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Subject MPE operational facility – Weed monitoring report August 2022

Introduction

Arcadis has 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 following:

- 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 has been monitoring the MPE operational facility for weed occurrence since April 2020. Soft landscaped areas surrounding the IMEX, warehouses and freight village, and drainage infrastructure have maintained low weed cover since the initial weed survey. Routine weed control works have not been observed across these areas in recent surveys. There are noticeable increases in priority weed species in all areas of the MPE operational facility. 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. However, weed control works must be re-established to maintain low weed densities.

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 on 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 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 Thea Kane and Jed Brown attended the MPE operational facility on Thursday, 25 August 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 survey day was sunny, with a maximum temperature of 23.3°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 2021 regarding revegetating 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 ecologically 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 Thursday, 25 August 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.

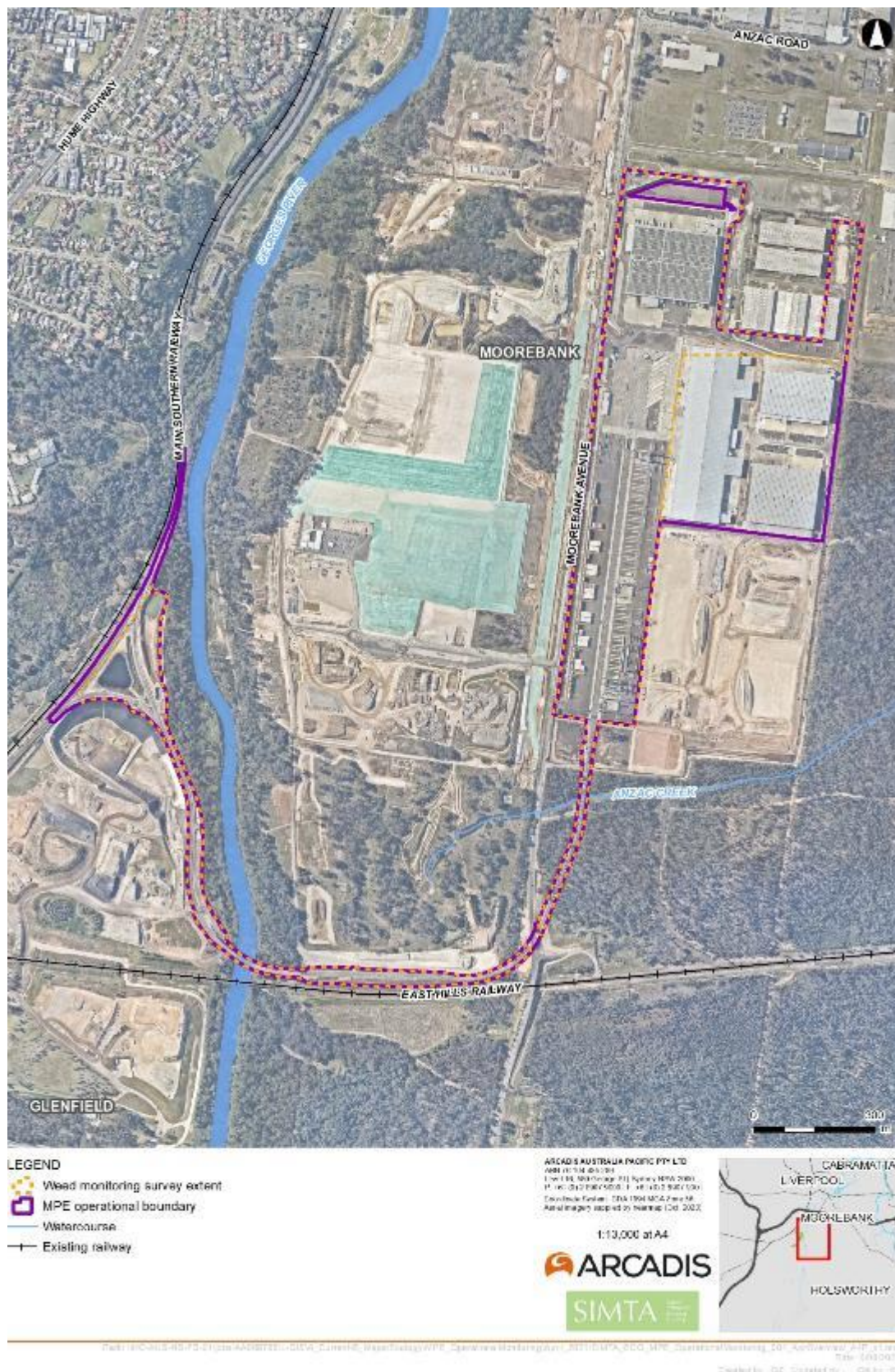


Figure 1. Survey extent within the MPE operational facility

Results

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

IMEX, warehouses and drainage infrastructure

Weed cover has slightly increased within the MPE operational facility to what was recorded during the July 2022 surveys. While weed cover remains low, the current survey identified new instances of priority weed *Senecio madagascariensis* (Fireweed) (Plate 1). No signs of weed control works (chipping or herbicide spraying of weeds) were observed at the northeastern extent of the facility surrounding drainage basins and swales.

Due to high rainfall across the Sydney region in June and July 2022, instances of erosion and damage to native species *Acacia falcata* (Hickory Wattle) were observed (Plate 2), as highlighted in the July 2022 report. Since the July surveys there has been no management action undertaken to remedy this damage. Several native species are present and continue to grow on soft batters and in the drainage swale, including Hickory 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



Plate 2. Observation of native plant damage and erosion in drainage basins. Observations were also present in the July 2022 survey.

