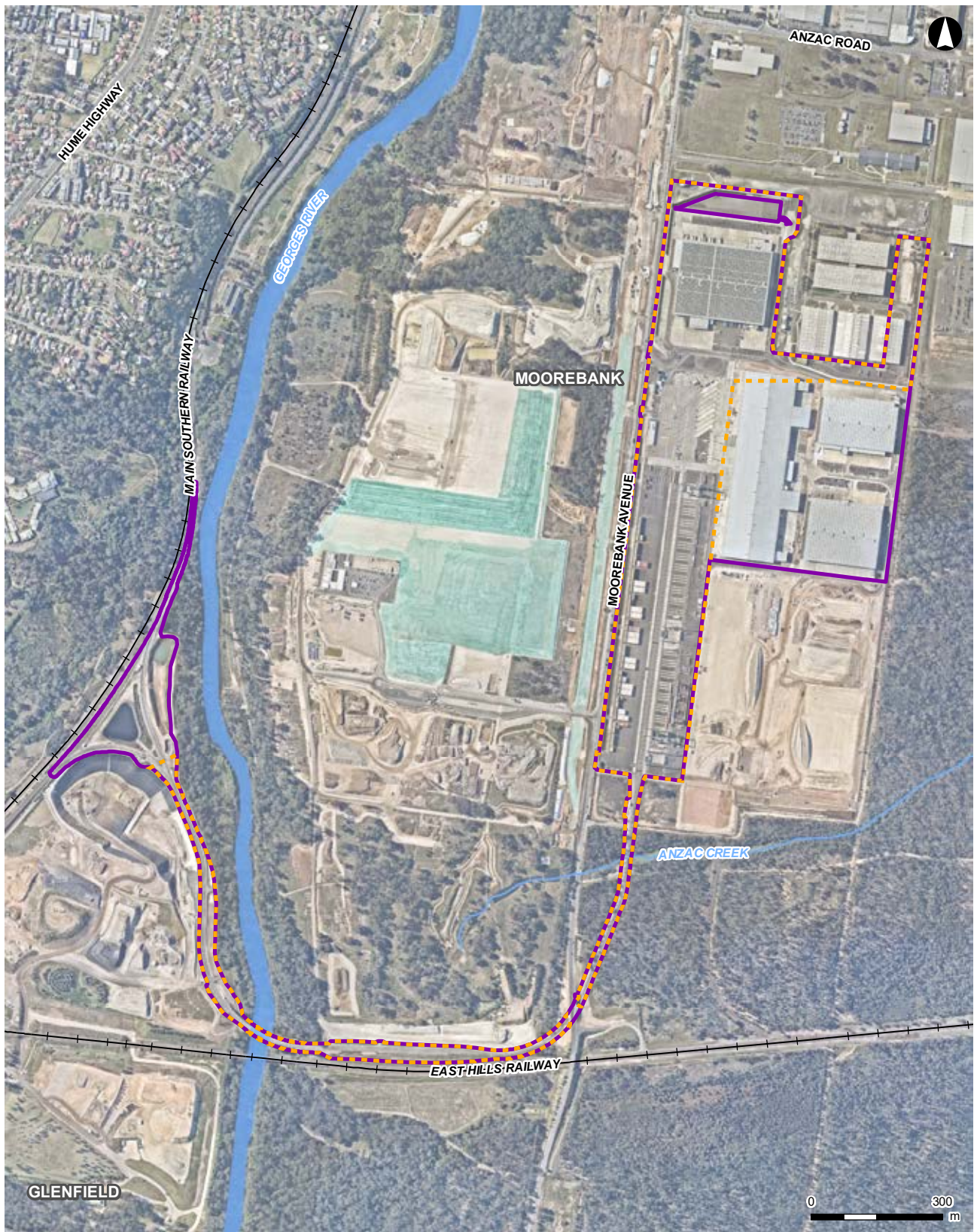
The weather on the day of survey was sunny with a maximum temperature of 18.5°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2020).

## Study Limitations

The data presented within this report is restricted to what was observed and recoded by the attending Arcadis ecologist during the site assessment on the 16 June 2021.

Monitoring of weeds was restricted to operational areas; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologist was not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys will require the attendance of a PO to access these areas.

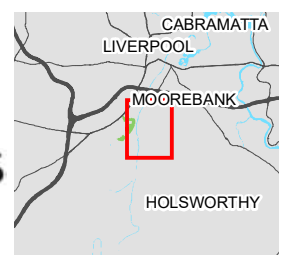


#### LEGEND

- Weed monitoring survey extent
- MPE operational boundary
- Watercourse
- Existing railway

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## Results

Observations made by the attending ecologist during the June 2021 weed monitoring survey are summarised below.

### Weeds

No significant weed infestations were identified within the MPE operation facility during the June surveys. Weed levels on soft batters within the trunk drainage system along the western boundary remain low. Invasive grasses are present however are providing stabilisation for the batter and herbaceous weeds are sparsely scattered. Water sprinkler systems were observed in bare areas along the batters which have likely been installed to encourage plant growth. Planting of suitable species which grow well in a sandy substrate should be considered for these areas (discussed more in Recommendations)

The planted garden bed adjacent to the Target warehouse is in good condition with a suit of established native species and little to no weed occurrence (Plate 1).



Plate 1. Planted garden bed adjacent to Target with little to no weed occurrence

Weed levels at the north-eastern extent of the facility surrounding drainage basins and swales have been controlled and reduced since the April survey. Herbicide application and chipping of woody weeds was observed throughout the area (Plate 2). The following weed species were observed to be targeted during weed control works: *Modiola caroliniana* (Red-flowered Mallow), *Plantago lanceolata* (Lambs Tongue), *Hypochaeris radicata* (Catsear) and *Acacia saligna* (Golden-wreath Wattle).



*Plate 2. Signs of weed control works around drainage basins at the northern extent of the operational area*

The area surrounding the drainage basin and along the drainage swale is showing good native resilience with a suite of native species being present including *Acacia falcata* (Sickle Wattle), *Cynodon dactylon* (Couch grass), *Daviesia ulicifolia* (Gorse Bitter Pea), *Hardenbergia violacea* (False Sarsaparilla), *Dichanthium sericeum* (Queensland Bluegrass), *Bulboschoenus* sp. *Typha orientalis* (Bull rush), *Persicaria decipiens* (Slender Knotweed) and *Paspalum distichum* (Water couch). Plate 3 shows *Acacia falcata* (Sickle Wattle) regenerating along with a suite of other native groundcover species along one of the basins soft batters.



*Plate 3. Areas around drainage basins which are regularly maintained by a contractor*



No signs were observed within the Rail Link corridor to indicate weed control or bush regeneration activities have occurred since the previous survey in April. Patches of weeds identified on soft batters during the previous inspection have been left untreated and have now developed into established localised infestations. A photograph of patches of *Eragrostis curvula* (African Love Grass) identified in May (Plate 4) have been again photographed during the June monitoring survey (Plate 5) to highlight the rate at which this exotic grass can colonise new areas. African Lovegrass is an aggressive invasive grass which readily colonises areas outcompeting other species if not adequately controlled.

A number of other weed species were observed colonising bare areas between patches of the sterile cover crop planted in April/May including *Sonchus oleraceus* (Common Sowthistle), *Themeda quadrivalvis* (Grader Grass), *Fumaria officinale*, *Tagetes minuta* (Stinking Roger), *Medicago polymorpha* (Bur Medic), *Melinis repens* (Red Natal Grass), *Stachys arvensis* (Stagger Weed) and *Cirsium vulgare* (Spear Thistle). Native seedlings were not observed to be sprouting in remediated areas during surveys. It is likely that native seeds included in the seed mix as per the UDLP (Arcadis 2019a; 2020) will not germinate until warmer temperatures are experienced in spring.

Progress photos of the remediation works have been included in Appendix B.



Plate 4. African Lovegrass tussocks (dark green grass tussocks) identified in April surveys



Plate 5. Patches of established African Lovegrass tussocks on remediated sections of soft batter.

Weed infestations remain on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor, including invasive grasses, herbaceous and woody weeds. This area poses a risk to the recently remediated areas. Consideration should be given to management of these areas to reduce the risk of encroachment of weeds into recently remediated areas.

A sparse scattering of priority weeds are present with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)

The location of these priority weeds as well as the percent coverages of weeds across the MPE operational area is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the June 2021 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 2).

Table 2. Weed control works tracking

Priority	Action	Action description	June '21 performance assessment
1	Eradicate Priority weeds	Target Priority weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Three priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive) and <i>Lantana camara</i> (Lantana) (Figure 2 - Figure 6). These should be removed.
2	Removal of notable weed species	Notable weed species including African Lovegrass, Moth Vine, Castor Oil Plant and Grader Grass should be removed from operational areas using a combination of manual and herbicide control.	New occurrences of African Lovegrass and Grader Grass are present on the remediated soft batters in the Rail Link. These should be removed.  Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into recently remediated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of environmental weeds adjacent to biobank areas and natural bushland environments. Manual removal should be adopted in areas adjacent to threatened flora locations.	No weeds were observed encroaching on the biobank site and other natural bushland environments.
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African Love Grass through regular mowing or slashing.	Regrowth of invasive grasses (African Lovegrass, Grader Grass) have not been controlled within the Rail Link.  Slashing of invasive grasses has occurred at the north-eastern extent of the operational area surrounding the drainage basins and swales.
5	Reduce percent coverage of environmental weeds within the Rail Link	Reduction in percent coverage of environmental weed infestations by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	No weed control works have occurred with the Rail Link to remove weed re-growth and prevent establishment. In some sections African Lovegrass has established forming isolated infestations.
6	Remove herbaceous and woody within the	Reduction in herbaceous and woody weeds by applying control methods	Herbaceous weeds and woody weeds have been maintained at



Priority	Action	Action description	June '21 performance assessment
	operational area and trunk drainage infrastructure.	commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	low levels within the trunk drainage infrastructure.  Weed control works were conducted at the north-eastern extent of the MPE operational facility to reduce the extent and coverage of exotic grasses, herbaceous and woody weeds.

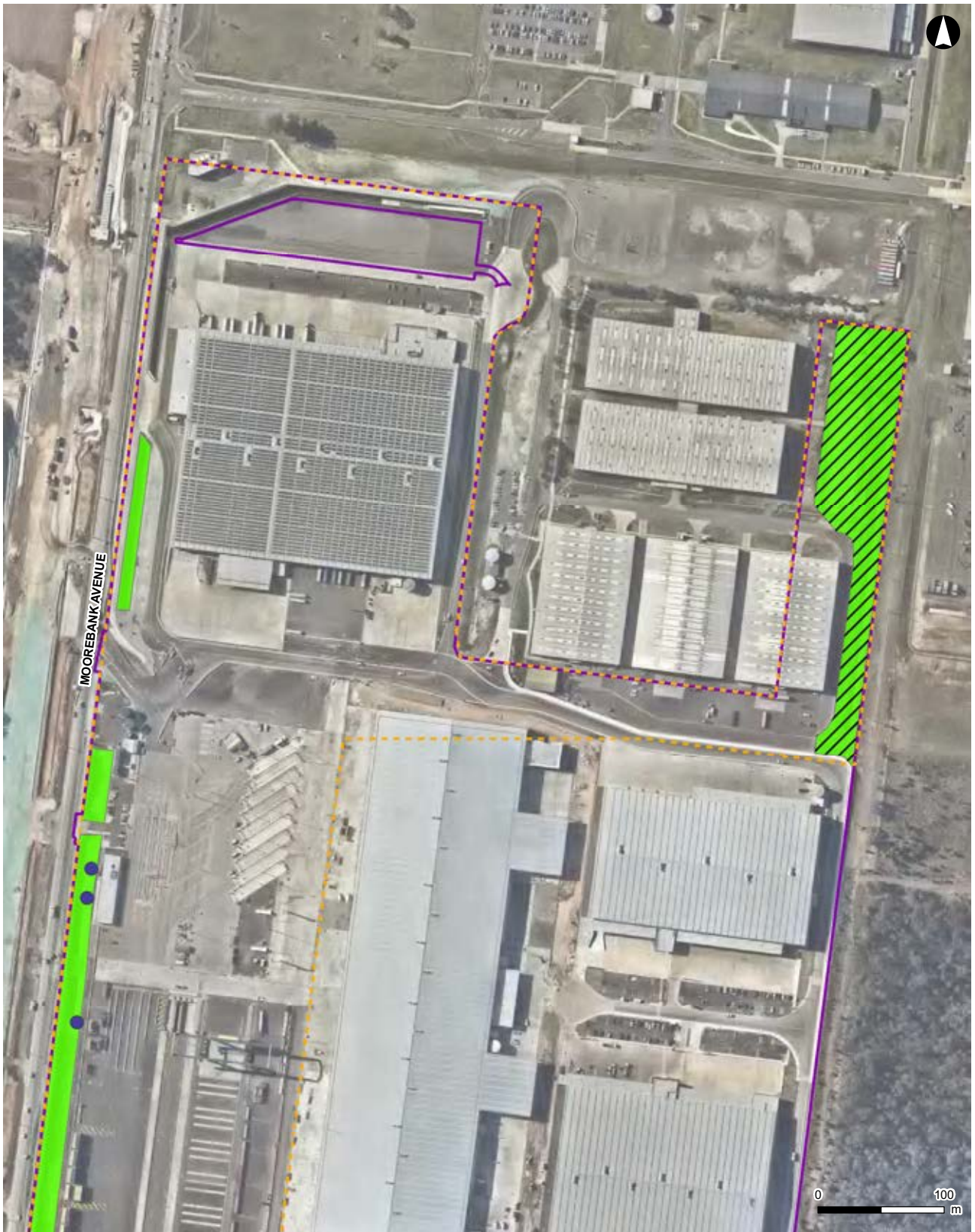
## Erosion

Periods of heavy rainfall since the February surveys has resulted in slipping of sections of remediated soft batters within the Rail Link corridor (Plate 6). The location of the two areas where batter slipping was observed is presented in Figure 4 and Figure 5.



*Plate 6. Two sections of soft batter within the Rail Link which have slipped following periods of high rainfall*



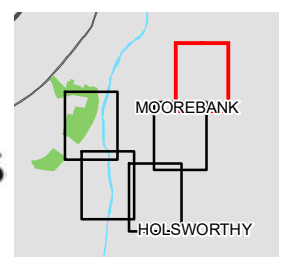


- MPE operational boundary
- Weed monitoring survey extent

- Weed coverage**
  - Low
  - None
- Works recently conducted**
  - Weed spraying and chipping

- Priority and notable weeds**
  - Acacia saligna

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 ABN 76 104 485 289  
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 Coordinate System: GDA 1994 MGA Zone 56  
 Aerial imagery supplied by nearmap (Oct, 2020)



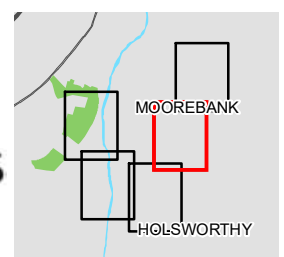
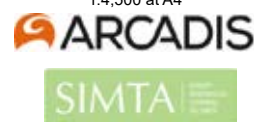




- |                               |                        |   |
|-------------------------------|------------------------|---|
| MPE operational boundary      | Weed coverage Low      | Priority and notable weeds Acacia saligna |
| Weed monitoring survey extent | Weed coverage Moderate | Priority and notable weeds Grader Grass   |
| Watercourse                   |                        |   |

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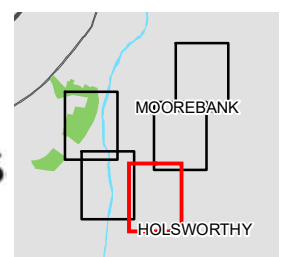
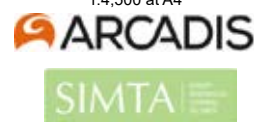
- MPE operational boundary
- Weed monitoring survey extent
- Watercourse
- Existing railway

- Weed coverage**
- High
- Low
- Moderate
- Erosion issue**
- Slumping batter

- Priority and notable weeds**
- Acacia saligna
- African Lovegrass
- Moth Vine
- Grader Grass

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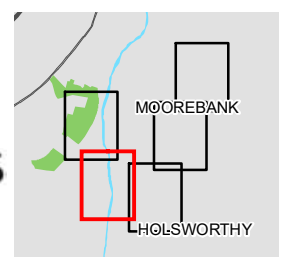
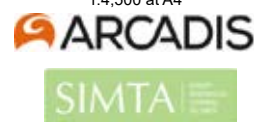
- MPE operational boundary
- Weed monitoring survey extent
- Existing railway

- Weed coverage**
- High
- Low
- Moderate
- Erosion issue**
- Slumping batter

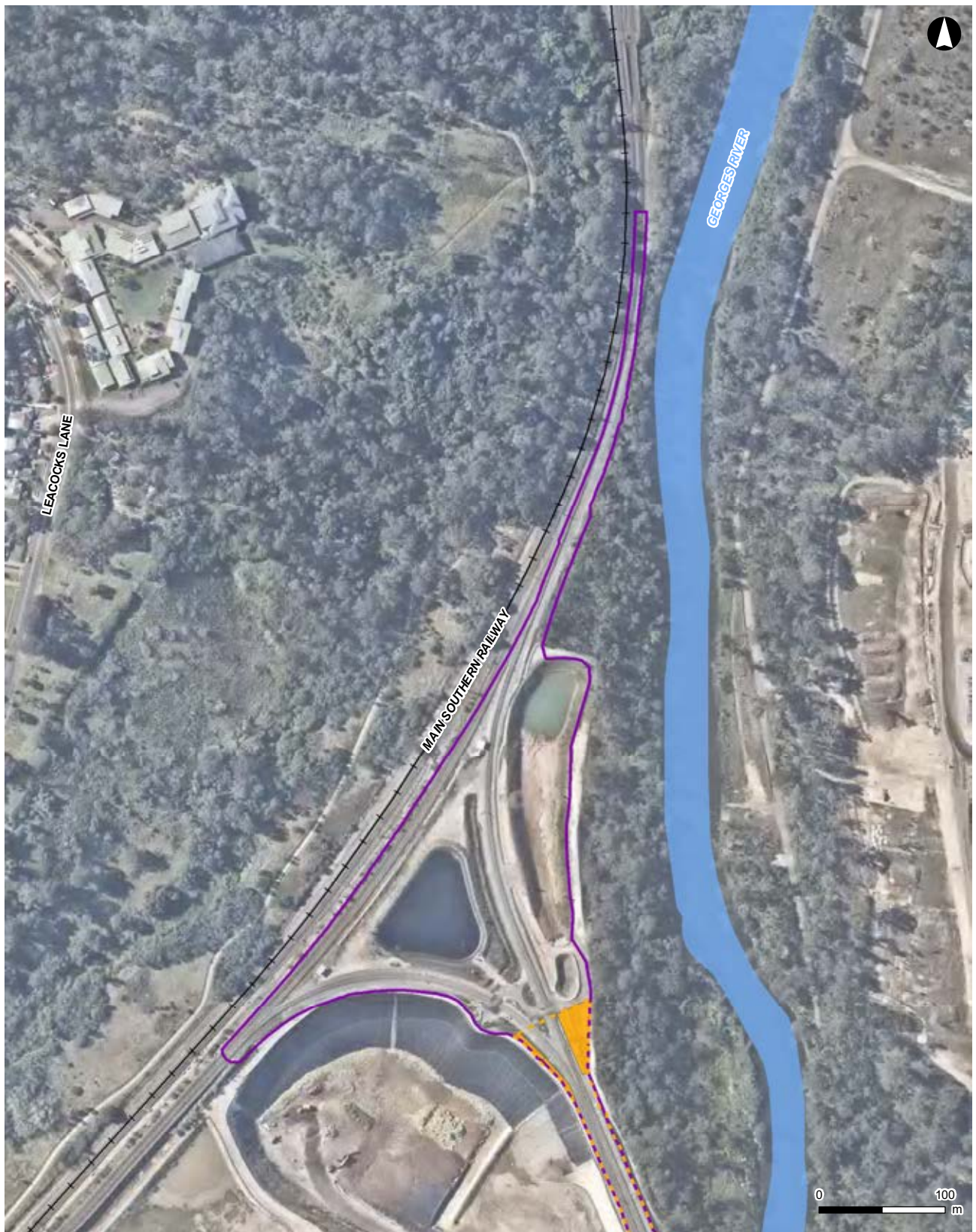
- Priority and notable weeds**
- African Lovegrass
- Castor Oil Plant
- Narrow-leaf Privet
- Fireweed
- Grader Grass

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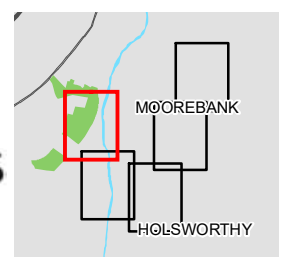
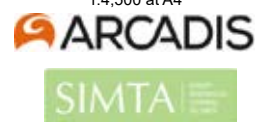


- MPE operational boundary
- Weed monitoring survey extent
- Existing railway

- Weed coverage**
- Moderate

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## Recommendations

Recommended weed control actions resulting from the previous weed monitoring surveys are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the April surveys.

The actions recommended in the April monitoring report are still applicable and should be implemented to reduce weed levels across the MPE operational facility and Rail Link. These include:

- Remove all occurrence of *Acacia saligna* (Golden Wreath Wattle), *Araujia sericifera* (Moth Vine), *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Themeda quadrivalvis* (Grader Grass), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ricinus communis* (Castor Oil Plant) within the Rail Link.
- Spot spraying with herbicide should be conducted throughout remediated areas within the Rail Link targeting the exotic grass species African Love Grass. Herbicide application should be conducted in accordance with the approved Weed Management Plan.
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Additional recommendations that have been developed based on findings from the June survey include:

- Revegetate bare areas within trunk drainage system with *Imperata cylindrica* (Blady Grass). This is a hardy native grass species which is able to grow in well drained sandy soils and would likely take on the batters in the trunk drainage system. If planted at top of the batter it is likely to colonise lower section of the batters overtime.

Application of herbicide within the Rail Link, in areas adjacent to the Moorebank biobank site and threatened flora locations, should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. Priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate Priority weeds species including Bridal Creeper, Chilean Needle Grass, Alligator Weed, Lantana, Ludwigia and African Olive	Commenced	Lantana, African Olive and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove notable weed species including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine within Rail Link	Commenced	Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed as a priority before establishing and forming infestations.  Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE Operational Facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).  Native seed is yet to germinate.
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Weeds outside of the Rail Link corridor fencing should be removed following a pre-clearing inspection by an ecologist to search for threatened flora, specifically <i>Hibbertia fumana</i> .
December 2020	Remove exotic grasses and herbaceous weeds in areas not remediated within the Rail Link.	Commenced	Weeds have been observed regrowing in remediated areas with the Rail Link. Weeds should be removed and suppressed until native seed sprouts and establishes long soft batters.
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Not started	

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
June 2021	Trail the revegetation of bare area within trunk drainage system with <i>Imperata cylindrica</i> (Baldy Grass)	Not started	

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



October 2020



April 2021



June 2021



October 2020



April 2021



June 2021





October 2020



April 2021



June 2021



October 2020



April 2021



June 2021





October 2020



April 2021



June 2021



October 2020



April 2021



June 2021



October 2020



April 2021



June 2021



## APPENDIX C. PRIORITY WEED PROFILES



Chilean Needle Grass (*Nassella neesiana*)



Pampas Grass (*Cortaderia selloana*)



Lantana (*Lantana camara*)



Fireweed (*Senecio madagascariensis*)



Alligator Weed (*Alternanthera philoxeroides*)



African Olive (*Olea europaea* subsp. *cuspidata*)



Bridal Creeper (*Asparagus asparagoides*)



Peruvian Primrose (*Ludwigia peruviana*)

## APPENDIX D. WEED SPECIES INVENTORY

Scientific Name	Common name	Status
<i>Acacia saligna</i>	Golden Wreath Wattle	
<i>Acetosa sagittata</i>	Rambling Dock	
<i>Alternanthera philoxeroides</i>	Alligator Weed	Priority
<i>Anagallis arvensis</i>	Scarlet Pimpernel	
<i>Araujia sericifera</i>	Moth Vine	
<i>Asparagus asparagoides</i>	Bridal Creeper	Priority
<i>Bidens pilosa</i>	Cobbler's Pegs	
<i>Cardiospermum grandiflorum</i>	Balloon Vine	
<i>Chenopodium album</i>	Fat Hen	
<i>Chloris gayana</i>	Rhodes Grass	
<i>Cirsium vulgare</i>	Spear Thistle	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	
<i>Cortaderia selloana</i>	Pampas Grass	Priority
<i>Cyperus eragrostis</i>	Umbrella Sedge	
<i>Echinochloa crus-galli</i>	Barnyard Grass	
<i>Eragrostis curvula</i>	African Lovegrass	
<i>Foeniculum vulgare</i>	Fennel	
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	
<i>Hyparrhenia hirta</i>	Coolatai Grass	
<i>Hypochaeris radicata</i>	Catsear	
<i>Ipomoea purpurea</i>	Common Morning Glory	
<i>Lantana camara</i>	Lantana	Priority
<i>Ligustrum sinense</i>	Small-leaved Privet	
<i>Ludwigia peruviana</i>	Peruvian Primrose	Priority
<i>Modiola caroliniana</i>	Red-flowered Mallow	
<i>Nassella neesiana</i>	Chilean Needle Grass	Priority
<i>Olea europaea subsp. cuspidata</i>	African Olive	Priority
<i>Paspalum dilatatum</i>	Paspalum	
<i>Paspalum urvillei</i>	Vasey Grass	
<i>Pennisetum clandestinum</i>	Kikuyu Grass	
<i>Pennisetum setaceum</i>	Fountain Grass	
<i>Phytolacca octandra</i>	Inkweed	
<i>Plantago lanceolata</i>	Lamb's Tongues	
<i>Ricinus communis</i>	Castor Oil Plant	
<i>Secale cereale</i>	Cereal Rye	

Scientific Name	Common name	Status
<i>Senecio madagascariensis</i>	Fireweed	Priority
<i>Senna pendula</i>	Cassia	
<i>Setaria pumila</i>	Pale Pigeon Grass	
<i>Sida rhombifolia</i>	Paddy's Lucerne	
<i>Solanum nigrum</i>	Black-berry Nightshade	
<i>Solanum sisymbriifolium</i>		
<i>Sonchus oleraceus</i>	Common Sowthistle	
<i>Tagetes minuta</i>	Stinking Roger	
<i>Themeda quadrivalvis</i>	Grader grass	
<i>Trifolium repens</i>	White Clover	
<i>Verbena bonariensis</i>	Purpletop	
<i>Vicia sativa</i>	Common vetch	



**Date** 7/09/2021  
**To** Fei Chen (Tactical)  
**From** Nathan Banks (Arcadis)  
**Copy to** Ketan Patel (Arcadis)  
**Subject** MPE Operational Facility – Weed Monitoring Report August 2021

---

## Introduction

Arcadis have been commissioned by Tactical on behalf of Qube Holdings to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed coverages and the presence of any weeds listed as Priority under the *Biosecurity Act 2015*.

The first monitoring report (April 2020) included a comprehensive baseline assessment of weed coverage within the MPE operational facility. Subsequent reports, including this report (August 2021), include survey methodology, summarise changes to weed condition and assess weed control actions against previous recommendations listed in Table 2.

## Methodology

Arcadis ecologist Nathan Banks attended the MPE Operational Facility on Tuesday 17 August 2021. The area surveyed by the attending ecologist is presented in Figure 1.

Monitoring involved traversing the MPE operational facility on foot surveying landscaped areas, stormwater infrastructure and areas adjoining the Rail Link for the occurrence of weed species and signs of weed control works. Areas that have previously undergone remediation were prioritised to assess the status of these. The following information was collected where weeds were identified:

- Presence of exotic species, including priority weeds
- Per cent foliage cover of exotic species
- Per cent foliage cover of priority weeds

The cover of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1.

Table 1. Categories to describe percent coverage of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

The weather on the day of survey was sunny with a maximum temperature of 18.6°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2020).

## Study Limitations

The data presented within this report is restricted to what was observed and recoded by the attending Arcadis ecologist during the site assessment on the 17 August 2021.

Monitoring of weeds was restricted to the operational facility; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologist was not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys along the Southern Sydney Freight Line (SSFL) will require the attendance of a PO.

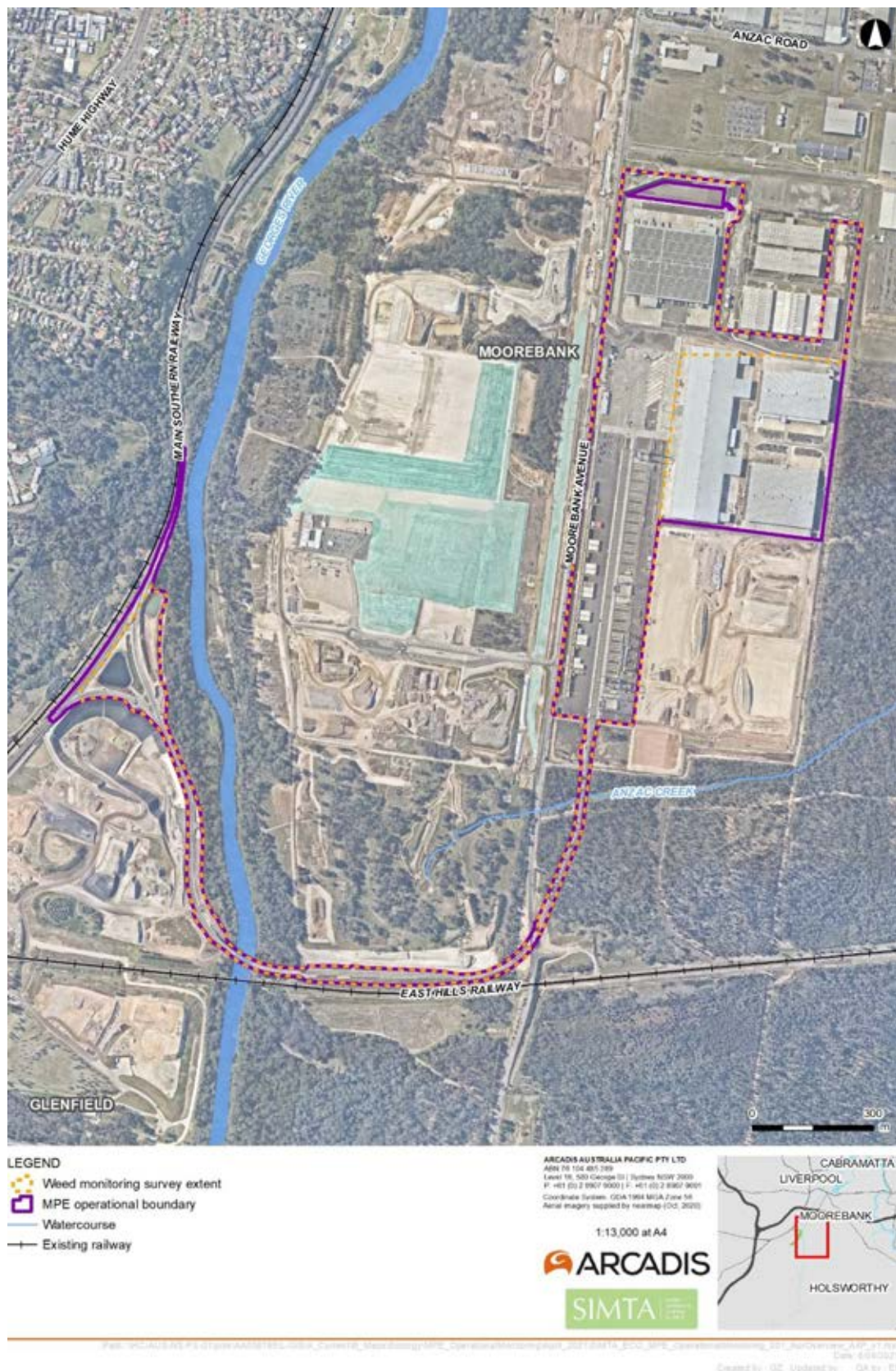


Figure 1. Survey extent within the MPE operational facility



## Results

Observations made by the attending ecologist during the August 2021 weed monitoring survey are summarised below.

### Weeds

Weed levels within the MPE operational facility have maintained similar coverages to what was recorded during the June surveys. Weed control works (chipping of weeds) was observed at the north-eastern extent of the facility surrounding drainage basins and swales. This area has a low cover of weeds as result of ongoing weed control works.



*Plate 1. Soft batters and landscapes surrounding the basins and the drainage channel with low weed occurrence at the north-eastern extent of the operation facility*

Construction works have commenced for the Moorebank Avenue upgrade which will act to remove the trunk drainage system running along the eastern side of the road which falls within the operational facility. The soft batters of this trunk drainage system have a low cover of exotic grasses which are currently acting to stabilise the soil.



*Plate 2. Low weed cover within the drainage channel. Note: construction works have begun in adjacent areas which will act to decommission and remove this drainage infrastructure in the near future*

No signs were observed within the Rail Link corridor to indicate weed control or bush regeneration activities have occurred since the previous survey in June. It was anticipated that native seeds included in the hydromulch applied to remediated batters would have showed some signs of germination following the recent string of warmer days. No native grasses, forbs or scramblers were observed on remediated areas of batters. Instead, weed species including *Sonchus oleraceus* (Common Sowthistle), *Themeda quadrivalvis* (Grader Grass), *Fumaria officinale*, *Tagetes minuta* (Stinking Roger), *Medicago polymorpha* (Bur Medic), *Stachys arvensis* (Stagger Weed) and *Cirsium vulgare* (Spear Thistle) have increased in cover since the June surveys. Remediated batters are becoming increasingly colonised by exotic species (Plate 3) and are beginning to resemble (if not already) the condition of the areas/batters prior to remediation works (see Appendix B).



Plate 3. Aggressive exotic grass species African Lovegrass and Grader Grass colonising remediated soft batters

A sparse scattering of priority weeds are present with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)

The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the August 2021 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 2).

Table 2. Weed control works tracking

Priority	Action	Action description	June '21 performance assessment
1	Eradicate Priority weeds	Target Priority weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Three priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive) and <i>Lantana camara</i> (Lantana) (Figure 2 - Figure 6). These should be removed.
2	Removal of notable weed species	Notable weed species including African Lovegrass, Moth Vine, Castor Oil Plant and Grader Grass should be removed from operational areas using a combination of manual and herbicide control.	New occurrences of African Lovegrass and Grader Grass are present on the remediated soft batters in the Rail Link. These should be removed.  Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into recently remediated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of environmental weeds adjacent to biobank areas and natural bushland environments. Manual removal should be adopted in areas adjacent to threatened flora locations.	Weed growth is increasing on soft batters adjacent to the biobank areas and natural bushland environments.  Targeted weed control works should be conducted to create a buffer between the soft batters and adjacent high value areas. Weed control works should not include high volume spraying with herbicide
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African Love Grass through regular mowing or slashing.	Regrowth of invasive grasses (African Lovegrass, Grader Grass) has not been controlled within the Rail Link.  Slashing of invasive grasses has occurred at the north-eastern extent of the operational area surrounding the drainage basins and swales.
5	Reduce percent coverage of environmental	Reduction in percent coverage of environmental weed infestations by applying control methods commensurate with the Operational	No weed control works have occurred with the Rail Link to remove weed re-growth and prevent establishment. In some



Priority	Action	Action description	June '21 performance assessment
	weeds within the Rail Link	Flora and Fauna Management Plan (Arcadis 2019)	sections African Lovegrass and Grader Grass has established forming isolated infestations.
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	<p>Herbaceous weeds and woody weeds have been maintained at low levels within the trunk drainage infrastructure.</p> <p>Routine weed control works continue to be undertaken at the north-eastern extent of the MPE operational facility to reduce the extent and coverage of exotic grasses, herbaceous and woody weeds.</p>

## Litter

A large amount of litter was observed within the rail corridor and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within areas of native vegetation, blocking drainage infrastructure within the rail corridor, and in the Georges River (Plate 4).



*Plate 4. Litter observed within the rail corridor during the August inspection*

## Erosion

Two sections of soft batters which have slipped since being remediated within the Rail Link corridor (Plate 5) have not be re-stabilised. The location of the two areas where batter slipping was observed is presented in Figure 5.



*Plate 5. Two sections of soft batter within the Rail Link which have slipped following periods of high rainfall*



Figure 2. Weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 5)





Figure 3. Weed covers and aggressive weeds identified across the MPE operational facility (Map 2 of 5)



Figure 4 Weed covers and aggressive weeds identified across the MPE operational facility (Map 3 of 5)





Figure 5. Weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 5)



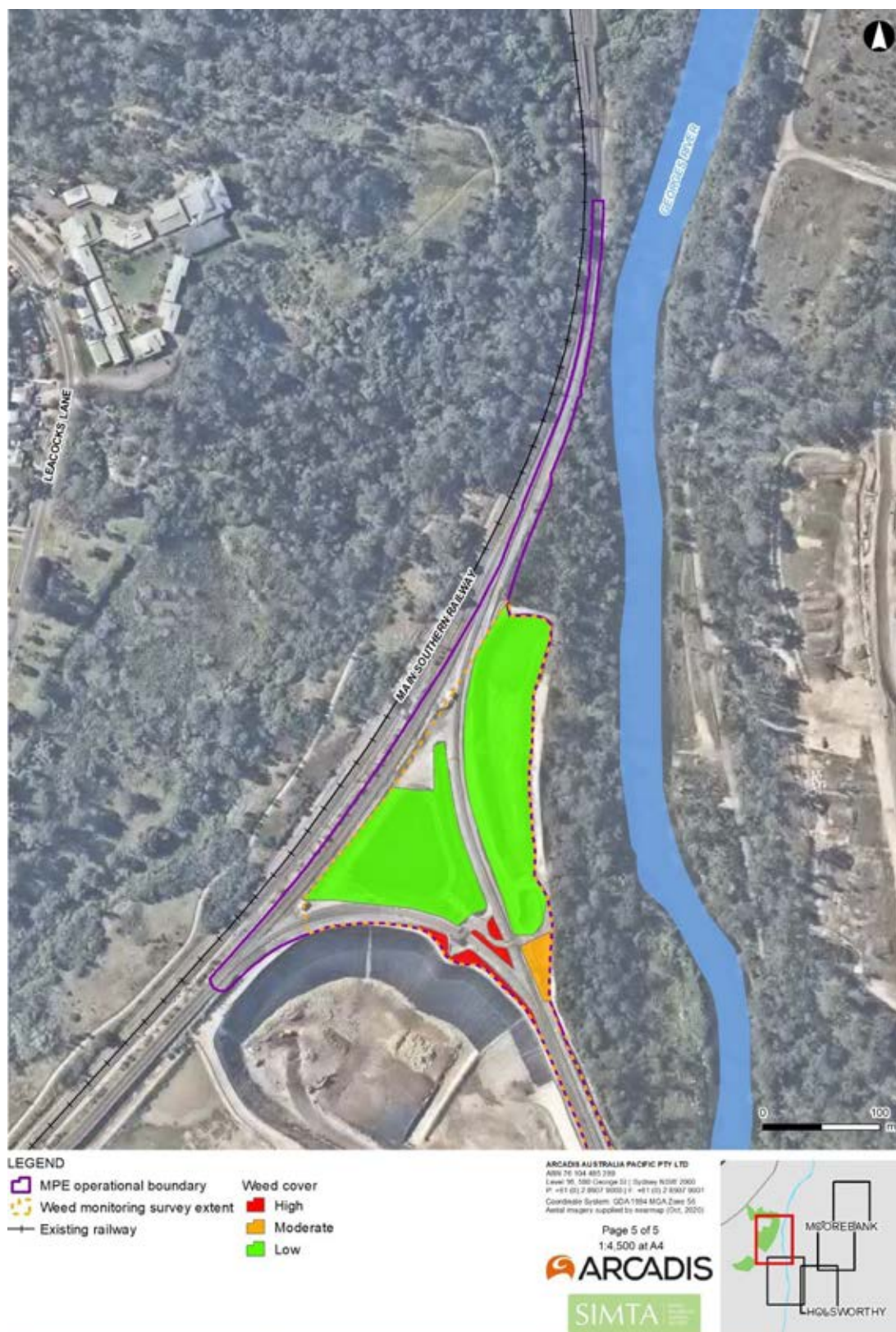


Figure 6. Weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 5)

## Recommendations

Recommended weed control actions resulting from the previous weed monitoring surveys are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the April surveys.

The actions recommended in the June monitoring report are still applicable and should be implemented to reduce weed levels across the MPE operational facility and Rail Link. These include:

- Remove all occurrence of *Acacia saligna* (Golden Wreath Wattle), *Araujia sericifera* (Moth Vine), *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Themeda quadrivalvis* (Grader Grass), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ricinus communis* (Castor Oil Plant) within the Rail Link.
- Spot spraying with herbicide should be conducted throughout remediated areas within the Rail Link targeting the exotic grass species African Love Grass. Herbicide application should be conducted in accordance with the approved Weed Management Plan.
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Additional recommendations that have been developed based on findings from the August survey include:

- Collect litter from with the rail link and in adjacent areas
- Re-form two sections of soft batter within the Rail Link which have slipped
- Determine the species palette of seeds used in the hydromulch to understand whether native species were included. This will help to determine which follow up management actions are most suitable.

Application of herbicide within the Rail Link, in areas adjacent to the Moorebank biobank site and threatened flora locations, should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. Priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate Priority weeds species including Bridal Creeper, Chilean Needle Grass, Alligator Weed, Lantana, Ludwigia and African Olive	Commenced	Lantana, African Olive and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove notable weed species including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine within Rail Link	Commenced	Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed as a priority before establishing and forming infestations.  Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE Operational Facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).  Native seed is yet to germinate.
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Weeds outside of the Rail Link corridor fencing should be removed following a pre-clearing inspection by an ecologist to search for threatened flora, specifically <i>Hibbertia fumana</i> .
December 2020	Remove exotic grasses and herbaceous weeds in areas not remediated within the Rail Link.	Commenced	Weeds have been observed regrowing in remediated areas with the Rail Link. Weeds should be removed and suppressed until native seed sprouts and establishes long soft batters.
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Not started	

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
June 2021	Trail the revegetation of bare area within trunk drainage system with <i>Imperata cylindrica</i> (Baldy Grass)	Not required	This section of trunk drainage is being removed as a component of the Moorebank Avenue upgrade works.
August 2021	Collect litter scattered through the Rail Link corridor and in adjacent areas	Not started	

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



October 2020



April 2021



August 2021



October 2020



April 2021



August 2021





October 2020



April 2021



August 2021



October 2020



April 2021



August 2021





October 2020



April 2021



August 2021



October 2020



April 2021



August 2021



October 2020



April 2021



August 2021



## APPENDIX C. PRIORITY WEED PROFILES



Chilean Needle Grass (*Nassella neesiana*)



Pampas Grass (*Cortaderia selloana*)



Lantana (*Lantana camara*)



Fireweed (*Senecio madagascariensis*)



Alligator Weed (*Alternanthera philoxeroides*)



African Olive (*Olea europaea* subsp. *cuspidata*)



Bridal Creeper (*Asparagus asparagoides*)



Peruvian Primrose (*Ludwigia peruviana*)

## APPENDIX D. WEED SPECIES INVENTORY

Scientific Name	Common name	Status
<i>Acacia saligna</i>	Golden Wreath Wattle	
<i>Acetosa sagittata</i>	Rambling Dock	
<i>Alternanthera philoxeroides</i>	Alligator Weed	Priority
<i>Anagallis arvensis</i>	Scarlet Pimpernel	
<i>Araujia sericifera</i>	Moth Vine	
<i>Asparagus asparagoides</i>	Bridal Creeper	Priority
<i>Bidens pilosa</i>	Cobbler's Pegs	
<i>Cardiospermum grandiflorum</i>	Balloon Vine	
<i>Chenopodium album</i>	Fat Hen	
<i>Chloris gayana</i>	Rhodes Grass	
<i>Cirsium vulgare</i>	Spear Thistle	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	
<i>Cortaderia selloana</i>	Pampas Grass	Priority
<i>Cyperus eragrostis</i>	Umbrella Sedge	
<i>Echinochloa crus-galli</i>	Barnyard Grass	
<i>Eragrostis curvula</i>	African Lovegrass	
<i>Foeniculum vulgare</i>	Fennel	
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	
<i>Hyparrhenia hirta</i>	Coolatai Grass	
<i>Hypochaeris radicata</i>	Catsear	
<i>Ipomoea purpurea</i>	Common Morning Glory	
<i>Lantana camara</i>	Lantana	Priority
<i>Ligustrum sinense</i>	Small-leaved Privet	
<i>Ludwigia peruviana</i>	Peruvian Primrose	Priority
<i>Modiola caroliniana</i>	Red-flowered Mallow	
<i>Nassella neesiana</i>	Chilean Needle Grass	Priority
<i>Olea europaea subsp. cuspidata</i>	African Olive	Priority
<i>Paspalum dilatatum</i>	Paspalum	
<i>Paspalum urvillei</i>	Vasey Grass	
<i>Pennisetum clandestinum</i>	Kikuyu Grass	
<i>Pennisetum setaceum</i>	Fountain Grass	
<i>Phytolacca octandra</i>	Inkweed	
<i>Plantago lanceolata</i>	Lamb's Tongues	
<i>Ricinus communis</i>	Castor Oil Plant	
<i>Secale cereale</i>	Cereal Rye	

Scientific Name	Common name	Status
<i>Senecio madagascariensis</i>	Fireweed	Priority
<i>Senna pendula</i>	Cassia	
<i>Setaria pumila</i>	Pale Pigeon Grass	
<i>Sida rhombifolia</i>	Paddy's Lucerne	
<i>Solanum nigrum</i>	Black-berry Nightshade	
<i>Solanum sisymbriifolium</i>		
<i>Sonchus oleraceus</i>	Common Sowthistle	
<i>Tagetes minuta</i>	Stinking Roger	
<i>Themeda quadrivalvis</i>	Grader grass	
<i>Trifolium repens</i>	White Clover	
<i>Verbena bonariensis</i>	Purpletop	
<i>Vicia sativa</i>	Common vetch	



**Date** 9/11/2021  
**To** Marvin Do (Tactical)  
**From** Nathan Banks (Arcadis)  
**Copy to** Mark Howley (Tactical); Marc Ragwoski (Tactical); Thea Kane (Arcadis)  
**Subject** MPE Operational Facility – Weed Monitoring Report October 2021

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## Introduction

Arcadis have been commissioned by Tactical Group on behalf of Qube Holdings to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed coverages and the presence of any weeds listed as Priority under the *Biosecurity Act 2015*.

The first monitoring report (April 2020) included a comprehensive baseline assessment of weed coverage within the MPE operational facility. Subsequent reports, including this report (October 2021), include survey methodology, summarise changes to weed condition and assess weed control actions against previous recommendations listed in Table 2.

## Methodology

Arcadis ecologists Nathan Banks and Thea Kane attended the MPE Operational Facility on Monday 18 October 2021. The area surveyed by the attending ecologist is presented in Figure 1.

Monitoring involved traversing the MPE operational facility on foot surveying landscaped areas, stormwater infrastructure and areas adjoining the Rail Link for the occurrence of weed species and signs of weed control works. Areas that have previously undergone remediation were prioritised to assess the status of these. The following information was collected where weeds were identified:

- Presence of exotic species, including priority weeds
- Per cent foliage cover of exotic species
- Per cent foliage cover of priority weeds

The cover of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1.

Table 1. Categories to describe percent coverage of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

The weather on the day of survey was sunny with a maximum temperature of 26.7°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2021).

## Study Limitations

The data presented within this report is restricted to what was observed and recoded by the attending Arcadis ecologists during the site assessment on the 18 October 2021.

Monitoring of weeds was restricted to the operational facility; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologists were not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys along the Southern Sydney Freight Line (SSFL) will require the attendance of a PO.

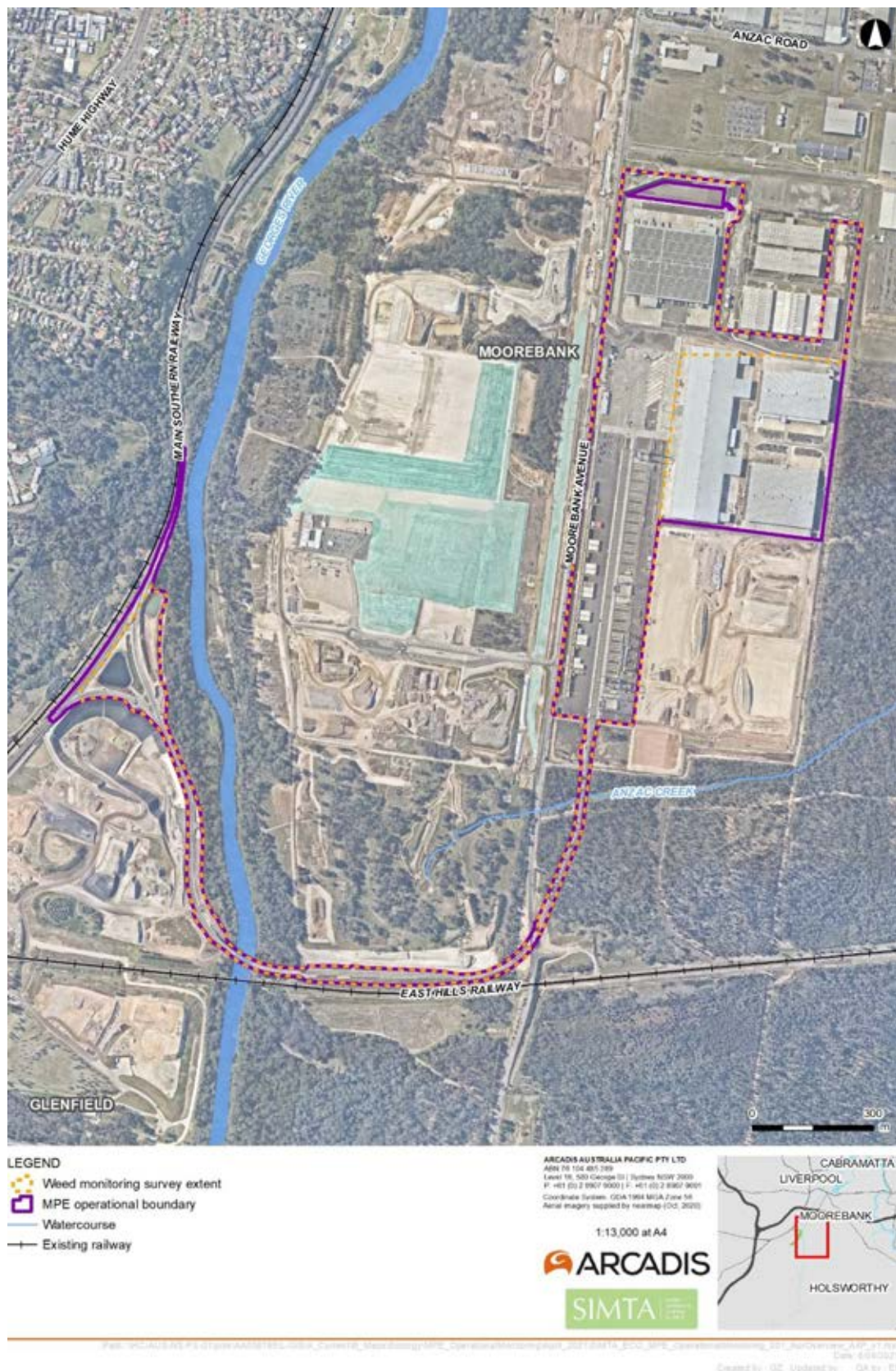


Figure 1. Survey extent within the MPE operational facility



## Results

Observations made by the attending ecologist during the October 2021 weed monitoring survey are summarised below.

### Weeds

Weed levels within the MPE operational facility have maintained similar coverages to what was recorded during the August surveys. No weed control works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales however weed levels remain to be low.



*Plate 1. Low levels of weeds observed on soft batters surrounding the basins and drainage channel at the north-eastern extent of the operation facility*

Construction works have commenced for the Moorebank Avenue upgrade which will act to remove the trunk drainage system running along the eastern side of the road which falls within the operational facility. The soft batters of this trunk drainage system have a low cover of exotic grasses which are currently acting to stabilise the soil.



*Plate 2. Low weed cover within the drainage channel subject to removal in the near future*

No signs were observed within the Rail Link corridor to indicate weed control or bush regeneration activities have occurred since the previous survey in August. No native grasses, forbs or scramblers were observed on remediated areas of batters. Instead, there has been an increase in cover of weed species previously observed during the August surveys, including *Sonchus oleraceus* (Common

Sowthistle), *Themeda quadrivalvis* (Grader Grass), *Fumaria officinale*, *Tagetes minuta* (Stinking Roger), *Medicago polymorpha* (Bur Medic), *Stachys arvensis* (Stagger Weed) and *Cirsium vulgare* (Spear Thistle). Two new aggressive weed species were also identified during the recent monitoring event including *Echium plantagineum* (Paterson's Curse) and *Hyparrhenia hirta* (Coolatai Grass). Both weed species have potential to rapidly colonise soft batters within the Rail Link and spread into adjoining areas of native bushland within the biobank site. Remediated batters are becoming increasingly colonised by exotic species (Plate 3) and largely resemble their pre-remediation weedy condition (see Appendix B).



Plate 3. Aggressive exotic grass species African Lovegrass and Grader Grass colonising remediated soft batters within the Rail Link

A sparse scattering of priority weeds are present with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)

The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the October 2021 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 2).

Table 2. Weed control works tracking

Priority	Action	Action description	October '21 performance assessment
1	Eradicate Priority weeds	Target Priority weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Three priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive) and <i>Lantana camara</i> (Lantana) (Figure 2 - Figure 6). These should be removed.
2	Removal of notable weed species	Notable weed species including African Lovegrass, Paterson's Curse, Coolatai Grass, Moth Vine, Castor Oil Plant and Grader Grass should be removed from operational areas using a combination of manual and herbicide control.	Aggressive weed species including African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass are increasingly colonising soft batters in the Rail Link. These weeds should be prioritised for removed.  Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into recently remediated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of environmental weeds adjacent to the biobank site and environmentally sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations.	Weed growth is increasing on soft batters adjacent to the biobank site and environmentally sensitive areas.  Targeted weed control works should be conducted to create a buffer between the soft batters and adjacent high value areas (biobanks site and environmentally sensitive areas containing threatened plant species). Weed control works should not include high volume spraying of herbicide  A pre-clearing survey should be undertaken by an ecologist to identify <i>Hibbertia fumana</i> prior to any remediation or weed control works being conducted in the Rail Link adjacent to environmentally sensitive areas Figure 3 .
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African	Regrowth of invasive grasses (African Lovegrass, Grader Grass)



Priority	Action	Action description	October '21 performance assessment
		Love Grass through regular mowing or slashing.	has not been controlled within the Rail Link.
5	Reduce percent coverage of environmental weeds within the Rail Link	Reduction in percent coverage of environmental weed infestations by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	No weed control works have occurred with the Rail Link to remove weed re-growth and prevent establishment. In some sections African Lovegrass and Grader Grass has established forming isolated infestations.
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Weed cover is generally low within trunk drainage infrastructure and at the north-eastern extent of the MPE operational facility.

## Litter

Litter was again observed within the rail corridor and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within areas of native vegetation, blocking drainage infrastructure within the rail corridor, and in the Georges River (Plate 4).



*Plate 4. Litter observed within the rail corridor during the October inspection*

## Erosion

One section of soft batter, previously identified as requiring remediation within the Rail Link, was being re-stabilised during the October monitoring event (Plate 5). One section of soft batter remains to be re-stabilised following slipping earlier in the year. A new instance of erosion was recorded at the north-eastern end of the operational area within the drainage swale. A small area of the soft batter is showing signs of undermining (Plate 5).

The locations of the area where batter slipping and batter slip re-stabilisation works were observed is presented in Figure 5.



*Plate 5. A section of soft batter within the Rail Link being remediated following a slip, and a new instance of batter slip within the MPE operational area*



Figure 2. Weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 5)







Figure 4 Weed covers and aggressive weeds identified across the MPE operational facility (Map 3 of 5)





Figure 5. Weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 5)



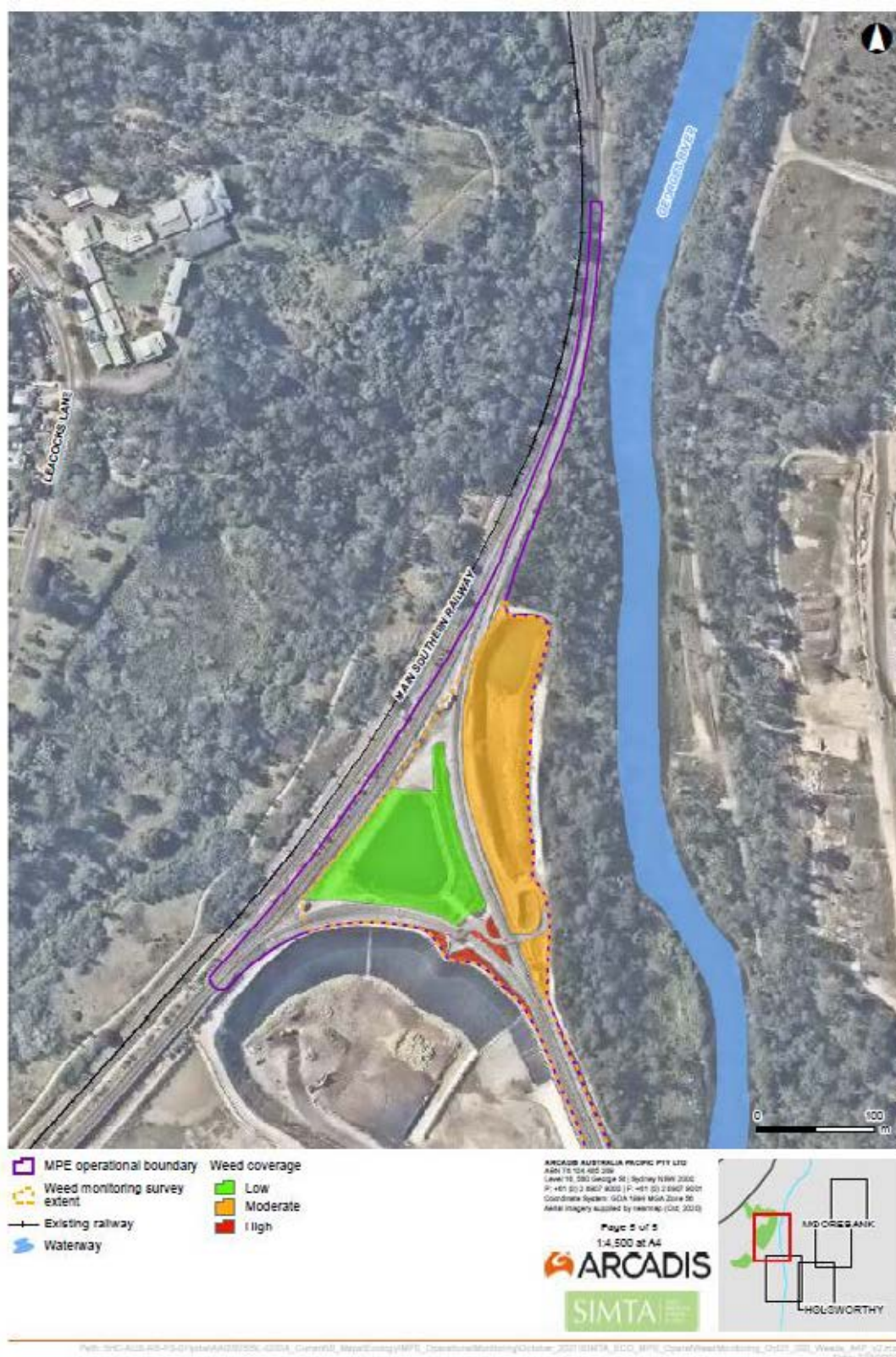


Figure 6. Weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 5)

## Recommendations

Recommended weed control actions resulting from the previous weed monitoring surveys are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the August surveys.

The following actions recommended in the August monitoring report are still applicable and should be implemented to reduce weed levels across the MPE operational facility and Rail Link. These include:

- Remove all occurrence of *Acacia saligna* (Golden Wreath Wattle), *Araujia sericifera* (Moth Vine), *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Themeda quadrivalvis* (Grader Grass), *Olea europaea* subsp. *cuspidata* (African Olive) and *Ricinus communis* (Castor Oil Plant) within the Rail Link.
- Spot spraying with herbicide should be conducted throughout remediated areas within the Rail Link targeting the exotic grass species African Love Grass. Herbicide application should be conducted in accordance with the approved Weed Management Plan.
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.
- Collect litter from within the Rail Link and in adjacent areas
- Re-form one section of soft batter within the Rail Link which has slipped
- Determine the species palette of seeds used in the hydromulch to understand whether native species were included. This will help to determine which follow up management actions are most suitable.

Additional recommendations that have been developed based on findings from the October survey include:

- Control and remove weeds encroaching on the biobank site and other environmentally sensitive areas at the northern extent of the Rail Link.
- Ecologists should do a pre-clearing survey to identify *Hibbertia fumana* in the environmentally sensitive area nearest the operational facility prior to any remediation and/or weed control works being conducted.

Application of herbicide within the Rail Link, in areas adjacent to the Moorebank biobank site and threatened flora locations, should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. Priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate Priority weeds species including Bridal Creeper, Chilean Needle Grass, Alligator Weed, Lantana, Ludwigia and African Olive	Commenced	Lantana, African Olive and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove notable weed species including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine within Rail Link	Commenced	Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed as a priority before establishing and forming infestations.  Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and undeveloped areas within the MPE Operational Facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).  Native seed is yet to germinate.
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Weeds outside of the Rail Link corridor fencing should be removed following a pre-clearing inspection by an ecologist to search for threatened flora, specifically <i>Hibbertia fumana</i> .
December 2020	Remove exotic grasses and herbaceous weeds in areas not remediated within the Rail Link.	Commenced	Weeds have been observed regrowing in remediated areas with the Rail Link. Weeds should be removed and suppressed until native seed sprouts and establishes long soft batters.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Not started	
June 2021	Trail the revegetation of bare area within trunk drainage system with <i>Imperata cylindrica</i> (Baldy Grass)	Not required	This section of trunk drainage is being removed as a component of the Moorebank Avenue upgrade works.
August 2021	Collect litter scattered through the Rail Link corridor and in adjacent areas	Not started	
October 2021	Manage encroachment of weeds into the biobank site and environmentally sensitive areas at the northern extent of the Rail Link.	Not started	Weeds encroaching on the biobank and other environmentally sensitive areas should be removed. Pre-clearing surveys should be undertaken to identify <i>Hibbertia fumana</i> prior to any remediation works.
October 2021	Reform/stabilise one section of soft battery within the Rail Link	Commenced	
October 2021	Remove aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link	Not started	New instances of aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link should be removed as soon as practicable to avoid spread of these species into environmentally sensitive areas adjacent to the Rail Link.

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



August 2020



April 2021



October 2021



August 2020



April 2021



October 2021





August 2020



April 2021



October 2021



August 2020



April 2021



October 2021





August 2020



April 2021



October 2021



August 2020



April 2021



October 2021



August 2020



April 2021



August 2021



## APPENDIX C. PRIORITY WEED PROFILES



Chilean Needle Grass (*Nassella neesiana*)



Pampas Grass (*Cortaderia selloana*)



Lantana (*Lantana camara*)



Fireweed (*Senecio madagascariensis*)



Alligator Weed (*Alternanthera philoxeroides*)



African Olive (*Olea europaea* subsp. *cuspidata*)



Bridal Creeper (*Asparagus asparagoides*)



Peruvian Primrose (*Ludwigia peruviana*)

## APPENDIX D. WEED SPECIES INVENTORY

Scientific Name	Common name	Status
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<i>Acetosa sagittata</i>	Rambling Dock	
<i>Alternanthera philoxeroides</i>	Alligator Weed	Priority
<i>Anagallis arvensis</i>	Scarlet Pimpernel	
<i>Araujia sericifera</i>	Moth Vine	
<i>Asparagus asparagoides</i>	Bridal Creeper	Priority
<i>Bidens pilosa</i>	Cobbler's Pegs	
<i>Cardiospermum grandiflorum</i>	Balloon Vine	
<i>Chenopodium album</i>	Fat Hen	
<i>Chloris gayana</i>	Rhodes Grass	
<i>Cirsium vulgare</i>	Spear Thistle	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	
<i>Cortaderia selloana</i>	Pampas Grass	Priority
<i>Cyperus eragrostis</i>	Umbrella Sedge	
<i>Echinochloa crus-galli</i>	Barnyard Grass	
<i>Echium plantagineum</i>	Paterson's Curse	
<i>Eragrostis curvula</i>	African Lovegrass	
<i>Foeniculum vulgare</i>	Fennel	
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	
<i>Hyparrhenia hirta</i>	Coolatai Grass	
<i>Hypochaeris radicata</i>	Catsear	
<i>Ipomoea purpurea</i>	Common Morning Glory	
<i>Lantana camara</i>	Lantana	Priority
<i>Ligustrum sinense</i>	Small-leaved Privet	
<i>Ludwigia peruviana</i>	Peruvian Primrose	Priority
<i>Modiola caroliniana</i>	Red-flowered Mallow	
<i>Nassella neesiana</i>	Chilean Needle Grass	Priority
<i>Olea europaea subsp. cuspidata</i>	African Olive	Priority
<i>Paspalum dilatatum</i>	Paspalum	
<i>Paspalum urvillei</i>	Vasey Grass	
<i>Pennisetum clandestinum</i>	Kikuyu Grass	
<i>Pennisetum setaceum</i>	Fountain Grass	
<i>Phytolacca octandra</i>	Inkweed	
<i>Plantago lanceolata</i>	Lamb's Tongues	
<i>Ricinus communis</i>	Castor Oil Plant	

Scientific Name	Common name	Status
<i>Secale cereale</i>	Cereal Rye	
<i>Senecio madagascariensis</i>	Fireweed	Priority
<i>Senna pendula</i>	Cassia	
<i>Setaria pumila</i>	Pale Pigeon Grass	
<i>Sida rhombifolia</i>	Paddy's Lucerne	
<i>Solanum nigrum</i>	Black-berry Nightshade	
<i>Solanum sisymbriifolium</i>		
<i>Sonchus oleraceus</i>	Common Sowthistle	
<i>Tagetes minuta</i>	Stinking Roger	
<i>Themeda quadrivalvis</i>	Grader grass	
<i>Trifolium repens</i>	White Clover	
<i>Verbena bonariensis</i>	Purpletop	
<i>Vicia sativa</i>	Common vetch	



**Date** 14/01/2022  
**To** Marvin Do (Tactical)  
**From** Nathan Banks (Arcadis)  
**Copy to** Marc Ragwoski (Tactical); Thea Kane (Arcadis)  
**Subject** MPE operational facility – Weed monitoring report December 2021

---

## Introduction

Arcadis have been commissioned by Tactical Group on behalf of Qube Holdings to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed coverages and the presence of any weeds listed as 'priority' under the *Biosecurity Act 2015*.

## Background

Arcadis have been monitoring the MPE operational facility for weed occurrence since April 2020. Soft landscaped areas surrounding the IMEX, warehouses and freight village and within drainage infrastructure have maintained low weed cover since the initial weed survey. Routine weed control works have been observed across these areas which have maintained the low weed cover. Overall, the change in weed cover across these areas has been minor since monitoring began and is considered acceptable against the operational requirements of the precinct.

The RALP which includes the MPE operational Rail Link has seen significant change and works over the time Arcadis has conducted weed monitoring. The soft batters either side of the Rail Link have had varying levels of exotic cover. In early spring 2020 Spray Grass solutions commenced a rehabilitation project to remove weeds from the batters and revegetate with native species commensurate with the Urban Design and Landscaping Plan (UDLP) for MPE. Spray Grass solutions procured Cumberland Plain Seeds to provide technical oversight of the revegetation effort with native seed.

A site meeting was held on the 7 December 2021 to discuss progress of the rehabilitation project and understand how the areas included are to be managed going forward. During the site meeting native grasses, forbs and shrubs were observed to have established in revegetated areas amongst exotic species. The biomass of exotic species was significantly greater than native species. Spray Grass solutions and Cumberland Plain Seeds did not identify a need for any major actions instead advised on a 'watch and wait' approach. It is anticipated by Spray Grass solutions and Cumberland Plain Seeds that overtime native species which have established will further colonise and begin to outcompete the present exotic species; increasing the proportional cover of native to exotic species. The following management actions were decided upon to align with the 'watch and wait' approach:

- Removal of exotic plant species from soft batters should be restricted to priority species and key weeds (as listed in Table 1)
- Other exotic herbaceous plants should be left in situ and monitored except where encroachment on environmentally significant lands is observed to be detrimentally impacting natural bushland

- Striking native species in revegetated areas should be preserved and protected by limiting human impacts including trampling and over spraying with herbicide

The bi-monthly weed monitoring methodology for the Rail Link has been differentiated from the rest of the MPE operational facility to consider the revegetation methodology and management recommendations proposed by Spray Grass Solutions and Cumberland Valley Seeds. Instead of reporting on the cover of all exotic species within the Rail Link, going forward, the focus will be shifted to monitoring the covers of 'priority' and key weeds. Similarly, recommendations made for the Rail Link will align with the decided upon management actions. The monitoring methodology for the Rail Link has been included below.

## Methodology

Arcadis ecologists Nathan Banks and Thea Kane attended the MPE operational facility on Monday 7 December 2021. Monitoring involved traversing the MPE operational facility on foot surveying landscaped areas, stormwater infrastructure and soft batters adjoining the Rail Link. The areas surveyed are presented in Figure 1.

The weather on the day of survey was sunny with a maximum temperature of 29.2°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2021).

### IMEX, warehouses and drainage infrastructure

In soft landscaped areas surrounding the IMEX, warehouses, freight village and within drainage infrastructure the following activities were conducted:

- Identifying and mapping the occurrence of weeds listed as priority
- Mapping and estimating the per cent foliage cover of exotic species
- Mapping and estimating the per cent foliage cover of priority weeds
- Recording and mapping the extent of weed control works

The cover of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1

*Table 1. Categories to describe percent coverage of weeds*

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

### Rail link

Following recent discussion regarding revegetating of the Rail Link, the monitoring methodology for weeds within the Rail Link has been refined to focus on key and priority weed species rather than all exotic species.

priority weed species are any exotic species listed under the *Biosecurity Act 2015* for the Greater Sydney Local Land Services Area and key weed species have been identified as site-specific exotic plants with the potential to have detrimental outcomes for recruitment of native seedlings or impacts

on adjacent environmentally sensitive areas. A list of priority and key weed species known from the Rail Link is included in Table 2.

Table 2. priority and key weed species subject to control within the Rai Link

priority weed species	key weed species
<i>Senecio madagascariensis</i> (Fireweed)	<i>Chloris gayana</i> (Rhodes Grass)
<i>Alternanthera philoxeroides</i> (Alligator weed)	<i>Eragrostis curvula</i> (African Lovegrass)
<i>Asparagus asparagoides</i> (Bridal Creeper) *	<i>Themeda quadrivalvis</i> (Grader Grass)
<i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive)	<i>Hyparrhenia hirta</i> (Coolatai Grass)
<i>Lantana camara</i> (Lantana)	<i>Echium plantagineum</i> (Paterson's Curse)
<i>Ludwigia peruviana</i> (Ludwigia)	

The location of key and priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

## Study Limitations

The data presented within this report is restricted to what was observed and recorded by the attending Arcadis ecologists during the site assessment on the 7 December 2021.

Monitoring of weeds was restricted to the operational facility; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologists were not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys along the Southern Sydney Freight Line (SSFL) will require the attendance of a PO.



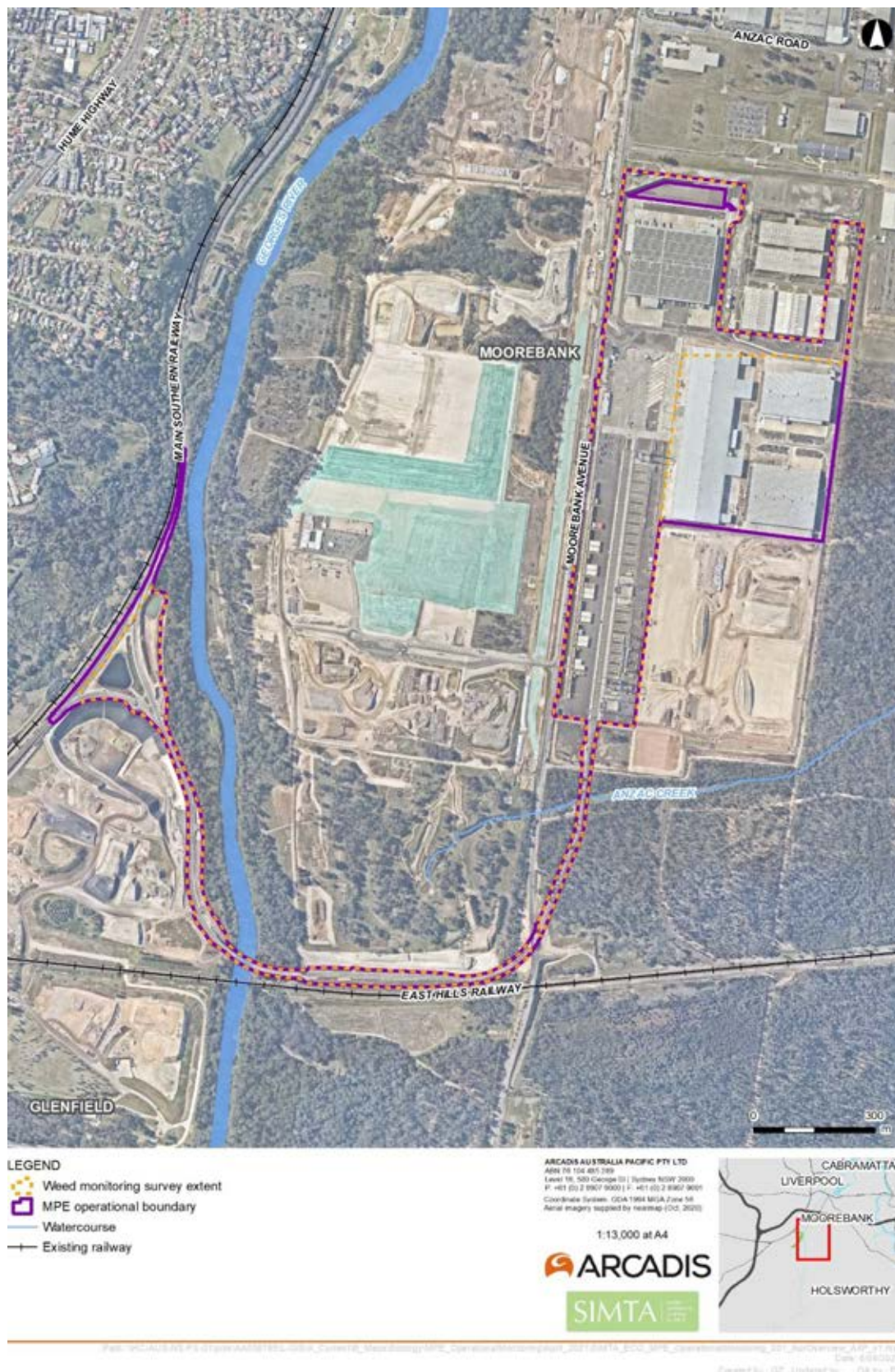


Figure 1. Survey extent within the MPE operational facility

## Results

Observations made by the attending ecologists during the December 2021 weed monitoring survey are summarised below.

### Weeds

Weed levels within the MPE operational facility have maintained similar coverages to what was recorded during the October surveys. No weed control works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales however weed levels remain to be low. Several native species are present and continue to grow on soft batters and in the drainage swale including *Acacia falcata*, *Daviesia ulicifolia*, *Typha orientalis*, *Persicaria decipiens*, *Austrodanthonia* sp. *Dichanthium sericeum*, *Ficinia nodosa* and *Lomandra longifolia*.



Plate 1. Low levels of weeds and established native plants observed on soft batters surrounding the basins and drainage channel at the north-eastern extent of the operation facility

Construction works continue for the Moorebank Avenue upgrade which will act to remove the trunk drainage system running along the eastern side of the road which falls within the operational facility. The soft batters of this trunk drainage system have a low cover of exotic grasses which are currently acting to stabilise the soil. No priority or aggressive weed species were observed.

On the day of monitoring, herbicide spraying was conducted targeting large clumps of exotic grasses including *Chloris gayana* (Rhodes Grass) and *Eragrostis curvula* (African Lovegrass) along the batters of the Rail Link as well as isolated infestations of *Alternanthera philoxeroides* (Alligator weed). No other weed control works have occurred since the previous survey in October.

Most areas of soft batter either side of the Rail Link were dominated by exotic plants which have increased in cover since the previous monitoring survey in October. Commonly encountered exotic species included African Lovegrass, Rhodes Grass, *Plantago lanceolata* (Lambs tongue), *Lolium perenne* (Perennial Ryegrass), *Trifolium michelianum* (Bolansa Clover), *Medicago polymorpha* (Bur Medic), *Melilotus albus* (Bokhara), *Cirsium vulgare* (Spear Thistle) and *Senecio madagascariensis* (Fire Weed).





Plate 2. Exotic species continue colonising remediated soft batters within the Rail Link

Where exotic species were not present or with reduced coverage on soft batters, recruitment of native seedlings was occasionally observed. Native species observed during the inspection included *Acacia falcata* (Hickory Wattle), *Atriplex semibaccata* (Creeping Saltbush), *Dichanthium sericeum* (Queensland Bluegrass), *Chloris truncata* (Windmill Grass), *Hardenbergia violacea* (False Sarsaparilla), *Dichondra repens* (Kidney Weed), *Indigofera australis* (Indigofera), *Themeda triandra* (Kangaroo Grass) and *Eragrostis brownii* (Brown's Lovegrass). Patches of *Cynodon dactylon* (Couch Grass) were also observed growing on the edges of the batter where exotic plant cover was low.



Plate 3. Native seedlings observed growing on soft batters: *Indigofera* (left), *Hickory Wattle* (centre), *Kidney Weed* (right)

A sparse scattering of priority weeds are present with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)
- *Senecio madagascariensis* (Fireweed)

The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 6.



The status of weeds and weed control works observed during the December 2021 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 3).

Table 3. Weed control works tracking

priority	Action	Action description	December '21 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Four priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive) and <i>Lantana camara</i> (Lantana) and <i>Senecio madagascariensis</i> (Fireweed) (Figure 2 - Figure 6). These should be removed.
2	Removal of key an aggressive weed species	<p>key weed species including African Lovegrass, Rhodes Grass, Paterson's Curse. Coolatai Grass and Grader Grass should be removed from the soft batters subject to revegetation.</p> <p>Aggressive weed species including Moth Vine, Castor Oil Plant should be removed from all operational areas using a combination of manual and herbicide control.</p>	<p>key weed species including African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass are increasingly colonising soft batters in the Rail Link. These weeds should be prioritised for removal.</p> <p>Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into recently remediated areas.</p>
3	Supress further colonisation of environmental weeds and encroachment into areas of bushland	Control of environmental weeds adjacent to the biobank site and environmentally sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations.	<p>Weed growth is increasing on soft batters adjacent to the biobank site and environmentally sensitive areas.</p> <p>Manual removal including routine slashing should be adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent adjacent high value areas (biobanks site and environmentally sensitive areas containing threatened plant species). All works should be restricted to the operational area and should not extend into the biobank site or identified environmentally sensitive areas.</p>

priority	Action	Action description	December '21 performance assessment
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African Love Grass through regular mowing or slashing.	<p>Slashing has not been adopted to managed regrowth of invasive grasses (African Lovegrass, Grader Grass) within the Rail Link.</p> <p>Slashing should be used to manage large expanses of exotic grassland to prevent seeding events.</p>
5	Reduce percent coverage of environmental weeds within the Rail Link	Reduction in percent coverage of environmental weed infestations by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	<p>Limited weed control works have occurred with the Rail Link to remove weed re-growth and prevent establishment. During the monitoring inspection isolated patches of African Lovegrass and Grader Grass on soft batters were sprayed with herbicide.</p> <p>Going forward, weed control works within revegetated areas of the Rail Link will focus on priority and key weed species rather than all exotic species as per the rehabilitation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds. This action will be undated in the February monitoring report to reflect this change in focus.</p>
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Weed cover has generally remained low within trunk drainage infrastructure and at the north-eastern extent of the MPE operational facility.

## Litter

Litter was again observed within the rail corridor and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within areas of native vegetation, blocking drainage infrastructure within the rail corridor, and in the Georges River (Plate 4).



*Plate 4. Litter observed within the rail corridor during the December inspection*

## Erosion

The section of soft batter previously identified as requiring repair was observed to have been reformed and stabilised with a grass cover Plate 5 since the previous inspection.



*Plate 5. Two sections of soft batter within the Rail Link remediated since the August monitoring event. Currently remediated batters have been vegetated with a exotic grass cover, thought to be Cereale Rye.*

Erosion/scouring of the soft batter recorded during the October monitoring survey at the north-eastern end of the operational area within the drainage swale remains to be re-stabilised. One new instance of erosion was observed during the December survey. A large crack was observed in the Rail Link platform at the western extent of the Rail Link. The crack dissects a large portion of the platform and is approximately 2 inches wide. A photograph has been included below.





*Plate 6. Instances of erosion observed during the December monitoring event*

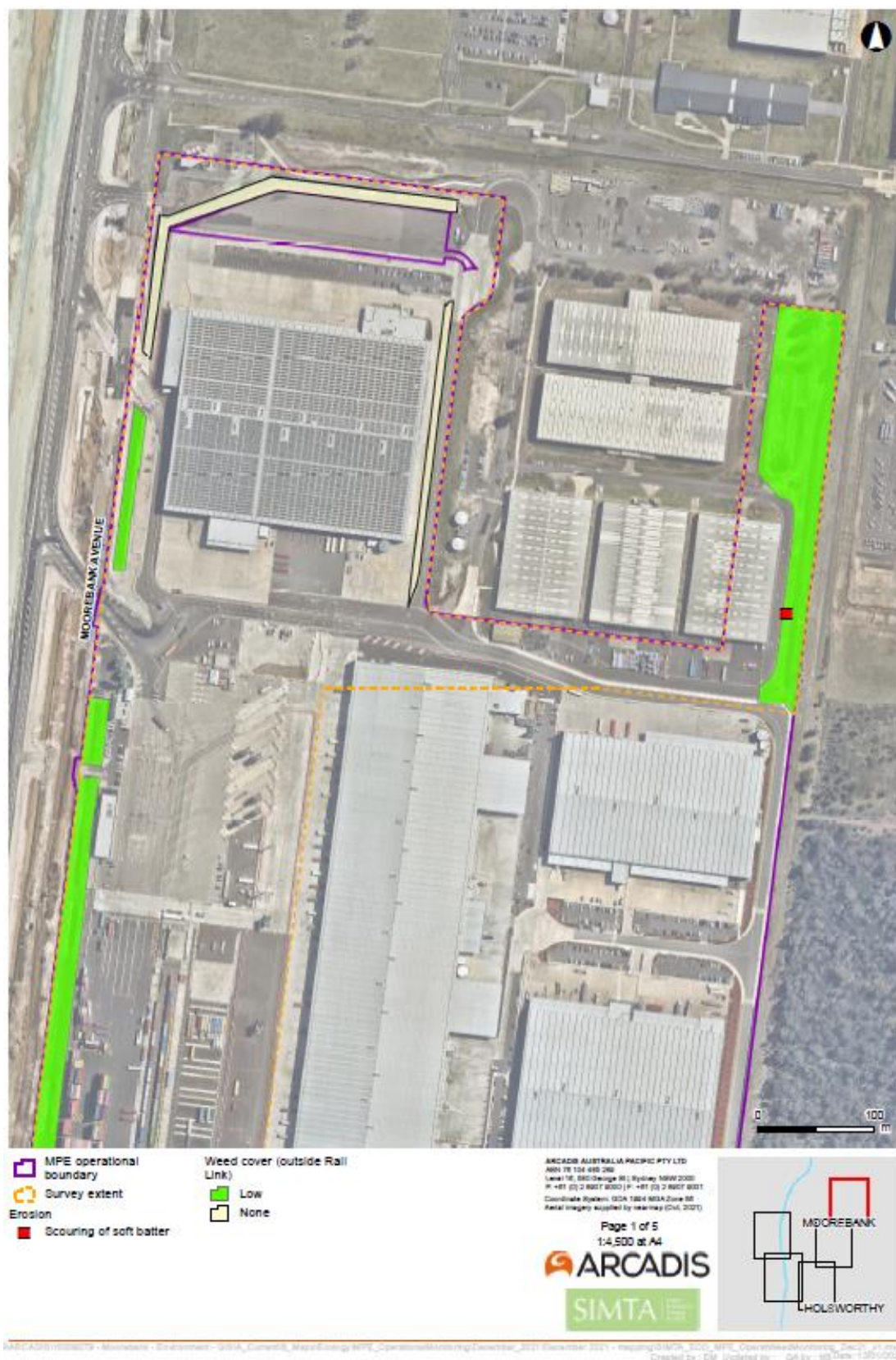


Figure 2. Weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 5)





Figure 3. Weed covers and aggressive weeds identified across the MPE operational facility (Map 2 of 5)





Figure 4 Weed covers and aggressive weeds identified across the MPE operational facility (Map 3 of 5)



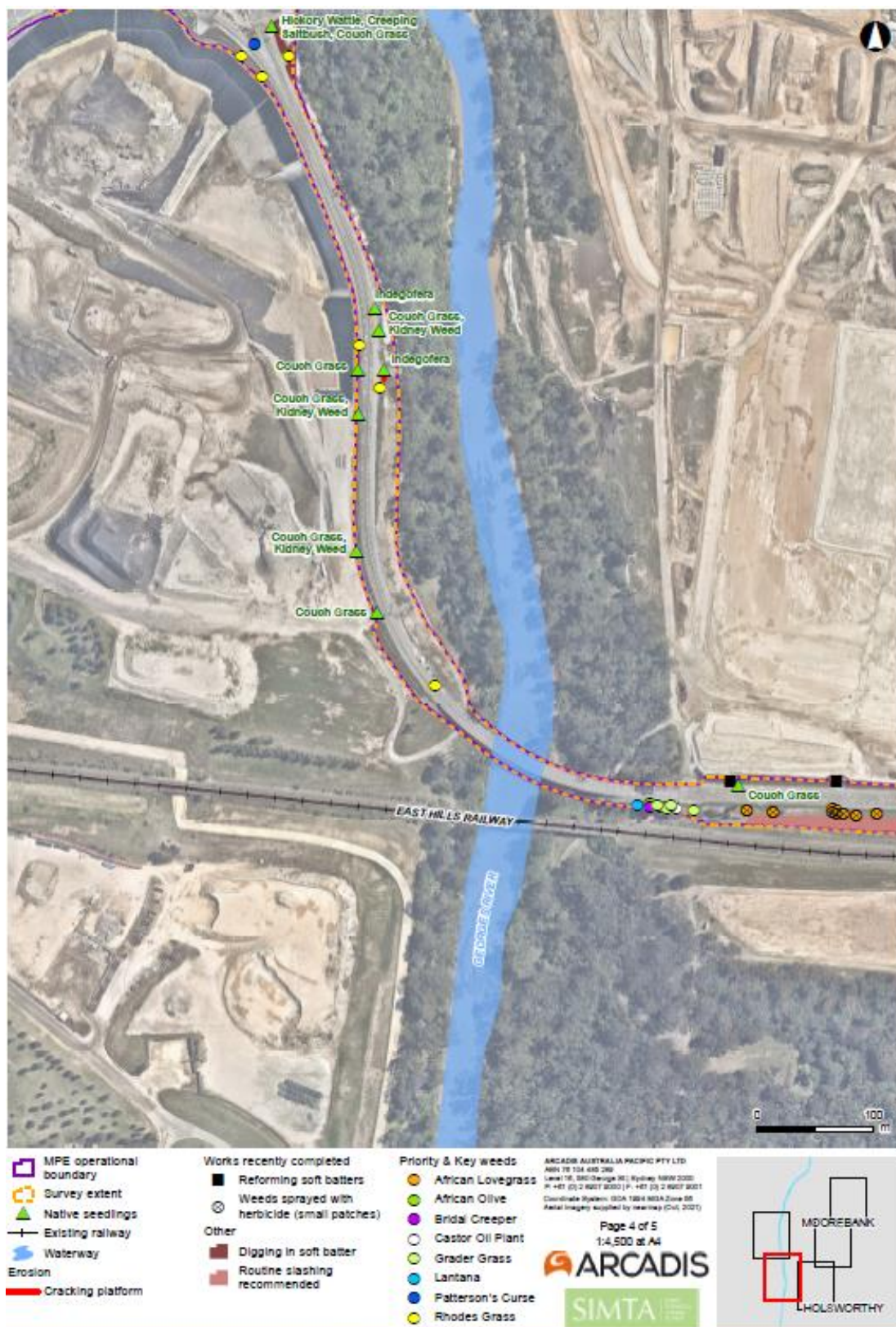


Figure 5. Weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 5)





Figure 6. Weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 5)



## Recommendations

Recommended actions documented in previous weed monitoring reports are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the October survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

Following the discussions and observations made during the December monitoring survey the following weed control and management actions are recommended:

- Targeted weed control works along revegetated soft batters. Weed control works will focus on controlling priority and key weed species. Hand weeding should be conducted for individuals whereas a combination of slashing and herbicide spraying should be adopted to target larger patches of weeds. A suggested process to target weeds along revegetated soft batters is presented in Figure 7.
- Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.
- Large patches of African Lovegrass and Rhodes Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events (Figure 4, Figure 5). This will reduce colonisation of these grasses into revegetation areas.
- Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility (Figure 3) should be slashed regularly to prevent seeding events. Slashing should be targeted to avoid impacts to naturally regenerating shrubs including Acacias. No herbicide should be used in these locations and all works should be contained within the construction envelope of the RALP. Qualified bush regenerators should be procured to conduct these works to reduce off-target impacts to native species. A suggested process to target weeds within these areas is presented in Figure 8.
- Collect litter from within the Rail Link and in adjacent areas
- Investigate large crack in Rail Link platform (Figure 5) and the small area of soft batter at the north-eastern area of the MPE operational facility subject to scouring (Figure 1).
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be continued to be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Application of herbicide within the Rail Link and in areas adjacent to the Moorebank biobank site should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

No herbicide spraying should be conducted outside of the Rail Link corridor, specifically adjacent to environmentally sensitive areas south of the MPE Operational facility (Figure 3). Manual weed control works in environmentally sensitive areas should not extend beyond the construction envelope of the RALP project. If further clarification the project ecologist should be consulted.