The soft batters of the northeast trunk drainage system have a low cover of exotic grasses, which are currently acting to stabilise the soil, with some native species such as Hickory Wattle persisting. Instances of Fireweed observed in the July 2022 survey persist in the current survey.

No plant growth was observed in the trunk drainage systems at the northernmost point of MPE (Plate 3). The absence of soil or other growing substrate will likely mean a continued lack of vegetation in this area.



Plate 3 Northern drainage area of MPE with lack of any plant growth

Weed cover remains along soft batters in the drainage line running along the western extent of MPE. Generally, these soft batters have a low vegetation cover, with sparse occurrences of native species such as Hickory Wattle and *Davesia ulicifolia* (Gorse Bitter-pea).

Rail Access Land Package (RALP)

No evidence of recent 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 April 2022 inspection. However, some slashing appears to have been conducted on either side of a gate located along the western side of the rail link corridor (Plate 4) which appears to aid access rather than targeting weed species in this area.



Plate 4 Evidence of slashing at the western side of the rail link corridor

Most areas of soft batter on either side of the rail link displayed increases in exotic biomass since the previous inspection during the July 2022 survey. Notable increases were observed in the height of *Cirsium vulgare* (Spear Thistle), where there are instances of thistles up to 2 meters (Plate 5). An increase in priority and key weed species, including Fireweed, *Chloris gayana* (Rhodes Grass) and *Themeda quadrivalvis* (Grader Grass) was observed along the entire Rail Link. It is likely that recent climatic variables, including the combination of high rainfall and sunny days, in addition to the lack of weed management, have created favourable conditions for herbaceous and grass weeds to thrive. As the weather warms heading into spring, there are expected to be many emergent weed species.

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



Plate 5 Spear Thistle approaching two meters in height



Plate 6. Exotic species, Rhodes Grass and Fireweed continue colonising remediating soft batters within the Rail Link corridor

The new instances of native grasses observed in the July 2022 survey mostly remain intact, with some of the native grasses showing increased biomass and flowering. However, *Cymbopogon refractus* (Barbed Wire Grass) biomass appears to have been stunted potentially due to increased competition from increased weed biomass. New instances of native grasses continue to be observed along the rail link corridor, including *Themeda triandra* (Kangaroo Grass), *Chloris truncata* (Windmill Grass), *Dichanthium sericeum* (Queensland bluegrass) and Barbed Wire Grass.