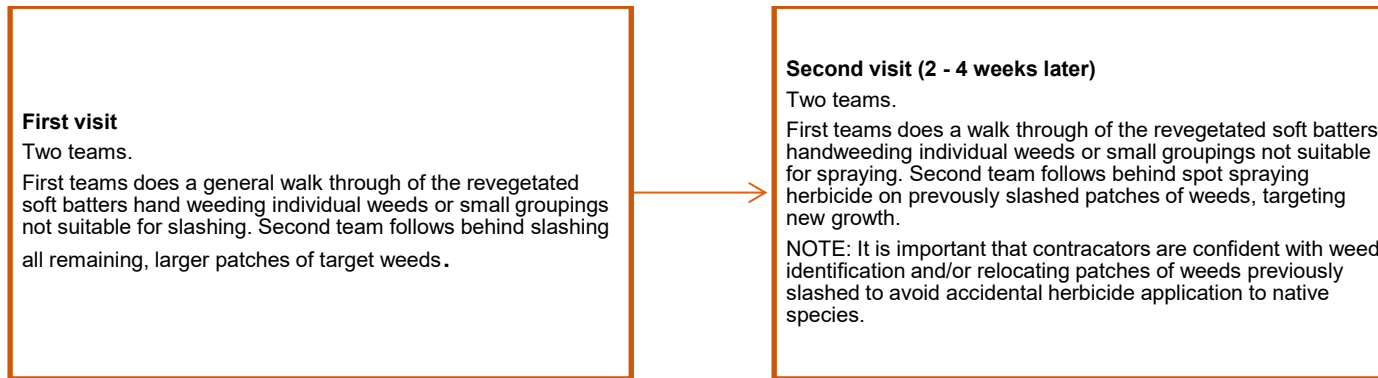


Figure 7. Suggested process to controlling target weeds on revegetated soft batters

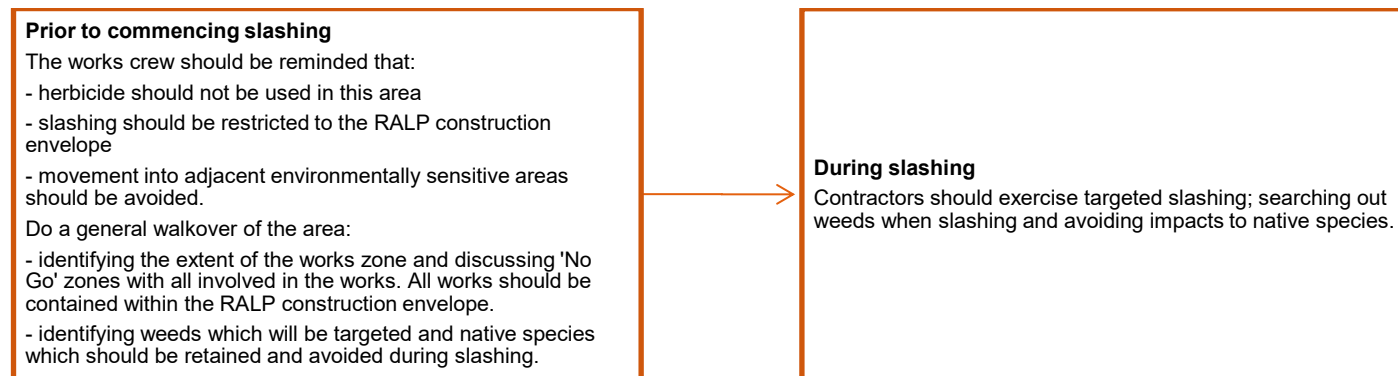


Figure 8. Slashing target weeds within the RALP construction envelope adjacent to environmentally sensitive areas

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate priority weeds species including Bridal Creeper, Alligator Weed, Lantana, Fireweed and African Olive	Commenced	Lantana, African Olive, Fireweed and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove key and aggressive weed species within Rail Link including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine	Commenced	<p>Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed to prevent further colonisation and infestations.</p> <p>Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.</p>
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE operational facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	<p>Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).</p> <p>Striking of native seed was observed during the December 2021 monitoring inspection within the Rail Link. The following native species were observed growing Hickory Wattle, Indigofera, Windmill Grass, Queensland Bluegrass, Couch Grass, Kangaroo Grass, Kidney Weed and Creeping Saltbush.</p>
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Targeted manual removal including slashing should be conducted for exotic species outside of the Rail Link corridor fencing. A qualified bush regeneration contractor should be used to avoid

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
			impacts to native species. Strictly no herbicide should be used in this area and works should not extend beyond the RALP construction envelope. Where possible, contractors should not access/pass through adjacent areas.
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Completed	Patches of African Love Grass on soft batters were sprayed by the contractor during the weed monitoring survey.
August 2021	Collect litter scattered through the Rail Link corridor and in adjacent areas	Not started	Litter still remains in Rail Link corridor and adjacent areas.
October 2021	Control aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link	Not started	New instances of aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link should be removed as soon as practicable to avoid spread of these species into environmentally sensitive areas adjacent to the Rail Link.

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



October 2021



December 2021



April 2021



October 2021



December 2021





April 2021



October 2021



December 2021



April 2021



October 2021



December 2021





April 2021



October 2021



December 2021



April 2021



October 2021



December 2021



April 2021



August 2021



December 2021



## APPENDIX C. PROFILES: PRIORITY WEEDS

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Lantana



Fireweed



Alligator Weed



African Olive



Bridal Creeper



Peruvian Primrose



## APPENDIX D. PROFILES: KEY WEEDS



Rhodes Grass



African Love Grass



Patterson's Curse



Coolatai Grass



Grader Grass



Red Natal Grass

## APPENDIX E. PLANT SPECIES INVENTORY

Scientific name	Common name	Exotic	priority/key weed
<i>Acacia falcata</i>	Hickory Wattle		
<i>Acacia parramattensis</i>	Parramatta Wattle		
<i>Acacia saligna</i>	Golden Wreath Wattle	*	
<i>Alternanthera philoxeroides</i>	Alligator weed	*	priority
<i>Alternanthera pungens</i>	Khaki Weed	*	
<i>Araujia sericifera</i>	Moth Vine	*	
<i>Asparagus asparagoides</i>	Bridal Creeper	*	priority
<i>Atriplex semibaccata</i>	Creeping Saltbush		
<i>Austrodanthonia spp.</i>			
<i>Avena spp.</i>	Oats	*	
<i>Bidens pilosa</i>	Cobbler's Pegs	*	
<i>Brassica rapa</i>	Field Mustard	*	
<i>Briza maxima</i>	Quaking Grass	*	
<i>Briza minor</i>	Shivery Grass	*	
<i>Cenchrus clandestinus</i>	Kikuyu Grass	*	
<i>Centaureum spp.</i>		*	
<i>Chloris gayana</i>	Rhodes Grass	*	key
<i>Chloris truncata</i>	Windmill Grass		
<i>Cirsium vulgare</i>	Spear Thistle	*	
<i>Convolvulus erubescens</i>	Pink Bindweed		
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*	
<i>Cyclospermum leptophyllum</i>	Slender Celery	*	
<i>Cynodon dactylon</i>	Common Couch		
<i>Cyperus eragrostis</i>	Umbrella Sedge	*	
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea		
<i>Dichanthium sericeum</i>	Queensland Bluegrass		
<i>Dichondra repens</i>	Kidney Weed		
<i>Echium plantagineum</i>	Paterson's Curse	*	key
<i>Eragrostis brownii</i>	Brown's Lovegrass		
<i>Eragrostis curvula</i>	African Lovegrass	*	key
<i>Euchiton spp.</i>			
<i>Ficinia nodosa</i>	Knobby Club-rush		
<i>Foeniculum vulgare</i>	Fennel	*	
<i>Glycine clandestina</i>			
<i>Hardenbergia violacea</i>	False Sarsaparilla		



Scientific name	Common name	Exotic	priority/key weed
<i>Hypochoeris radicata</i>	Catsear	*	
<i>Indigofera australis</i>	Australian Indigo		
<i>Juncus usitatus</i>			
<i>Lantana camara</i>	Lantana	*	priority
<i>Lachnagrostis filiformis</i>			
<i>Lactuca serriola</i>	Prickly Lettuce	*	
<i>Linum trigynum</i>	French Flax	*	
<i>Lolium perenne</i>	Perennial Ryegrass	*	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		
<i>Lysimachia arvensis</i>	Scarlet Pimpernel	*	
<i>Ludwigia peruviana</i>	Peruvian water primrose	*	priority
<i>Medicago polymorpha</i>	Burr Medic	*	
<i>Melilotus alba</i>	Bokhara	*	
<i>Melinis repens</i>	Red Natal Grass	*	key
<i>Modiola caroliniana</i>	Red-flowered Mallow	*	
<i>Olea europaea subsp. cuspidate</i>	African Olive	*	priority
<i>Paspalum dilatatum</i>	Paspalum	*	
<i>Persicaria decipiens</i>	Slender Knotweed		
<i>Phytolacca octandra</i>	Inkweed	*	
<i>Plantago lanceolata</i>	Lamb's Tongues	*	
<i>Portulaca oleracea</i>	Common Purslane		
<i>Rumex crispus</i>	Curled Dock	*	
<i>Senecio madagascariensis</i>	Fireweed	*	priority
<i>Setaria parviflora</i>		*	
<i>Sida rhombifolia</i>	Paddy's Lucerne	*	key
<i>Solanum nigrum</i>	Black-berry Nightshade	*	
<i>Solanum sisymbriifolium</i>		*	
<i>Sonchus oleraceus</i>	Common Sowthistle	*	
<i>Tagetes minuta</i>	Stinking Roger	*	
<i>Themeda quadrivalvis</i>	Grader Grass	*	key
<i>Themeda triandra</i>			
<i>Trifolium arvense</i>	Haresfoot Clover	*	
<i>Trifolium repens</i>	White Clover	*	
<i>Trifolium michelianum</i>	Bolansa Clover	*	
<i>Verbena bonariensis</i>	Purpletop	*	
<i>Verbena rigida var. Rigida</i>	Veined Verbena	*	

**Date** 11/03/2022  
**To** Marvin Do (Tactical)  
**From** Thea Kane (Arcadis)  
**Copy to** Marc Ragwoski (Tactical); Nathan Banks (Arcadis)  
**Subject** MPE operational facility – Weed monitoring report February 2022

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## Introduction

Arcadis have been commissioned to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed cover and the presence of any weeds listed as 'priority' for the Greater Sydney Local Land Services region under the *Biosecurity Act 2015*.

## Background

Arcadis have been monitoring the MPE operational facility for weed occurrence since April 2020. Soft landscaped areas surrounding the IMEX, warehouses and freight village and within drainage infrastructure have maintained low weed cover since the initial weed survey. Routine weed control works have been observed across these areas which have maintained the low weed cover. Overall, the change in weed cover across these areas has been minor since monitoring began and is considered acceptable against the operational requirements of the precinct.

The RALP which includes the MPE operational Rail Link has seen significant change and works over the time Arcadis has conducted weed monitoring. The soft batters either side of the Rail Link have had varying levels of exotic cover. In early spring 2020 Spray Grass solutions commenced a rehabilitation project to remove weeds from the batters and revegetate with native species commensurate with the Urban Design and Landscaping Plan (UDLP) for MPE. Spray Grass solutions procured Cumberland Plain Seeds to provide technical oversight of the revegetation effort with native seed.

A meeting was held on 7 December 2021 which discussed the progress of the rehabilitation project and how the areas included were to be managed going forward. As a result of this meeting, the monitoring methodology for the Rail Link was differentiated from the rest of the MPE operational facility to consider the revegetation methodology and management recommendations proposed by Spray Grass Solutions and Cumberland Valley Seeds.

Instead of reporting on the cover of all exotic species within the Rail Link the focus be shifted to monitoring the covers of 'priority' and key weeds, specific to this project. Similarly, recommendations made for the Rail Link will align with the decided upon management actions. The monitoring methodology for the Rail Link has been included below.

## Methodology

Arcadis ecologist Thea Kane attended the MPE operational facility on Thursday 17 February 2022. Monitoring involved traversing the MPE operational facility on foot surveying landscaped areas, stormwater infrastructure and soft batters adjoining the Rail Link. The areas surveyed are presented in Figure 1.

The weather on the day of survey was sunny with a maximum temperature of 34.7°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2021).

### IMEX, warehouses and drainage infrastructure

In soft landscaped areas surrounding the IMEX, warehouses, freight village and within drainage infrastructure the following activities were conducted:

- Identifying and mapping the occurrence of weeds listed as priority
- Mapping and estimating the per cent foliage cover of exotic species
- Mapping and estimating the per cent foliage cover of priority weeds
- Recording and mapping the extent of weed control works

The cover of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1

Table 1. Categories to describe percent cover of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

### Rail link

Following the meeting held in December 2022 regarding revegetating of the Rail Link, the monitoring methodology for weeds within the Rail Link has been refined to focus on key and priority weed species rather than all exotic species.

Priority weed species are any exotic species listed under the *Biosecurity Act 2015* for the Greater Sydney Local Land Services Area and key weed species have been identified as site-specific exotic plants with the potential to have detrimental outcomes for recruitment of native seedlings or impacts on adjacent environmentally sensitive areas. A list of priority and key weed species known from the Rail Link is included in Table 2.

Table 2. priority and key weed species subject to control within the Rail Link

priority weed species	key weed species
<i>Senecio madagascariensis</i> (Fireweed)	<i>Chloris gayana</i> (Rhodes Grass)
<i>Alternanthera philoxeroides</i> (Alligator weed)	<i>Eragrostis curvula</i> (African Lovegrass)
<i>Asparagus asparagoides</i> (Bridal Creeper) *	<i>Themeda quadrivalvis</i> (Grader Grass)
<i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive)	<i>Hyparrhenia hirta</i> (Coolatai Grass)



priority weed species	key weed species
<i>Lantana camara</i> (Lantana)	<i>Echium plantagineum</i> (Paterson's Curse)
<i>Ludwigia peruviana</i> (Ludwigia)	

The location of key and priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

## Study Limitations

The data presented within this report is restricted to what was observed and recorded by the attending Arcadis ecologists during the site assessment on the 17 February 2022.

Monitoring of weeds was restricted to the operational facility; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologists were not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys along the Southern Sydney Freight Line (SSFL) will require the attendance of a PO.

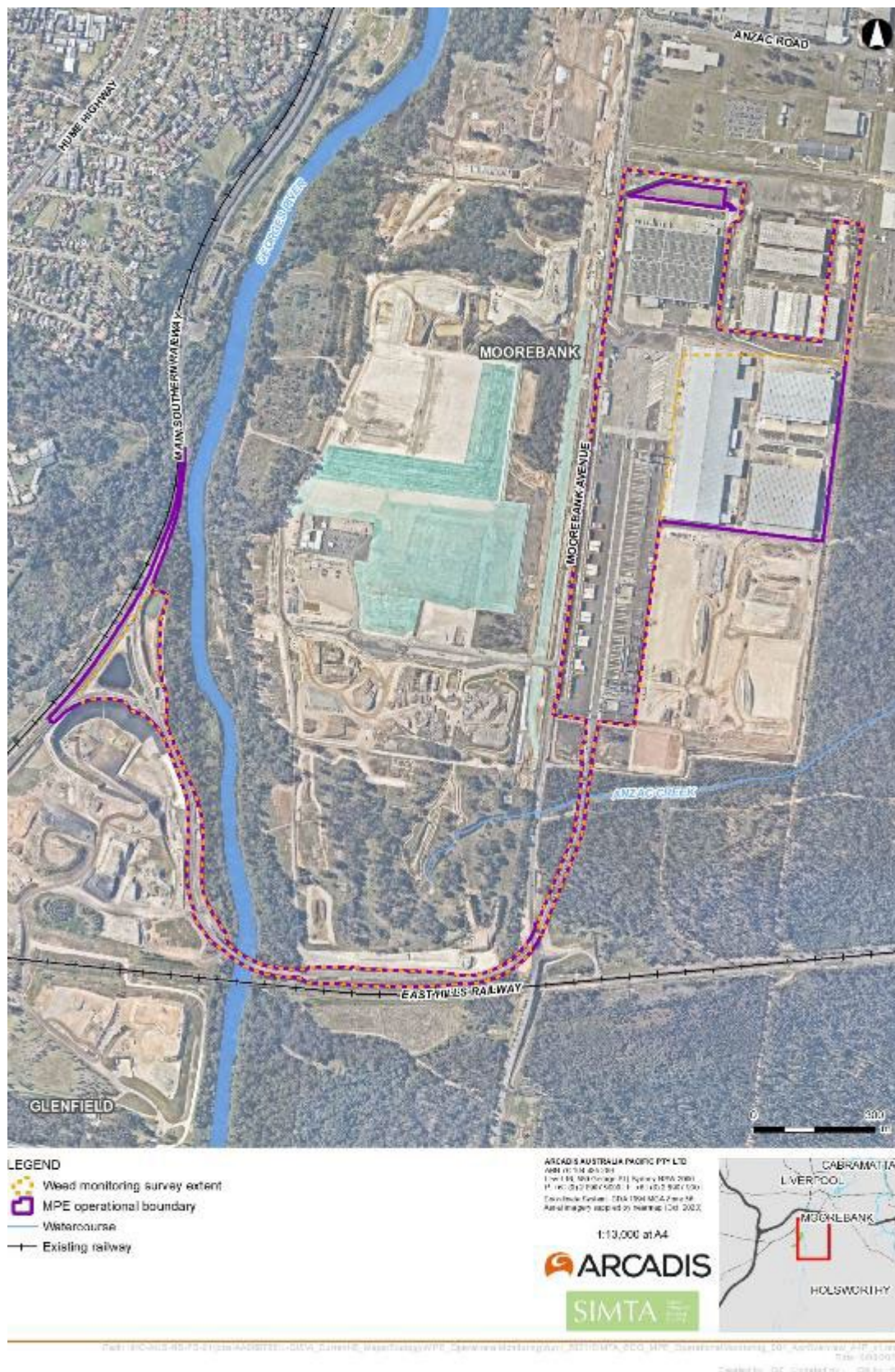


Figure 1. Survey extent within the MPE operational facility



## Results

Observations made by the attending ecologists during the February 2022 weed monitoring survey are summarised below.

### Weeds

Weed levels within the MPE operational facility have maintained similar covers to what was recorded during the December 2021 surveys. No weed control works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales however weed levels remain to be low. Several native species are present and continue to grow on soft batters and in the drainage swale including *Acacia falcata*, *Typha orientalis*, *Persicaria decipiens*, *Ficinia nodosa* and *Lomandra longifolia*.



*Plate 1. Low levels of weeds and established native plants observed on soft batters surrounding the basins and drainage channel at the north-eastern extent of the operation facility*

Construction works continue for the Moorebank Avenue upgrade which will act to remove the trunk drainage system running along the eastern side of the road which falls within the operational facility. The soft batters of this trunk drainage system have a low cover of exotic grasses which are currently acting to stabilise the soil. No priority or aggressive weed species were observed.

Evidence of targeted slashing of large woody weeds (such as *Conyza bonariensis*) was observed along the extent of the Rail Link which has been conducted between the current inspection and the December 2021 inspection. This targeted slashing aims to remove the seed heads from these weeds to manage their spread in this area (Plate 2).





Plate 2 Targeted slashing of large woody weeds observed within the Rail Link

Most areas of soft batter either side of the Rail Link displayed a high cover of exotic plants. No browning off of *Trifolium michelianum* (Bolans Clover) was observed. Commonly encountered exotic species included African Lovegrass, Rhodes Grass, *Bidens Pilosa* (Cobbler's Pegs), *Medicago polymorpha* (Bur Medic), *Hypochaeris radicata* (Catsear), *Lactuca serriola* (Prickly Lettuce), *Cirsium vulgare* (Spear Thistle) and *Senecio madagascariensis* (Fire Weed).



Plate 3. Exotic species continue colonising remediated soft batters within the Rail Link

Along soft batters adjacent to the Rail Link where exotic species were not present or with reduced cover, recruitment of native seedlings was occasionally observed. Native species observed during the inspection included *Acacia falcata* (Hickory Wattle), *Chloris truncata* (Windmill Grass), *Lachnagrostis filiformis* (Blown Grass), *Themeda triandra* (Kangaroo Grass) and *Cymbopogon refractus* (Barbed Wire Grass). Patches of *Cynodon dactylon* (Couch Grass) were also observed growing on the edges of the batter where exotic plant cover was low.





*Plate 4. Native seedlings observed growing on soft batters amongst exotic species included Barbed Wire Grass (left), Windmill Grass (centre) Blown Grass (right)*

An example of successful striking of native seedlings in areas subject to rehabilitation was observed on soft batters surrounding the basin adjacent to the SSFL. A suite of native species were observed accounting for a high cover; anticipated to be between 60-70 percent. Little to no exotic cover was observed in some locations. Revegetation in this area is thought to have been particularly successful due to the location being at the top of a slope with no exotic species located above, a seeding mix being applied which included a majority proportion of native species and good access sunlight. Photographs of these high-quality patches of native plantings are included in Plate #.



*Plate 5. A rehabilitated area which has a high native cover and a diversity of native grasses and scattered forbs*

A sparse scattering of priority weeds are present with the Rail Link, specifically on the eastern side of the Rail Link bridge. Species present include:

- *Asparagus asparagoides* (Bridal Creeper)
- *Lantana camara* (Lantana)
- *Olea europaea* subsp. *cuspidata* (African Olive)
- *Senecio madagascariensis* (Fireweed)

A slight increase in the number of Fireweed individuals was observed along the Rail Link, with most occurrences located on the eastern side.

The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the February 2022 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 3).

Table 3. Weed control works tracking

priority	Action	Action description	February '22 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Four priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive), <i>Lantana camara</i> (Lantana) and <i>Senecio madagascariensis</i> (Fireweed) (Figure 2 - Figure 6). These should be removed.
2	Removal of key an aggressive weed species	Key weed species including African Lovegrass, Rhodes Grass, Paterson's Curse. Coolatai Grass and Grader Grass should be removed revegetated areas of soft batter.  Aggressive weed species including Moth Vine, Castor Oil Plant should be removed from all operational areas using a combination of manual and herbicide control.	Key weed species including African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass are increasingly colonising soft batters in the Rail Link. These weeds should be prioritised for removal.  Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into revegetated areas.
3	Supress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and environmentally sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations.	Weed growth is increasing on soft batters adjacent to the biobank site and environmentally sensitive areas.  Manual removal including routine slashing has been adopted to



priority	Action	Action description	February '22 performance assessment
			prevent present weeds from reaching seeding maturity and further encroaching on adjacent high value areas (biobanks site and environmentally sensitive areas containing threatened plant species). All works should be restricted to the operational area and should not extend into the biobank site or identified environmentally sensitive areas.
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African Love Grass through regular mowing or slashing.	Slashing has not been adopted to managed regrowth of invasive grasses (African Lovegrass, Grader Grass) within the Rail Link.  Slashing should be used to manage large expanses of exotic grassland to prevent seeding events.
5	Reduce cover of weeds within the Rail Link	Reduction weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Targeted slashing has been employed to control weed colonisation on soft batters. Slashing has targeted mature plants, removing flowering and seed heads to minimise seeding.  Limited works have been conducted to reduce the cover of weeds within the Rail Link.  Future weed control actions will focus on removing and reducing the cover of priority and key weed species and suppressing the further colonisation of common weeds; which is consistent with the rehabilitation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Weed cover has generally remained low within trunk drainage infrastructure and at the north-eastern extent of the MPE operational facility.  No signs of weed control works were observed during the recent survey.

## Litter

A small amount of litter was again observed within the rail corridor and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within areas of native vegetation, blocking drainage infrastructure within the rail corridor, and in the Georges River (Plate ). It is not clear whether litter previously observed had been removed, or whether it had begun to deteriorate and be covered by vegetation.



*Plate 6. Litter observed within the rail corridor during the February inspection*

## Erosion

Erosion/scouring of the soft batter recorded during the December monitoring survey at the north-eastern end of the operational area within the drainage swale remains to be re-stabilised (Plate ). The large crack in the rail platform recorded during December 2021 survey at the western extent of the rail link remains. This was raised during an onsite inspection early in 2022 and it was not considered to be an issue and was hypothesised to be a result of platform sinking beneath the rail track. The platform and ballast supporting the rail track requires tampering over time to maintain levels due to compaction of the supporting substrate.



*Plate 7. Instances of erosion observed during the February monitoring event*



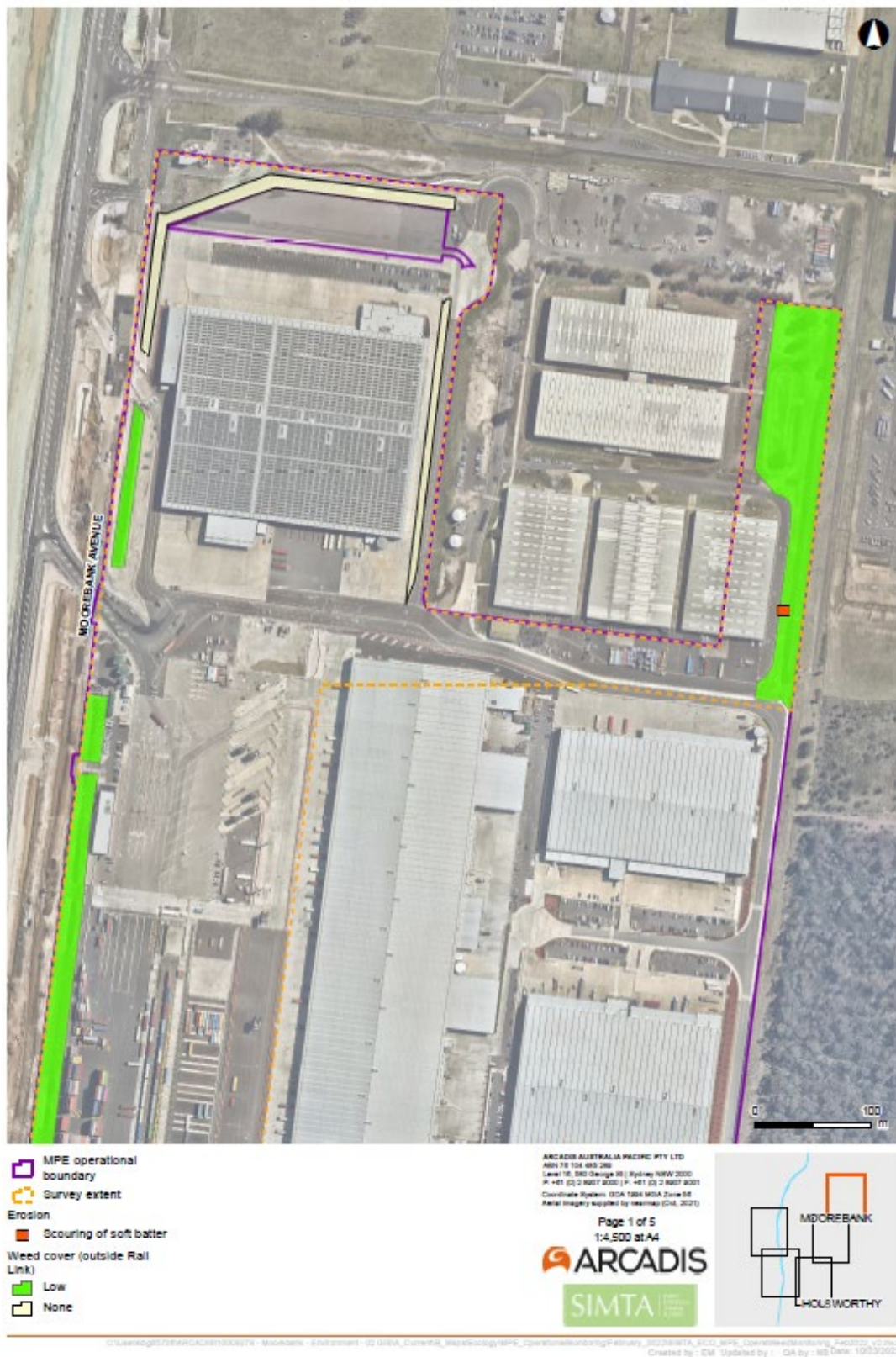


Figure 2. Weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 5)





Figure 3. Weed covers and aggressive weeds identified across the MPE operational facility (Map 2 of 5)





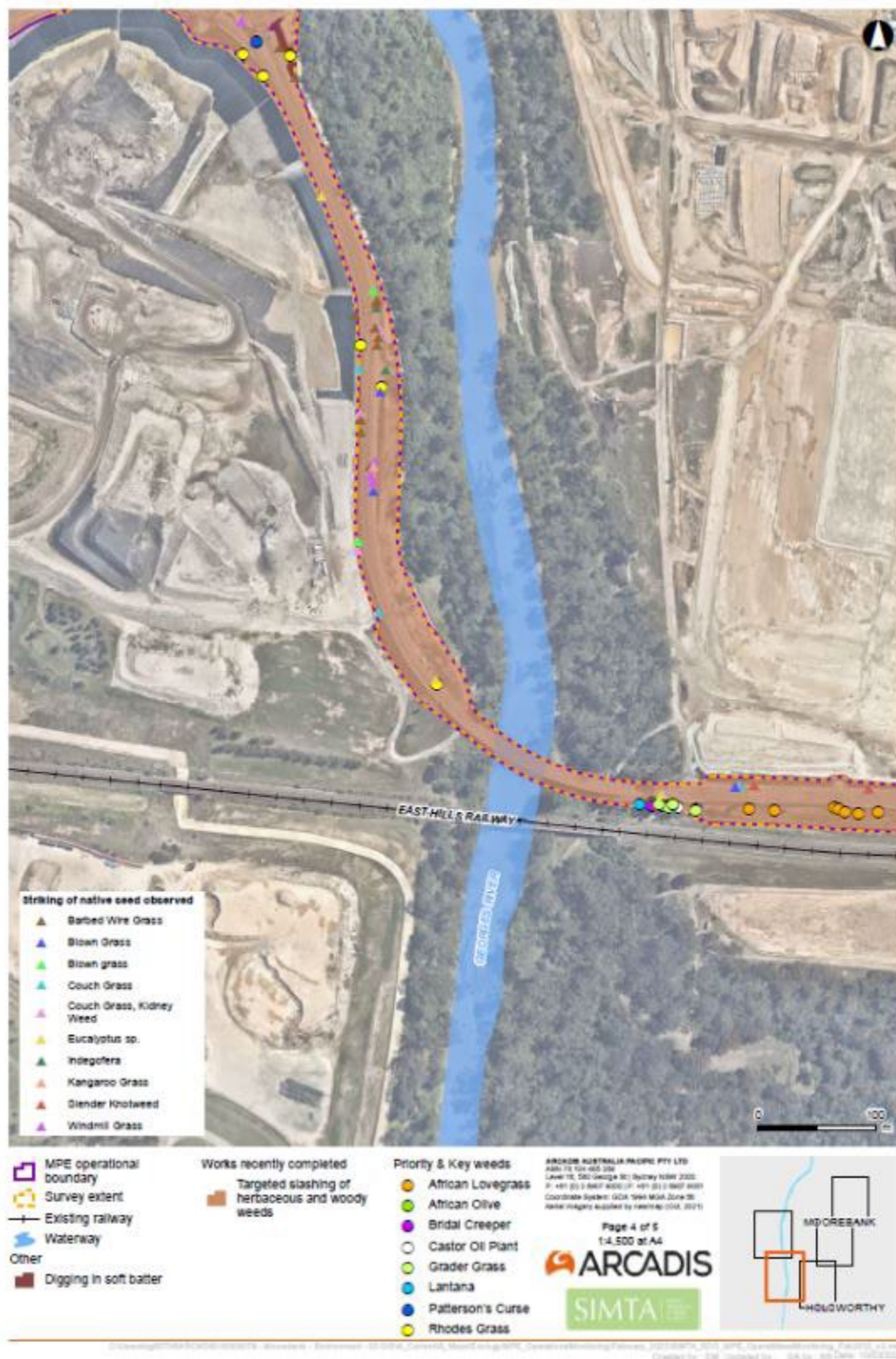


Figure 5. Weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 5)



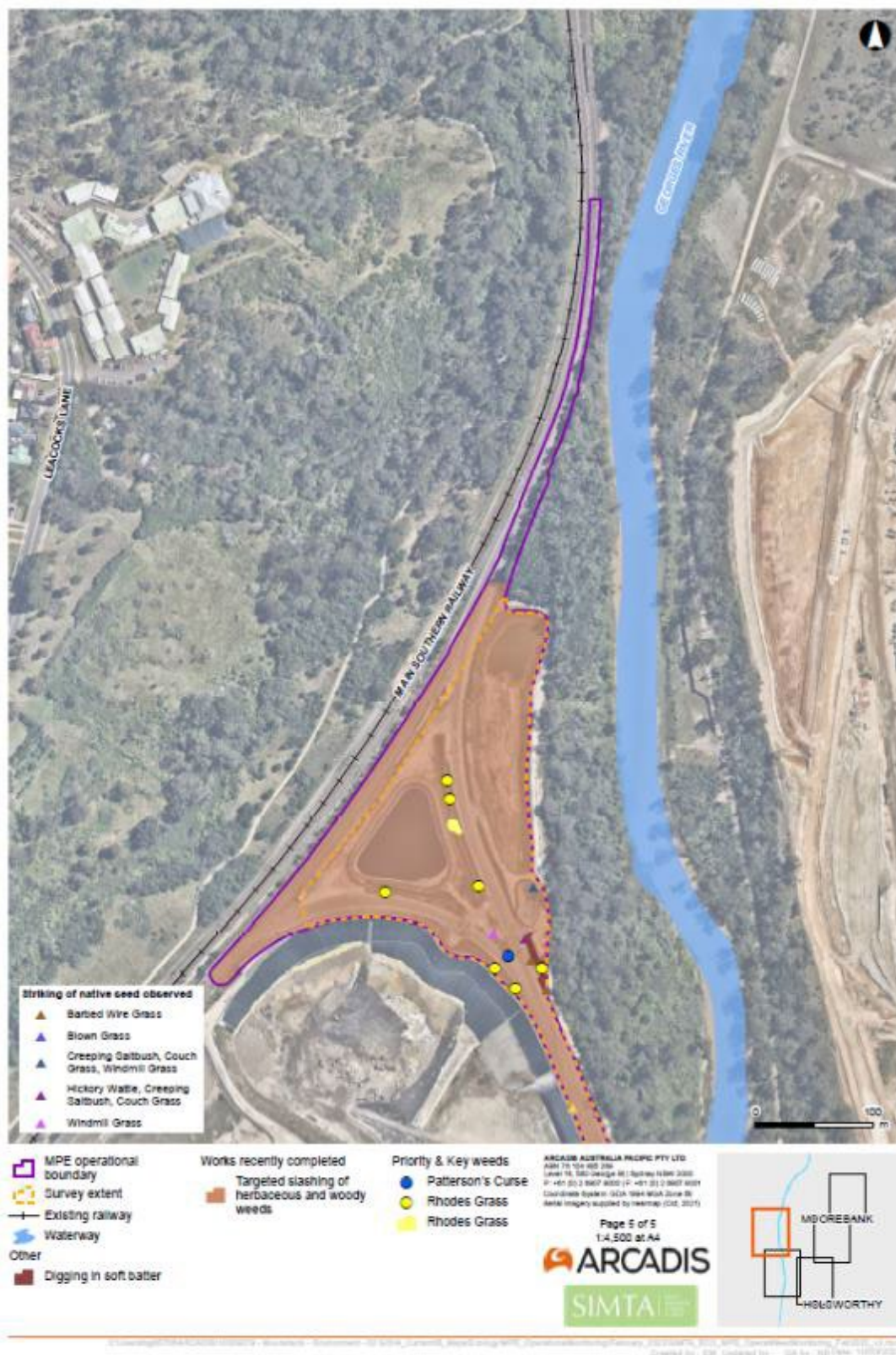


Figure 6. Weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 5)

## Recommendations

Recommended actions documented in previous weed monitoring reports are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the December 2021 survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

Majority of weed control and management actions recommendations documented in the December 2021 weed monitoring report are still applicable to management of the site. These include:

- Targeted weed control works along revegetated soft batters. Weed control works will focus on controlling priority and key weed species. Hand weeding should be conducted for individuals whereas a combination of slashing and herbicide spraying should be adopted to target larger patches of weeds. A suggested process to target weeds along revegetated soft batters is presented in Figure 7.
- Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.
- Large patches of African Lovegrass and Rhodes Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events (Figure 4, Figure 5). This will reduce colonisation of these grasses into revegetation areas.
- Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility (Figure 3) should be slashed regularly to prevent seeding events. Slashing should be targeted to avoid impacts to naturally regenerating shrubs including Acacias. No herbicide should be used in these locations and all works should be contained within the construction envelope of the RALP. Qualified bush regenerators should be procured to conduct these works to reduce off-target impacts to native species. A suggested process to target weeds within these areas is presented in Figure 8.
- Continue to collect litter from with the Rail Link and in adjacent areas
- Investigate the small area of soft batter at the north-eastern area of the MPE operational facility subject to scouring (Figure 1).
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be continue to be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Application of herbicide within the Rail Link and in areas adjacent to the Moorebank biobank site should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

No herbicide spraying should be conducted outside of the Rail Link corridor, specifically adjacent to environmentally sensitive areas south of the MPE Operational facility (Figure 3). Manual weed control works in environmentally sensitive areas should not extend beyond the construction envelope of the RALP project. If further clarification the project ecologist should be consulted.

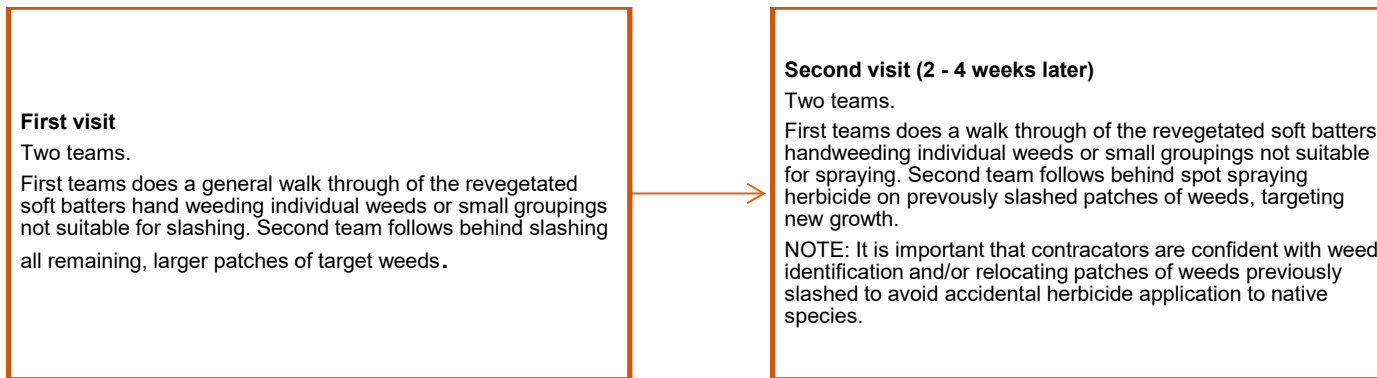


Figure 7. Suggested process to controlling target weeds on revegetated soft batters

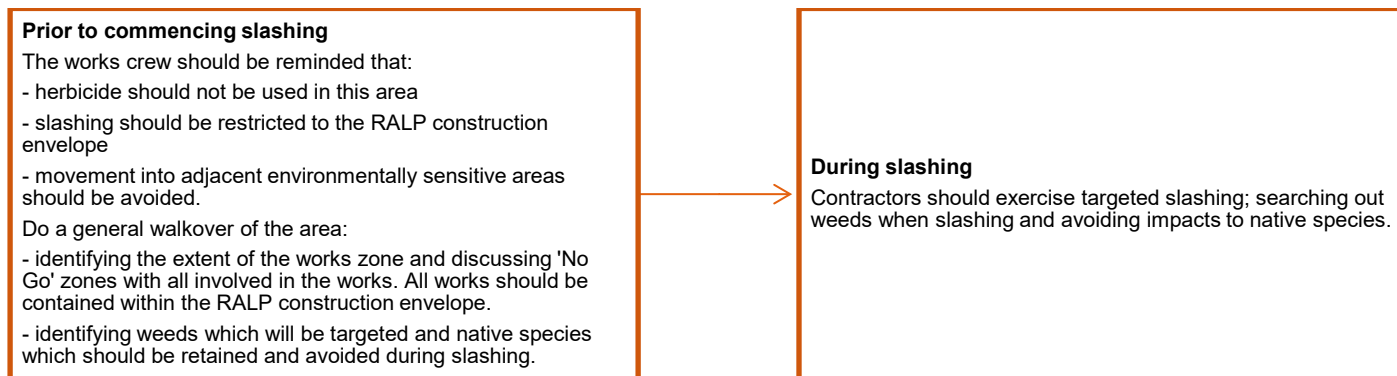


Figure 8. Slashing target weeds within the RALP construction envelope adjacent to environmentally sensitive areas



## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>

## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate priority weeds species including Bridal Creeper, Alligator Weed, Lantana, Fireweed and African Olive	Commenced	Lantana, African Olive, Fireweed and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove key and aggressive weed species within Rail Link including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine	Commenced	Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed to prevent further colonisation and infestations.  Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE operational facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).  Additional striking of native seed was observed during the February 2022 monitoring inspection within the Rail Link. The following native species were observed growing Hickory Wattle, Indigofera, Windmill Grass, Queensland Bluegrass, Couch Grass, Kangaroo Grass, Kidney Weed, Barbed Wire Grass, Blown Grass and Creeping Saltbush.
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Targeted manual removal including slashing has been conducted for exotic species outside of the Rail Link corridor fencing. A qualified bush

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
			regeneration contractor should be used to avoid impacts to native species. Strictly no herbicide should be used in this area and works should not extend beyond the RALP construction envelope. Where possible, contractors should not access/pass through adjacent areas.
April 2021	Spot spraying tussocks of African Lovegrass within remediated areas	Completed	Patches of African Love Grass on soft batters were sprayed by the contractor during the weed monitoring survey.
August 2021	Collect litter scattered through the Rail Link corridor and in adjacent areas	Not started	Litter still remains in Rail Link corridor and adjacent areas.
October 2021	Control aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link	Not started	New instances of aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link should be removed as soon as practicable to avoid spread of these species into environmentally sensitive areas adjacent to the Rail Link.
February 2022	Continued targeted slashing of woody and herbaceous weeds within the Rail Link.	Commenced	Continue regular slashing of large woody weeds to remove the fertile seed head and discourage further germination of these weeds within the Rail Link.



## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



December 2021



February 2022



April 2021



December 2021



February 2022





April 2021



December 2021



February 2022



April 2021



December 2021



February 2022





April 2021



December 2021



February 2022



April 2021



December 2021



February 2022





April 2021



December 2021



February 2022

## APPENDIX C. PROFILES: PRIORITY WEEDS



Lantana



Fireweed



Alligator Weed



African Olive



Bridal Creeper



Peruvian Primrose



## APPENDIX D. PROFILES: KEY WEEDS



Rhodes Grass



African Love Grass



Patterson's Curse



Coolatai Grass



Grader Grass



Red Natal Grass



## APPENDIX E. PLANT SPECIES INVENTORY

Scientific name	Common name	Exotic	priority/key weed
<i>Acacia falcata</i>	Hickory Wattle		
<i>Acacia parramattensis</i>	Parramatta Wattle		
<i>Acacia saligna</i>	Golden Wreath Wattle	*	
<i>Alternanthera philoxeroides</i>	Alligator weed	*	priority
<i>Alternanthera pungens</i>	Khaki Weed	*	
<i>Araujia sericifera</i>	Moth Vine	*	
<i>Asparagus asparagoides</i>	Bridal Creeper	*	priority
<i>Atriplex semibaccata</i>	Creeping Saltbush		
<i>Austrodanthonia spp.</i>			
<i>Avena spp.</i>	Oats	*	
<i>Bidens pilosa</i>	Cobbler's Pegs	*	
<i>Brassica rapa</i>	Field Mustard	*	
<i>Briza maxima</i>	Quaking Grass	*	
<i>Briza minor</i>	Shivery Grass	*	
<i>Cenchrus clandestinus</i>	Kikuyu Grass	*	
<i>Centaureum spp.</i>		*	
<i>Chloris gayana</i>	Rhodes Grass	*	key
<i>Chloris truncata</i>	Windmill Grass		
<i>Cirsium vulgare</i>	Spear Thistle	*	
<i>Convolvulus erubescens</i>	Pink Bindweed		
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*	
<i>Cyclospermum leptophyllum</i>	Slender Celery	*	
<i>Cynodon dactylon</i>	Common Couch		
<i>Cymbopogon refractus</i>	Barbed Wire Grass		
<i>Cyperus eragrostis</i>	Umbrella Sedge	*	
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea		
<i>Dichanthium sericeum</i>	Queensland Bluegrass		
<i>Dichondra repens</i>	Kidney Weed		
<i>Echium plantagineum</i>	Paterson's Curse	*	key
<i>Eragrostis brownii</i>	Brown's Lovegrass		
<i>Eragrostis curvula</i>	African Lovegrass	*	key
<i>Euchiton spp.</i>			
<i>Ficinia nodosa</i>	Knobby Club-rush		
<i>Foeniculum vulgare</i>	Fennel	*	
<i>Glycine clandestina</i>			

Scientific name	Common name	Exotic	priority/key weed
<i>Hardenbergia violacea</i>	False Sarsaparilla		
<i>Hypochoeris radicata</i>	Catsear	*	
<i>Indigofera australis</i>	Australian Indigo		
<i>Juncus usitatus</i>			
<i>Lantana camara</i>	Lantana	*	priority
<i>Lachnagrostis filiformis</i>	Blown Grass		
<i>Lactuca serriola</i>	Prickly Lettuce	*	
<i>Linum trigynum</i>	French Flax	*	
<i>Lolium perenne</i>	Perennial Ryegrass	*	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		
<i>Lysimachia arvensis</i>	Scarlet Pimpernel	*	
<i>Ludwigia peruviana</i>	Peruvian water primrose	*	priority
<i>Medicago polymorpha</i>	Burr Medic	*	
<i>Melilotus alba</i>	Bokhara	*	
<i>Melinis repens</i>	Red Natal Grass	*	key
<i>Modiola caroliniana</i>	Red-flowered Mallow	*	
<i>Olea europaea subsp. cuspidate</i>	African Olive	*	priority
<i>Paspalum dilatatum</i>	Paspalum	*	
<i>Persicaria decipiens</i>	Slender Knotweed		
<i>Phytolacca octandra</i>	Inkweed	*	
<i>Plantago lanceolata</i>	Lamb's Tongues	*	
<i>Portulaca oleracea</i>	Common Purslane		
<i>Rumex crispus</i>	Curled Dock	*	
<i>Senecio madagascariensis</i>	Fireweed	*	priority
<i>Setaria parviflora</i>		*	
<i>Sida rhombifolia</i>	Paddy's Lucerne	*	key
<i>Solanum nigrum</i>	Black-berry Nightshade	*	
<i>Solanum sisymbriifolium</i>		*	
<i>Sonchus oleraceus</i>	Common Sowthistle	*	
<i>Tagetes minuta</i>	Stinking Roger	*	
<i>Themeda quadrivalvis</i>	Grader Grass	*	key
<i>Themeda triandra</i>			
<i>Trifolium arvense</i>	Haresfoot Clover	*	
<i>Trifolium repens</i>	White Clover	*	
<i>Trifolium michelianum</i>	Bolansa Clover	*	
<i>Verbena bonariensis</i>	Purpletop	*	

Scientific name	Common name	Exotic	priority/key weed
<i>Verbena rigida</i> var. <i>Rigida</i>	Veined Verbena	*	



**Date** 29/04/2022  
**To** Marvin Do (Tactical)  
**From** Thea Kane (Arcadis)  
**Copy to** Marc Ragwoski (Tactical); Nathan Banks (Arcadis)  
**Subject** MPE operational facility – Weed monitoring report April 2022

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## Introduction

Arcadis have been commissioned to conduct bi-monthly weed monitoring surveys within Moorebank Precinct East (MPE) operational facility at Moorebank Logistics Park. The MPE operational facility includes the:

- Import and Export Terminal (IMEX)
- Rail Access Land Package (RALP)
- Warehouses, distribution facilities and freight village
- Stormwater trunk drainage infrastructure and landscaping areas

Regular monitoring of the MPE operational facility will inform the land manager of weed cover and the presence of any weeds listed as 'priority' for the Greater Sydney Local Land Services region under the *Biosecurity Act 2015*.

## Background

Arcadis have been monitoring the MPE operational facility for weed occurrence since April 2020. Soft landscaped areas surrounding the IMEX, warehouses and freight village and within drainage infrastructure have maintained low weed cover since the initial weed survey. Routine weed control works have been observed across these areas which have maintained the low weed cover. Overall, the change in weed cover across these areas has been minor since monitoring began and is considered acceptable against the operational requirements of the precinct.

The RALP which includes the MPE operational Rail Link has seen significant change and works over the time Arcadis has conducted weed monitoring. The soft batters either side of the Rail Link have had varying levels of exotic cover. In early spring 2020 Spray Grass solutions commenced a rehabilitation project to remove weeds from the batters and revegetate with native species commensurate with the Urban Design and Landscaping Plan (UDLP) for MPE. Spray Grass solutions procured Cumberland Plain Seeds to provide technical oversight of the revegetation effort with native seed.

A meeting was held on 7 December 2021 which discussed the progress of the rehabilitation project and how the areas included were to be managed going forward. As a result of this meeting, the monitoring methodology for the Rail Link was differentiated from the rest of the MPE operational facility to consider the revegetation methodology and management recommendations proposed by Spray Grass Solutions and Cumberland Valley Seeds.

Instead of reporting on the cover of all exotic species within the Rail Link the focus be shifted to monitoring the covers of 'priority' and key weeds, specific to this project. Similarly, recommendations made for the Rail Link will align with the decided upon management actions. The monitoring methodology for the Rail Link has been included below.

## Methodology

Arcadis ecologist Thea Kane attended the MPE operational facility on Wednesday 20 April 2022. Monitoring involved traversing the MPE operational facility on foot surveying landscaped areas, stormwater infrastructure and soft batters adjoining the Rail Link. The areas surveyed are presented in Figure 1.

The weather on the day of survey was sunny with a maximum temperature of 23.5°C recorded at Holsworthy Aerodrome (station 066161) (BOM 2021).

### IMEX, warehouses and drainage infrastructure

In soft landscaped areas surrounding the IMEX, warehouses, freight village and within drainage infrastructure the following activities were conducted:

- Identifying and mapping the occurrence of weeds listed as priority
- Mapping and estimating the per cent foliage cover of exotic species
- Mapping and estimating the per cent foliage cover of priority weeds
- Recording and mapping the extent of weed control works

The cover of exotic species and priority weeds were estimated based on the area of cover within a patch and categorised as per Table 1

Table 1. Categories to describe percent cover of weeds

Categories	Percentage cover of weeds within a patch (%)
Low	5 – 25
Moderate	25 – 75
High	75 – 100

The location of weed infestations, priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

### Rail link

Following the meeting held in December 2022 regarding revegetating of the Rail Link, the monitoring methodology for weeds within the Rail Link has been refined to focus on key and priority weed species rather than all exotic species.

Priority weed species are any exotic species listed under the *Biosecurity Act 2015* for the Greater Sydney Local Land Services Area and key weed species have been identified as site-specific exotic plants with the potential to have detrimental outcomes for recruitment of native seedlings or impacts on adjacent environmentally sensitive areas. A list of priority and key weed species known from the Rail Link is included in Table 2.

Table 2. Priority and key weed species subject to control within the Rail Link

priority weed species	key weed species
<i>Senecio madagascariensis</i> (Fireweed)	<i>Chloris gayana</i> (Rhodes Grass)
<i>Alternanthera philoxeroides</i> (Alligator weed)	<i>Eragrostis curvula</i> (African Lovegrass)
<i>Asparagus asparagoides</i> (Bridal Creeper)	<i>Themeda quadrivalvis</i> (Grader Grass)
<i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive)	<i>Hyparrhenia hirta</i> (Coolatai Grass)

priority weed species	key weed species
<i>Lantana camara</i> (Lantana)	<i>Echium plantagineum</i> (Paterson's Curse)
<i>Ludwigia peruviana</i> (Ludwigia)	

The location of key and priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

## Study Limitations

The data presented within this report is restricted to what was observed and recorded by the attending Arcadis ecologists during the site assessment on the 20 April 2022.

Monitoring of weeds was restricted to the operational facility; weeds were not assessed within the bounds of the active construction areas surrounding new warehouses.

Surveys were not undertaken in areas extending beyond the junction between the Qube Rail Link and the Southern Sydney Freight Line (SSFL) as the ecologists were not under the supervision of an Australian Rail Track Corporation (ARTC) Protection Officer (PO). Future surveys along the Southern Sydney Freight Line (SSFL) will require the attendance of a PO.





## Results

Observations made by the attending ecologists during the April 2022 weed monitoring survey are summarised below.

### Weeds

Weed levels within the MPE operational facility have maintained similar covers to what was recorded during the February 2022 surveys. No weed control works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales. While weed cover remains low, the current survey identified new instances of priority weed Fireweed (Plate 1) and key weed Rhodes Grass in this area, not previously recorded (Figure 2). Several native species are present and continue to grow on soft batters and in the drainage swale including *Acacia falcata* (Sickle Wattle), *Typha orientalis* (Bulrush), *Persicaria decipiens* (Slender Knotweed), *Ficinia nodosa* (Knotted Club-rush) and *Lomandra longifolia* (Mat Rush).



Plate 1. New observations of Fireweed in drainage basins (left) and low cover of exotic species around drainage basin (right)

Construction works continue for the Moorebank Avenue upgrade which will act to remove the trunk drainage system running along the eastern side of the road which falls within the operational facility. The soft batters of this trunk drainage system have a low cover of exotic grasses which are currently acting to stabilise the soil. Some instances of Fireweed were observed during the current survey, not previously observed in this area (Figure 3).

No evidence of targeted weed control works was observed along the extent of the Rail Link since targeted slashing of herbaceous weeds (Fleabane) was undertaken between the December 2021 and February 2022 inspection. Fleabane was not recorded to have regrown in these areas.

Most areas of soft batter either side of the Rail Link displayed a large increase in exotic biomass since the previous inspection during February 2022. An increase to the biomass of Fireweed, Rhodes Grass and Grader Grass patches was observed along the Rail Link, with most occurrences located on the eastern side. It is likely that recent climactic variables, including the combination of high rainfall and sunny days have created favourable conditions for herbaceous and grass weeds to thrive.

No weed control works or browning off of other herbaceous weeds were observed during current surveys.





*Plate 2. Exotic species continue colonising remediated soft batters within the Rail Link*

Native seedlings observed during previous surveys of the Rail Link soft batters were not re-found during current surveys. The increase in exotic plant cover observed since previous surveys has likely smothered native seedlings of *Chloris truncata* (Windmill Grass), *Lachnagrostis filiformis* (Blown Grass) and Creeping Saltbush (*Atriplex semibaccata*), which previously occurred (Plate 4).



*Plate 3. Large areas of Rhodes Grass suppressing native seedling regeneration*

Some hardier native seedlings, such as Sickle Wattle and *Indigofera australis* (Australia indigo), were observed to be growing unimpeded by increasing weed cover (Plate 4).





*Plate 4 Sickle Wattle observed to be growing despite increase in exotic biomass*

An isolated area containing priority and key weeds remains to be untreated on the eastern side of the Rail Link bridge. aggressive weed species present include *Asparagus asparagoides* (Bridal Creeper), *Lantana camara* (Lantana), *Olea europaea* subsp. *cuspidata* (African Olive), *Senecio madagascariensis* (Fireweed), *Chloris gayana* (Rhodes Grass) and *Themeda quadrivalvis* (Grader Grass).

The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 6.

The status of weeds and weed control works observed during the April 2022 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 3).

Table 3. Weed control works tracking

priority	Action	Action description	April '22 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through a combination of manual removal and herbicide treatment. Herbicide application should be considerate of timing (i.e. applying herbicide when weeds are actively growing) and best practice methodologies.	Four priority weed species are present within the Rail Link: <i>Asparagus asparagoides</i> (Bridal Creeper), <i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive), <i>Lantana camara</i> (Lantana) and <i>Senecio madagascariensis</i> (Fireweed) (Figure 2 - Figure 6). These should be removed.
2	Removal of key an aggressive weed species	<p>Key weed species including African Lovegrass, Rhodes Grass, Paterson's Curse. Coolatai Grass and Grader Grass should be removed revegetated areas of soft batter.</p> <p>Aggressive weed species including Moth Vine, Castor Oil Plant should be removed from all operational areas using a combination of manual and herbicide control.</p>	<p>Key weed species including African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass are increasingly colonising soft batters in the Rail Link. These weeds should be prioritised for removal.</p> <p>Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link, however are likely outside of the operational boundary (Figure 2 - Figure 6). Despite this, these weeds should be removed to avoid encroachment into revegetated areas.</p>
3	Supress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and environmentally sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations.	<p>Weed growth is increasing on soft batters adjacent to the biobank site and environmentally sensitive areas. In some instances, exotic species are encroaching into these environmentally sensitive areas.</p> <p>Manual removal including routine slashing has been adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent high value areas (biobanks site and environmentally sensitive areas containing threatened plant species). All works should be restricted to the operational area and should not extend into the biobank site or identified environmentally sensitive areas.</p>
4	Slashing of invasive grasses to prevent seeding.	Management of invasive grasses such as Rhodes Grass and African	Slashing has not been adopted to managed regrowth of invasive

priority	Action	Action description	April '22 performance assessment
		Love Grass through regular mowing or slashing.	grasses (African Lovegrass, Grader Grass) within the Rail Link.  Slashing should be used to manage large expanses of exotic grassland to prevent seeding events.
5	Reduce cover of weeds within the Rail Link	Reduction weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Targeted slashing has been previously employed to control weed colonisation on soft batters, however needs to be continued to limit re-colonisation of weeds within the Rail Link. Works should involve targeted slashing of mature plants, removing flowering and seed heads to minimise seeding.  No works have been conducted to reduce the cover of weeds within the Rail Link since the February 2022 monitoring event.  Future weed control actions will focus on removing and reducing the cover of priority and key weed species and suppressing the further colonisation of common weeds; which is consistent with the rehabilitation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.
6	Remove herbaceous and woody within the operational area and trunk drainage infrastructure.	Reduction in herbaceous and woody weeds by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019)	Weed cover has generally remained low within trunk drainage infrastructure and at the north-eastern extent of the MPE operational facility.  No signs of weed control works were observed during the recent survey.



## Litter

A small amount of litter was again observed within the rail corridor and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within areas of native and exotic vegetation, blocking drainage infrastructure within the rail corridor, and in the Georges River (Plate 6). It is not clear whether litter previously observed had been removed, or whether it had begun to deteriorate and be covered by vegetation.



*Plate 5. Litter observed within the rail corridor during the February inspection*



Figure 2. Weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 5)





Figure 3. Weed covers and aggressive weeds identified across the MPE operational facility (Map 2 of 5)



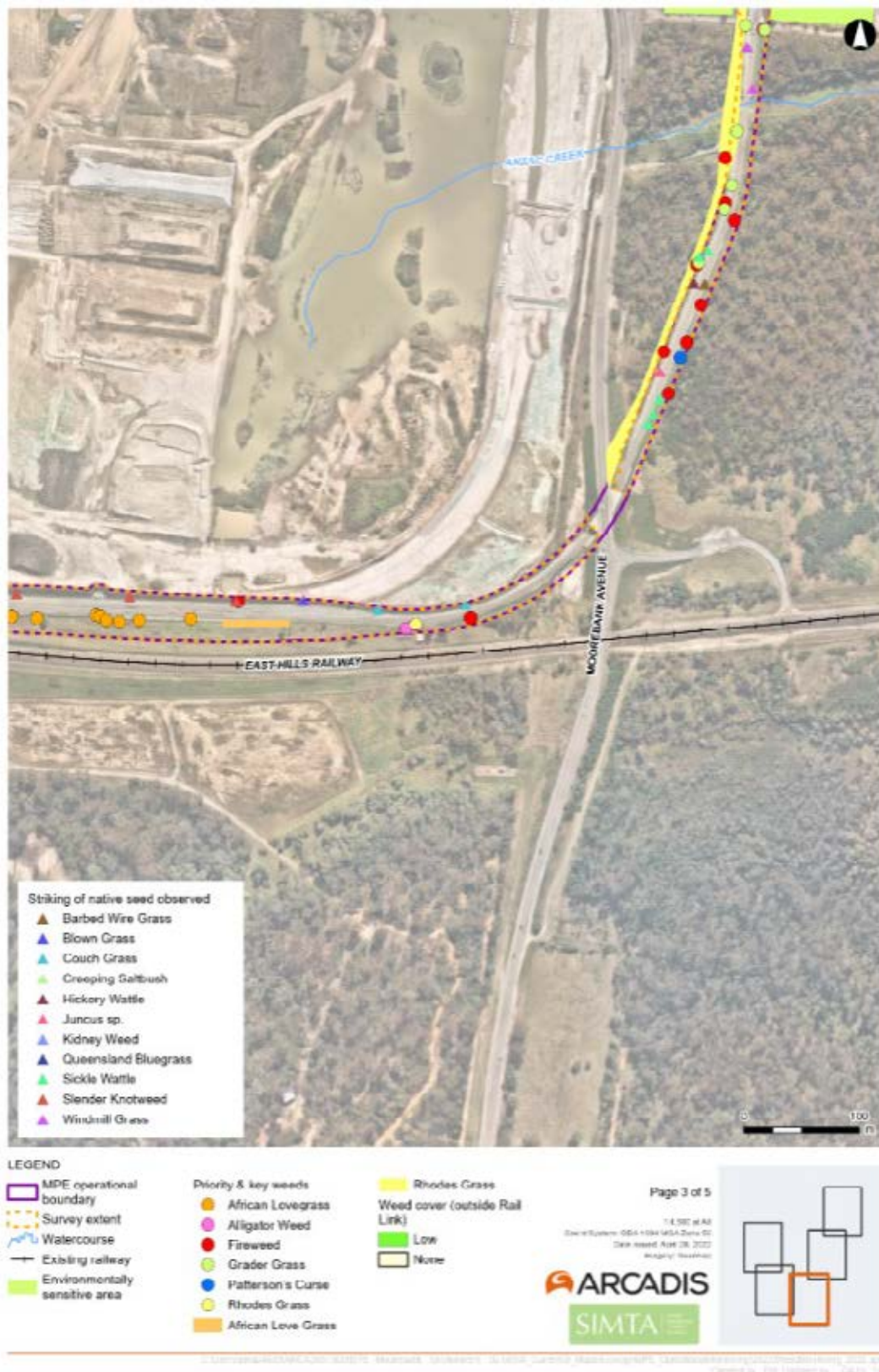


Figure 4 Weed covers and aggressive weeds identified across the MPE operational facility (Map 3 of 5)

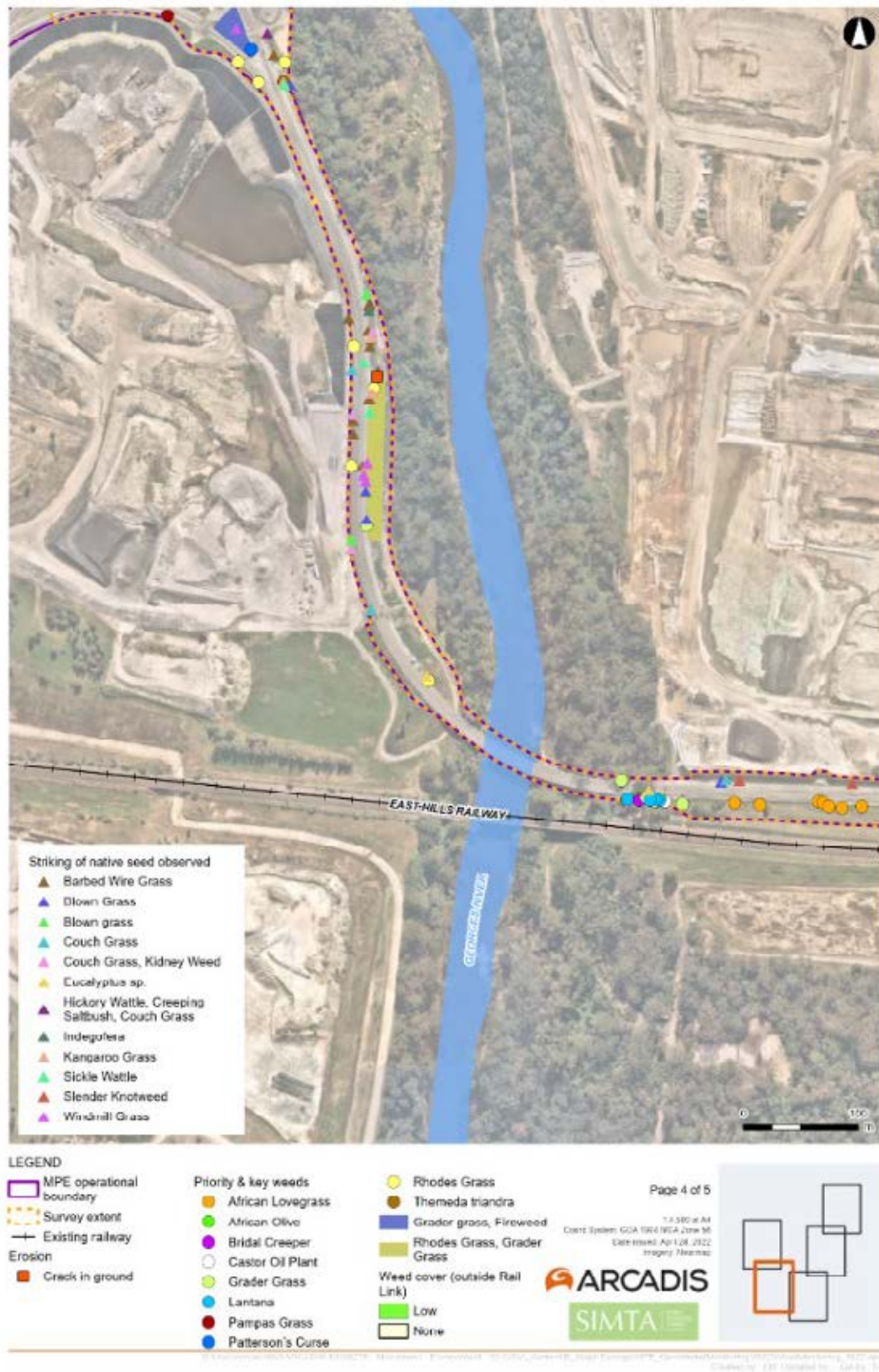


Figure 5. Weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 5)





Figure 6. Weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 5)



## Recommendations

Recommended actions documented in previous weed monitoring reports are included in *Appendix A: Recommended Actions Catalogue*. The catalogue has been reviewed and updated to reflect works undertaken since the February 2022 survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

Majority of weed control and management actions recommendations documented in the February 2022 weed monitoring report are still applicable to management of the site. These include:

- Targeted weed control works along revegetated soft batters. Weed control works will focus on controlling priority and key weed species. Hand weeding should be conducted for individuals whereas a combination of slashing and herbicide spraying should be adopted to target larger patches of weeds. A suggested process to target weeds along revegetated soft batters is presented in Figure 7.
- Priority and aggressive weed species outside of revegetated areas within the Rail Link should be removed. Weeds which should be targeted include Lantana, African Olive, Bridal Creeper, Moth Vine, Castor Oil, Alligator Weed and Fireweed.
- Large patches of African Lovegrass, Rhodes Grass and Grader Grass between the Rail Link and the East Hills train line should be slashed on a regular basis to prevent seeding events (Figure 4, Figure 5). This will reduce colonisation of these grasses into revegetation areas.
- Exotic understory vegetation in the two locations outside of the Rail Link fence at the southern extent of the MPE operational facility (Figure 3) should be slashed regularly to prevent seeding events. Slashing should be targeted to avoid impacts to naturally regenerating shrubs including Acacias. No herbicide should be used in these locations and all works should be contained within the construction envelope of the RALP. Qualified bush regenerators should be procured to conduct these works to reduce off-target impacts to native species. A suggested process to target weeds within these areas is presented in Figure 8.
- Continue to collect litter from with the Rail Link and in adjacent areas
- Soft batters within the trunk drainage system and retention basin/swale at the north-eastern extent of the facility should be inspected for weed growth. Weed levels should be continue to be suppressed through a combination of herbicide application, slashing and hand weeding. Weed control works should be conducted in accordance with the approved Weed Management Plan.

Application of herbicide within the Rail Link and in areas adjacent to the Moorebank biobank site should be conducted in a way which prevents overspray (off target poisoning). Native vegetation outside of the Rail Link fence should not be affected by herbicide during weed control works.

No herbicide spraying should be conducted outside of the Rail Link corridor, specifically adjacent to environmentally sensitive areas south of the MPE Operational facility (Figure 3). Manual weed control works in environmentally sensitive areas should not extend beyond the construction envelope of the RALP project. If further clarification the project ecologist should be consulted.

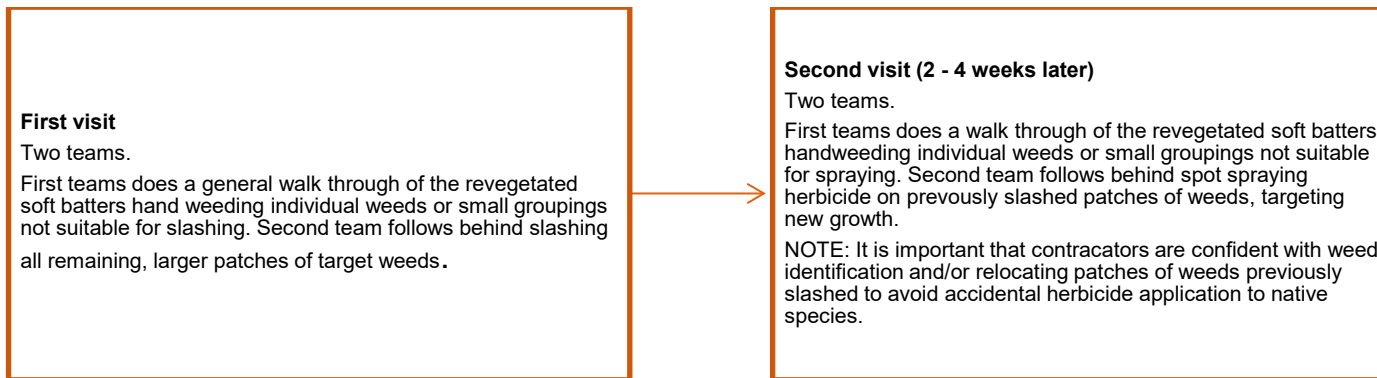


Figure 7. Suggested process to controlling target weeds on revegetated soft batters

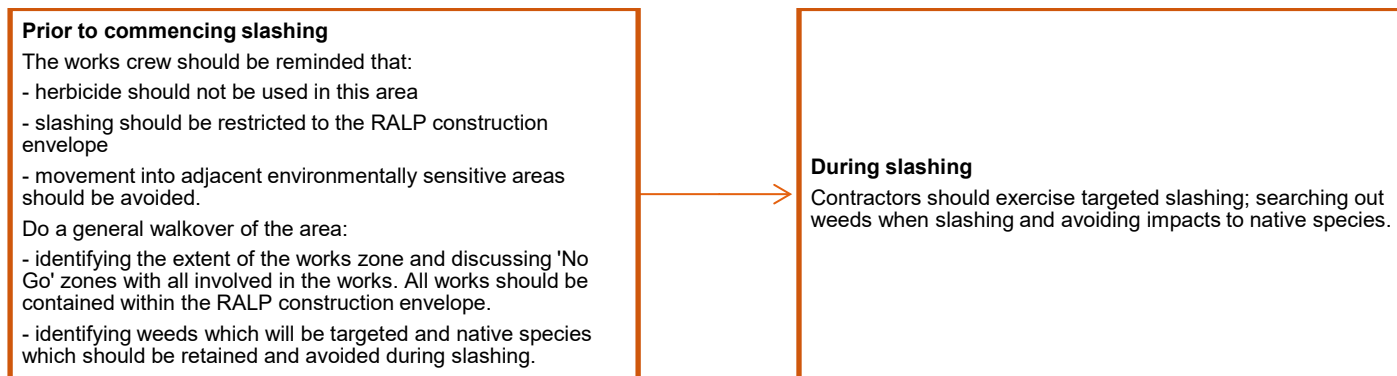


Figure 8. Slashing target weeds within the RALP construction envelope adjacent to environmentally sensitive areas

## References

Arcadis (2019a) Urban Design and Landscape Plan. Moorebank Precinct East Stage 1

Arcadis (2019b) Operational Flora and Fauna Management Plan. Moorebank Logistics Park – East Precinct

Arcadis (2019c) Landscape Vegetation Management Sub Plan. Moorebank Precinct East Stage 2

Arcadis (2020) MPE Operational – Weed Monitoring Report October 2020

Arcadis (2020) Urban Design and Landscape Plan. Moorebank Precinct East Stage 2

Bureau of Meteorology (BOM) (2021) Climate Data Online. Weather and Climate: Holsworthy Aerodrome NSW (station 066161) <http://www.bom.gov.au/climate/dwo/IDCJDW2161.latest.shtml>

NSW Department of Primary Industries (DPI) (accessed 2021) NSW WeedWise. priority weeds for the Greater Sydney. <https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=3>



## APPENDIX A. RECOMMENDED ACTIONS CATALOGUE

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
April 2020	Eradicate priority weeds species including Bridal Creeper, Alligator Weed, Lantana, Fireweed and African Olive	Commenced	Lantana, African Olive, Fireweed and Bridal Creeper remain within the Rail Link. These weed species should be prioritise for removal.
April 2020	Remove key and aggressive weed species within Rail Link including Golden Wreath Wattle, Moth Vine, Castor Oil Plant, Small-leafed Privet, Grader Grass and Balloon Vine	Commenced	Grader Grass has been observed colonising remediated areas within the Rail Link. This species should be removed to prevent further colonisation and infestations.  Golden Wreath Wattle, Moth Vine and Castor Oil Plant on the southern side of the Rail Link in the area between the operational boundary and the East Hills line rail corridor. Consideration should be given to management of these areas to reduce encroachment into recently remediated areas.
June 2020	Planning should commence to revegetate soft batters and un-developed areas within the MPE operational facility with native species in accordance with the approved Urban Design and Landscaping Plan (Arcadis 2019a, Arcadis 2020)	Commenced	Revegetation has commenced for remediated areas using a hydro-mulch containing a seed palette commensurate with the UDLP (Arcadis 2020).  Additional striking of native seed was observed during the February 2022 monitoring inspection within the Rail Link. The following native species were observed growing Hickory Wattle, Indigofera, Windmill Grass, Queensland Bluegrass, Couch Grass, Kangaroo Grass, Kidney Weed, Barbed Wire Grass, Blown Grass and Creeping Saltbush.
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic) should be removed from grassland either side of the Rail Link at its eastern extent, closest to the operational area.	Commenced	Targeted manual removal including slashing has been conducted for exotic species outside of the Rail Link corridor fencing. A qualified bush

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
			regeneration contractor should be used to avoid impacts to native species. Strictly no herbicide should be used in this area and works should not extend beyond the RALP construction envelope. Where possible, contractors should not access/pass through adjacent areas.
August 2021	Collect litter scattered through the Rail Link corridor and in adjacent areas	Not started	Litter still remains in Rail Link corridor and adjacent areas.
October 2021	Control aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link	Not started	New instances of aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link should be removed as soon as practicable to avoid spread of these species into environmentally sensitive areas adjacent to the Rail Link.
February 2022	Continued targeted slashing of woody and herbaceous weeds within the Rail Link.	Commenced	Continue regular slashing of large woody weeds to remove the fertile seed head and discourage further germination of these weeds within the Rail Link.
April 2022	Prioritise weed control works for priority and key weed species which have experienced accelerated growth in recent months.	Not started	Areas of particularly high biomass of priority and key weeds species should be prioritised for weed control works in coming months to avoid mass seeding events.

## APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



December 2021



April 2022



April 2021



December 2021



April 2022





April 2021



December 2021



April 2022



April 2021



December 2021



April 2022





April 2021



December 2021



April 2022



April 2021



December 2021



April 2022





April 2021



December 2021



April 2022



## APPENDIX C. PROFILES: PRIORITY WEEDS



Lantana



Fireweed



Alligator Weed



African Olive



Bridal Creeper



Peruvian Primrose



## APPENDIX D. PROFILES: KEY WEEDS



Rhodes Grass



African Love Grass



Patterson's Curse



Coolatai Grass



Grader Grass



Red Natal Grass

## APPENDIX E. PLANT SPECIES INVENTORY

Scientific name	Common name	Exotic	priority/key weed
<i>Acacia falcata</i>	Hickory Wattle		
<i>Acacia parramattensis</i>	Parramatta Wattle		
<i>Acacia saligna</i>	Golden Wreath Wattle	*	
<i>Alternanthera philoxeroides</i>	Alligator weed	*	priority
<i>Alternanthera pungens</i>	Khaki Weed	*	
<i>Araujia sericifera</i>	Moth Vine	*	
<i>Asparagus asparagoides</i>	Bridal Creeper	*	priority
<i>Atriplex semibaccata</i>	Creeping Saltbush		
<i>Austrodanthonia spp.</i>			
<i>Avena spp.</i>	Oats	*	
<i>Bidens pilosa</i>	Cobbler's Pegs	*	
<i>Brassica rapa</i>	Field Mustard	*	
<i>Briza maxima</i>	Quaking Grass	*	
<i>Briza minor</i>	Shivery Grass	*	
<i>Cenchrus clandestinus</i>	Kikuyu Grass	*	
<i>Centaureum spp.</i>		*	
<i>Chloris gayana</i>	Rhodes Grass	*	key
<i>Chloris truncata</i>	Windmill Grass		
<i>Cirsium vulgare</i>	Spear Thistle	*	
<i>Convolvulus erubescens</i>	Pink Bindweed		
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*	
<i>Cyclospermum leptophyllum</i>	Slender Celery	*	
<i>Cynodon dactylon</i>	Common Couch		
<i>Cymbopogon refractus</i>	Barbed Wire Grass		
<i>Cyperus eragrostis</i>	Umbrella Sedge	*	
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea		
<i>Dichanthium sericeum</i>	Queensland Bluegrass		
<i>Dichondra repens</i>	Kidney Weed		
<i>Echium plantagineum</i>	Paterson's Curse	*	key
<i>Eragrostis brownii</i>	Brown's Lovegrass		
<i>Eragrostis curvula</i>	African Lovegrass	*	key
<i>Euchiton spp.</i>			
<i>Ficinia nodosa</i>	Knobby Club-rush		
<i>Foeniculum vulgare</i>	Fennel	*	
<i>Glycine clandestina</i>			



Scientific name	Common name	Exotic	priority/key weed
<i>Hardenbergia violacea</i>	False Sarsaparilla		
<i>Hypochoeris radicata</i>	Catsear	*	
<i>Indigofera australis</i>	Australian Indigo		
<i>Juncus usitatus</i>			
<i>Lantana camara</i>	Lantana	*	priority
<i>Lachnagrostis filiformis</i>	Blown Grass		
<i>Lactuca serriola</i>	Prickly Lettuce	*	
<i>Linum trigynum</i>	French Flax	*	
<i>Lolium perenne</i>	Perennial Ryegrass	*	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		
<i>Lysimachia arvensis</i>	Scarlet Pimpernel	*	
<i>Ludwigia peruviana</i>	Peruvian water primrose	*	priority
<i>Medicago polymorpha</i>	Burr Medic	*	
<i>Melilotus alba</i>	Bokhara	*	
<i>Melinis repens</i>	Red Natal Grass	*	key
<i>Modiola caroliniana</i>	Red-flowered Mallow	*	
<i>Olea europaea subsp. cuspidate</i>	African Olive	*	priority
<i>Paspalum dilatatum</i>	Paspalum	*	
<i>Persicaria decipiens</i>	Slender Knotweed		
<i>Phytolacca octandra</i>	Inkweed	*	
<i>Plantago lanceolata</i>	Lamb's Tongues	*	
<i>Portulaca oleracea</i>	Common Purslane		
<i>Rumex crispus</i>	Curled Dock	*	
<i>Senecio madagascariensis</i>	Fireweed	*	priority
<i>Setaria parviflora</i>		*	
<i>Sida rhombifolia</i>	Paddy's Lucerne	*	key
<i>Solanum nigrum</i>	Black-berry Nightshade	*	
<i>Solanum sisymbriifolium</i>		*	
<i>Sonchus oleraceus</i>	Common Sowthistle	*	
<i>Tagetes minuta</i>	Stinking Roger	*	
<i>Themeda quadrivalvis</i>	Grader Grass	*	key
<i>Themeda triandra</i>			
<i>Trifolium arvense</i>	Haresfoot Clover	*	
<i>Trifolium repens</i>	White Clover	*	
<i>Trifolium michelianum</i>	Bolansa Clover	*	
<i>Verbena bonariensis</i>	Purpletop	*	

Scientific name	Common name	Exotic	priority/key weed
<i>Verbena rigida</i> var. <i>Rigida</i>	Veined Verbena	*	

## **APPENDIX B. LETTER - REVIEW OF MPE RAIL LINK REVEGETATION**



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[www.arcadis.com](http://www.arcadis.com)

**Subject:** Review of MPE Rail Link Revegetation  
**Date:** 24/03/2022

Dear Marc,

Arcadis commenced weed monitoring of Moorebank Precinct East operational facility and Rail Link in April 2020 as a part of operational environmental monitoring program for the precinct. In early spring 2020 a rehabilitation project was initiated by CPB Contractors in the Rail Link to remove weeds from soft landscaped areas and revegetate with native plant species endemic to the locality.

CPB Contractors engaged Spray Grass Solutions to undertake the on-ground works. Spray Grass solutions engaged Cumberland Plain Seeds to provide technical oversight of the revegetation effort with native seed.

A year following commencement of the rehabilitation project Arcadis was engaged by Tactical Group to provide technical advice regarding the progress of the rehabilitation works being undertaken by Spray Grass Solutions under instruction of CPB Contractors. This letter summarises observations made by me (Arcadis Senior Ecologist) and provides an assessment against one of the projects objectives (focus objective in bold). The two objectives of the project as defined by CPB contractors include:

*1. There is sufficient vegetation cover on the rail embankment and other vegetated areas to control erosion, as required by Detailed Design*

***2. The quantity of any weed presence is not detrimental to the survival of native grasses and shrub species, and can be managed through ongoing and regular maintenance***

I attended three walkovers with CPB Contractors, Tactical Group, Spray Grass Solutions and Cumberland Plain Seeds to review the progress of revegetation; December 2021, January 2022 and March 2022.

During the December 2021 site walkover lengthy discussion were had onsite between myself, Spray Grass Solutions and the Cumberland Plain Seeds representative to understand the proposed revegetation methodology and what 'revegetation goals' could be achieved in the months leading up to March 2022. A review against these goals during the later walkovers would help determine whether the implemented methodology was having/leading towards the desired result. Goals anticipated to be observed over the coming months, communicated by Spray Grass Solutions and Cumberland Plain Seeds, included:

- an increase in native seed striking
- further growth of observed native shrubs, grasses and forbs
- haying-off of cover crop species to make room for native species growth
- present native species would not be outcompeted by common herbaceous weed species and cover crops

During this initial inspection several exotic grass species were identified as requiring control and management due to their ability to outcompete native species and be detrimental to native species survival. These species

included *Melinus repens* (Red Natal Grass), *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Love Grass), *Hyparrhenia hirta* (Coolatai Grass) and *Themeda quadrivalvis* (Grader Grass).