Some hardier native seedlings, such as Hickory Wattle and *Indigofera australis* (Australia Indigo), were observed to be growing unimpeded by increasing weed cover (Plate 7). The juvenile vine-like growth form of Australia Indigo allows for growth in the spaces between weed biomass (Plate 7). During the August 2022 survey, Australian Indigo was observed to be flourishing with many new and established instances of the species. The flowering of Australian Indigo was observed and occurring due to the warming temperatures heading into spring (Plate 7).



Plate 7 *Australia indigo* juvenile (left) and in flower (right) observed to be growing despite an 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), Fireweed, Rhodes Grass and Grader Grass. The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 9.

The status of weeds and weed control works observed during the August 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	August '22 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through manual removal and herbicide treatment. Herbicide application should consider timing (i.e., applying herbicide when weeds are actively growing) and best practice methodologies. Areas outlined by coloured polygons in Figure 2 - Figure 9 should be prioritised.	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 9). These should be removed as a priority.
2	Removal of key and aggressive weed species	Key weed species, including African Lovegrass, Rhodes Grass, Paterson's Curse, Coolatai Grass and Grader Grass, should be removed from revegetated areas of soft batter. Aggressive weed species, including Moth Vine and Castor Oil Plant, should be removed from all operational areas using a combination of manual and herbicide control. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Key weed species, including Rhodes Grass, African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass, are increasingly colonising soft batters in the Rail Link. These weeds should be removed. Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link but are likely outside the operational boundary (Figure 2 - Figure 9). Despite this, these weeds should be removed to avoid encroachment into revegetated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and ecologically sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Weed growth is increasing on soft batters adjacent to the biobank site and ecologically sensitive areas. In some instances, exotic species are encroaching into these ecologically sensitive areas. Manual removal, including routine slashing, has not recently been adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent high-value areas (biobank site and ecologically sensitive areas containing threatened plant species). All works should be restricted to the operational area and not extend into the biobank site or identified ecologically sensitive areas. Slashing should only be conducted when weed species are not in flower to prevent further spread.

Priority	Action	Action description	August '22 performance assessment
			Appropriate slashing time is during winter for most species.
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. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Slashing has not been adopted to manage the 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. However, as native grasses become established, extreme care must be taken, and indiscriminate slashing must be avoided. A contractor with knowledge of native species should be employed to carry out this task.
5	Reduce cover of weeds within the Rail Link	Reduction of weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019). Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Works should involve targeted slashing of mature plants and removing flowering and seed heads to minimise seeding. Targeted slashing has been previously employed to control weed colonisation on soft batters. However, it must be continued to limit the re-colonisation of weeds within the Rail Link. No works have been conducted to reduce the cover of weeds within the Rail Link since the July 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 northeastern extent of the MPE operational facility. No signs of weed control works were observed during the recent survey.

Litter

An increased 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 native and exotic vegetation and blocking drainage infrastructure within the rail corridor and the Georges River (Plate 8).



Plate 8. Litter observed within the rail corridor during the August inspection

Erosion

High rainfall events between April and July 2022 resulted in the slipping of remediated soft batters within the Rail Link corridor, as observed in the July 2022 survey (Plate 9). The location of the areas where batter slipping was observed is presented in Figure 6. During the August 2022 survey, no evidence of erosion control or management has been put in place. *Plantago lanceolata* (Lambs tongue) was observed recruiting in bare soil exposed by slippage. It is recommended that native deep rooted grasses and shrubs be installed along these batter to increase batter stability into the future.