During site inspections in January and March 2022 areas of the Rail Link were observed to be meeting the revegetation goals communicated in the first walk over:

- In some locations it is was evident that the number of natives had increased, and present shrub and groundcovers had exhibited growth.
- Where native plantings have established, they were observed colonising additional areas in the immediate surround.
- The occurrence of common herbaceous weeds and regenerating cover crop species was not observed outcompeting or detrimentally impacting native plants observed in December 2021.
- Haying-off was observed for the cover crop *Trifolium michelianum* (Bolansa Clover), however native seedlings were not yet observed emerging though.

It should be noted that weed management activities occurred over this period which likely contributed to meeting the revegetating goals.

There are revegetated sections of the Rail Link which have nil-low cover of native species; although these areas may not be achieving the native species cover objective, they may be meeting the stabilisation objective of the rehabilitation project.

Based on what has been observed over the past four months, in areas which currently support native species it is anticipated that overtime native cover will increase; as such meeting the second objective of the rehabilitation project. Existing plantings, with support from bush regenerators, will colonise surrounding areas outcompeting annual common herbaceous weeds. To support the continued regeneration and colonisation of native species that have been established within the Rail Link through this rehabilitation project the following actions should be implemented:

- on-boarding of a trained bush regeneration contractor to conduct regular ongoing weed control work
- weed control works targeting exotic species listed as 'priority' for the Greater Sydney Local Land Services region and the exotic grass species: *Melinus repens* (Red Natal Grass), *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Love Grass), *Hyparrhenia hirta* (Coolatai Grass) and *Themeda quadrivalvis* (Grader Grass)
- monitoring of rehabilitated areas of the Rail Link to identify areas which may require additional support (i.e. seeding) or any novel exotic species which may be detrimental to the survival of natives

If you require additional information regarding observations made on the rehabilitation of the MPE Rail Link please don't hesitate to contact me.

Kind regards,  
Nathan Banks



Senior Ecologist

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Mobile: 0416 875 546

## **APPENDIX C. REMOTE CAMERA: FAUNA SPECIES INVENTORY**



Species	Pest monitoring - Wattle Grove						Connectivity - Wattle Grove				Connectivity - Georges River			
	C1-13	C1-14	C1-15	C1-17	C1-19	C1-20	C1-11	C1-12	C1-4	C1-5	C1-2	C1-26	C1-7	C2
Australasian Swamphen <i>Porphyrio melanotus</i>							.	.		.				
Australian Magpie <i>Gymnorhina tibicen</i>				.										
Australian Raven <i>Corvus coronoides</i>	.	.	.	.	.	.				.	.	.		.
Australian White Ibis <i>Threskiornis molucca</i>										.				
Black Rat <i>Rattus rattus</i>									.	.				
Brown Hare <i>Lepus europaeus</i>	.	.	.	.	.	.								
Common Brushtail Possum <i>Trichosurus vulpecula</i>			.											
Common Myna <i>Acridotheres tristis</i>											.		.	.
Common Ringtail Possum <i>Pseudocheirus peregrinus</i>							.		.					
Common Wallaroo <i>Macropus robustus</i>		.	.	.	.			.		.				

## MPE Operational Facility AMR 2021/2022

Species	Pest monitoring - Wattle Grove						Connectivity - Wattle Grove				Connectivity - Georges River			
	C1-13	C1-14	C1-15	C1-17	C1-19	C1-20	C1-11	C1-12	C1-4	C1-5	C1-2	C1-26	C1-7	C2
Crested Pigeon <i>Ocyphaps lophotes</i>				•										
Domestic Cat <i>Felis catus</i>			•				•	•	•	•				
Eastern Grey Kangaroo <i>Macropus giganteus</i>		•	•	•	•			•	•	•				
European Red Fox <i>Vulpes vulpes</i>	•		•	•	•	•	•	•	•	•	•	•		•
Koala <i>Phascolarctos cinereus</i>		•	•	•	•									
Magpie-lark <i>Gymnorhina cyanoleuca</i>				•		•								
Noisy Miner <i>Manorina melanocephala</i>				•		•								
Pacific Black Duck <i>Anas superciliosa</i>			•											
Rat sp. <i>Rattus sp.</i>							•	•	•					
Red Wattlebird <i>Anthochaera carunculata</i>					•	•								

## MPE Operational Facility AMR 2021/2022

Species	Pest monitoring - Wattle Grove						Connectivity - Wattle Grove				Connectivity - Georges River			
	C1-13	C1-14	C1-15	C1-17	C1-19	C1-20	C1-11	C1-12	C1-4	C1-5	C1-2	C1-26	C1-7	C2
Red-browed Finch <i>Neochmia temporalis</i>										•				
Short-beaked Echidna <i>Tachyglossus aculeatus</i>							•					•		
Spotted Dove <i>Streptopelia chinensis</i>														•
Superb Fairy-wren <i>Malurus cyaneus</i>							•			•		•		
Swamp Wallaby <i>Wallabia bicolor</i>			•				•				•	•		•
White-faced Heron <i>Egretta novaehollandiae</i>			•							•				
Unidentified Bird Sp. <i>Aves sp.</i>			•		•		•							
Unidentified Macropod <i>Macropod sp.</i>						•								



## **APPENDIX D. EPBC OFFSET SITES - ANNUAL MONITORING REPORT**

# MPE EPBC OFFSET SITE

## EPBC Threatened Flora Monitoring Report

24 MAY 2022



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# MOOREBANK LOGISTICS PARK - PRECINCT EAST

## EPBC Threatened Flora Monitoring Report

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*Nathan Banks*

**Report No** 1.0

**Date** 24/05/2022

**Revision Text** B

This report has been prepared for Qube Project Management Services in accordance with the terms and conditions of appointment for Moorebank Precinct East Ongoing Operations dated 22 June 2016. Arcadis Australia Pacific Pty Limited (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

## REVISIONS

Revision	Date	Description	Prepared by	Approved by
A	26/04/2022	First Draft	Thea Kane	Nathan Banks
B	24/05/2022	Final	Thea Kane	Nathan Banks

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# APPENDICES

**APPENDIX A BAM MONITORING QUADRAT DATA SET**

**APPENDIX B BAM QUADRATS VEGETATION SCORE SUMMARY**

**APPENDIX C ANNUAL MONITORING PHOTOGRAPHS**

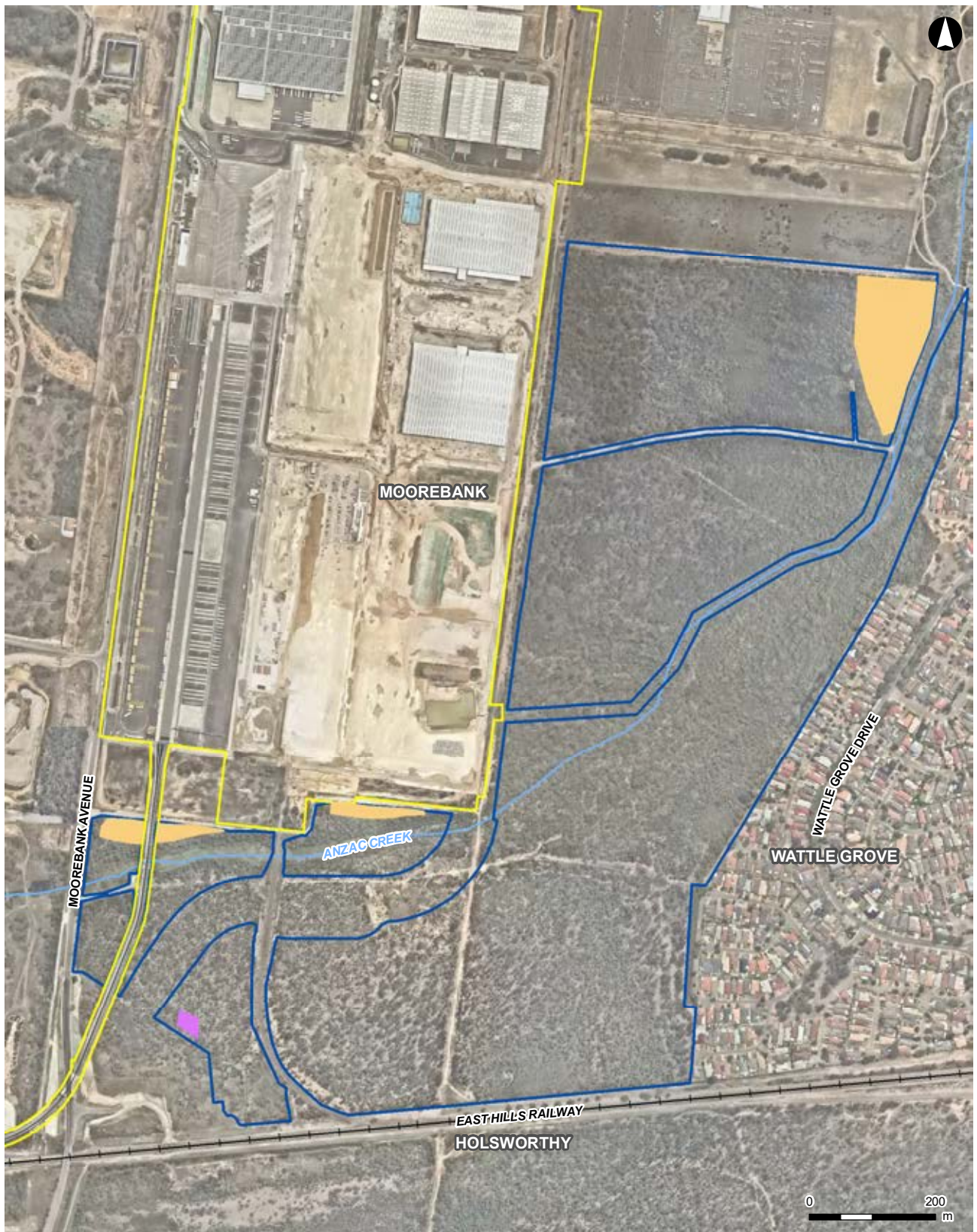
**APPENDIX D PHOTO POINT DETAIL**



## 1 INTRODUCTION

Arcadis have been commissioned to monitor two threatened plant species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and *Persoonia nutans* (Nodding Geebung) within designated offset sites in the Wattle Grove offset area, adjacent Moorebank Logistics Precinct East operational facility (hereinafter referred to as MPE). Monitoring of offset sites is being conducted annually to satisfy the conditional requirements of the Commonwealth Conditions of Approval (CoA) for the MPE project (EPBC 2011/6229) Monitoring commenced in spring 2019 and is set to continue for the life of the offset which has been anticipated at 20 years.

Objectives of monitoring, survey methodologies, timings and guidelines have been described in the Threatened Flora Offset Management Plan (TFOMP) prepared by Arcadis in 2017 and updated in 2020. This monitoring report addresses the requirements to monitor Small-flower Grevillea and Nodding Geebung and presents the results of 2021 monitoring surveys for populations of these plants with designated EPBC offset sites (Figure 1).



#### LEGEND

- MPE site
- Wattle Grove offset site (Bootland)
- EPBC offset site (Small-flower Grevillea)
- EPBC offset site (Nodding Geebung)
- Operational rail link
- Existing railway
- Watercourse

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 Coordinate System: GDA 1994 MGA Zone 56  
 Date issued: December 3, 2021  
 Aerial imagery supplied by Nearmap (Jan, 2020)

1:9,000 at A4



Figure 1. EPBC offset sites within Wattle Grove offset area; adjacent to the MLP East Precinct

## 1.1 Project background

The MPE project received Commonwealth approval under the EPBC Act for the construction and operation on 6 March 2014 (EPBC 2011/6229).

Construction of the MPE project commenced in mid-2016 with operations being launched in a staged manner from Q2-2020. The MPE project includes an intermodal terminal facility and warehouse/distribution facility, which offers container storage and warehousing solutions with direct rail access to Port Botany.

Two threatened flora species listed under the EPBC Act were directly impacted by the MPE project:

- *Persoonia nutans* (Nodding Geebung), a shrub listed as Endangered under the EPBC Act and *Biodiversity Conservation Act 2016* (BC Act). The MPE project removed 17 Nodding Geebung.
- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea), a shrub listed as Vulnerable under the EPBC Act and BC Act. The MPE project removed 20 Small-flower Grevillea stems.

Impacts to EPBC threatened flora species occurred at two locations within the MPE project footprint:

- within a portion of Stage 1, Package 1: the Rail Link; and
- within the MPE Stage 2 Modification 2 project area: onsite stormwater detention basin (OSD) 2 (which includes a section of the MPL East Stage 2 project footprint)

A total of 11 Nodding Geebung and 20 Small-flower Grevillea were removed to make way for construction of the MPE Rail Link and an additional six Nodding Geebung were removed during the construction of the OSD basin at the southern extent of the MPE Stage 2 project site.

## 1.2 Requirement to monitor

Arcadis prepared a Threatened Species Offset Management Plan (TFOMP) in 2017, which was updated in 2020, specifying how SIMTA would achieve the requirements of the EPBC Act Environmental Offset Policy for impacts to Small-flower Grevillea and Nodding Geebung. The TFOMP is a conditional requirement (Condition 6) of the MPE CoA (EPBC 2011/6229) (Table 1).

Table 1. CoA (EPBC 2011/6229): Condition 6

CoA	Requirement
6	<p>For the better protection of Nodding Geebung, Small-flower Grevillea (and potentially, Hibbertia sp. Bankstown and Bynoe's Wattle pending the outcome of conditions 3 and 4) the person taking the action must engage a suitably qualified expert to prepare a Threatened Flora Offset Management Plan (TFOMP) (or plans) for the approval of the Minister. The TFOMP must include (but need not be limited to):</p> <ul style="list-style-type: none"> <li>(a) Details of a direct offset that satisfies the requirement of the Department's offset policy, in accordance with the offset user guide (including timeframes for the delivery or acquisition of the direct offset);</li> <li>(b) Maps (s) and shapefile that identify the location and boundaries of the direct offset;</li> <li>(c) Details of the management action and performance objectives which will maintain and enhance the Nodding Geebung and Small-flower Grevillea habitat and/or population covered by the TFOMP (including duration, intensity, and timing of management actions);</li> <li>(d) An assessment of the baseline population and distribution for Nodding Geebung and Small-flower Grevillea within the direct offset, including: <ul style="list-style-type: none"> <li>• The number of plants protected and their location; and</li> </ul> </li> </ul>



CoA	Requirement
	<ul style="list-style-type: none"> <li>• Plant and habitat protection</li> </ul> <p>(e) Measures for regular monitoring of the status of individuals of Nodding Geebung and Small-flower Grevillea and their habitat as measured against the baseline population and distribution, including:</p> <ul style="list-style-type: none"> <li>• Fluctuations in population size and distribution; and</li> <li>• response to disturbance and/or management actions</li> </ul> <p>(f) Provisions to revise the approved TFOMP in response to monitoring associated with condition 6 (e)</p> <ul style="list-style-type: none"> <li>• Native vegetation clearance must not occur until the TFOMP has been approved. The TFOMP must be implemented once approved.</li> <li>• Should the action result in, or be likely to result in, residual impacts to <i>Hibbertia</i> sp. Bankstown or Bynoe's Wattle (as determined by the Minister), the TFOMP must also demonstrate how it meets the standards described in (a) and (f), for these two species.</li> </ul>

This report has been prepared to specifically address CoA 6(e):

*Measures for regular monitoring of the status of individuals of Nodding Geebung and Small-flower Grevillea and their habitat as measured against the baseline population and distribution, including:*

- *fluctuations in population size and distribution; and*
- *response to disturbance and/or management actions*

## 1.3 Project documents

The following project documents were reviewed prior to establishing offset sites and referenced during the inaugural monitoring surveys to ensure adherence to the EPBC offsetting requirements and to maximise the chance of success in achieving the monitoring objectives:

- BioBanking Agreement (BA341) for Moorebank Intermodal Terminal Biobank Site (OEH 2017)
- Biodiversity Assessment Report: Biobanking Agreement – Wattle Grove Offset Area, Casula Offset Area and Moorebank Conservation Area (WSP & Parsons Brinckerhoff 2017)
- Biodiversity Management Implementation Plan (Arcadis 2019)
- Conditions attached to the approval: SIMTA Moorebank Intermodal Terminal Facility, Sydney, NSW (EPBC 2011/6229) (DoE 2014)
- Threatened Flora Offset Management Plan (Arcadis 2020a).

## 1.4 Establishment of offset sites

To deliver the required offset for impacts to EPBC listed threatened plants, five designated offset sites were established. Offset sites were situated within the Wattle Grove offset area which is a part of the BA341 Moorebank biobank site. Inclusion of these offset sites within the biobank site affords better protection to these plants, being secured under a conservation agreement which provides in-perpetuity funding for management actions that are tied to a strong regulatory framework of monitoring and auditing.

In accordance with the revised TFOMP (Arcadis 2020a), four offset sites are designated for the conservation of Nodding Geebung and one is for Small-flower Grevillea. It is anticipated that conservation and management of EPBC offset sites will maintain the initial number of plants/stems of these species and will result in a population increase across a 20-year management period. It is

anticipated that the protection and management of the offset sites over a 20-year period, will result in an increase of Nodding Geebung and Small-flower Grevillea by 16 and 17 individuals, respectively.

In order to achieve this population growth within the offset sites, a total of 155 Nodding Geebung and 142 Small-flower Grevillea were included across the five offset sites (see Table 2).

Offset calculations were prepared for Nodding Geebung and Small-flower Grevillea based on guidance provided in the EPBC Offset Assessments Guide (DOEE 2012). Offset calculations and associated species information (temporal scale, risk scales, future habitat quality, result confidence) has been included within the approved TFOMP (Arcadis 2020a). These calculations assessed and supported the suitability of the proposed offset sites to achieve 100percent of the required EPBC offset for the MPE project over a period of 20 years.

*Table 2. Details of EPBC offset sites: Nodding Geebung*

EPBC Offset Site	Area	Number of individual plants to be conserved within the offset site per the EPBC Act offset requirement	Offset requirement objective
P1	0.25 ha	31 plants of Nodding Geebung	Increase Nodding Geebung population within EPBC Offset Sites by 16 plants over 20 years
P2	0.2 ha	46 plants of Nodding Geebung	
P3	0.26 ha	35 plants of Nodding Geebung	
P4	2.17 ha	43 plants of Nodding Geebung	
Total	2.88 ha	155 plants of Nodding Geebung	

*Table 3. Details of EPBC offset sites: Small-flower Grevillea*

EPBC Offset Site	Area	Number of stems to be conserved within the offset site per the EPBC Act offset requirement	Offset requirement objective
G1	0.24 ha	142 stems of Small-flower Grevillea	Increase Small-flower Grevillea population within EPBC Offset Sites by 17 plants over 20 years

## 1.5 Monitoring history

The inaugural monitoring survey took place in spring 2019 when four of the EPBC offset sites were established in accordance with the Threatened Flora Offset Management Plan (TFOMP) (Arcadis 2017). These four offset sites were established as direct offset sites to compensate for impacts to 11 Nodding Geebung and 20 Small-flower Grevillea from the MPE project.

In 2020, an additional 6 Nodding Geebung plants were impacted by the MPE Stage 2 development and subsequently required offsetting in accordance with the EPBC Offsetting Guide. The TFOMP was updated (Arcadis 2020a) to include the additional impacts and document how the additional offsets would be delivered. Resultingly during the second year of monitoring, an additional Nodding Geebung offset site (P4) was established at the northern extent of Wattle Grove offset area. This additional offset area (P4) was monitored along with the existing Nodding Geebung and Small-flower Grevillea offset sites (P1, P2, P3 and G1) during 2021.

Monitoring of EPBC offset sites commenced approximately 18 months following a wildfire which burnt the southern portion of Wattle Grove offset area. The locations of offset sites (P1, P2, P3 and G1) were all burnt by the fire which destroyed majority of the individuals of Nodding Geebung and Small-

flower Grevillea previously recorded; offset site P4 was unaffected. A summary of the results of first two years of monitoring is included in Section 1.5.1.

The 2021 monitoring event marks the third year of monitoring for EPBC offset sites and the findings of these surveys are the subject of this report.

### 1.5.1 Summary of 2020 monitoring results

In spring 2020 monitoring was conducted for the four Nodding Geebung (P1, P2, P3 and P4) offset sites and the single Small-flower Grevillea offset site (G1). The population census recorded 133 individuals of Nodding Geebung and 60 individuals of Small-flower Grevillea.

Of the 133 Nodding Geebung identified, a total of 90 individuals were identified across offset sites P1, and P3, and 43 individuals at offset site P4. No individual were recorded in offset site P2 for the second year running; since the area was burnt by the 2018 wildfire. Offset site P4 was surveyed for the first time in 2020 and all plants located were marked with numbered metal tags to be tracked in proceeding monitoring events. A thorough search was conducted throughout offset sites P1, P2 and P3 to re-find Nodding Geebung individuals previously tagged during the 2019 survey and any new plants which may have recruited. Searches re-found 61 tagged Nodding Geebung individuals and identified 29 new plants. A total of 50 numbered metal tags were re-found without a Nodding Geebung plant. It is assumed that the 50 previously marked Nodding Geebung individuals died at some time in the following year.

The condition of vegetation across the Nodding Geebung offset sites was observed to be in good condition. No evidence of impacts from mammals (trampling or grazing) was observed, however there was some evidence of historical damage from insects in juvenile plants in offset site P3. The majority of individuals which had signs of historical damage were observed to have produced new growth during the 2020 monitoring period. A diversity of native plant species was recorded across all offset sites and exotic species occurrence was restricted to the edges of bushland, specifically on the interface between access tracks and bushland. *Eragrostis curvula* (African Love Grass) was the most encountered weed species.

Small-flower Grevillea stems were more prevalent towards the east and west of the offset site (G1) with only a small number of plants being distributed centrally. No Small-flower Grevillea stems were observed to be flowering at the time of survey nor did any appear to have seed present. Plants were generally sparsely scattered, however close groupings of up to five plants was occasionally observed. Individuals appeared to have a healthy condition and displaying new growth. Small-flower Grevillea displayed a habitat preference for exposed areas with reduced vegetation and litter cover. The condition of vegetation across the Small-flower Grevillea offset sites was observed to be in good condition.



## 2 METHODOLOGY

Annual monitoring of EPBC offset sites was undertaken by Arcadis ecologists over six days between 8 September 2021 and 14 November 2021.

Generally, the weather on the dates of survey was sunny and the temperature was mild to warm. Weather records from the nearest weather station, Holsworthy Aerodrome AWS (station 066161) for the surveyed dates are presented in Table 4.

Threatened flora searches were undertaken during sunny, dry weather conditions and during the recommended survey season for Nodding Geebung and Small-flower Grevillea (DPIE 2019a, 2019b), to maximise the chance of detection.

Table 4. Surveying ecologists and climatic conditions during EPBC offset site monitoring

Date	Surveying ecologists	Temperature		Rain
		Min (°C)	Max (°C)	(mm)
8 September 2021	Nathan Banks Thea Kane	6.2	22.44	0.2
9 September 2021	Meredith Leal Thea Kane	4.7	26.9	0
16 September 2021	Meredith Leal Thea Kane	6.2	18.1	0
17 September 2021	Nathan Banks Thea Kane	5.0	22.1	0
8 October 2021	Grace Paul Thea Kane	16.1	21.4	0
22 October 2021	Nathan Banks Taylor Bliss-Henaghan	12.6	24.7	0

### 2.1 Population census

Targeted searches for Nodding Geebung and Small-flower Grevillea were conducted within EPBC offset sites. Transects were walked at three metre spacings, covering the entire offset site. The location of plants were recorded on an Arc-GIS enabled iPad.

Counts were made for Small-flower Grevillea and Nodding Geebung within designated offset sites. Additional information was recorded for Nodding Geebung individuals:

- Size (height and spread)
- General health (i.e. evidence of insect damage)
- Reproductive status (i.e. evidence of flowering and fruiting)

Individual Nodding Geebung were marked with numbered metal tags, to allow individual tracking across monitoring periods.

Juvenile plants were classified as individuals which were small and lacked any reproductive features including flowers and seeds. Adult plants were generally larger shrubs and displayed reproductive

features. Most adult Nodding Geebung identified during surveys were observed to be seeding (Plate 1).

### 2.1.1 Limitations

In offset areas burned by the bushfire (P1, P2, P3 and G1), Nodding Geebung and Small-flower Grevillea transects were difficult to conduct due to large stands of fallen *Petrophile pulchella* (Conesticks) trees blocked access. Transects were recorded on GPS devices to keep track of approximate lines and in some small areas where walking in straight lines was not possible, ecologists sought to prioritise areas of high-quality habitat.

Due to the density of bushland in some offset sites and the inconspicuous nature of seedling Nodding Geebung and Small-flower Grevillea, transects may have failed to locate / re-locate all of the plants present.

## 2.2 Habitat Assessment

Offset sites were evaluated for habitat suitability to Nodding Geebung or Small-flower Grevillea. An assessment of the habitat value of each offset site was determined by quantitatively measuring the condition of native vegetation, noting significant changes to site characteristics (vegetation growth, weed occurrence, erosion) and identifying potential impacts.

The condition of native vegetation within each offset site was measured using vegetation quadrats in accordance with Section 5.3 of Biodiversity Assessment Method (BAM) (DPIE, 2020). Results of BAM quadrats were used to inform upon the following vegetation attributes:

- Percent foliage cover of canopy species
- Percent foliage cover of shrub species
- Percent foliage cover of ground cover species
- Percent foliage cover of exotic species

A Vegetation Integrity (VI) score was calculated using the result of vegetation quadrats conducted at each offset site. VI scores will be compared between monitoring periods to measure changes to vegetation condition. It is anticipated that the VI score continually improves and the contributing attributes (composition, function etc.) moves towards the benchmark scores for the present Plant Community Type (PCT); being PCT 883 *Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion*.

Notes were made for observations of native vegetation dieback within or surrounding the EPBC offset sites.

## 2.3 Photo points

Four photo points were established on the perimeter of each EPBC offset site and a single photo point was established centrally within the offset site. Photo points on the boundary were captured in a single cardinal direction. In the middle of the plot, four photographs were captured from the central photo point in four cardinal directions.

Photo points are located at metal boundary stakes and a stake in the middle of the offset site. The metal stakes were demarcated with a numbered metal tag identifying the relevant photo point. The locations of photo points and the orientation of photographs is presented in Appendix D.

## 3 RESULTS

The results of the 2021 monitoring events are summarised within the following sections.

### 3.1 Population census for EPBC threatened flora

The population census results for Nodding Geebung and Small-flower Grevillea are presented below.

#### 3.1.1 Nodding Geebung

A total of 92 Nodding Geebung were identified across Nodding Geebung offset sites during the 2021 survey. Of the 92 plants located, 51 were identified across offset sites P1 and P3, and 41 individuals at offset site P4. No individuals were located at P2.

A thorough search was conducted throughout offset sites P1, P2, P3 and P4 to re-find Nodding Geebung individuals previously tagged during the 2019 and 2020 surveys and any new plants which may have recruited. Searches re-found 84 tagged Nodding Geebung individuals and identified 8 new plants. A total of 49 individuals located during the previous years survey (2020 monitoring event) were not re-found and are presumed to have died at some time between the 2020 and current survey.

Generally, Nodding Geebung within offset sites were observed to be in good condition. No evidence of impacts from mammals (trampling or grazing) was observed, however there was some evidence of damage from insects on juvenile plants in offset site P3. Insect damage was also observed during the 2020 surveys.

Offset sites P1 and P3 mainly supported juvenile Nodding Geebung whereas offset site P4, which was not impacted by the 2018 wildfire, has a Nodding Geebung population consisting of adult plants greater than one metre in height and width. Population dynamics of Nodding Geebung within each offset site is discussed below.



*Plate 1. Juvenile (left) and adult (right) Nodding Geebung identified during population census*



## Offset site P1

A total of 12 Nodding Geebung were found in offset site P1 during the 2021 survey. All individuals were juvenile plants showing no signs of seeding or flowering. Of the 12 plants identified, ten had been previously recorded and marked with numbered metal tags. The additional two plants are considered new individuals germinating since the previous surveys. Three individuals identified during the 2020 survey were not re-found and are presumed to have died at some time between the 2020 and current survey. A summary of changes to the Nodding Geebung population within offset site P1 has been presented in Table 5.

Table 5. Summary of changes to Nodding Geebung population in offset site P1

Offset site P1	Count
Existing individuals	10
New individuals	2
<b>Total</b>	<b>12</b>
Individuals not re-found (presumed dead)	3

Nodding Geebung within offset site P1 were located towards the northern boundary of the offset site in disturbed areas near an access track (Figure 2). Nodding Geebung were observed growing as individuals and in small groupings on a sandy soil profile interspersed amongst tussocks of *Eragrostis curvula* (African Love Grass) and beneath burnt Conesticks. Nodding Geebung were more prevalent in exposed areas with reduced leaf litter and reduced vegetation cover.

All but one individual was found to be in a healthy condition with no signs of insect or other damage. One newly identified individual was found to be in a poor condition and displayed signs of dieback (Plate 2). Given that the individual did not exhibit signs of insect damage or grazing, and was located in a moderately shaded position, the cause of the dieback is unknown.



Plate 2. Juvenile Nodding Geebung observed to be in poor health within the P1 EPBC Offset Site

## Offset site P2

No Nodding Geebung were identified within offset site P2 during the recent monitoring event. No individuals have been recorded since the 2019 monitoring, therefore no tags could be re-found. There have been no changes to the Nodding Geebung population within offset site P2 as can be seen in Table 6.

Table 6. Summary of changes to Nodding Geebung population in offset site P2

Offset site P2	Count
Existing individuals	0
New individuals	0
<b>Total</b>	<b>0</b>
Individuals not re-found (presumed dead)	0

## Offset site P3

A total of 39 Nodding Geebung were identified in offset site P3 during the 2021 survey. Two adult plants and 37 juveniles were present. Of the 39 individuals identified, 35 had been recorded and marked with numbered metal tags during previous surveys. The additional 4 plants are considered new individuals germinating since the previous surveys. A total of 42 Nodding Geebung recorded during the 2020 surveys were not re-found and are presumed to have died. A summary of changes to the Nodding Geebung population within offset site P3 has been presented in Table 7.

Table 7. Summary of changes to Nodding Geebung population in offset site P3

Offset site P3	Count
Existing individuals	35
New individuals	4
<b>Total</b>	<b>39</b>
Individuals not re-found (presumed dead)	42

Majority of individuals were observed growing in dense groupings along the northern boundary of the offset site interspersed amongst tussocks of African Love Grass, beneath stands of *Kunzia ambigua* (Tickbush). Individuals were observed to preference the disturbed edge of the bushland adjacent to an access track. One plant was found centrally within the offset site in bushland (Figure 5).

## Offset Site P4

A total of 41 Nodding Geebung were identified in offset site P4 during the 2021 survey. Only adult plants were present most of which were observed flowering and seeding. Of the 41 individuals identified, 39 had been previously recorded and marked with numbered metal tags during the 2020 survey. A number plants included in the 2020 population census were found to have been misidentified and were not included in the 2021 count. These individuals are believed to be a result of hybridisation between Nodding Geebung and *Persoonia laurina* (Laurel Geebung) and *Persoonia linearis* (Narrow-leaved Geebung).

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Offset site P4	Count
Existing individuals	39
New individuals	2
<b>Total</b>	<b>41</b>
Individuals not re-found (presumed dead)	4

Nodding Geebung within offset site P4 were distributed throughout Hard-leaved Scribbly Gum woodland. Individuals were identified in areas of open woodland with a sparse shrub layer as well as areas densely vegetated with mid-storey species and shrubs. All Nodding Geebung identified were observed to be healthy adult plants and, in most instances, bearing seed.





Figure 2: EPBC offset site P1: Nodding Geebung population monitoring

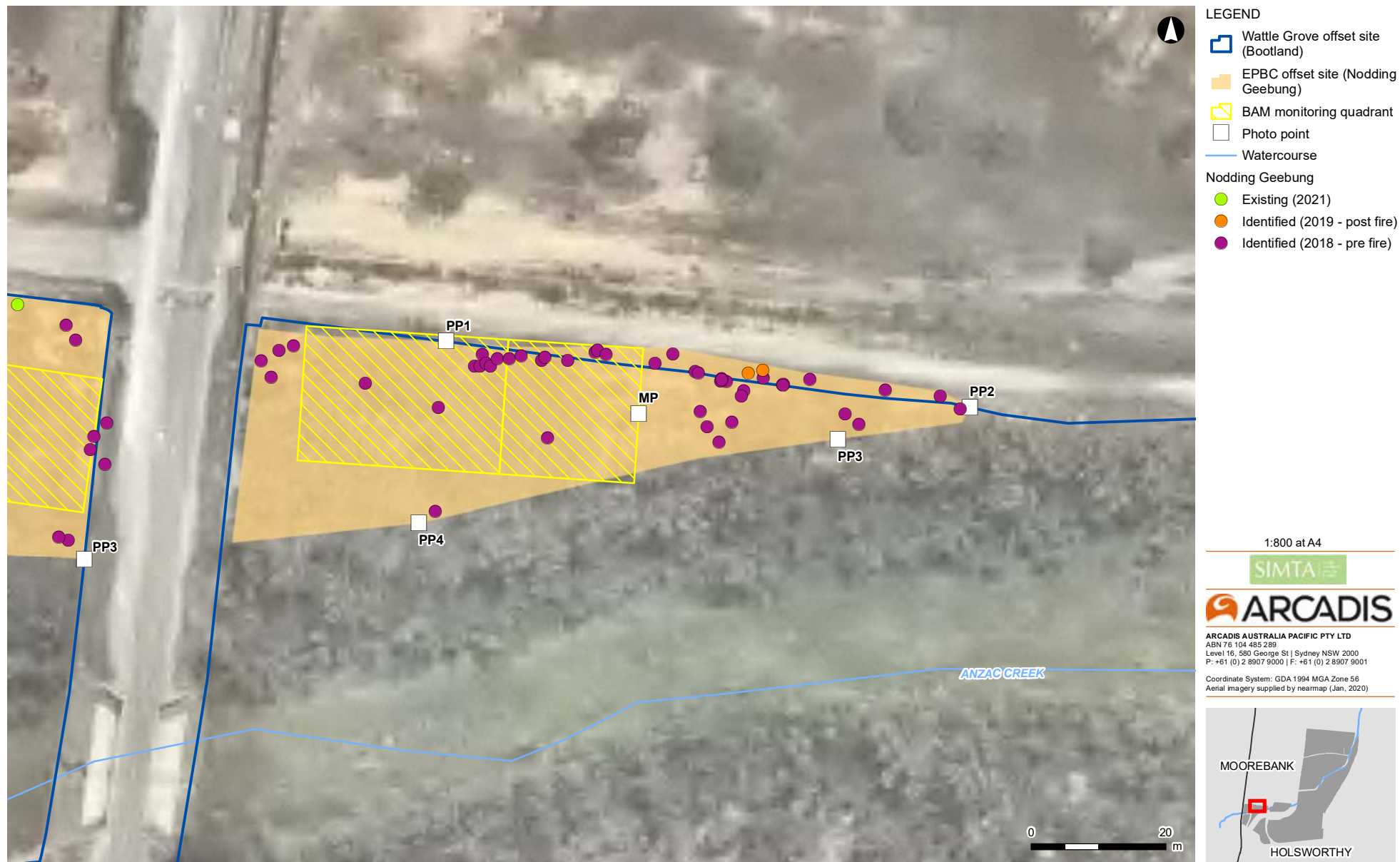


Figure 3: EPBC offset site P2: Nodding Geebung population monitoring

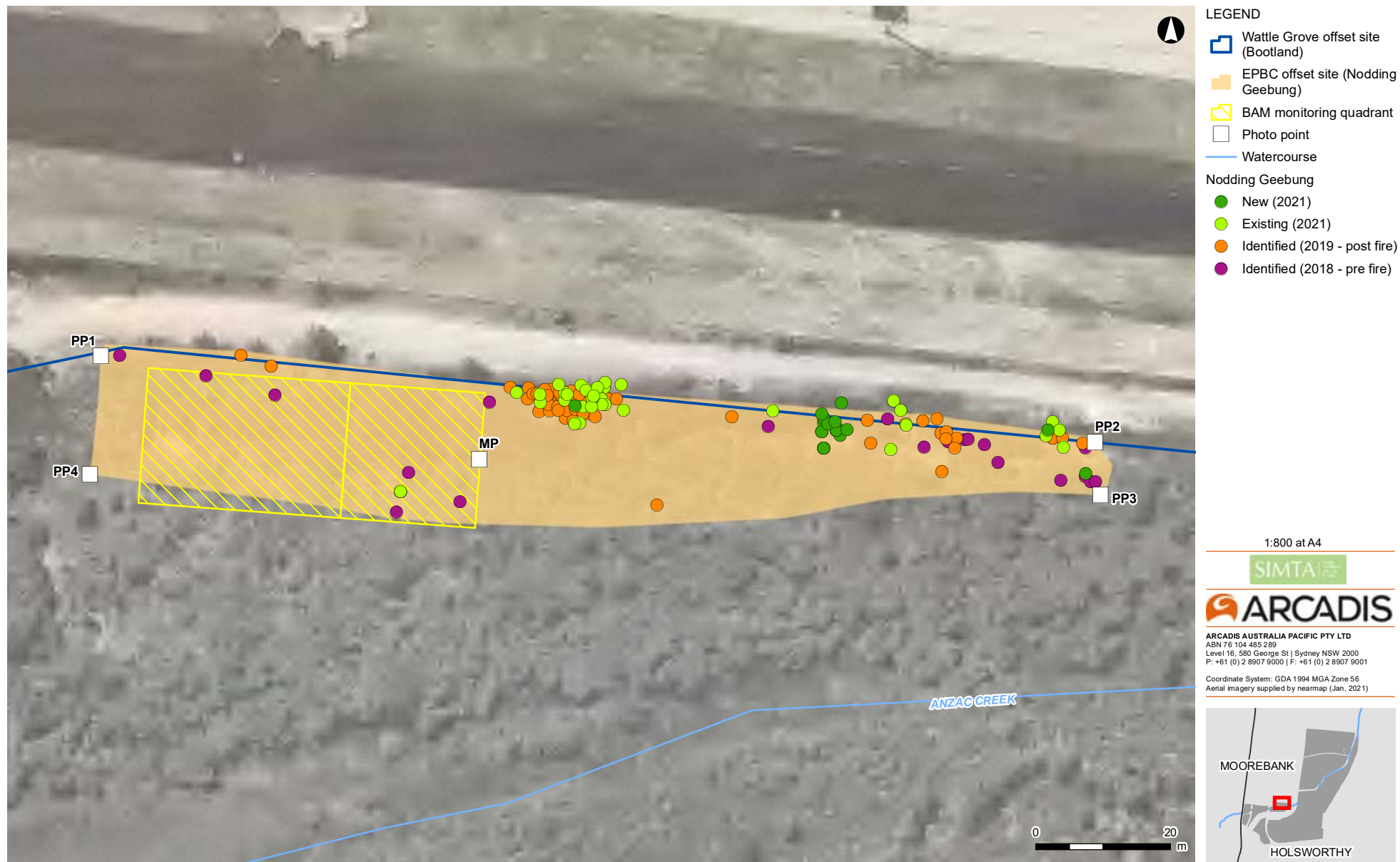


Figure 4: EPBC offset site P3: Nodding Geebung population monitoring



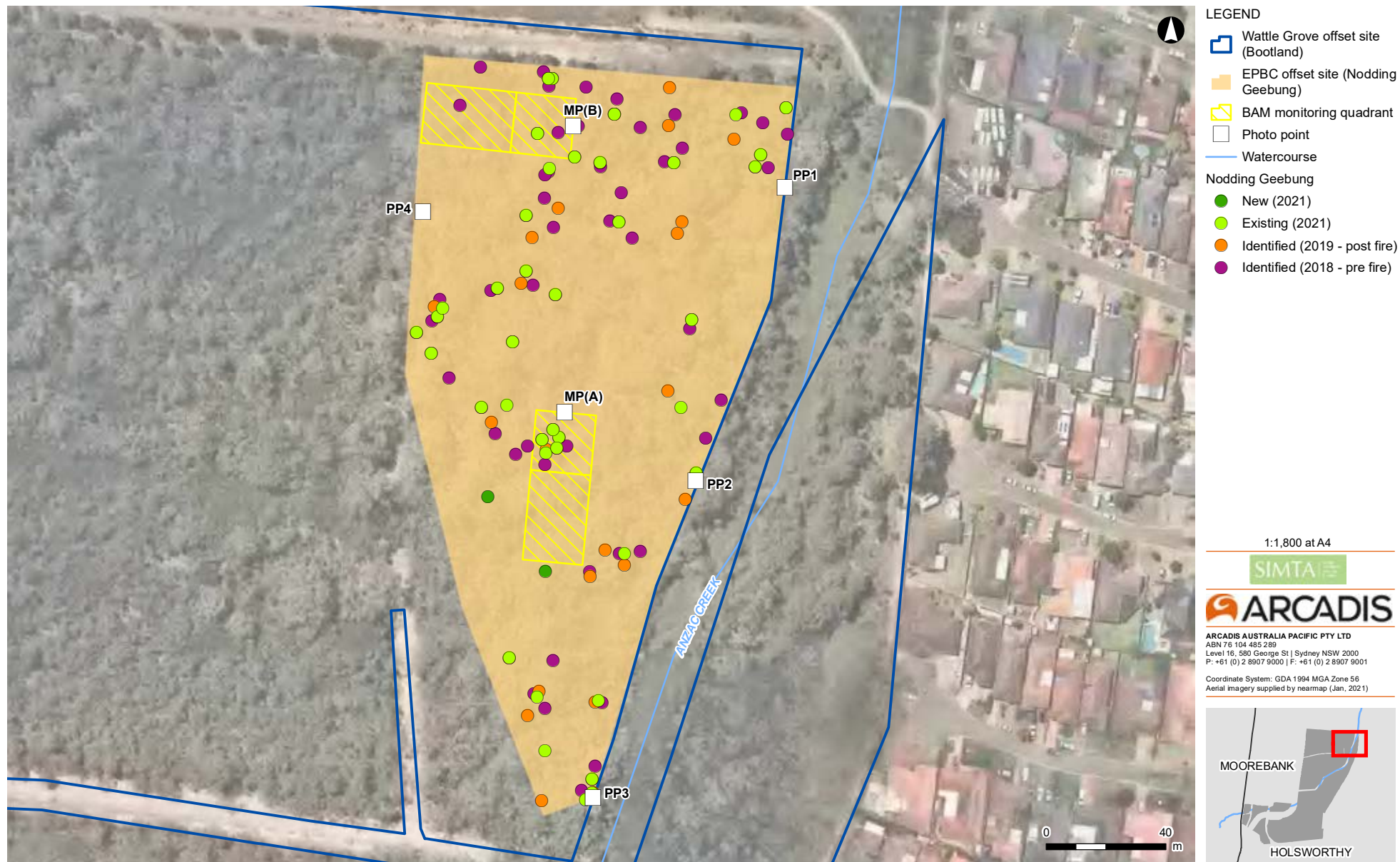


Figure 5: EPBC offset site P4: Nodding Geebung population monitoring

### 3.1.2 Small-flower Grevillea

A total of 50 Small-flower Grevillea stems were identified within offset site G1 during the 2021 survey. Unlike Nodding Geebung, the TFOMP (Arcadis 2020) did not include a requirement to mark Small-flower Grevillea individuals during the 2019 survey, therefore, recruitment and death rates within the population can't be accurately determined.

Small-flower Grevillea stems were more prevalent towards the east and west of the offset site with only a small number of plants being distributed centrally.

Some Small-flower Grevillea stems were observed to be flowering at the time of survey however did not appear to have seed present. Plants were generally sparsely scattered, however close groupings of up to five plants was occasionally observed, generally in areas where leaf litter and ground cover species were absent. Individuals appeared to have a healthy condition and displaying new growth. Small-flower Grevillea displayed a habitat preference for exposed areas with reduced vegetation and litter cover at offset site G1.