Plate 9. Batter slumping observed within the Rail Link

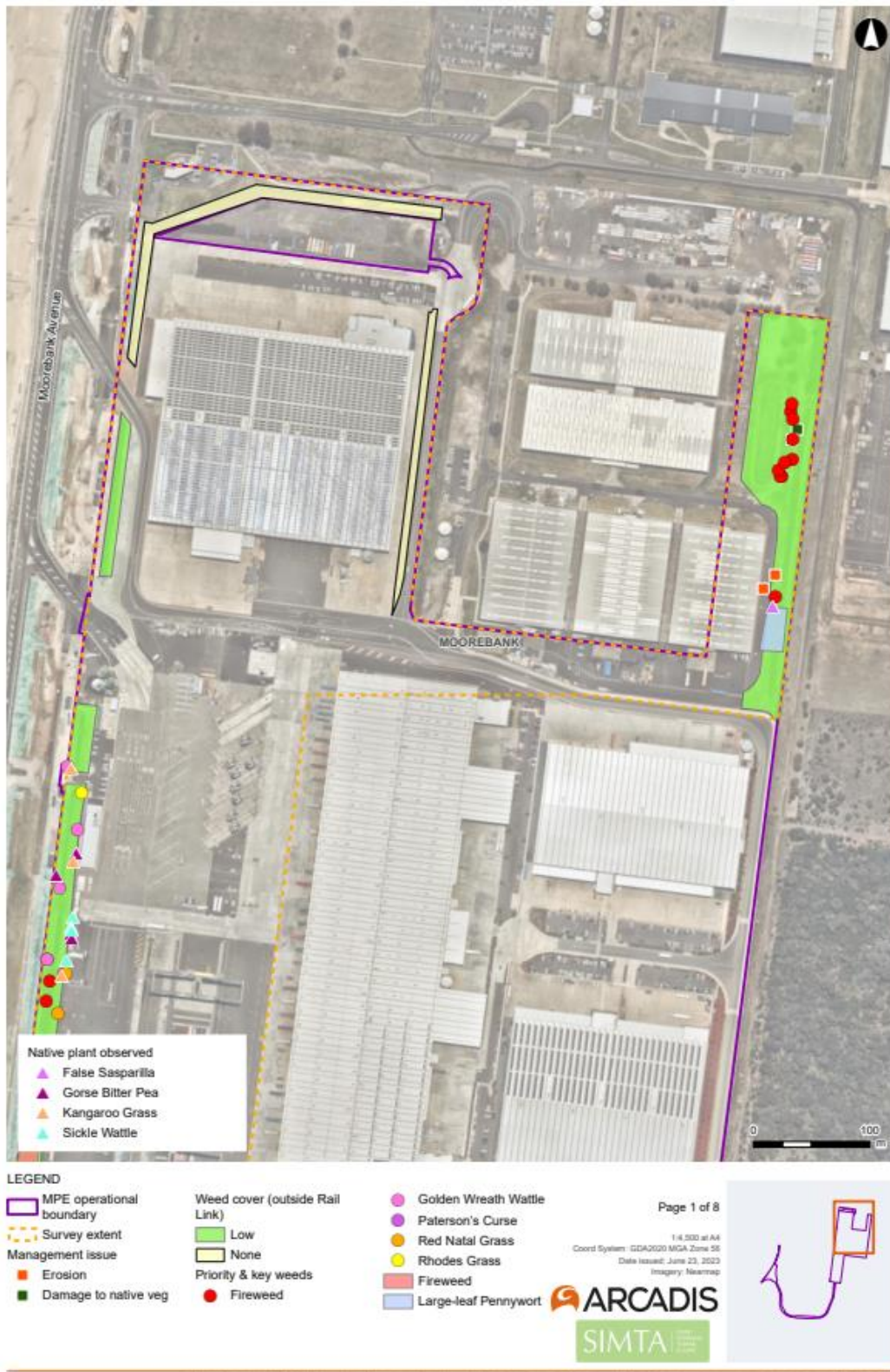


Figure 2 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 8)

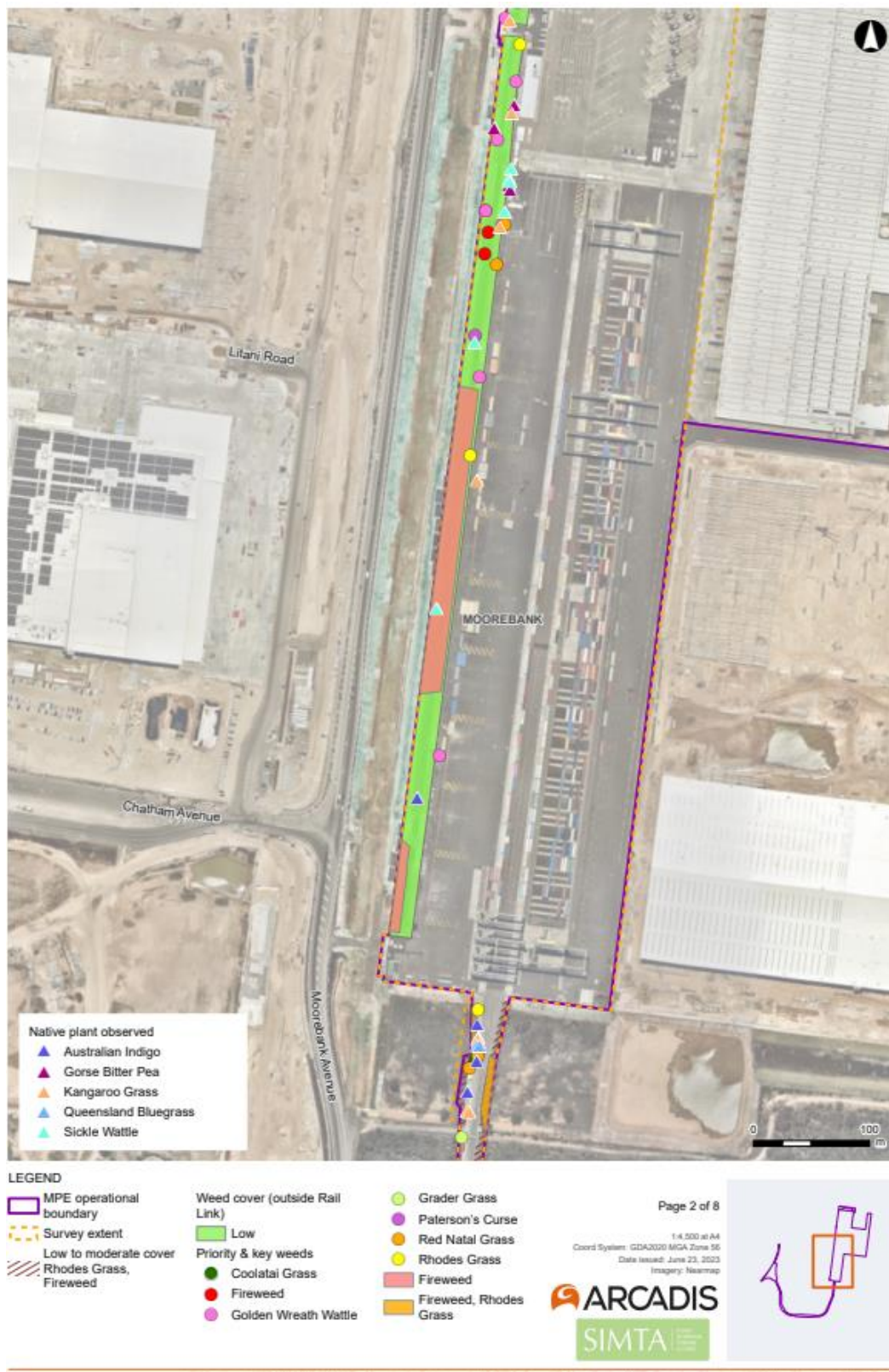


Figure 3. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 2 of 8)



Figure 4. Native species, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 3 of 8)