Plate 3. Small-flower Grevillea observed to be in flower within the offset site



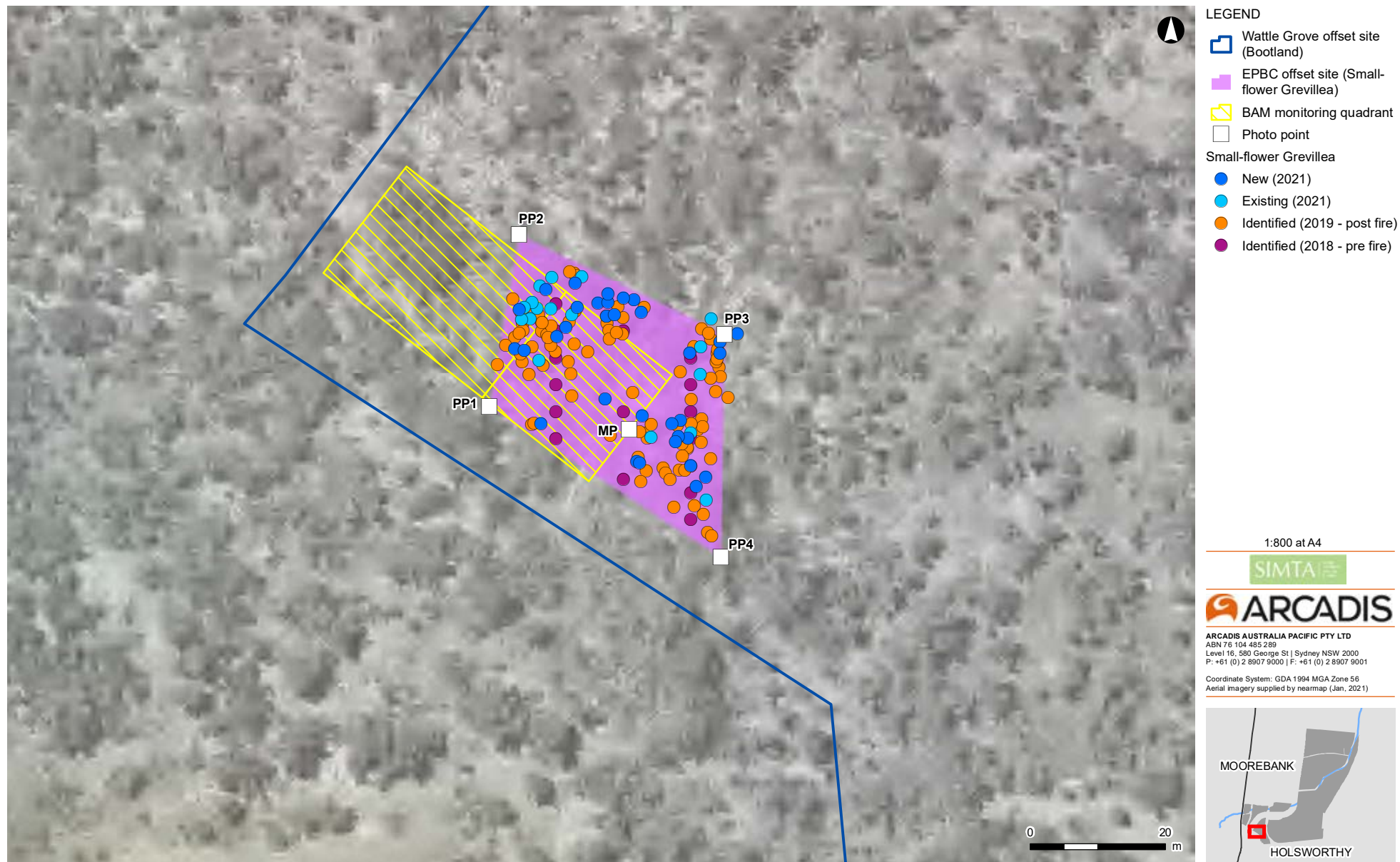


Figure 6: EPBC offset site G1: Small-flower Grevillea population monitoring



## 3.2 Habitat assessment

All five EPBC offset sites are situated within Plant Community Type (PCT) 883 Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion.

This community is one of several unique dry shrub woodland communities found on poorly consolidated sand deposits on hinterland plains and valleys of the Sydney region. This community occurs on old stream deposits at Holsworthy (Tozer et al. 2010).

This vegetation has a woodland formation comprising an open, low-growing eucalypt cover dominated by *Eucalyptus racemosa* (Hard-leaved Scribbly Gum), *Angophora bakeri* (Narrow-leaved Apple) and *Eucalyptus parramattensis* subsp. *parramattensis* (Parramatta Red Gum). A sparse cover of *Melaleuca decora* (Tall paperbark) is often present. Banksias, hakeas, wattles, tea-trees and paperbarks provide a well-developed shrub layer. The ground cover is usually a diverse mix of species typically including a high cover of grasses and sedges (Tozer et al. 2010).

### 3.2.1 Nodding Geebung

#### 3.2.1.1 General habitat preference (OEH, 2019)

The ecology of Nodding Geebung is poorly known and this species has a disjunct distribution. The southern population of Nodding Geebung, which includes this population, is isolated and consists of relatively small populations in the Liverpool, Campbelltown, Bankstown and Blacktown local government areas. The southern populations occupies tertiary alluvium extending onto shale sandstone transition communities and into Cooks River / Castlereagh Ironbark Forest.

Habitat preference is not well understood however abundance at sites appear to be related to disturbance history. Sites with higher abundance also appear to be more disturbed. The frequency of disturbance, particularly fire, is of vital importance for the management and conservation of Nodding Geebung.

The species prefers low woodland communities dominated by Hard-leaved Scribbly Gum and Narrow-leaved Apple with a diverse understorey of sclerophyllous shrub species. Nodding Geebung is an obligate seeder, and therefore may be difficult to detect during targeted surveys even if it is present, as it can be stored in the seed bank, and the number of above ground individuals will fluctuate in space and time (DEC, 2006).

### 3.2.1.2 Offset Site P1 (Nodding Geebung)



Plate 4. Vegetation within EPBC Offset Site P1

The patch of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset site P1 recorded a VI score of 64.4. This patch of vegetation had a complete structure including native species from each vegetation stratum; canopy, shrub and ground layer. Weed cover across the offset site was low, with only scattered occurrences of two exotic species being present.

The upper stratum was comprised of four tree species *Acacia parramattensis* (Parramatta Wattle), Narrow-leaved Apple, *Eucalyptus parramattensis* (Parramatta Red Gum) and Hard-leaved Scribbly Gum. The canopy accounted for a cover of 20 percent across the quadrat.

Native shrubs recorded a cover of 41.1 percent across the quadrat with 12 different species identified in this stratum. The dominant shrub species included *Melaleuca nodosa* (Prickly-leaved Paperbark), *Hakea sericea* (Bushy Needlewood), *Leptospermum trinervium* (Slender Tea-tree), *Callistemon rigidus* (Stiff Bottlebrush), *Melaleuca linariifolia* (Flax-leaved Paperbark) and *Pimelea linifolia* (Slender Rice Flower).

A total of 20 ground cover species were recorded within the BAM vegetation quadrat, having a combined cover of 14.1 percent. The dominant ground cover species included *Cyathochaeta diandra*, *Dianella caerulea* (Blue Flax-lily), *Entolasia stricta* (Wiry Panic), *Gahnia aspera* (Rough Saw-sedge), *Microlaena stipoides* (Weeping Grass) and *Xanthorrhoea* sp. (Grass Tree).

Two exotic species were identified within the quadrat, *Conyza bonariensis* (Hairy Fleabane) and *Paspalum urvillei* (Vaseygrass). This species was sparse within the bushland however become more prominent on the northern edge of the offset site nearest the access road. The quadrat recorded a total exotic species cover of 0.2 percent.

Table 8. Habitat assessment summary: EPBC Offset Site P1

Attributes	PCT Benchmark	Survey results	Dominant species
Tree cover	28	20	<i>Eucalyptus racemosa</i> (5%) <i>Angophora bakeri</i> (8%) <i>Eucalyptus parramattensis</i> (4%)

Attributes	PCT Benchmark	Survey results	Dominant species
Shrub cover	82	41.1	<i>Melaleuca nodosa</i> (30%) <i>Pimelea linifolia</i> (3%) <i>Acacia longifolia</i> (3%)
Ground cover	66	14.1	<i>Microlaena stipoides</i> (5%) <i>Cyathochaeta diandra</i> (1%) <i>Themeda triandra</i> (1%)
Exotic cover	NA	0.2	<i>Conyza bonariensis</i> (0.1%) <i>Paspalum urvillei</i> (0.1%)
Vegetation Integrity Score	100	64.4	

### 3.2.1.3 Offset Site P2 (Nodding Geebung)



Plate 5. Vegetation within EPBC Offset Site P2

The patch of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset site P2 recorded a VI score of 67.2. The vegetation assemblage is fully structured with an established canopy, shrub layer and developing ground layer. There is little to no weed occurrence within the core of the offset site. Invasive grasses are present on the northern boundary of the offset site, on the peripheries of natural bushland next to a vehicle access track.

Three species were present within the canopy stratum including Hard-leaved Scribbly Gum, Parramatta Wattle and Narrow-leaved Apple. The canopy recorded a cover of 47 percent across the quadrat.

A total of 11 shrub species were identified in the vegetation quadrat. The dominant shrubs species present include *Exocarpos cupressiformis* (Native Cherry), *Hibbertia aspera* (Rough Guinea Flower), *Melaleuca nodosa*, *Melaleuca linariifolia* (Flax-leaved Paperbark) and *Persoonia pinifolia* (Pine-leaved Geebung). The total shrub cover recorded for the quadrat was 21.5 percent.

The ground stratum had cover of 41.9 percent including 15 different flora species. The dominant ground covers species included *Themeda triandra* (Kangaroo Grass), *Lomandra longifolia* (Spiny-



headed Mat-rush), *Lomanda multiflora* (Many-flower Mat Rush), *Dianella revoluta* (Blueberry Lily), and *Microlaena stipoides* (Weeping Grass).

Weeds cover was generally low across the offset site with only one exotic flora species being identified. Patches of African Love Grass are present along the northern boundary of the offset site on the periphery of bushland next to an access track.

Table 9. Habitat assessment summary: EPBC Offset Site P2

Attribute	PCT Benchmark	Survey results	Dominant species
Tree cover	28	47	<i>Eucalyptus racemosa</i> (40%) <i>Angophora bakeri</i> (3%) <i>Acacia parramattensis</i> (4%)
Shrub cover	82	21.5	<i>Melaleuca nadosa</i> (15%) <i>Melaleuca linariifolia</i> (2%) <i>Exocarpos cupressiformis</i> (2%)
Ground cover	66	41.9	<i>Lomandra longifolia</i> (15%) <i>Microlaena stipoides</i> (5%) <i>Themeda triandra</i> (15%)
Exotic cover	NA	0.2	<i>Eragrostis curvula</i> (0.2%)
Vegetation Integrity Score	100	67.2	

### 3.2.1.4 Offset Site P3 (Nodding Geebung)



Plate 6. Vegetation within EPBC Offset Site P3

The patch of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset site P3 recorded a VI score of 63.5. The assemblage has recovered significantly since the wildfire and contains a diverse shrub and ground cover stratum. Within the natural bushland weed occurrence is sparse. Weed occurrence was only observed on the northern boundary, on the peripheries of bushland adjacent to a vehicle access track.

Four canopy species were identified within the vegetation quadrat including *Acacia binervia* (Coast Myall), Hard-leaved Scribbly Gum and Narrow-leaved Apple. Canopy cover accounted for 37.2 percent across the quadrat.

Shrubs accounted for 12.6 percent cover across the quadrat. A total of 22 native shrubs species were identified including *Pimelea linifolia* (Slender Rice-flower), *Petrophile pulchella* (Conesticks), *Leptospermum parvifolium* (Lemon-scented Tea Tree), *Hakea sericea* (Silky Hakea) and *Persoonia linearis* (Narrow-leaved Geebung).

A total of 23 ground cover species was recorded within the vegetation quadrat, accounting for a cover of 26 percent. Groundcover species identified included *Cyathochaeta diandra* (Sheath Rush), *Microlaena stipoides* (Weeping Grass), *Laxmannia gracilis* (Slender Wire-lily), *Calochilus campestris* (Copper Beard Orchid), and *Entolasia stricta* (Wiry Panic).

African Love Grass was the only exotic species recorded within the vegetation quadrant. This invasive species recorded a percentage cover of 0.2 percent. Similarly, to other Nodding Geebung offset sites weed occurrence was mainly restricted to the peripheries of intact bushland adjacent to a vehicle access track.

Table 10. Habitat assessment summary: EPBC Offset Site P3

Attributes	PCT Benchmark	Survey results	Dominant species
Tree cover	28	37.2	<i>Angophora bakeri</i> (30%) <i>Eucalyptus racemosa</i> (5%) <i>Acacia binervia</i> (1%)
Shrub cover	82	12.6	<i>Pimelea linifolia</i> (7%) <i>Petrophile puchella</i> (1%) <i>Leptospermum parvifolium</i> (1%)
Ground cover	66	26	<i>Microlaena stipoides</i> (12%) <i>Cyathochaeta diandra</i> (10%) <i>Entolasia stricta</i> (1.2%)
Exotic cover	NA	0.2	<i>Eragrostis curvula</i> (0.2%)
Vegetation Integrity Score	100	63.5	

### 3.2.1.5 Offset site P4 (Nodding Geebung)



Plate 7. Vegetation within EPBC Offset Site P4

The patch of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset site P4 recorded an average VI score of 71.5 across the two vegetation quadrats. Due to the large size of the offset site two vegetation quadrats were conducted to give a representative condition score for vegetation. The results of each quadrat area summarised in Table 11. This patch of bushland was not impacted by the 2018 wildfire. This assemblage has an established canopy and a well-developed tall shrub layer, transitioning between a densely shrubby woodland to a more open woodland. Where shrubs density was less ground covers were more prominent.

The dominant canopy species at offset site P4 is Hard-leaved Scribbly Gum, however a number of other tree species are present albeit at lower abundances including *Allocasuarina* sp., *Casuarina glauca* (Swamp Oak), Narrow-leaved Apple and Parramatta Red Gum. Canopy cover was recorded at 40.5 percent and 32.2 percent at two locations within the offset site. Both canopy cover scores exceed the benchmark tree cover scores for the Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland community.

Shrub cover differs through the offset site, with some areas having a more open shrubby structure and others a dense thicket of shrubs. Shrub cover at two locations recorded 49.8 percent and 46.4 percent. A suite of tall shrub species are common across the site including *Hakea sericea* (Needlebush), *Persoonia laurina* (Laurel Geebung), *Persoonia linearis* (Narrow-leaved Geebung), *Petrophile pulchella* (Conesticks) and *Melaleuca decora*. A total of 23 shrub species was recorded across vegetation quadrats conducted within the offset site.

A total of 23 ground cover species were recorded across the two vegetation quadrats conducted within offset site P4. The cover of ground covers differs across the site measuring 19.7 percent at one location and 26.2 percent at another. Forbs and twining plants were common within the ground stratum, some species present included *Lomandra longifolia* (Spiny-head Mat-rush), *Trachymene incisa* (Wild Parsnip), *Cyathochaeta diandra* (Sheath Rush), *Billardiera scandens* (Hairy Apple Berry), *Hardenbergia violacea* (False Sarsaparilla) and *Cassytha glabella* (Slender Devil's Twine).

Exotic species occurrence across the offset site was generally low. A moderately sized patch (approximately 100 metres square) of the woody weed *Cinnamomum camphora* (Camphor laurel) was observed inside the eastern boundary of the site and the Priority weed species *Rubus fruticosus* sp. agg (Blackberry) was observed encroaching at the southernmost section of the site. A small occurrence of *Eragrostis curvula* (African Lovegrass) was recorded in one of the plots (Figure 5).



Table 11. Habitat assessment summary: EPBC Offset Site P4(A)

Attributes	PCT Benchmark	Survey result	Dominant species
Tree cover	28	40.5	<i>Eucalyptus racemosa</i> (30%) <i>Angophora bakeri</i> (10%)
Shrub cover	82	49.8	<i>Melaleuca nodosa</i> (10%) <i>Hakea sericea</i> (15%) <i>Petrophile pulchella</i> (15%)
Ground cover	66	26.2	<i>Cyathochaeta diandra</i> (19%) <i>Lomandra longifolia</i> (5%) <i>Empodisma minus</i> (2%)
Exotic cover	NA	0	None
Vegetation Integrity Score	100	72.4	

Table 12. Habitat assessment summary: EPBC Offset Site P4(B)

Attributes	PCT Benchmark	Survey results	Dominant species
Tree cover	28	32.2	<i>Eucalyptus racemosa</i> (22%) <i>Angophora bakeri</i> (6%) <i>Eucalyptus parramattensis</i> (3%)
Shrub cover	82	46.4	<i>Melaleuca decora</i> (3%) <i>Petrophile pulchella</i> (3%) <i>Leptospermum trinervium</i> (14%)
Ground cover	66	19.7	<i>Cyathochaeta diandra</i> (10%) <i>Gahnia aspera</i> (1%) <i>Xanthorrhoea</i> spp. (1%)
Exotic cover	NA	0.1	<i>Eragrostis curvula</i> (0.1%)
Vegetation Integrity Score	100	70.6	

### 3.2.2 Small-flower Grevillea

#### 3.2.2.1 General habitat preference (OEH, 2019)

Small-flower Grevillea has a habitat preference for sandy or light clay soils usually over thin shales, often with lateritic ironstone gravels and nodules. Populations of Small-flower Grevillea in the Sydney region usually occur on Tertiary sands and alluvium, and soils derived from the Mittagong Formation.

This species occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Southern Sydney occurrences are typically at 100-300m ASL. Often occurs in open, slightly disturbed sites such as along tracks.

Habitat preference of this species also includes open, slightly disturbed sites such as along tracks.

### 3.2.2.2 Offset Site G1 (Small-flower Grevillea)



Plate 8. Vegetation within EPBC Offset Site G1

The patch of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset site G1 recorded a VI score of 55.7.

The assemblage has a sparse canopy cover and a well-developed shrub and ground stratum. A diversity of native flora species are present, and the occurrence of weeds is low. A patch of African Lovegrass immediately to the west of the offset site and was observed to be encroaching on the offset site.

The canopy stratum is composed of five different tree species and recorded a cover of 27.3 percent within the vegetation quadrat. Trees species present within the offset site include *Acacia parramattensis* (Parramatta Wattle), *Banksia integrifolia* (Coast Banksia), Parramatta Red Gum, Narrow-leaved Apple and Hard-leaved Scribbly Gum.

Shrub cover was relatively uniform across the offset site and continues to regenerate following the wild fire in 2018, recording a cover of 41.2 percent. A total of 11 different shrubs species were identified including *Acacia ulicifolia* (Prickly Moses), *Hakea sericea* (Needlebush), *Melaleuca thymifolia* (Honey Myrtle) and *Melaleuca erubescens* (Pink Honey myrtle).

Ground cover species including grasses, forbs, herbs and scrambling plants recorded a cover of 40.6 percent across the vegetation quadrat. A total of 14 different species were identified including *Tricoryne elatior* (Yellow Autumn-lily), *Ptilothrix deusta* (Feather Sedge), *Hakea sericea* (Silky Hakea), *Patersonia sericea* (Silky Purple-Flag) and *Opercularia diphylla* (Stinkweed).

The herbaceous weed *Senecio madagascariensis* (Fireweed) was rarely encountered through the offset site and recorded a cover of 0.1 percent with the vegetation quadrat.

Table 13. Habitat assessment summary: EPBC offset site G1

Attributes	PCT Benchmark	Survey results	Dominant species
Tree cover	28	27.3	<i>Eucalyptus parramattensis</i> (20%) <i>Eucalyptus racemosa</i> (5%)

## Annual EPBC Offset Site Monitoring for SIMTA (2021)

Attributes	PCT Benchmark	Survey results	Dominant species
			<i>Angophora bakeri</i> (2%)
Shrub cover	82	41.2	<i>Melaleuca nodosa</i> (15%) <i>Pimelea linifolia</i> (10%) <i>Leptospermum trinervium</i> (5%)
Ground cover	66	40.6	<i>Cyathochaeta diandra</i> (10%) <i>Xanthorrhoea sp.</i> (8%) <i>Patersonia sericea</i> (5%)
Exotic cover	NA	0.1	<i>Senecio madagascariensis</i> (0.1)
Vegetation Integrity Score	100	55.7	

### 3.3 Photo point monitoring

Annual monitoring photographs are presented in Appendix C.



## 4 REVIEW OF CURRENT MANAGEMENT ACTIONS

Threatened species	Recovery strategies	Timing and duration	Performance criteria		Comments
			Objective	Status (2020)	
Small-flower Grevillea	Restrict access to sites	Year 1: 20 years	Fencing installed and maintained to remain functional	Achieved	<p>An existing cyclone fence follows the external boundary of the Wattle Grove offset site. All EPBC offset sites are within the Wattle Grove offset site boundary fence.</p> <p>EPBC offset sites have been demarcated with metal pickets. Exclusion fencing for individual offset site has not been erected.</p> <p>All areas within the boundary fence are secure and can only be accessed by relevant personnel with a regulated key managed by Knight Frank.</p> <p>Additional fencing has been installed along the MPE operational Rail Link passing through the western corner of Wattle Grove offset site delineating the bushland environment from the rail corridor.</p>
	Create and maintain weed free bushland areas	Primary weed control: Year 1-5	<5% weed cover	Achieved	<p>No weed control works have been conducted within the Small-flower Grevillea offset site during the 2020/2021 monitoring year. However, weed levels within the offset site remain to be low and don't pose a threat to Small-flower Grevillea at this stage.</p> <p>The BAM vegetation quadrat conducted within offset site G1 recorded a weed cover of 0.1 percent across 400 square metres. Weed cover within offset site G1 is estimated at less than 5 percent cover.</p> <p>Site inspection did not identify any notable weed infestations. One exotic species was identified within the BAM vegetation quadrat; <i>Senecio madagascariensis</i> (Fireweed) was recorded with a cover of 0.1%. The aggressive invasive grass species African Love Grass is located immediately to the west of the offset site and was observed to be encroaching on the offset site.</p>

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Threatened species	Recovery strategies	Timing and duration	Performance criteria		Comments
			Objective	Status (2020)	
	Ensure appropriate fire regimes for species (minimum fire free period of 8 - 15 years)	Conduct ecological burns every 6-20 years in winter: 20 years	Monitoring of burn site to be undertaken every 6 months. Net gain in the number of stems over the duration of management to meet the offset obligation	Achieved	A wildfire directly impacted the EPBC offset site in April 2018. No ecological burns will be conducted within the EPBC offset site until 2026. At this time, the appropriateness of an ecological burn will be assessed to determine whether it will have a positive impact on the populations of Small-flower Grevillea.
	Avoid spraying herbicide within the vicinity of the species	At all times (monitored annually in spring): 20 years	No damage to threatened species through inappropriate herbicide use. Evidence would trigger corrective actions	Achieved	No herbicide spraying has been conducted within the offset site during the monitoring year.
	Monitor species for grazing or damage, this may indicate large macropod overabundance to inform control frequency	Monitored annually in spring: 20 years	Evidence of excessive grazing would trigger corrective actions under the overabundant herbivore management action plan	Achieved	No evidence was observed to suggest that Small-flower Grevillea have been impacted through grazing or trampling by large macropods.
	Protect individuals from pedestrian traffic along formal tracks, use fencing if required	Year 1: 20 years	Fencing installed and maintained to remain functional	Achieved	The location of EPBC offset sites have been demarcated using metal star pickets with secured yellow caps. The delineation of boundaries will act to remind personnel working within the Wattle Grove offset area of a sensitive area. All personnel working with the Wattle Grove offset area should be made aware of sensitive areas during the introductory biobank site induction.
	Ensure that this species is considered in all works and future planning matters	At all times: 20 years	Net gain in the number of stems over the duration of management to meet the offset obligation	Achieved	No activities (works and planning matters) have arose which have required the consideration of the EPBC offset sites

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Threatened species	Recovery strategies	Timing and duration	Performance criteria		Comments
			Objective	Status (2020)	
Nodding Geebung	Restrict access to sites	Year 1 - 20 years	Fencing installed and maintained to remain functional	Achieved	<p>An existing cyclone fence follows the external boundary of the Wattle Grove offset site. All EPBC offset sites are within the Wattle Grove offset site boundary fence.</p> <p>EPBC offset sites have been demarcated with metal pickets. Exclusion fencing for individual offset site has not been erected.</p> <p>All areas within the boundary fence are secure and can only be accessed by relevant personnel with a regulated key managed by Knight Frank.</p> <p>Additional fencing has been installed along the MPE operational Rail Link passing through the western corner of Wattle Grove offset site delineating the bushland environment from the rail corridor.</p>
	Create and maintain weed free bushland areas	Primary weed control: Year 1-5	<5% weed cover	Achieved	<p>Weed levels across Nodding Geebung offset sites is low. BAM vegetation quadrat conducted within offset site P1, P2, P3 and P4 recorded weed covers of less than five percent; 0.2, 0.2, 0.2 and 0.1 respectively. Weed covers at each Nodding Geebung offset site is estimated at less than 5 percent cover.</p> <p>Weed presence is sparse consisting mainly of scattered individuals on the peripheries of natural bushland. The invasive grass species African Love Grass was observed at the three of the offset areas, P2 P3 and P4. Majority of occurrences of this species was restricted to the disturbed edges of bushland parallel to existing access tracks. There is no evidence to suggest that weeds identified within the offset sites are negatively impacting individuals of Nodding Geebung.</p>
	Ensure appropriate fire regimes for species (minimum fire free period of 10 years)	Annually in spring: 20 years	Monitoring of burn site to be undertaken every 6 months. Net gain in the number of plants over the duration of	Not achieved	<p>A wildfire directly impacted the EPBC offset sites in April 2018. This wildfire did not coincide with timings or suitable conditions for ecological burning in respect to Nodding Geebung.</p>



Annual EPBC Offset Site Monitoring for SIMTA (2021)

Threatened species	Recovery strategies	Timing and duration	Performance criteria		Comments
			Objective	Status (2020)	
			management to meet the offset obligation		No ecological burns will be conducted within the EPBC offset site until 2026. At this time, the appropriateness of an ecological burn will be assessed to determine whether it will have a positive impact on the populations of Nodding Geebung.
	Monitor site for <i>Acacia baileyana</i> , which may outcompete species	Annually in spring: 20 years	Evidence of encroachment by this species would trigger corrective actions (see Section)	Achieved	<i>Acacia baileyana</i> was not identified within the BAM monitoring quadrants undertaken to assess habitat quality nor was it identified in other areas of the offset sites.
	Monitor species for grazing or damage, this may indicate large macropod overabundance to inform control frequency	Monitored annually in spring: 20 years	Evidence of excessive grazing would trigger corrective actions under the overabundant herbivore management action plan (see Section 7.2)	Achieved	No evidence was observed to suggest that Nodding Geebung have been impacted through grazing or trampling by large macropods.
	Protect individuals from pedestrian traffic along formal tracks, use fencing if required	Year 1: 20 years	Fencing installed and maintained to remain functional	Achieved	The location of EPBC offset sites have been demarcated using metal star pickets with secured yellow caps. The delineation of boundaries will act to remind personnel working within the Wattle Grove offset site of a sensitive area. All personnel working with the Wattle Grove offset area should be made aware of sensitive areas during the introductory biobank site induction.
	Ensure that this species is considered in all works and future planning matters	At all times: 20 years	Net gain of 16 plants over the duration of management to meet the offset obligation	Achieved	Planning has commenced for the removal and remediation a section of disused rail (DURS) at the southern extent of Wattle Grove offset area. The remediation footprint of DURS does not intersect EPBC offset sites, however a proposed access route to the project site may pass along the northern boundary of Nodding Geebung offset site P3. The chosen access route will be used by used by demolition machinery, site vehicles and other

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Threatened species	Recovery strategies	Timing and duration	Performance criteria		Comments
			Objective	Status (2020)	
					<p>machines required to remove the old rail track and remediate the area.</p> <p>There is the potential for indirect or inadvertent impacts to the EPBC offset site and individuals of Nodding Geebung if a risk assessment is not conducted. If this route is identified as the preferred option, the potential impacts of the access track and any necessary mitigation measures should be considered further.</p>

## 5 DISCUSSION & RECOMMENDATIONS

The 2021 survey marked the third monitoring event for offset sites P1, P2, P3 and G1, and the second monitoring event for offset site P4. Comparisons can be made between this year's data and the results of previous monitoring events to analyse population dynamics of Nodding Geebung and Small-flower Grevillea within EPBC offset sites, specifically:

- Fluctuations in population size and distribution, and
- Response to disturbance and/or management actions

The condition of vegetation has been scored and a habitat assessment has been conducted for offset sites across monitoring periods to provide more context to changes in Nodding Geebung and Small-flower Grevillea populations.

Changes to Nodding Geebung and Small-flower Grevillea populations across offset sites P1, P2, P3, P4 and G1 have been discussed below.

### 5.1.1 Nodding Geebung

A comparison of results for Nodding Geebung between the 2019, 2020 and 2021 monitoring events has been discussed below.

#### Population assessment

A total of 51 individuals of Nodding Geebung were identified across offset sites P1, P2 and P3 during the 2021 monitoring event in comparison to 90 individuals recorded in 2020 and 112 individuals recorded in 2019. A total of 41 individuals were recorded in P4, which is a slight decrease from 43 individuals recorded during the establishment of the site in 2020. Across all sites, the number of Nodding Geebung individuals has decreased from 133 (2020) to 92 individuals recorded during the 2021 surveys.

The number of Nodding Geebung individuals in all offset sites have decreased since the 2020 population. No Nodding Geebung were identified within P2 for the second year in a row, despite searches for individuals at locations where individuals were previously located pre (2018) and post wildfire (2019). A comparison of populations counts at each offset site across survey years is presented in Table 14.

Table 14. Comparison of Nodding Geebung population census across monitoring years

Offset site	Census year	Life stage	Sub-count	Count
P1	2019	Adult	0	9
		Juvenile	9	
	2020	Adult	0	13
		Juvenile	13	
	2021	Adult	0	12
		Juvenile	12	
P2	2019	Adult	0	3
		Juvenile	3	



Offset site	Census year	Life stage	Sub-count	Count
	2020	Adult	0	0
		Juvenile	0	
	2021	Adult	0	0
		Juvenile	0	
P3	2019	Adult	2	100
		Juvenile	98	
	2020	Adult	2	77
		Juvenile	75	
	2021	Adult	2	39
		Juvenile	37	
P4	2019	Adult	N/A	N/A
		Juvenile		
	2020	Adult	43	43
		Juvenile	0	
	2021	Adult	41	41
		Juvenile	0	

Of the 133 individuals recorded during the 2020 surveys, 88 were juvenile plants and were considered to be sensitive to certain environmental variables and having reasonable chance of perishing. During the current surveys, 64 of the 88 juveniles marked during the 2020 survey were re-found, equating to a survival rate of 72.7 percent for juvenile Nodding Geebung across the monitoring year. This is higher than the previous year's survival rate, which was 56 percent. Persistence of less than 50 percent of Nodding Geebung individuals is not considered an ideal outcome, however there is insufficient data to determine whether this rate of persistence is significant.

It was anticipated that a proportion of the juvenile Nodding Geebung observed during monitoring events would not survive the following year due to several environmental and ecological factors. Majority of juvenile plants recorded are in dense clusters containing many individuals. It is possible that the death of the juvenile plants represents a natural dieback whereby the strongest plants in the cluster survive and utilise the available resources. In other locations of Wattle Grove offset area, which were unaffected by the 2018 wildfire, large numbers of adult Nodding Geebung are present however are not often observed in close proximity to each other. It is hypothesised that only a small number of individuals within clusters of Nodding Geebung juveniles will persist to become adult plants.

The current surveys recorded 41 less individuals across the four Nodding Geebung offset sites in comparison to the previous (2020) survey period. The largest decline was identified at P3, where a decline of 38 individuals between the 2020 and 2021 survey periods was observed. A similar decline was also recorded at this site between the 2019 and 2020 surveys, with a decline of 22 in individuals during between those survey periods. However, new recruitment was observed at offset sites P1 and P3, which is a positive sign that Nodding Geebung are continuing to germinate and replace individuals which perish. New individuals were generally recorded within or in close proximity to existing clusters of juveniles. At P3, juvenile individuals were also re-found in areas away from dense clusters, whereas many juveniles recorded in clusters during the 2020 surveys were not. This could

indicate that an increase in distribution of Nodding Geebung across the site will reduce interspecies competition and may provide a greater chance of individuals persisting to maturity.

It was calculated using the EPBC offsetting policy that 155 Nodding Geebung require conservation and management within offset sites to achieve a net gain of 16 Nodding Geebung individuals over a 20-year period. Unforeseen impacts from the 2018 wildfire, saw majority of the Nodding Geebung population within offset sites burnt. Regeneration of the species over the past three years has seen a fluctuation in the recovery of the population with 133 individuals being recorded in 2020 survey and 92 in the 2021 survey. It is evident that to assist this species in achieving a net gain of 16 individuals across offset sites some level of intervention will likely be required. Over the coming year the establishment of experimental disturbance plots will be investigated for offset sites P1, P2 and P3 to promote germination of Nodding Geebung (discussed in more detail below). It is anticipated that with adaptive management and ongoing monitoring the population of Nodding Geebung within offset sites will increase to 171 individuals within the 20-year time frame.

### Habitat assessment and potential impacts

Current surveys found that patches of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within offset sites have achieved a greater or similar VI score than was recorded in 2020 (Table 15). Exotic species cover was recorded to be low across all offset sites over the 2021 monitoring period. An increasing vegetation condition does not necessarily reflect an increase in habitat value for Nodding Geebung as the abundance of this species can often be related to disturbance history. Sites with higher abundance also appear to be more disturbed (DPIE 2019).

Table 15. A summary of changes to vegetation condition at offset site P1, P2 and P3 across monitoring periods

Offset site	Monitoring year	Cover across BAM quadrat				VI score
		Tree	Shrub	Groundcover	Exotic	
P1	2019	11.5	47.7	4.2	0.2	52.5
	2020	16	46	6.8	0.1	64.8
	2021	20	41.1	14.1	0.2	64.4
P2	2019	52.5	4.7	19.4	0.6	51.8
	2020	47.3	15.5	22.1	0	56.5
	2021	47	21.5	41.9	0.2	67.2
P3	2019	22.5	8	17.3	0.1	51.5
	2020	36	5.7	22.9	0.2	59.6
	2021	37.2	12.6	26	0.2	63.5
P4a	2020	45	43.9	25.4	0	73.4
	2021	40.5	49.8	26.2	0	72.4
P4b	2020	32.4	18	8.2	50	50
	2021	32.2	46.4	19.7	0.1	70.6

No obvious signs of impact to Nodding Geebung were observed within the offset sites. Some minor insect damage was observed on a few individuals; however, it appears that this damage may be existing from previous years. Plants observed to have insect damage were also observed as having fresh new green shoots and foliage. There were no signs of foraging or trampling upon this species by mammals.

Adult Nodding Geebung are at less risk of being outcompeted by other plant species compared to juveniles. Populations of Nodding Geebung at offset sites P1 and P3 consist mainly of juvenile plants which are more susceptible to being outcompeted by native and exotic plants. Currently there is significant competition in the shrub and understorey as there is an overabundance of post-fire recruiters like *Acacia decurrens* (Black Wattle), *Imperata cylindrica* (Blady Grass), *Pimelea linifolia* (Slender Rice Flower), *Platysace ericoides*, *Pultenaea villosa* (Hairy Bush-pea) and *Trachymene incisa* (Trachymene). An increase in native shrub and ground stratum vegetation cover within offset site P1, P2 and P3 may be reducing the availability of space and resources (light, water etc.) for Nodding Geebung to regenerate. Juvenile Nodding Geebung were observed being smothered by the native vine *Cassytha glabella* (Devils Twine) in offset site P3, however this is not likely directly resulting in death of plants. Increased competition by native species provides reasoning for why majority of Nodding Geebung individuals in offset sites P1 and P3 are located on the peripheries of intact bushland in disturbed, more open areas, amongst the exotic species African Love Grass where there is less competition from other plants.

The cover of African Love Grass is increasing on the edges of native bushland which may reduce the availability of habitat for Nodding Geebung or directly outcompete juvenile plants in the future. Increases in cover of African Love Grass should be monitored over the following years to determine if it is having an impact upon Nodding Geebung.

It is likely that too frequent disturbance, and potentially a long-term absence of disturbance, may be detrimental to the persistence of Nodding Geebung in local populations. In this instance, the presence of a seed bank is essential for persistence after a fire event. If fires occur at an interval too small to allow re-establishment of a soil stored seed bank following a previous fire event, then local extinction will occur. A long-term absence of fire may also be detrimental to the persistence of the species, as recruitment is likely to be largely dependent upon disturbance. This critical fire frequency rate has not yet been determined, however the NSW National Parks and Wildlife Service (NPWS) suggests greater than 7-year intervals, and the Threatened Species Hazard Reduction List for the Bushfire Environmental Assessment Code states that fire should not occur more frequently than once every ten years in the habitat of Nodding Geebung (DEC, 2006).

### Corrective actions

It is evident that Nodding Geebung populations within offset sites that burned in 2018 are fluctuating with new individuals germinating and other juvenile plants perishing. This fluctuation is due to the opportunistic nature of post-bushfire vegetation recovery and the high levels of competition amongst post-fire recruitment specialist species. Although a moderate proportion of juvenile Nodding Geebung identified during the 2019 monitoring period have perished, each proceeding monitoring event has recorded recruitment suggesting that population recovery is ongoing.

The localised nature of recruitment/regeneration of Nodding Geebung on the disturbed edge of offset sites due to increasing competition by native species has initiated a management response to support the germination of individuals within bushland areas of the offset sites, specifically for P1, P2 and P3. Experimental disturbance plots will be positioned in areas of the offset sites where individuals do not currently occur but have been recorded as occurring prior to the 2018 wildfire. In each of the experimental plots the following actions will be implemented:



- Disturbance stimulus - a disturbance stimulus including raking of leaf litter back to bare earth will be trialled to promote germination in areas where viable seed may be present
- Competition control - selective pruning or removal of ground layer and shrubs to reduce competition to Nodding Geebung and encourage recruitment/survival of juvenile plants

A conservative methodology will be developed for each offset site considering all present biodiversity values prior to implementation. As per the requirements of the TFOMP, NSW DPIE (EES) and the Commonwealth Department of Agriculture, Water and the Environment (DAWE) will be consulted prior to implementation of the proposed adaptive management measure. The methodology and results of experimental disturbance plots will be presented in the 2022 annual monitoring report for the EPBC offset sites.

Additional bush regeneration activities will be implemented over the coming year to support existing Nodding Geebung including weed control works and native vegetation pruning where smothering cover is occurring.

If Nodding Geebung populations across offset sites continue to show decline in future surveys a translocation project could be initiated whereby seeds collected from adult individuals in offset sites P3 and P4 are propagated at an offsite location and re-introduced at a later stage as young plants.

Table 16. Recommended corrective actions

Identified issues	Offset site	Recommended action
Patch of the woody weed Camphor Laurel with offset site P4	P4	Bush regenerators to remove occurrence of Camphor laurel.
Encroaching Blackberry at offset site P4	P4	Blackberry infestation should be monitored and controlled as necessary to prevent encroachment into the offset site.
Increased cover of African Love Grass along the edges of offset sites, nearest access roads.	P1, P2, P3	Monitoring of African Love Grass adjacent to access roads within EPBC offset sites. If this invasive grass species is thought to be having a negative impact upon Nodding Geebung weed control works may be implemented.  Manual control methodologies should be prioritised unless a targeted herbicide treatment, that has no risk of over spray or off target poisoning, can be used. An example of a selective herbicide that may be suitable for control of African Lovegrass within offset areas is Flupropanate granular herbicide.
Native plant species outcompeting Nodding Geebung (i.e. smothering, occupying open areas)	All offset site	Monitoring of juvenile Nodding Geebung in plots P1, P2 and P3 should be monitored for smothering from native plant species.  On a quarterly basis inspection should be made of juvenile Nodding Geebung with offset site P1, P2 and P3. Any native plants observed to be crushing or smothering individuals should be cut back. i.e. Slender Devils Twine observed on juvenile Nodding Geebung should be removed.

Identified issues	Offset site	Recommended action
Lack of recruitment of Nodding Geebung in bushland areas at offset site P1, P2 and P3.	P1, P2, P3	<p>Establishment of experimental disturbance plots in offset sites to:</p> <ul style="list-style-type: none"> <li>• encourage germination of Nodding Geebung individuals within bushland</li> <li>• increase distribution of Nodding Geebung across sites</li> <li>• reduce competition from native and exotic vegetation</li> <li>• increase overall population numbers of Nodding Geebung</li> </ul>

### 5.1.2 Small-flower Grevillea offset sites

A comparison of results for Small-flower Grevillea between the 2020 and 2021 monitoring events has been discussed below.

#### Population assessment

The 2021 monitoring survey saw a reduction in the number of stems of Small-flower Grevillea within offset site G1. The population has reduced from 60 to 50 stems; marking a decline of 16 percent. A reduced distribution of Small-flower Grevillea was observed centrally across the offset site and most unrecovered Small-flower Grevillea were located toward the south-eastern end of the site.

A reduction in stem count across the offset site does not necessarily mean that there has been a reduction in the number of Small-flower Grevillea individuals. This species is capable of suckering from rootstock and demonstrates a degree of vegetative spread, particularly after disturbance such as fire (DPIE 2019a). It is feasible that stems may have died back following increased competition over the 2021 monitoring period from an overabundance of post-fire recruiters in the shrub and understory stratum, however the individual is still alive and present within the offset site, albeit with a lesser biomass. Furthermore, it is noted that there was a marked increase in the ground layer and shrub cover, which has almost doubled since the 2020 survey, making it difficult to detect Small-flower Grevillea within the site.

It was calculated using the EPBC offsetting policy that 142 Small-flower Grevillea require conservation and management within offset sites to achieve a net gain of at least 17 individuals over a 20-year period. Due to unforeseen impacts from the 2018 wildfire all Small-flower Grevillea within the offset site perished. The 2021 survey recorded a total of 50 stems within the offset site. It is anticipated that fluctuations in native vegetation cover resulting from natural die back and maturing shrubbery will increase habitat resources for Small-flower Grevillea and promote further growth and recruitment. It is anticipated that with ongoing management and monitoring the population of Small-flower Grevillea within offset sites will increase to 162 stems within the 20-year time frame.

#### Habitat assessment and potential impacts

The condition of Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland within the offset site has increased in condition as demonstrated by an increasing VI score from 37.7 in 2019 to 47 in 2020 and increasing again to 55.7 in 2021 (Table 17). The patch has seen a large increase in the groundcover and shrub vegetation which may have temporarily reduced the available habitat for Small-flower Grevillea. Weed cover has remained similar across all monitoring periods.

Table 17. Changes in vegetation cover at offset site G1 across monitoring periods (2019 - 2021)

	Tree	Shrub	Groundcover	Exotic	VI score
2019	9.1	22.6	9.2	0.1	37.7
2020	24	21.2	17	0.1	47
2021	27.3	41.2	41.9	0.1	55.7

No obvious signs of impacts to this species were observed. Individuals were not observed to have been foraged upon by animals or showing signs of damage from insects. Most individuals were recorded to be in a healthy condition, with only three individuals recorded in poor health. Weed occurrence within the offset area is low and is not impacting upon the occurrence or persistence of this species.

Areas of open woodland with a sparser shrub and ground layer vegetation have healthy populations of Small-flower Grevillea with many individuals. It is evident that numbers of Small-flower Grevillea are greatest in open woodland areas with reduced competing shrub and ground covers.

### Corrective actions

It is recommended that the population be monitored for another year prior to implementing any management actions to increase the population of Small-flower Grevillea. It is not suggested that individuals be tracked for monitoring as has been done for Nodding Geebung. Small-flower Grevillea are capable of suckering from a rootstock and most populations demonstrate a degree of vegetative spread, particularly after disturbance such as fire. Therefore, it would be futile trying to track individuals via stems to monitor recruitment and death rates.

Table 18. Recommended corrective actions

Identified issues	Recommended action
Moderate infestation of African Love Grass beginning to encroach on offset site	Infestations of African Love Grass should be monitored and controlled as necessary to prevent encroachment into the offset site.
Native plant species outcompeting Small-flower Grevillea (i.e. smothering, occupying open areas)	Monitoring of Small-flower Grevillea population over the following year to determine whether individuals are reducing in areas which are becoming increasingly vegetated by other native plant species.



## 6 REFERENCES

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## **7 APPENDICES**

**Appendix A. BAM monitoring quadrat data set**

**Appendix B. BAM quadrats vegetation score summary**

**Appendix C. Annual monitoring photographs**

**Appendix D. Photo point detail**

## **APPENDIX A BAM MONITORING QUADRAT DATA SET**



Annual EPBC Offset Site Monitoring for SIMTA (2021)

Scientific name	Common name	Exotic	G1		P1		P2		P3		P4(A)		P4(B)	
			Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
<i>Acacia binervata</i>	Two-veined Hickory								1	10				
<i>Acacia brownii</i>	Heath Wattle								0.1	10				
<i>Acacia falciformis</i>	Broad-leaved Hickory						0.5	2						
<i>Acacia longifolia</i>					3	50					0.2	10		
<i>Acacia parramattensis</i>	Parramatta Wattle		0.2	5	3	50	4	30	1.2	20				
<i>Acacia ulicifolia</i>	Prickly Moses		0.5	30			0.1	5						
<i>Allocasuarina littoralis</i>	Black She-Oak										0.5	1		
<i>Allocasuarina spp.</i>													0.2	1
<i>Angophora bakeri</i>	Narrow-leaved Apple		2	10	8	16	3	6	30	6	10	10	6	10
<i>Aristida ramosa</i>	Purple Wiregrass								0.2	30				
<i>Aristida spp.</i>											0.1	50		
<i>Aristida vagans</i>	Threeawn Speargrass								0.1	40				
<i>Banksia integrifolia</i>	Coast Banksia		0.1	3										
<i>Banksia oblongifolia</i>	Fern-leaved Banksia								0.1	5	0.2	2	0.5	5
<i>Banksia spinulosa</i>	Hairpin Banksia				0.5	2					0.5	3	2	5
<i>Billardiera scandens</i>	Hairy Apple Berry				0.2	50	0.1	20	0.1	10	0.2	50	0.1	25
<i>Bossiaea heterophylla</i>	Variable Bossiaea								0.5	100	0.2	15		
<i>Burchardia umbellata</i>	Milkmaids										0.1	10	0.1	10
<i>Bursaria spinosa</i>	Native Blackthorn								0.1	5				
<i>Callistemon linearifolius</i>	Netted Bottle Brush								0.1	3				
<i>Callistemon pinifolius</i>	Pine-leaved Bottlebrush												1	20
<i>Callistemon rigidus</i>	Stiff Bottlebrush				2	25								
<i>Calochilus campestris</i>	Copper Beard Orchid								0.1	1				
<i>Cassytha glabella</i>			1	60	2	50	0.1	3	0.2	50	0.2	50	0.5	40

## Annual EPBC Offset Site Monitoring for SIMTA (2021)

Scientific name	Common name	Exotic	G1		P1		P2		P3		P4(A)		P4(B)	
			Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
<i>Casuarina glauca</i>	Swamp Oak												1	1
<i>Cheilanthes sieberi</i>	Rock Fern				0.2	150								
<i>Clematis aristata</i>	Old Man's Beard				0.1	5								
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*			0.1	10								
<i>Coronidium scorpioides</i>	Button Everlasting				0.2	10			0.1	5				
<i>Cyathochaeta diandra</i>			10	40	1	2			10	900	15	150	10	200
<i>Cynodon dactylon</i>	Common Couch				0.1	15								
<i>Daviesia genistifolia</i>	Broom Bitter Pea								0.1	15				
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea						0.1	5						
<i>Dianella caerulea</i>	Blue Flax-lily				0.5	20			0.1	60				
<i>Dianella revoluta</i>	Blueberry Lily						1	20					0.2	10
<i>Dianella spp.</i>			0.1	5										
<i>Empodisma minus</i>											2	150		
<i>Entolasia marginata</i>	Bordered Panic										0.5	50		
<i>Entolasia stricta</i>	Wiry Panic		0.5	30	0.5	40	0.1	20	1.2	300	1	150	1	50
<i>Eragrostis brownii</i>	Brown's Lovegrass								0.2	20				
<i>Eragrostis curvula</i>	African Lovegrass	*					0.2	5	0.2	10			0.1	2
<i>Eucalyptus parramattensis</i>	Parramatta Red Gum		20	6	4	3							3	4
<i>Eucalyptus racemosa</i>	Narrow-leaved Scribbly Gum		5	2	5	2	40	7	5	10	30	2	22	4
<i>Exocarpos cupressiformis</i>	Cherry Ballart						2	10						
<i>Gahnia aspera</i>	Rough Saw-sedge						0.1	5	0.1	1			1	30
<i>Gahnia spp.</i>			0.1	2										
<i>Glycine clandestina</i>	Twining glycine				0.1	5	0.1	5						
<i>Gompholobium glabratum</i>	Dainty Wedge Pea		0.1	1										

## Annual EPBC Offset Site Monitoring for SIMTA (2021)

Scientific name	Common name	Exotic	G1		P1		P2		P3		P4(A)		P4(B)	
			Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
<i>Gompholobium minus</i>	Dwarf Wedge Pea								0.1	40				
<i>Gonocarpus teucrioides</i>	Germander Raspswort										0.2	100		
<i>Grevillea parviflora</i>			0.1	3										
<i>Hakea dactyloides</i>	Finger Hakea												0.3	5
<i>Hakea dactyloides broad leaf form</i>											0.5	10		
<i>Hakea sericea</i>	Needlebush		0.1	5	0.5	50	0.2	15	1	150	15	12	3	25
<i>Hardenbergia violacea</i>	False Sarsaparilla				0.5	50	0.1	2	0.1	15			0.1	5
<i>Hibbertia aspera</i>	Rough Guinea Flower						0.3	15						
<i>Hibbertia fumana</i>					0.1	1								
<i>Hibbertia puberula</i>											0.1	2		
<i>Hibbertia riparia</i>									0.1	1				
<i>Imperata cylindrica</i>	Blady Grass				0.2	25								
<i>Isopogon anemonifolius</i>	Broad-leaf Drumsticks										0.5	5		
<i>Kunzea ambigua</i>	Tick Bush								0.2	20				
<i>Kunzea capitata</i>			0.1	1					0.2	25				
<i>Laxmannia gracilis</i>	Slender Wire Lily				0.1	20			0.2	50				
<i>Leptocarpus tenax</i>													4	50
<i>Leptospermum parvifolium</i>			0.2	3	0.2	1			1	50	0.2	5		
<i>Leptospermum polygalifolium</i>	Tantoon				0.2	1	0.2	2	0.2	10				
<i>Leptospermum trinervium</i>	Slender Tea-tree		5	20	1	15					5	14	14	80
<i>Leucopogon spp.</i>									0.1	10				
<i>Lissanthe strigosa</i>	Peach Heath										1	150		
<i>Lobelia purpurascens</i>	whiteroot				0.1	10								
<i>Lomandra filiformis</i>	Wattle Matt-rush								0.5	100	0.5	20		



## Annual EPBC Offset Site Monitoring for SIMTA (2021)

Scientific name	Common name	Exotic	G1		P1		P2		P3		P4(A)		P4(B)	
			Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
<i>Lomandra gracilis</i>											0.1	50		
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush				0.5	5	15	20			5	75	1	30
<i>Lomandra multiflora</i>	Many-flowered Mat-rush						5	5			0.1	20		
<i>Melaleuca decora</i>													3	1
<i>Melaleuca erubescens</i>	Pink Honeymyrtle												0.1	2
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark				0.5	5	2	5	0.1	10				
<i>Melaleuca nodosa</i>			15	50	30	200	15	50	0.1	10	10	60	15	60
<i>Melaleuca thymifolia</i>	Thyme Honey-myrtle		0.1	2					0.2	50				
<i>Microlaena stipoides</i>	Weeping Grass		0.1	20	5	150	5	50	12	750	0.1	50	0.5	50
<i>Mitrasacme polymorpha</i>											0.1	50		
<i>Notodanthonia longifolia</i>	Long-leaved Wallaby Grass								0.2	100				
<i>Olearia spp.</i>											0.2	5		
<i>Opercularia diphylla</i>	Stinkweed		0.1	1										
<i>Opercularia varia</i>	Variable Stinkweed				0.2	100			0.1	30				
<i>Paspalum urvillei</i>	Vasey Grass	*			0.1	5								
<i>Patersonia sericea</i>	Silky Purple-Flag		5	40					0.1	10				
<i>Persoonia laurina</i>	Laurel Geebung												1	1
<i>Persoonia linearis</i>	Narrow-leaved Geebung				0.1	2			0.1	5			1	5
<i>Persoonia nutans</i>	Nodding Geebung								0.1	10	1	5	1	1
<i>Persoonia pinifolia</i>	Pine-leaved Geebung						0.1	2						
<i>Petrophile pulchella</i>	Conesticks				0.1	25			1	100	15	60	3	35
<i>Pimelea linifolia</i>	Slender Rice Flower		10	250	3	200	1	30	7	300	0.2	10	1	5
<i>Platysace ericoides</i>			10	60									0.5	30
<i>Pomax umbellata</i>	Pomax						0.1	20	0.1	10	0.2	50		

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Scientific name	Common name	Exotic	G1		P1		P2		P3		P4(A)		P4(B)	
			Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
<i>Pratia purpurascens</i>	whiteroot								0.1	30	0.1	50		
<i>Ptilothrix deusta</i>			4	30										
<i>Pultenaea villosa</i>	Hairy Bush-pea								0.1	5				
<i>Schizaea bifida</i>	Forked Comb Fern								0.1	10				
<i>Senecio madagascariensis</i>	Fireweed	*	0.1	1										
<i>Stackhousia spp.</i>			0.1	5										
<i>Stylidium graminifolium</i>	Grass Triggerplant								0.1	1				
<i>Stylidium spp.</i>			4	20										
<i>Themeda triandra</i>					1	50	15	200					0.1	10
<i>Trachymene incisa</i>	Trachymene		0.5	50	0.1	20	0.1	5	0.1	40	0.2	50	0.1	40
<i>Tricoryne elatior</i>	Yellow Autumn-lily		0.1	10										
<i>Xanthorrhoea spp.</i>			15	30	1.5	5	0.1	3			0.5	10	1	10
<i>Acacia binervata</i>	Two-veined Hickory								1	10				

## **APPENDIX B BAM QUADRATS VEGETATION SCORE SUMMARY**



Annual EPBC Offset Site Monitoring for SIMTA (2021)

Vegetation attributes	P1			P2			P3			P4A		P4B		G1		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2020	2021	2020	2021	2019	2020	2021
Total Count Tree (TG)	3	4	4	3	4	3	3	3	4	2	3	5	5	3	5	5
Total Count Shrub (SG)	11	11	12	11	13	11	19	20	22	17	16	14	15	12	11	11
Total Count Grass & grasslike (GG)	7	7	7	8	5	6	7	8	9	4	10	6	7	10	9	5
Total Count Forb (FG)	6	5	6	4	3	3	4	8	10	7	6	2	3	9	11	7
Total Count Fern (EG)	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0
Total Count Other (OG)	6	6	6	3	5	5	3	3	3	3	3	5	4	2	2	2
Total Cover Tree (TG)	11.5	16	20.00	52.5	47.3	47.0	22.5	36	37.2	45	40.5	32.4	32.2	9.1	24	27.3
Total Cover	47.7	46	41.10	4.7	15.7	21.5	8	5.7	12.6	43.9	49.8	18	46.4	22.6	21.2	41.2

## Annual EPBC Offset Site Monitoring for SIMTA (2021)

Vegetation attributes	P1			P2			P3			P4A		P4B		G1		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2020	2021	2020	2021	2019	2020	2021
Shrub (SG)																
Total Cover Grass & grasslike (GG)	1.2	4.5	8.30	18.7	20.7	40.2	16.6	21.5	24.5	24.2	24.4	7	17.6	7.5	13.5	14.7
Total Cover Forb (FG)	1	1	1.20	0.4	0.8	1.2	0.4	0.9	1.1	0.7	0.9	0.2	0.4	1.4	2.2	9.9
Total Cover Fern (EG)	0.1	0.1	0.20	0	0	0.0	0	0.1	0.0	0.1	0	0	0.0	0	0	0.0
Total Cover Other (OG)	1.9	1.2	4.40	0.3	0.6	0.5	0.3	0.4	0.4	0.4	0.9	1	1.7	0.3	1.2	16.0
Total Cover Exotics	0.2	0.1	0.2	0.6	0	0.2	0.1	0.2	0.2	0	0	0	0.1	0.1	0.1	0.1
Total Cover High Threat Weeds	0.2	0.1		0.5	0	0.2	0.1	0.2	0.2	0	0	0	0.1	0.1	0.1	0.1
Vegetation Integrity Score	<b>52.5</b>	<b>64.8</b>	<b>64.4</b>	<b>51.8</b>	<b>56.5</b>	<b>67.2</b>	<b>51.5</b>	<b>59.6</b>	<b>63.5</b>	<b>73.4</b>	<b>72.4</b>	<b>50</b>	<b>70.6</b>	<b>37.7</b>	<b>47</b>	<b>55.7</b>

## **APPENDIX C ANNUAL MONITORING PHOTOGRAPHS**



Monitoring Photographs – *Persoonia nutans* Offset site P1



PP\_MP(North) - 2019



PP\_MP(North) - 2020



PP\_MP(North) - 2021



PP\_MP(East) - 2019



PP\_MP(East) - 2020



PP\_MP(East) - 2021



PP\_MP(South) - 2019



PP\_MP(South) - 2020



PP\_MP(South) - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P1



PP\_MP(West) - 2019



PP\_MP(West) - 2020



PP\_MP(West) - 2021



PP1 – 2019



PP2 – 2020



PP1 - 2021



PP2 – 2019



PP2 – 2020



PP2 - 2021

Monitoring Photographs – *Persoonia nutans* Offset site P1



PP3 – 2019



PP3 – 2020



PP3 - 2021



PP4 – 2019



PP4 – 2020



PP4 - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P2



PP\_MP(North) - 2019



PP\_MP(North) - 2020



PP\_MP(North) - 2021



PP\_MP(East) - 2019



PP\_MP(East) - 2020



PP\_MP(East) - 2021



PP\_MP(South) - 2019



PP\_MP(South) - 2020



PP\_MP(South) - 2021

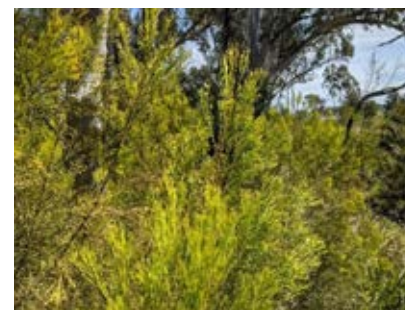
Monitoring Photographs – *Persoonia nutans* Offset site P2



PP\_MP(West) - 2019



PP\_MP(West) - 2020



PP\_MP(West) - 2021



PP1 – 2019



PP2 – 2020



PP1 - 2021



PP2 – 2019



PP2 – 2020



PP2 - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P2



PP3 – 2019



PP3 – 2020



PP3 - 2021



PP4 – 2019



PP4 – 2020



PP4 - 2021



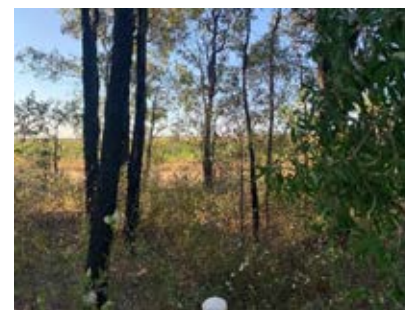
Monitoring Photographs – *Persoonia nutans* Offset site P3



PP\_MP(North) - 2019



PP\_MP(North) - 2020



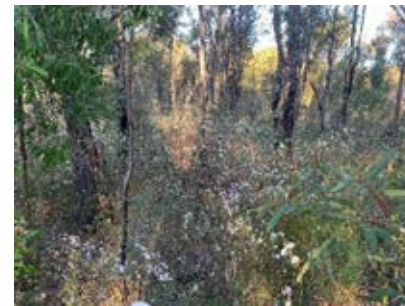
PP\_MP(North) - 2021



PP\_MP(East) - 2019



PP\_MP(East) - 2020



PP\_MP(East) - 2021



PP\_MP(South) - 2019



PP\_MP(South) - 2020



PP\_MP(South) - 2021

Monitoring Photographs – *Persoonia nutans* Offset site P3



PP\_MP(West) - 2019



PP\_MP(West) - 2020



PP\_MP(West) - 2021



PP1 – 2019



PP2 – 2020



PP1 - 2021



PP2 – 2019



PP2 – 2020



PP2 - 2021



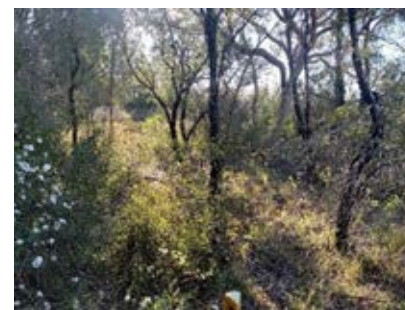
Monitoring Photographs – *Persoonia nutans* Offset site P3



PP3 – 2019



PP3 – 2020



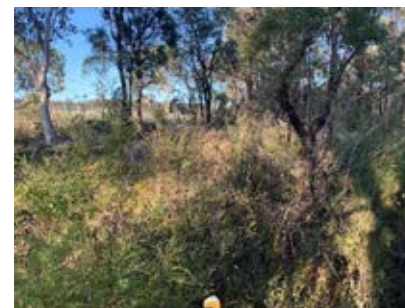
PP3 - 2021



PP4 – 2019



PP4 – 2020



PP4 - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P4



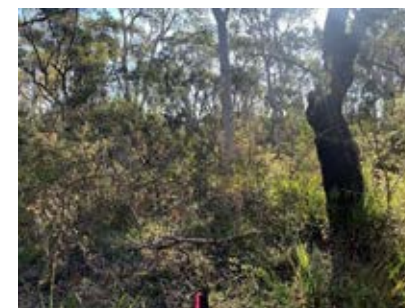
PP\_MP(A)\_(North) - 2020



PP\_MP(A)\_(North) - 2021



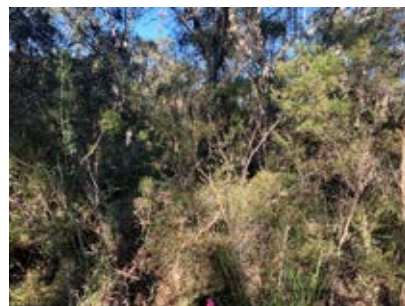
PP\_MP(A)\_(East) - 2020



PP\_MP(A)\_(East) - 2021



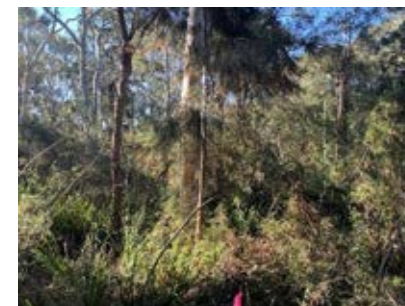
PP\_MP(A)\_(South) - 2020



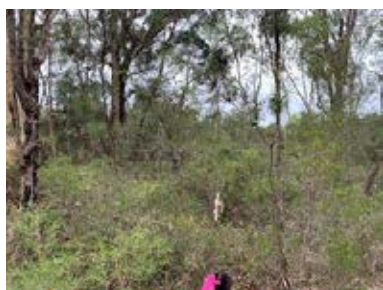
PP\_MP(A)\_(South) - 2021



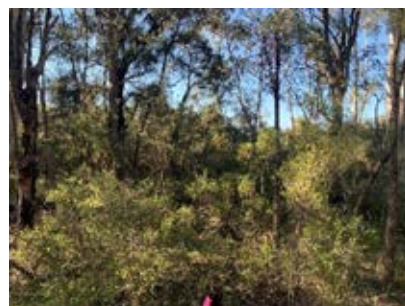
PP\_MP(A)\_(West) - 2020



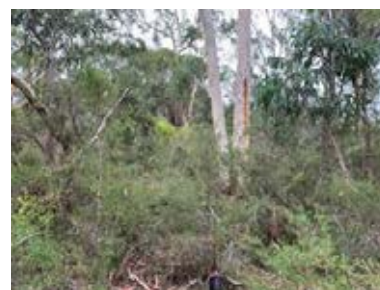
PP\_MP(A)\_(West) - 2021



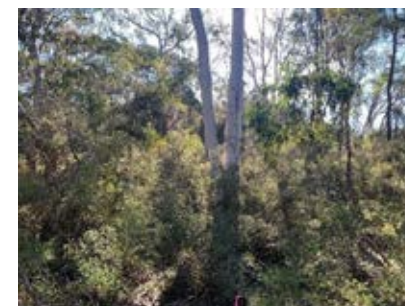
PP\_MP(B)\_(North) - 2020



PP\_MP(B)\_(North) - 2021



PP\_MP(B)\_(East) - 2020



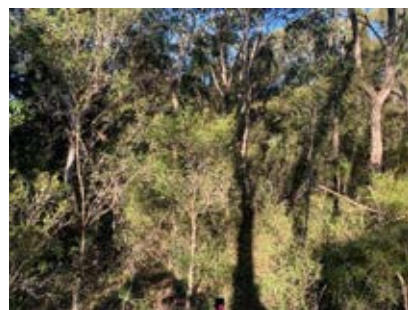
PP\_MP(B)\_(East) - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P4



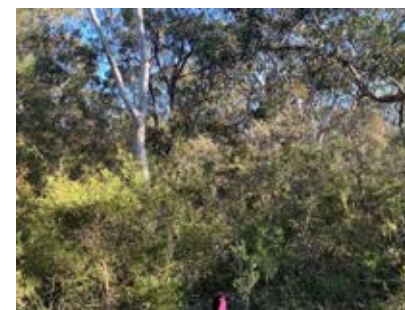
PP\_MP(B)\_(South) - 2020



PP\_MP(B)\_(South) - 2021



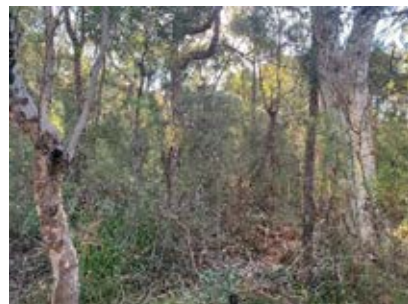
PP\_MP(B)\_(West) - 2020



PP\_MP(B)\_(West) - 2021



PP1 – 2020



PP1 – 2021



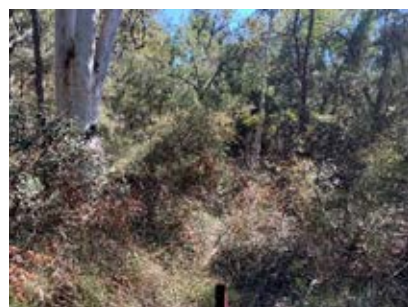
PP2 – 2020



PP2 - 2021



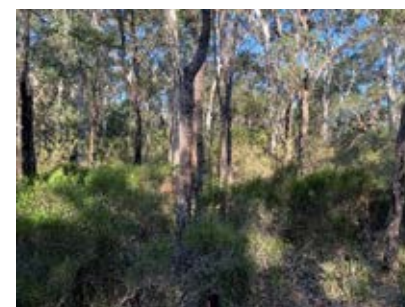
PP3 – 2020



PP3 – 2021



PP4 – 2020



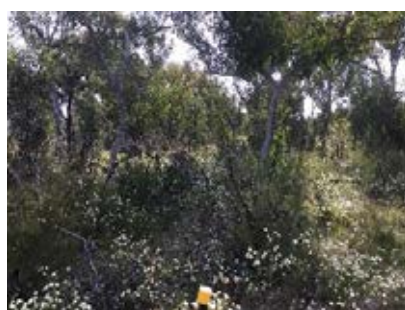
PP4 - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P4



PP\_MP(North) - 2019



PP\_MP(North) - 2020



PP\_MP(North) - 2021



PP\_MP(East) - 2019



PP\_MP(East) - 2020



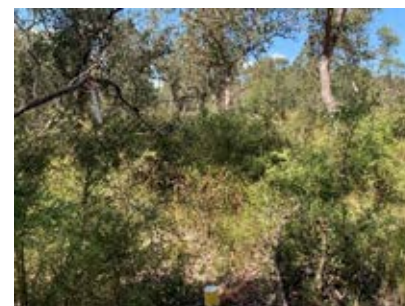
PP\_MP(East) - 2021



PP\_MP(South) - 2019



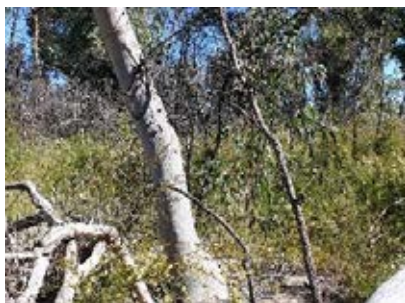
PP\_MP(South) - 2020



PP\_MP(South) - 2021



Monitoring Photographs – *Persoonia nutans* Offset site P4



PP\_MP(West) - 2019



PP\_MP(West) - 2020



PP\_MP(West) - 2021



PP1 – 2019



PP2 – 2020



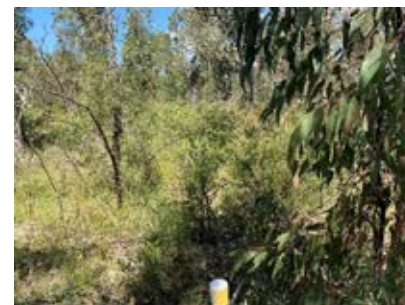
PP1 - 2021



PP2 – 2019



PP2 – 2020



PP2 - 2021

Monitoring Photographs – *Persoonia nutans* Offset site P4



PP3 – 2019



PP3 – 2020



PP3 - 2021



PP4 – 2019



PP4 – 2020



PP4 - 2021

## **APPENDIX D PHOTO POINT DETAIL**



Offset Site	Photo point identifier	Location of Photo Point		Direction of Photograph (degrees)
		Latitude	Longitude	
P1	MP (North)	-33.960619°	150.921811°	0/360
	MP (East)			90
	MP (South)			180
	MP (West)			270
	PP1	-33.960425°	150.921772°	140
	PP2	-33.960478°	150.922122°	200
	PP3	-33.960833°	150.922291°	250
	PP4	-33.960773°	150.921709°	340
P2	MP (North)	-33.960663°	150.923187°	0/360
	MP (East)			90
	MP (South)			180
	MP (West)			270
	PP1	-33.960550°	150.922926°	130
	PP2	-33.960670°	150.923663°	250
	PP3	-33.960702°	150.923512°	270
	PP4	-33.960783°	150.922837°	335
P3	MP (North)	-33.960451°	150.926147°	0/360
	MP (East)			90
	MP (South)			180
	MP (West)			270
	PP1	-33.960278°	150.925545°	65
	PP2	-33.960469°	150.927180°	260
	PP3	-33.960495°	150.927074°	260
	PP4	-33.960421°	150.925524°	35
P4	MP(A) (North)	-33.954026	150.93522	0/360
	MP(A) (East)			90
	MP(A) (South)			180
	MP(A) (West)			270
	MP(B) (North)	-33.953164	150.93527	0/360
	MP(B) (East)			90
	MP(B) (South)			180
	MP(B) (West)			270
	PP1	-33.953362	150.93603	268
	PP2	-33.954238	150.93568	316
	PP3	-33.955183	150.93529	352
	PP4	-33.953414	150.93472	90
G1	MP (North)	-33.963454°	150.923047°	0/360
	MP (East)			90

Annual EPBC Offset Site Monitoring for SIMTA (2021)

Offset Site	Photo point identifier	Location of Photo Point		Direction of Photograph (degrees)
		Latitude	Longitude	
	MP (South)			180
	MP (West)			270
	PP1	-33.963401°	150.922906°	50 degrees
	PP2	-33.963163°	150.922886°	140 degrees
	PP3	-33.963321°	150.923232°	200 degrees
	PP4	-33.963650°	150.923207°	320 degrees

## **APPENDIX E. RIPARIAN VEGETATION MANAGEMENT – FLORA INVENTORIES**



Scientific name	Common name	RFEFCF EEC	GZ1_ MR09	GZ1_ MR10	GZ1_ MR11	GZ2_ MR12	GZ2_ MR13	GZ4_ MR14	GZ2_ MR15	GZ4_ MR16	GZ2(W)_ MR18	GZ2(W)_ MR19
<i>Acacia binervata</i>	Two-veined Hickory		.	.	.					.	.	.
<i>Acacia decurrens</i>	Black Wattle									.	.	
<i>Acacia floribunda</i>	White Sally	*									.	
<i>Acacia parramattensis</i>	Parramatta Wattle	*			.						.	.
<i>Austrostipa ramosissima</i>	Stout Bamboo Grass				.							
<i>Breynia oblongifolia</i>	Coffee Bush			.	.							
<i>Bursaria spinosa</i>	Native Blackthorn										.	.
<i>Callistemon salignus</i>	Willow Bottlebrush						.					
<i>Carex appressa</i>	Tall Sedge						.	.				
<i>Cassutha glabella</i>			.	.								
<i>Casuarina glauca</i>	Swamp Oak					.				.		
<i>Cayratia clematidea</i>	Native Grape	*			.		.			.		
<i>Clematis aristata</i>	Old Man's Beard	*	.	.	.		.			.		
<i>Commelina cyanea</i>	Native Wandering Jew	*		.	.	.	.	.	.		.	
<i>Cymbopogon refractus</i>	Barbed Wire Grass	*				.					.	.
<i>Cynodon dactylon</i>	Common Couch									.		.
<i>Dichelachne micrantha</i>	Shorthair Plumegrass	*						.	.			.
<i>Dichelachne rara</i>						.	.					
<i>Dichondra repens</i>	Kidney Weed					.	.		.		.	.

Scientific name	Common name	RFEFCF EEC	GZ1_ MR09	GZ1_ MR10	GZ1_ MR11	GZ2_ MR12	GZ2_ MR13	GZ4_ MR14	GZ2_ MR15	GZ4_ MR16	GZ2(W)_ MR18	GZ2(W)_ MR19
<i>Echinopogon ovatus</i>	Forest Hedgehog Grass	*							•			•
<i>Einadia hastata</i>	Berry Saltbush			•								
<i>Einadia hastata</i>	Berry Saltbush									•		
<i>Entolasia marginata</i>	Bordered Panic	*	•	•		•			•	•	•	•
<i>Eucalyptus botryoides</i>	Bangalay	*	•		•		•		•	•		
<i>Geranium solanderi</i>	Native Geranium						•		•		•	
<i>Glycine clandestina</i>	Twining glycine					•			•		•	•
<i>Hardenbergia violacea</i>	False Sarsaparilla										•	•
<i>Hydrocotyle laxiflora</i>	Stinking Pennywort						•					
<i>Imperata cylindrica</i>	Blady Grass	*				•	•		•	•		
<i>Juncus usitatus</i>								•	•		•	
<i>Kunzea ambigua</i>	Tick Bush			•								
<i>Lobelia purpurascens</i>	whiteroot		•									
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	*				•	•		•	•	•	•
<i>Melaleuca decora</i>										•		
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	*				•			•			
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	*				•			•	•		
<i>Microlaena stipoides</i>	Weeping Grass	*	•	•		•	•		•	•		

Scientific name	Common name	RFEFCF EEC	GZ1_ MR09	GZ1_ MR10	GZ1_ MR11	GZ2_ MR12	GZ2_ MR13	GZ4_ MR14	GZ2_ MR15	GZ4_ MR16	GZ2(W)_ MR18	GZ2(W)_ MR19
<i>Modiola caroliniana</i>	Red-flowered Mallow							•				
<i>Olearia microphylla</i>				•								
<i>Oplismenus aemulus</i>							•					
<i>Oxalis perennans</i>		*			•				•			
<i>Parsonsia straminea</i>	Common Silkpod		•						•			
<i>Persoonia linearis</i>	Narrow-leaved Geebung			•								
<i>Plectranthus parviflorus</i>		*					•					
<i>Pomaderris</i> spp.						•	•					
<i>Pteridium esculentum</i>	Bracken									•		
<i>Rubus parvifolius</i>	Native Raspberry					•	•		•	•		
<i>Themeda australis</i>	Kangaroo Grass					•			•	•		•
<i>Viola hederacea</i>	Ivy-leaved Violet	*				•						
<i>Wahlenbergia gracilis</i>	Sprawling Bluebell							•				
<i>Acacia binervata</i>	Two-veined Hickory		•	•	•					•	•	•



## **APPENDIX F. RIPARIAN VEGETATION MANAGEMENT - PHOTO POINTS**



**MR09**



**MR10**



**MR11**



**MR12**



**MR13**



**MR14**



**MR15**



**MR16**



**MR18**



**MR19**

## **APPENDIX G. BA341 LANDS ADJOINING RAIL LINK - QUADRAT MONITORING DATA**



Scientific name	Common name	Monitoring quadrat on western side of Rail Link (Q1)		Monitoring quadrat on eastern side of Rail Link (Q2)	
		Cover	Abundance	Cover	Abundance
<i>Acacia brownii</i>	Heath Wattle	0.5	10	0.1	20
<i>Acacia longifolia</i>	Sydney Golden Wattle	0.5	5	1	1
<i>Acacia parramattensis</i>	Parramatta Wattle	0.2	10		
<i>Angophora bakeri</i>	Narrow-leaved Apple	8	35	10	39
<i>Anisopogon avenaceus</i>	Oat Speargrass	8	20	3	50
<i>Austrostipa puberula</i>	Fine-hairy Speargrass			0.1	100
<i>Banksia oblongifolia</i>	Fern-leaved Banksia	0.1	2	1	5
<i>Banksia spinulosa</i>	Hairpin Banksia	1	15	2	30
<i>Bossiaea ensata</i>	Sword Bossiaea			0.5	50
<i>Bossiaea heterophylla</i>	Variable Bossiaea	1	75	2	1000
<i>Brachyloma daphnoides</i>	Daphne Heath	0.1	5	0.2	100
<i>Burchardia umbellata</i>	Milkmaids	0.1	30	0.1	50
<i>Cassytha glabella</i>	Slender Devil's Twine	0.5	20	1	50
<i>Conyza sumatrensis</i>	Tall fleabane			0.1	300
<i>Coronidium scorpioides</i>	Button Everlasting	0.5	200	0.2	20
<i>Cyathochaeta diandra</i>	Sheath Rush'	2	50	2	500
<i>Dianella caerulea</i>	Blue Flax-lily	0.2	20	0.2	50
<i>Empodisma minus</i>	Wire Rush	2	300	0.1	50
<i>Entolasia stricta</i>	Wiry Panic	1	200	0.5	1000
<i>Eucalyptus parramattensis</i>	Parramatta Red Gum			2	3
<i>Eucalyptus racemosa</i>	Narrow-leaved Scribbly Gum	5	5	10	4
<i>Gahnia aspera</i>	Rough Saw-sedge	0.2	15	0.1	10
<i>Gompholobium minus</i>	Dwarf Wedge Pea	0.5	150	0.1	100
<i>Goodenia hederacea</i>	Ivy Goodenia	0.1	50	0.2	100

Scientific name	Common name	Monitoring quadrat on western side of Rail Link (Q1)		Monitoring quadrat on eastern side of Rail Link (Q2)	
		Cover	Abundance	Cover	Abundance
<i>Hakea dactyloides</i> (broad leaf form)	Broad leaf Hakea	0.1	2		
<i>Hakea sericea</i>	Needlebush	0.5	15	0.5	200
<i>Hardenbergia violacea</i>	False Sarsaparilla	0.2	50	0.1	50
<i>Hibbertia puberula</i>		0.1	2	0.1	2
<i>Hypericum gramineum</i>	Small St John's Wort	0.1	20	1	200
<i>Hypolaena fastigiata</i>	Tassel Rope-rush			0.5	1000
<i>Imperata cylindrica</i>	Blady Grass	0.1	10		
<i>Kunzea ambigua</i>	Tick Bush	0.5	1		
<i>Leptospermum parvifolium</i>	Lemon-scented Tea Tree	2	20	1	500
<i>Leptospermum trinervium</i>	Slender Tea-tree	2	15	1	3
<i>Lindsaea linearis</i>	Screw Fern	0.2	200	0.1	200
<i>Lomandra filiformis</i>	Wattle Matt-rush	0.1	50	1	100
<i>Lomatia silaifolia</i>	Crinkle Bush	0.1	2		
<i>Melaleuca nodosa</i>	Prickly-leaved Paperbark	5	100	30	2000
<i>Microlaena stipoides</i>	Weeping Grass	0.2	50		
<i>Opercularia varia</i>	Variable Stinkweed	0.1	10		
<i>Persoonia laurina</i>	Laurel Geebung			1	20
<i>Persoonia linearis</i>	Narrow-leaved Geebung	0.1	3		
<i>Petrophile pulchella</i>	Conesticks	0.1	25	1.5	200
<i>Philothea salsolifolia</i>		0.5	15	0.1	30
<i>Pimelea linifolia</i>	Slender Rice Flower	1	150	2	1000
<i>Plantago lanceolata</i>	Lamb's Tongues			0.1	100
<i>Platysace ericoides</i>	Heath Platysace	0.5	250	0.2	100

Scientific name	Common name	Monitoring quadrat on western side of Rail Link (Q1)		Monitoring quadrat on eastern side of Rail Link (Q2)	
		Cover	Abundance	Cover	Abundance
<i>Pomax umbellata</i>	Pomax			0.2	30
<i>Ptilanthelium deustum</i>		1	500		
<i>Pultenaea tuberculata</i>	Weath Bush-pea	0.1	5		
<i>Schizaea bifida</i>	Forked Comb Fern	0.1	1		
<i>Secale cereale</i>	Cereal Rye	0.1	50		
<i>Senecio madagascariensis</i>	Fireweed	0.1	10	0.1	5
<i>Stylidium graminifolium</i>	Grass Triggerplant	0.1	15	1	30
<i>Themeda triandra</i>	Kangaroo Grass	3	100	3	100
<i>Trachymene incisa</i>	Trachymene	50	0.1	200	
<i>Tricoryne simplex</i>	Yellow Rush Lily	50	0.1	10	
<i>Trifolium repens</i>	White Clover	20	0.1	500	
<i>Xanthorrhoea spp.</i>	Xanthorrhoea	5			

\* Exotic species



## **APPENDIX H. NEST BOX MONITORING REPORT (SPRING 2021)**

**DATE**

31 January 2022

**CLIENT**

Marvin Do (Tactical Group)

**FROM**

Nathan Banks (Arcadis)

**COPY TO**

Mark Howley (Tactical Group); Kate Carroll (Arcadis)

**SUBJECT**

Moorebank Logistics Park - Spring Nest Box Monitoring 2021

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Arcadis were commissioned by Tactical Group on behalf of Qube Holdings to conduct the 2021 annual spring nest box monitoring survey within the Moorebank Logistics Park (MLP). The 2021 monitoring event marks the fourth year that Arcadis has monitored nest boxes installed within the Bootland and Georges River corridor to offset removal of hollow-bearing trees for the construction of the MLP development. As a requirement of the state Conditions of Consent and Commonwealth Conditions of Approval and to guide the replacement of hollows removed during construction, a Nest Box Management Strategy (CPB 2017) was prepared. This project document also included the requirement for monitoring of nest boxes. This memorandum has been prepared to document the findings of the 2021 nest box monitoring survey.

## Background

The Sydney Intermodal Terminal Alliance (SIMTA) and Moorebank Intermodal Company entered an agreement to develop the Moorebank Precinct East (MPE) Project and Moorebank Precinct West (MPW) Project into the Moorebank Logistics Park (MLP). MLP is located in the suburb of Moorebank within the Liverpool Local Government Area (LGA).

The MLP development comprises an Import Export (IMEX) terminal on MPE and interstate terminal on MPW including rail links to the Southern Sydney Freight Line (SSFL), warehouse and distribution facilities, freight village, road and intersection upgrades, and ancillary activities such as landscaping and utilities installation and diversion.

Approval for the construction and operation of the MLP is divided into respective east and west precincts as follows:

- Stage 1 (SSD 6766), divided into Package 1 (RALP) and Package 2 (IMEX), and Stage 2 (SSD 7628) of MPE under the MPE Concept Consent (MP10\_0193) was provided in March 2018 (as amended through the Land and Environment Court) and January 2018 respectively. Commonwealth approval (EPBC 2011/6299) was received in March 2014.
- MPW Concept and Stage 1 (SSD 5066) received approval in June 2016, with commonwealth approval (EPBC 2011/6086) in September 2016. MPW Stage 2 (SSD 7709) received approval on 11 November 2019.

Prior to construction, vegetation clearing was conducted across the two project sites: MPE and MPW. Vegetation clearing was conducted in a staged approach and included the removal of important habitat features including hollow-bearing trees. To offset impacts to hollow-bearing trees a Nest Box Strategy Report (NBS) (CPB 2017) was prepared. Preparation of a NBS was a requirement of the approval (refer to Table 1) and was initially developed for MPE Stage 1 – RALP and MPW Stage 1. The MPE Stage 1 – RALP NBS was further adapted for implementation on MPE Stage 1 – IMEX and MPE Stage 2.

Table 1: Conditions relevant to installation and monitoring of nest boxes within MLP

Condition	Requirement
<b>MPE Stage 1 (SSD 6766)</b>	
CoC E34(d)(ii)(b)	The identification of areas to be cleared and details of management measures to avoid residual habitat damage or loss and to minimise or eliminate time lags between the removal and subsequent replacement of habitat such as: clearing procedures (including nest box plan)
Final compilation of mitigation measures: 8C	A nest box management strategy will be prepared prior to clearing of hollow bearing trees. The strategy will inform the installation of nest boxes in retained native vegetation in the riparian corridor of the Georges River and the woodland in the Southern Boot Land and the on-going monitoring and maintenance of nest boxes through the construction and operational phases.
<b>MPW Stage 1 (SSD 5066)</b>	
CoC D21(d)(ii)	The identification of areas to be cleared and details of management measures to avoid residual habitat damage or loss and to minimise or eliminate time lags between the removal and subsequent replacement of habitat such as: - clearing procedures (including nest box plan)
<b>MLP EPBC Approval</b>	
Commonwealth mitigation measures: 7.4.1.3 n	Consider the installation of nest boxes in woodland vegetation in the rail corridor that may offer alternative nesting habitat to hollow dependent species recorded in the study area.

## Hollow loss and replacement

Prior to vegetation removal to facilitate construction, pre-clearing surveys were conducted by the construction contractor's ecologist to record an inventory of tree hollows subject to removal. Review of the pre-clearing survey data identified that 108 tree hollows were removed during construction, as follows:

- IMEX: 25 hollows were identified across 13 hollow-bearing trees
- Rail Access Link Package (RALP): 33 hollows were identified across 30 hollow-bearing trees
- Precinct East Demolition Remediation (PEDR) Stage 2: 50 hollows across 39 hollow bearing trees.