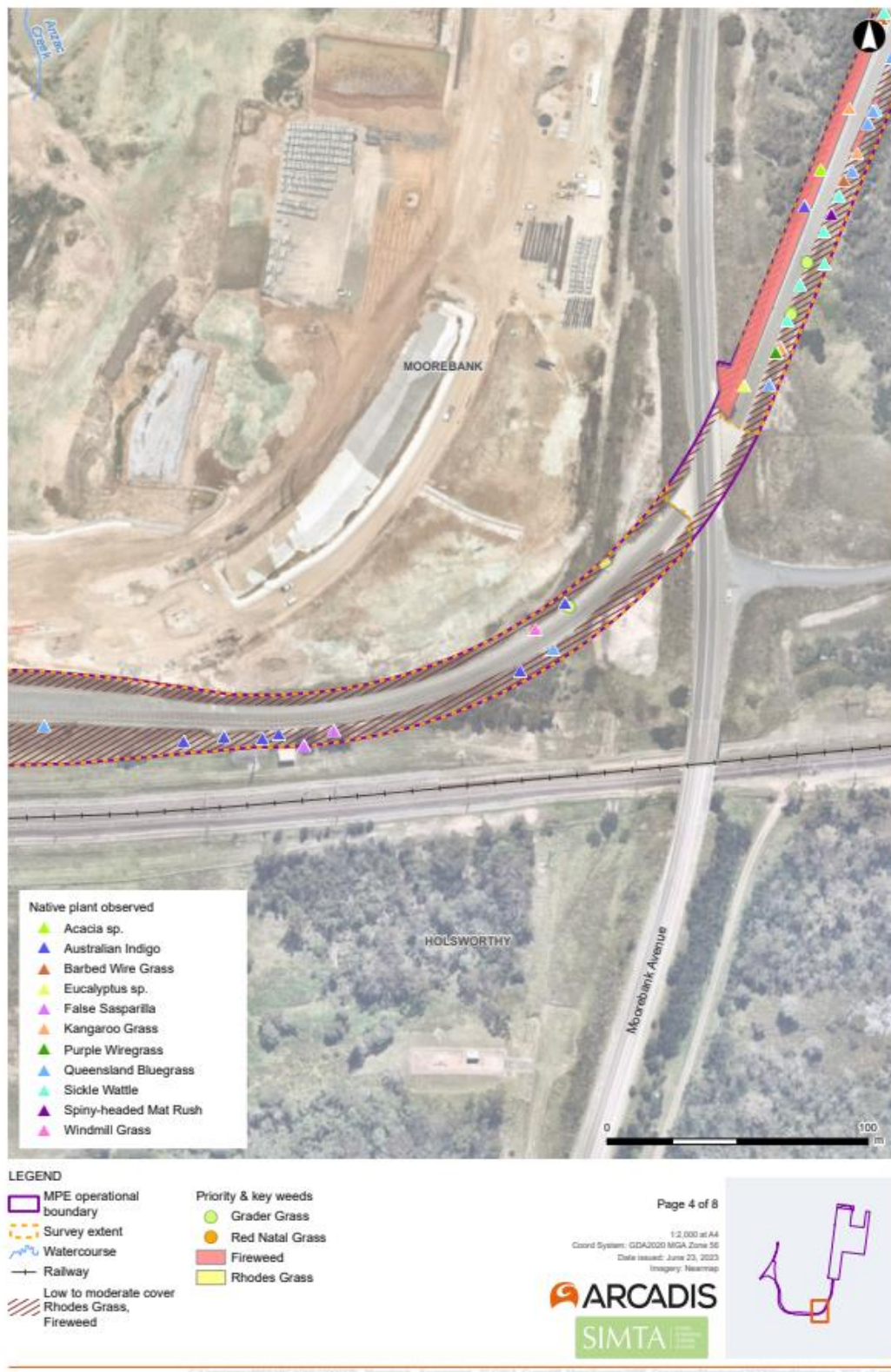


Figure 5 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 8)