Nest boxes of an appropriate size and specification were required to be installed within retained vegetation in MLP at a ratio of 2:1 to offset loss of hollows as per the Nest Box Strategy (NBS) (CPB 2017). As such a total of 216 nest boxes were required to be installed to offset the removal of 108 hollows.

Nest boxes were progressively installed within native vegetation at the Bootland and along the Georges River corridor. Majority of the areas where nest boxes were installed were included in the BA341 biobank site when it was established in January 2019. Nest boxes which were not within the biobank site have since been relocated into bushland within the Wattle Grove offset area (Bootland) and Moorebank offset area (Georges River corridor).

As of the 2021 nest box monitoring surveys there are a total of 229 nest boxes within the BA341 biobank site; 51 in Wattle Grove offset area (Bootland) and 178 in the Moorebank offset area (Georges River corridor).



## Monitoring

The MPE NBS (based on MPE Stage 1 – RALP) recommended that nest boxes installed for the project should be monitored shortly after installation and then on an annual basis in spring thereafter. There is a requirement for these nest boxes to be monitored and maintained to ensure they offer suitable habitat to locally occurring hollow-dependant fauna.

The first round of nest box monitoring on the Moorebank Precinct was completed by Arcadis in spring 2018. Arcadis was engaged to undertake the proceeding annual nest boxes spring monitoring surveys within the Moorebank Precinct in 2019, 2020 and 2021 (the subject of this report) in accordance with the requirements specified in the MPE NBS.

This memo summaries the results of the fourth round of nest box monitoring undertaken by Arcadis in spring 2021 across the Bootland and Georges River corridor.

## Nest box details

The types of nest boxes installed within the Bootland and Georges River corridor and details of installation are summarised in Table 2.

Table 2: Nest box designs and methods of installation utilised

Types	Installation method	Installation height	Other comments
Tree creeper Parrot Lorikeet Sugar Glider Possum/Arboreal mammal Microbat Cockatoo Kookaburra Wood Duck	'Habisure' method: hung using a wire Screwed directly into the trunk of the tree	3 – 15 metres above ground	Fixed or hinged lid

Several nest boxes mounted using the 'Habisure' method were mounted incorrectly, being loosely secured to tree branches or installed above a maximum height of ten metres to enable inspection, a requirement of the NBS.

## Previous surveys

Nest box surveys have been conducted annually by Arcadis since 2018. The number of nest boxes located within the Bootland and along the Georges River corridor has been inconsistent across the monitoring years for following reasons:

- the initial number of nest boxes installed within the Bootland and along the Georges River corridor was unknown due to nest boxes being installed progressively and a lack of installation records
- nest boxes not being relocated during annual monitoring events
- decommissioning of damaged and fallen nest boxes between monitoring years

A summary of the number of nest boxes found and inspected across the three previous years of monitoring is included in Table 3 .

Table 3: Number of nest boxes located and internally inspected during monitoring events

Survey year	Survey area	Number of nest boxes located	Number of nest boxes internally inspected
2018	Bootland	52	50
	Georges River corridor	195	169
	<b>Total</b>	<b>247</b>	<b>219</b>
2019	Bootland	54	51
	Georges River corridor	199	152
	<b>Total</b>	<b>253</b>	<b>200</b>
2020	Bootland	52	52
	Georges River corridor	161	140
	<b>Total</b>	<b>213</b>	<b>192</b>
2021	Bootland	51	51
	Georges River corridor	178	143
	<b>Total</b>	<b>229</b>	<b>194</b>

### Summary of findings from last years (2020) monitoring

The outcomes of the previous years (2020) nest box monitoring survey are summarised below:

- 213 nest boxes were located: 161 in the Georges River corridor and 52 in the Bootland
- 192 nest boxes were inspected internally using a pole mounted camera
- 27 nest boxes were not internally inspected
- 47 nest boxes were occupied by native fauna: 31 in the Georges River corridor and 16 in the Bootland
- Eight nest boxes were occupied by invasive fauna (European Honey Bee and Black Rat)
- Deceased Rainbow Lorikeet fledglings were recorded in two nest boxes (#8 and #28) in the Bootland
- 13 nest boxes had been decommissioned since the 2019 surveys, and a further 27 previously inspected nest boxes could be not relocated during the 2020 survey event.

## Methodology

Nest box monitoring surveys within the Bootland and Georges River corridor were undertaken by Arcadis ecologists James Rees, Nathan Banks and Taylor Bliss-Henaghan across five days in September and October 2021. Survey dates and weather conditions on the dates of survey are outlined in Table 4.

Table 4: Survey dates and climate data from the weather station closest to MLP, Holsworthy Aerodrome (066161) (BoM, 2021)

Date	Min (°C)	Max (°C)	Rain (mm)	Max wind gust (km/h)
08 September 2021	6.2	22.4	0.2	26
09 September 2021	4.7	26.9	0	26
30 September 2021	13.8	23.2	1.8	33
01 October 2021	13.1	26.0	0.6	44
08 October 2021	13.1	21.4	0	33

Ecologists traversed the Bootland and Georges River corridor on foot, using an Arc-GIS enabled iPad to locate nest boxes. A total of 229 nest boxes were located by Arcadis during the 2021 monitoring period: 51 in the Bootland and 178 in Georges River corridor.

Initial external inspections were made for each nest box, and if no fauna could be observed externally, internal inspections were conducted using a GoPro (Wi-Fi connected) camera attached to an 8-metre telescopic pole. The following information was collected for each nest box, as recommended in Section 5 of the MPE NBS:

- Date and time.
- Nest box number.
- Nest box location (GPS).
- Occupancy status (identification of fauna to a species level where possible).
- Life stage of occupying fauna (eggs, juvenile, adults)
- Condition of occupying fauna (healthy, deceased)
- Evidence of previous occupancy (such as nesting material, feathers, scratch/claw marks).
- General condition of the nest box and mount.
- Any recommendations for maintenance actions, such as:
  - Removal of invasive species.
  - Replacement, repair or re-installation of missing, damaged or fallen nest boxes or mounts.
  - Removal of excess nesting material.
  - Amending or moving of nest boxes that aren't functioning correctly.

## Survey limitations

Several nest boxes were installed with fixed lids or at a height greater than ten metres. These nest boxes were unable to be inspected using the pole-mounted camera. Five boxes located in the 2020 survey period could not be relocated in the 2021 surveys. This included one box from the Bootland and four boxes from Georges River corridor.



## Results

A total of 229 nest boxes were located by Arcadis during the spring 2021 survey period; 51 in the Bootland and 178 in the Georges River corridor. This included 11 nest boxes that did not have ID numbers, indicating they were not located during the 2020 survey period when the tree-tag numbering system was implemented and trees with nest boxes were numbered for easy identification. Three of the 11 boxes were found on the ground and in a dysfunctional state.

Of the 229 nest boxes located during the 2021 survey period, 194 nest boxes were internally inspected using a pole-mounted camera. The remaining 35 were not inspected internally for the following reasons:

- Eight nest boxes were observed to be occupied by fauna during external inspections. Internal inspections were not undertaken to avoid further disturbance to fauna.
- 15 nest boxes were installed greater than 10 metres above the ground and could not be reached with a pole-mounted camera.
- Seven nest boxes were not fitted with hinged lids and could not be internally inspected with a pole-mounted camera.
- Two nest boxes were too unstable on the tree to be internally inspected.
- Three nest boxes were on the ground or on fallen trees.

A summary of utilisation and condition of nest box boxes surveyed is discussed below and presented in Figure 1.

### Nest box occupancy

Nest box 'occupancy' was determined based on the number of nest boxes recorded as being occupied by native fauna at the time of survey. Only nest boxes that could be internally inspected or nest boxes with fauna observable from the outside were assessed as being occupied.

The following occupancy rates were recorded for nest boxes during the spring 2021 monitoring period:

- 68 nest boxes were occupied by native fauna: 14 nest boxes in the Bootland and 54 nest boxes in the Georges River corridor
- Four nest boxes were occupied by invasive fauna, all from the Georges River corridor.
- 18 nest boxes contained eggs or fledgelings from unidentified bird species, three in the Bootland and 15 from the Georges River corridor.
- A deceased Australian Wood Duck was recorded in nest box #14 in the Bootland

A detailed record for nest boxes which were identified as being occupied by fauna is included in Appendix B and fauna species observed occupying nest boxes are listed in Table 5

Table 5: Species observed occupying or utilising nest boxes within the survey area.

Native fauna	Invasive fauna
Sugar Glider ( <i>Petaurus breviceps</i> ) (Plate 1) Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) Common Brushtail Possum ( <i>Trichosurus vulpecula</i> ) Australian Wood Duck ( <i>Chenonetta jubata</i> ) (Plate 1) Peron's Tree Frog ( <i>Litoria peronii</i> ) Rainbow Lorikeet ( <i>Trichoglossus haematodus</i> )	Black Rat ( <i>Rattus rattus</i> ) Common Myna ( <i>Acridotheres tristis</i> ) European Honey Bee ( <i>Apis mellifera</i> ).



Plate 1: Native fauna recorded occupying nest boxes within the survey area – Sugar Gliders (left), Australian Wood Duck eggs (right)

## Nest box utilisation

Nest box 'utilisation' is measured for nest boxes currently occupied or with evidence of previous occupancy such as nesting material, feathers, or chewed entrances. Utilisation by invasive species was determined if an invasive species was recorded, or by the presence of nesting materials not used by native species including litter. Common Myna are known to use non-organic nesting materials including plastics, rubber, and metal (Dhandukia & Patel, 2012). Plate 2 shows nest boxes utilised by invasive fauna. All nest boxes with evidence of utilisation not associated with invasive fauna were considered to be utilised by native fauna. Nesting material indicative of occupation by native fauna included eucalypt leaves, bark shredding and other organic matter. The presence of feathers was also relied upon to determine whether a nest box was utilised by native or introduced species. Examples of nest boxes utilised by native fauna are shown in Plate 3.



Plate 2: Nest boxes utilised by invasive fauna - Common Myna nest and remnant European Honey Bee hive (left) and Black Rat (right)



Plate 3: Nest boxes utilised by native fauna – Remnant egg shells and nesting material from a Wood Duck nest (left) and Rainbow Lorikeet fledgling (right)

A summary of nest box utilisation observed during the 2021 survey event includes:

- 131 nest boxes are considered to be utilised by native fauna, equating to a utilisation rate of 57% for nest boxes in the 2021 survey period.
- 10 nest boxes are considered to be utilised by invasive species, equating to a utilisations rate of 4%

All nest boxes used by invasive fauna were located in the Georges River corridor. A summary of nest box utilisation by invasive fauna is included below:

- Two boxes contained a Black Rat
- One box contained an active European Honey Bee hive
- Seven boxes were utilised by or showed signs of utilisation by Common Myna. One box contained a fledgeling and six boxes contained nesting material (litter) used by the species.

## Nest box condition

Observations on nest box 'condition' assessed the structural condition of boxes as well as box mounts. The condition of each nest box was assessed upon inspection to identify if any maintenance actions are required. The majority of nest boxes located during the spring 2021 survey period showed minor deterioration due to weathering or use by fauna (e.g. plywood separation). Of the 229 nest boxes located 43 were identified to be dysfunctional and require removal or repair for the following reasons:

- nest box has potentially resulted in the fatality of occupying fauna. Fauna fatalities could be a result of occupying fauna not being able to exit the box due to missing internal ladders. One nest box was identified to have a dead Australian Wood Duck during the 2021 monitoring event and a further three boxes have caused fatalities in previous years.
- nest boxes are unstable on the tree due to incorrect mounting; a total of 17 boxes
- nest boxes are damaged, such as missing a lid or have a broken baffle; a total of ten boxes
- nest boxes are considered to be inhabited by invasive fauna; a total of six boxes
- nest boxes have fallen to ground or been attached to tree which has fallen; a total of three boxes

According to Section 5 of the MPE NBS, nest boxes must be installed at a height below 10 metres to allow for visual inspection using an inspection camera and extension pole. A total of 16 nest boxes (#71, #89, #117,



#125, #148, #159, #164, #172, #178, #206, #230, #233, #236, #250, and two unnumbered boxes) in the Georges River corridor were installed at a height above 10 metres and could not be reached using a pole-mounted camera. Issues with nest boxes that may put fauna at risk cannot be identified if boxes are unable to be inspected. For this reason, these boxes are considered to be in an unsuitable condition.

### **Fauna fatalities**

A deceased adult Australian Wood Duck was identified within nest box #14 during the spring 2021 monitoring event. This deceased bird was not identified during the previous survey (2020) indicating it has occurred within the year.

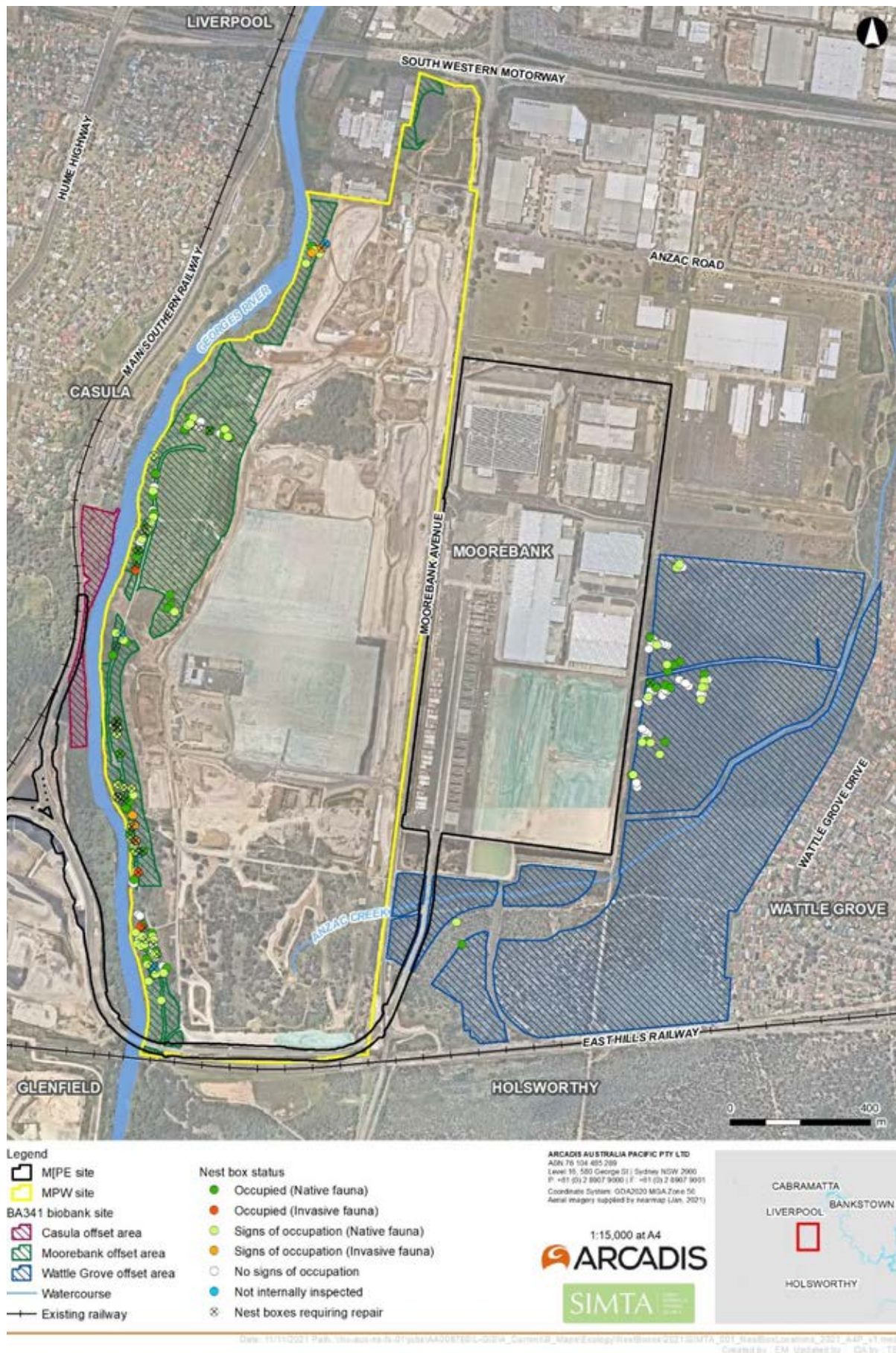


Figure 1. Results of the 2021 nest boxes monitoring survey

## Discussion and recommendations

### Native fauna

Comparison of nest box occupancy by native fauna can be made between different monitoring periods, given the occurrence of live animals is independent during each monitoring period. A summary of nest box occupation rates for all spring monitoring events conducted to date are included in Table 4.

Table 6: Occupation of nest boxes by fauna for annual survey periods

Survey year	Survey area	Number of nest boxes	Occupied by native fauna
2018	Bootland	52	(5) 6%
	Georges River corridor	195	(25) 12%
	<b>Total</b>	<b>247</b>	<b>(27) 11%</b>
2019	Bootland	54	(5) 9%
	Georges River corridor	199	(31) 16%
	<b>Total</b>	<b>253</b>	<b>(36) 14%</b>
2020	Bootland	52	(16) 31%
	Georges River corridor	161	(31) 19%
	<b>Total</b>	<b>213</b>	<b>(47) 22%</b>
2021	Bootland	51	(14) 27%
	Georges River corridor	178	(54) 30%
	<b>Total</b>	<b>229</b>	<b>(68) 30%</b>

A comparison between annual spring monitoring periods from 2018-2021 indicates a steady increase in occupation of nest boxes by native fauna (Figure 2). In the 2018 monitoring event 11 percent of nest boxes were occupied, which has increased to a 30 percent rate of occupation in the 2021 survey period.

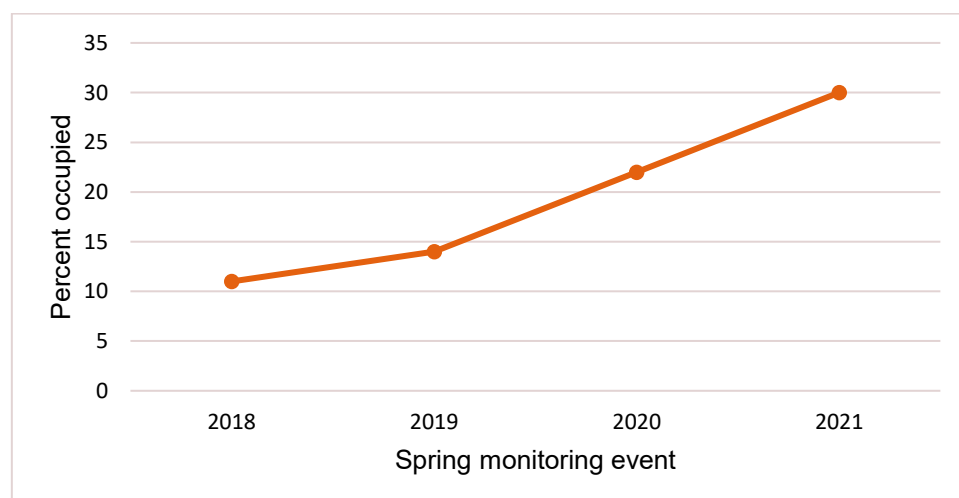


Figure 2: Occupancy rate of nest boxes by native fauna for spring monitoring events between 2018 and 2020



Comparisons of utilisation between monitoring periods are not reliable, given some evidence of previous occupation may still be present from previous survey years. Combining occupancy status with evidence of use does provide a cumulative measure of nest box utilisation over time. The rate of utilisation for all nest boxes has increased from 32 percent in 2018 to 57 percent in 2021 (Table 7).

Table 7: Utilisation of nest boxes within the survey area across each survey year.

Survey year	Survey area	Number of nest boxes	Utilisation by native fauna	Utilisation by invasive fauna
2018	Bootland	52	(5) 15%	(3) 6%
	Georges River corridor	195	(65) 35%	(5) 3%
	<b>Total</b>	<b>247</b>	<b>(70) 32%</b>	<b>(8) 4%</b>
2019	Bootland	54	(21) 39%	(2) 4%
	Georges River corridor	199	(60) 30%	(6) 3%
	<b>Total</b>	<b>253</b>	<b>(81) 32%</b>	<b>(8) 3%</b>
2020	Bootland	52	(28) 53%	(1) 2%
	Georges River corridor	161	(71) 44%	(7) 4%
	<b>Total</b>	<b>213</b>	<b>(99) 46%</b>	<b>(8) 4%</b>
2021	Bootland	51	(28) 55%	(0) 0%
	Georges River corridor	178	(109) 61%	(10) 6%
	<b>Total</b>	<b>229</b>	<b>(131) 57%</b>	<b>(10) 4%</b>

While many nest boxes may show signs of occupation from previous years, there has been almost a double in the total number of nest boxes with signs of use by native fauna. As annual monitoring continues, nest boxes showing no signs of use can be assessed to determine if design modifications or reinstallation into a more appropriate area may be needed to increase likelihood of utilisation.

Overall, nest box occupancy and utilisation by native fauna is adequate in both the Bootland and the Georges River corridor. This is based on the assumption that 10 percent of nest boxes should be occupied by target (native) fauna (Goldingay et al. 2018, Lindenmayer et al. 2017). The 2021 survey period occupancy of 30 percent is therefore above the target occupancy.

## Invasive fauna

Comparison of the nest boxes utilised by invasive fauna across all monitoring events identified that:

- the 2019 monitoring event had the lowest invasive nest box utilisation rate of 3%
- 2018, 2020 and 2021 recorded an invasive fauna utilisation rate of 4%

The occupancy of nest boxes by invasive fauna is low and is similar across annual monitoring periods. Management actions to improve capacity for nest box use by native fauna have been recommended for some nest boxes utilised by invasive fauna. This includes removal of active hives, and removal of Common Myna nesting material (rubbish). All species of invasive fauna observed in the 2021 survey period had been identified in previous survey years.

## Nest box management and maintenance

Currently 176 nest boxes across the Bootland and Georges River corridor are functional and providing suitable habitat for native hollow-dependant fauna species. To maintain the hollow replacement ratio of 2:1 for hollows removed by the MLP development, a minimum of 40 nest boxes require maintenance and repair to increase the number of functional nest boxes to 216.

A total of 53 nest boxes were identified as requiring maintenance, three from the Bootland and 50 from the Georges River corridor. Of the 53 nest boxes requiring maintenance, 43 were identified as requiring essential maintenance, with three boxes from the Bootland and 40 from the Georges River corridor. Essential maintenance has been prioritised for nest boxes which have been:

- identified as causing fauna fatalities
- damaged and require removal (decommissioning) or repairing
- installed above 10 metres in height and are unable to be internally inspected
- unstable on the tree

During the 2021 survey period, deceased Rainbow Lorikeet fledglings found in previous survey years were not again identified in the nest boxes #8, #24 and #133. Nest box #14 which was identified to have deceased fledglings in the 2019 monitoring event was found to have a deceased Australian Wood Duck during the current survey. These four boxes urgently require action to prevent further fauna fatalities and should be decommissioned or retrofitted with internal ladders. Urgent maintenance should be actioned within 4 weeks from submission of the annual monitoring report as stated in the NBS.

In addition to the 43 nest boxes requiring essential maintenance, 10 nest boxes require maintenance actions to improve functionality. Of these 10 nest boxes, seven nest boxes require the removal of unsuitable nesting materials (litter) from within the box, and a further three nest boxes were discovered on fallen trees or on the ground and need to be recovered and reinstalled dependent on their condition. The geographic coordinates of these boxes have been recorded to ease collection and locations have been displayed in Figure 1.

A summary of maintenance actions for nest boxes has been detailed in Table 8 and description of each of the issues for each box is detailed in Appendix A.

Table 8: Summary of issues of nest boxes found within the survey area and maintenance actions required.

Issue	Box ID Number	Action Required	Urgency
Hazardous to fauna	8, 14, 24, 133	Decommission box or modify to install internal ladder.	Urgent
Damaged box	53, 68, 91, 100, 125, 126, 128, 148, 161, 178	Decommission box or repair and reinstall at appropriate height	Non-urgent
Unstable on tree	51, 52, 73, 92, 93, 96, 97, 122, 127, 129, 135, 136, 137, 163, 164, 212, 222	Reinstall box securely on tree at appropriate height	Non-urgent
Installed above 10 metres in height and unable to be internally inspected	71, 89, 117, 159, 172, 206, 230, 233, 236, 250, No ID, No ID	Reinstall box at appropriate height	Non-urgent
Unsuitable material in box	144, 158, 166, 189, 191, No ID	Remove rubbish/plastic from inside box	Non-urgent
Box fallen to ground	Three unnumbered boxes – coordinates of each box taken	Recover box and reinstall if in good condition	Non-urgent
Box installed in inappropriate location and unused by fauna	253	Reinstall box in nearby bushland	Non-urgent

## References

Arcadis (2019a) Nest box monitoring report – Spring 2018

Arcadis (2019b) Nest box monitoring report – Spring 2019

Arcadis (2020) Nest box monitoring report – Spring 2020

CPB Contractors (CPB) (2017) Nest Box Management Strategy. Moorebank Precinct East Stage 1 – Rail Link

Dhandukia, S., & Patel, P. (2012). Selection of nesting sites and nesting material in common myna (*Acridotheres tristis*) in arban area. *Internal Journal of Pharmacy and Life Sciences*, 1897-1904.



## APPENDIX A. NEST BOXES REQUIRING MAINTENANCE

Box Location	Box ID	Box Condition	Action Required
Bootland	8	Hazardous to fauna	Decommission box or retrofit internal ladder before reinstalling.
Bootland	14	Hazardous to fauna	Remove deceased Wood Duck. Decommission box or retrofit internal ladder before reinstalling.
Bootland	24	Hazardous to fauna	Decommission box or retrofit internal ladder before reinstalling.
Georges River Corridor	51	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	52	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	53	Damaged	Decommission box or replace lid and reinstall
Georges River Corridor	68	Damaged	Decommission box
Georges River Corridor	71	Too high for inspection	Reinstall lower on tree
Georges River Corridor	73	Unstable on tree	Reinstall box to be securely attached to tree. Remove remnant hive from inside box.
Georges River Corridor	89	Too high for inspection	Reinstall lower on tree
Georges River Corridor	91	Damaged	Decommission box or replace lid and reinstall
Georges River Corridor	92	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	93	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	96	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	97	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	100	Fallen branch blocking access	Remove branch blocking internal access
Georges River Corridor	117	Too high for inspection	Reinstall lower on tree
Georges River Corridor	122	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	125	Damaged + too high for inspection	Decommission box, or replace lid and reinstall lower on tree
Georges River Corridor	126	Damaged	Decommission box, or replace lid and reinstall

Box Location	Box ID	Box Condition	Action Required
Georges River Corridor	127	Unstable on tree	Decommission box (fixed lid)
Georges River Corridor	128	Damaged	Decommission box or repair by replacing lid and reinstall
Georges River Corridor	129	Unstable on tree	Reinstall box to be securely attached to tree. Lower priority as box is currently in use.
Georges River Corridor	133	Hazardous to fauna	Decommission box or retrofit internal ladder before reinstalling.
Georges River Corridor	135	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	136	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	137	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	144	Unsuitable material in box	Remove rubbish/plastic from inside box
Georges River Corridor	148	Damaged + too high for inspection	Replace broken baffle and reinstall lower on tree
Georges River Corridor	158	Unsuitable material in box	Remove rubbish/plastic from inside box
Georges River Corridor	159	Too high for inspection	Reinstall lower on tree
Georges River Corridor	161	Damaged	Repair broken lid
Georges River Corridor	163	Unstable + unsuitable material in box	Remove rubbish/plastic from inside box, reinstall securely on tree
Georges River Corridor	164	Unstable + too high for inspection	Reinstall lower on tree
Georges River Corridor	166	Unsuitable material in box	Remove rubbish/plastic from inside box
Georges River Corridor	172	Too high for inspection	Reinstall lower on tree
Georges River Corridor	178	Damaged + too high for inspection	Repair lid and reinstall box lower on tree
Georges River Corridor	189	Unsuitable material in box	Remove rubbish/plastic from inside box.
Georges River Corridor	191	Unsuitable material in box	Remove rubbish/plastic from inside box
Georges River Corridor	206	Too high for inspection	Reinstall box lower on tree

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Box Location	Box ID	Box Condition	Action Required
Georges River Corridor	212	Unstable on tree	Reinstall box to be securely attached to tree
Georges River Corridor	222	Unstable on tree	Reinstall box to be securely attached to tree. Black Rat inside box may be dead, remove from box.
Georges River Corridor	230	Too high for inspection	Reinstall lower on tree
Georges River Corridor	233	Too high for inspection	Reinstall lower on tree
Georges River Corridor	236	Too high for inspection	Reinstall lower on tree
Georges River Corridor	250	Too high for inspection	Reinstall lower on tree
Georges River Corridor	253	Unused box	Reinstall in nearby bushland to increase likelihood of use
Georges River Corridor	No ID	Too high for inspection	Reinstall lower on tree
Georges River Corridor	No ID	Unsuitable material in box	Remove rubbish/plastic from inside box
Georges River Corridor	No ID	Uninhabitable + too high for inspection	Remove live beehive, reinstall box lower on tree



## APPENDIX B. FAUNA RECORDED IN NEST BOXES

Location	Box ID	Box Type	Species	Notes
Bootland	3	Lorikeet / Possum	Common Ringtail Possum	
Bootland	5	Possum / Arboreal mammal	Sugar Glider	Sugar Glider
Bootland	13	Glider	Sugar Glider	Multiple individuals
Bootland	14	Wood Duck	Australian Wood Duck	Deceased
Bootland	17	Lorikeet / Possum	Common Ringtail Possum	
Bootland	19	Lorikeet / Possum	Unidentified	Eggs (parrot)
Bootland	23	Glider	Sugar Glider	
Bootland	30	Glider	Sugar Glider	
Bootland	31	Lorikeet / Possum	Unidentified	Eggs (likely parrot)
Bootland	33	Possum / Arboreal mammal	Common Ringtail Possum	
Bootland	34	Lorikeet / Possum	Sugar Glider	Four individuals
Bootland	39	Glider	Sugar Glider	
Bootland	50	Possum / Arboreal mammal	Common Ringtail Possum	
Georges River Corridor	52	Lorikeet / Possum	Unidentified	Fledgling
Georges River Corridor	55	Parrot	Rainbow Lorikeet	
Georges River Corridor	58	Glider	Sugar Glider	
Georges River Corridor	63	Parrot	Rainbow Lorikeet	
Georges River Corridor	65	Lorikeet / Possum	Rainbow Lorikeet	Fledgling Rainbow Lorikeet.
Georges River Corridor	70	Possum / Arboreal mammal	Common Ringtail Possum	
Georges River Corridor	72	Parrot	Australian Wood Duck	
Georges River Corridor	76	Glider	Sugar Glider	Honeycomb in box.

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Location	Box ID	Box Type	Species	Notes
Georges River Corridor	77	Possum / Arboreal mammal	Common Ringtail Possum	
Georges River Corridor	79	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	83	Lorikeet / Possum	Common Brushtail Possum	
Georges River Corridor	84	Glider	Black Rat	Adult Rainbow Lorikeets on box
Georges River Corridor	85	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	86	Lorikeet / Possum	Unidentified	Fledgling from unknown bird
Georges River Corridor	89	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	93	Parrot	Common Ringtail Possum	
Georges River Corridor	95	Glider	Sugar Glider	
Georges River Corridor	104	Parrot	Rainbow Lorikeet	
Georges River Corridor	106	Lorikeet / Possum	Unidentified	Two eggs
Georges River Corridor	108	Cockatoo	Australian Wood Duck	10 + eggs, no adult
Georges River Corridor	109	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	112	Glider	Sugar Glider	
Georges River Corridor	114	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	116	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	123	Possum / Arboreal mammal	Unidentified	Two eggs
Georges River Corridor	129	Lorikeet / Possum	Unidentified	Two eggs
Georges River Corridor	133	Wood Duck	Rainbow Lorikeet	Adult with two eggs
Georges River Corridor	134	Lorikeet / Possum	Unidentified	Two eggs
Georges River Corridor	135	Lorikeet / Possum	Unidentified	Egg

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Location	Box ID	Box Type	Species	Notes
Georges River Corridor	137	Microbat	Peron's Tree Frog	
Georges River Corridor	139	Parrot	Unidentified	
Georges River Corridor	145	Parrot	Common Ringtail Possum	
Georges River Corridor	146	Glider	Sugar Glider	
Georges River Corridor	161	Possum / Arboreal mammal	Rainbow Lorikeet	
Georges River Corridor	164	Wood Duck	Rainbow Lorikeet	
Georges River Corridor	168	Wood Duck	Unidentified	Fledgling of unknown bird
Georges River Corridor	172	Glider	Rainbow Lorikeet	
Georges River Corridor	175	Glider	Unidentified	Single egg
Georges River Corridor	177	Possum / Arboreal mammal	Unidentified	Single egg
Georges River Corridor	189	Lorikeet / Possum	Common Brushtail Possum	
Georges River Corridor	191	Wood Duck	Common Myna	No bird, rubbish in nesting material
Georges River Corridor	193	Cockatoo	Cockatoo	
Georges River Corridor	196	Lorikeet / Possum	Common Brushtail Possum	
Georges River Corridor	197	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	199	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	200	Lorikeet / Possum	Common Ringtail Possum	
Georges River Corridor	207	Glider	Sugar Glider	
Georges River Corridor	210	Possum / Arboreal mammal	Common Ringtail Possum	
Georges River Corridor	214	Lorikeet / Possum	Rainbow Lorikeet	
Georges River Corridor	219	Possum / Arboreal mammal	Common Ringtail Possum	Baffle on box



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Location	Box ID	Box Type	Species	Notes
Georges River Corridor	222	Glider	Black Rat	Possibly deceased
Georges River Corridor	225	Glider	Sugar Glider	Multiple sugar gliders
Georges River Corridor	234	Possum / Arboreal mammal	Common Ringtail Possum	
Georges River Corridor	235	Wood Duck	Unidentified	Fledgling of unknown bird
Georges River Corridor	239	Parrot	Common Ringtail Possum	
Georges River Corridor	243	Cockatoo	Unidentified	Two large eggs
Georges River Corridor	247	Cockatoo	Unidentified	Large single egg
Georges River Corridor	x	Glider	Sugar Glider	Unknown box number
Georges River Corridor	x	Possum / Arboreal mammal	Unidentified	Two eggs. Unknown box number
Georges River Corridor	x	Glider	European Honey Bee	Unknown box number.

## **APPENDIX I. NEST BOX CORRECTIVE ACTION REPORT**

# Nest Box Maintenance and Repair

## Moorebank Biobank Site

**DATE**

18 May 2022

**CLIENT**

Danielle Eloss (Logos Property)

**FROM**

Nathan Banks (Arcadis)

**COPY TO**

Marvin Do (Tactical Group); Fei Chen (Tactical Group);  
Kate Carroll (Arcadis)

**SUBJECT**

Moorebank Logistics Park – Nest box maintenance and repair



This memo provides an overview of the works completed to repair and reinstall nest boxes as part of the biobank offset site at the Moorebank Logistics Park.

## Background

Ecological monitoring surveys conducted in Spring of 2021 identified that 43 nest boxes would require repair and relocation to meet the minimum offset requirements of 216 fully functioning nest boxes. These 43 boxes were considered dysfunctional for the following reasons:

- nest box had potentially resulted in the fatality of occupying fauna. Fauna fatalities could be a result of occupying fauna not being able to exit the box due to missing internal ladders. One nest box was identified to have a dead Australian Wood Duck during the 2021 monitoring event and a further three boxes have caused fatalities in previous years.
- nest boxes were unstable on the tree due to incorrect mounting; a total of 17 boxes
- nest boxes were damaged, such as missing a lid or have a broken baffle; a total of ten boxes
- nest boxes were considered to be inhabited by invasive fauna; a total of six boxes
- nest boxes had fallen to ground or been attached to tree which has fallen; a total of three boxes

According to Section 5 of the MPE NBS, nest boxes must be installed at a height below 10 metres to allow for visual inspection using an inspection camera and extension pole. A total of 16 nest boxes (#71, #89, #117, #125, #148, #159, #164, #172, #178, #206, #230, #233, #236, #250, and two unnumbered boxes) in the Georges River corridor were installed at a height above 10 metres and could not be reached using a pole-mounted camera. Issues with nest boxes that may put fauna at risk cannot be identified if boxes are unable to be inspected. For this reason, these boxes were considered to be in an unsuitable condition.

On the 23 and 24 March 2022, a senior ecologist from Arcadis was assisted by two tree climbers from Plateau Trees to relocate and repair nest boxes in the Bootland and Georges River Corridors.

## Methods

Tree climbers removed the specific nest boxes from the trees and then brought them to the ground for repair and inspection. All relocated nest boxes were installed via a simple nail in tree method which has been shown to be an effective method of installation (Goldingay et al. 2018). This method has minimal



impact to the tree health and allows the tree to grow with the box attached. As the tree grows, the box is moved along the exposed nail ensuring increased lifespan of the nest box. It also protects the tree from ringbarking from using cords. Nest boxes were reinstalled at less than 10 metres from the ground to ensure easy monitoring access.

All nest boxes were also relocated to the south-eastern side of the tree (Goldingay 2015) which reduces the impact of extreme heat on occupants. The majority of boxes were relocated on the same tree to avoid disturbing fauna that utilise the cavities.

## Results

Despite the wet conditions, the team were able to assess 29 nest boxes and climbed on 41 occasions to remove and reinstall boxes. Nest boxes that required maintenance were repaired and reinstalled on the same tree at a lower more management height.

Four high priority nest boxes where deaths had occurred were removed and inspected. Three of these boxes had a ladder installed using shade cloth stapled to the inside of the cavity (Plate 1.C). Three of these boxes contained the remains of recently deceased juvenile Rainbow Lorikeets confirming the design flaw found during monitoring in 2021. The fourth box was found to be in good condition and a ladder already in the box. This latter box had the entrance tunnel cut to improve entry and exit for fledgling birds. All four nest boxes were then installed on the same trees.

Three nest boxes were relocated and repaired while animals were kept inside the boxes. In this case, a towel was used to block the entrance to avoid accidents with escape. Animals remained calm and nest boxes were installed back without significant disturbance to the animals inside.

The only animals encountered (Figure 3) were an Eastern Ringtail Possum (*Pseudocheirus peregrinus*), 2 x Peron's Tree Frogs (*Litoria peronii*), and invasive Common Myna (*Acridotheres tristis*). A nest of bird eggs was also discovered inside of one box. This latter box was left in place as to not disturb the incubation process.





Plate 1. (A) Several nest boxes had poor water proofing and were flooded with water. Drainage holes has become blocked. A pair of Peron's Tree Frogs were found in this box. (B) Evidence of water damage around the hinges and joins on the rear. Nest boxes that do not contain an overhang are more prone to decay from moisture. (C) Shade cloth was stapled to the inside of each of the very large priority nest boxes to allow young birds to climb out. (D) Removal of large nest boxes for repair was a time-consuming team effort due to their heavy weight.

## Limitations

Nine nest boxes could not be reached by the tree climbers. This was due to a few reasons. Not all trees can be ascended by tree climbers. For example dead trees are considered too high risk for tree climbers. Also trees that are very narrow and do not contain a high anchor point are also unable to be climbed. These trees will require a cherry picker or other machine to access these nest boxes for relocation.

The presence of very thick weed species *Lantana camara* also presented a navigation difficulty which would have reduced the time efficiency of the work. Therefore, nest boxes located in these areas were not accessed.

The heavy rainfall experienced during the two days of fieldwork also made work more difficult for climbing and slowed the pace of workers as they took more care with each tree. Conditions were extremely muddy in some sections and extra care was required when using ladders with wet feet.

In addition, the three larger nest boxes located in the Bootland bushland area required extensive problem solving to remove the boxes which were screwed very tightly to the trees with seized bolts. A system was developed with an overhead wire to lift these boxes up and down the tree before they could be secured by the tree climber. These larger boxes took considerable time to remove, modify and install.

## Further actions required

Numerous other nest boxes were observed by the senior fauna ecologist and noted as requiring maintenance. In some instances, nest boxes were attached via a cable around which was slowly ringbarking the tree. Several nest boxes were located at very high locations, unable to be removed by the tree climbers due to safety concerns. Maintenance of these nest boxes is not considered time critical and can be deferred to after nest box monitoring in spring 2022.

We recommend that all future nest boxes be installed by hanging on a large nail at a height lower than 10 metres off the ground. At this height, the nest boxes can be easily accessed via an extension ladder, thus reducing the need for tree climbers and potentially reducing expenses for long-term management.

Most nest boxes retrieved also had signs of decay suggesting limited lifespans. Five boxes contained water with the drainage holes blocked by decaying timber. The lack of a waterproofing paint on many of the boxes meant that decay would be rapid. These boxes could be refurbished with fresh-paint to increase their lifespan.

## References

Goldingay, RL, Thomas, KJ and Shanty, D (2018), Outcomes of decades long installation of nest boxes for arboreal mammals in southern Australia. *Ecol Manag Restor*, 19: 204-211.

Goldingay RL. (2015) Temperature variation in nest boxes in eastern Australia. *Australian Mammalogy* 37, 225-233.





## Appendix 1. Map of nest boxes assessed



### Legend

#### Biobank sites

- Casula offset area (Hourglass)
- Moorebank offset area (Georges River)
- Wattle Grove offset area (Bootland)

#### Nest box actions

- Fallen box
- Inaccessible
- Installed
- Remain
- Removed
- Repaired

1:14,000 at A4  
Coordinate System: GDA 1984 MGA Zone 56  
Date issued: May 12, 2022  
Imagery: Nearmap



Path: C:\Users\amap\Documents\1008279 - Moorebank - Environment - 42 GFA - Current\Map\Ecology\NestBox\_Construction\Map\NestBox\_Construction.aprx

## Appendix 2. Table of all nest boxes assessed.

No.	Status	Occupied	Type of box	Notes
8	Repair	0	Parrot	Priority nest box. Repaired. Relocated on same tree
14	Repair	0	Parrot	Priority nest box. Repaired. Relocated on same tree
24	Repair	0	Parrot	Priority nest box. Repaired. Relocated on same tree
51	Removed	0	Microbat	On Willow tree. Box broken
52	Installed	0	Microbat	Relocated box
53	Installed	0	Glider	Repaired and installed
74	Installed	0	Possum	Full of water
76	Inaccessible	0	Microbat	Too difficult to climb
77	Installed	0	Glider	Box was lowered
81	Inaccessible	-	Microbat	Needs cherry picker
82	Installed	0	Microbat	Removed due to cord cutting into tree
91	Removed	0	Microbat	Requires repair
92	Inaccessible	0	Glider	Tree cannot be climbed
93	Inaccessible	0	Parrot	Tree cannot be climbed
99	Inaccessible	-	Parrot	Dead tree cannot be climbed
100	Inaccessible	-	Wood Duck	Dead tree cannot be climbed
101	Inaccessible	-	Microbat	Dead tree cannot be climbed
102	Installed	Peron's Tree Frog	Possum	Lowered on same tree. Full of water
103	Installed	0	Parrot	Lowered on same tree. Full of water
116	Installed	Ringtail possum	Possum	Lowered on same tree
117	Installed	0	Parrot	Lowered on same tree
133	Repair	0	Duck	Priority nest box. No issues observed. Installed at lower height
148	Lowered	Indian Mynas	Possum	Lowered on same tree
159	Installed	0	Parrot	Lowered on same tree
168	Fallen box recovered	0	Glider	Lying on ground. Reinstalled
206	Inaccessible		Possum	Too high to access.

## Memo



No.	Status	Occupied	Type of box	Notes
212	Inaccessible	-	Possum	Lantana blocking access
222	Installed	0	Glider	Relocated box
250	Remain	0	Duck	Contained eggs