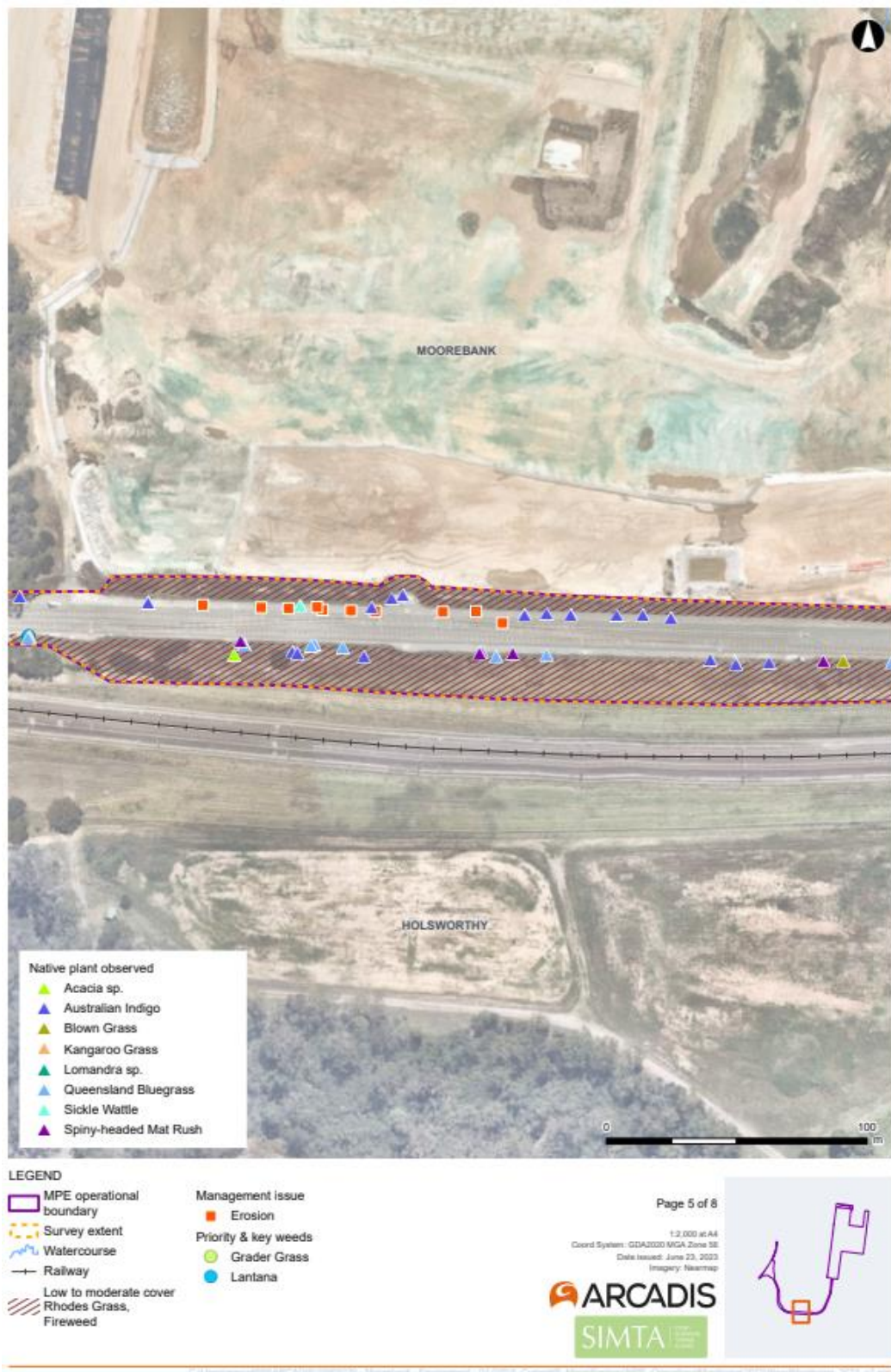


Figure 6. Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 8)

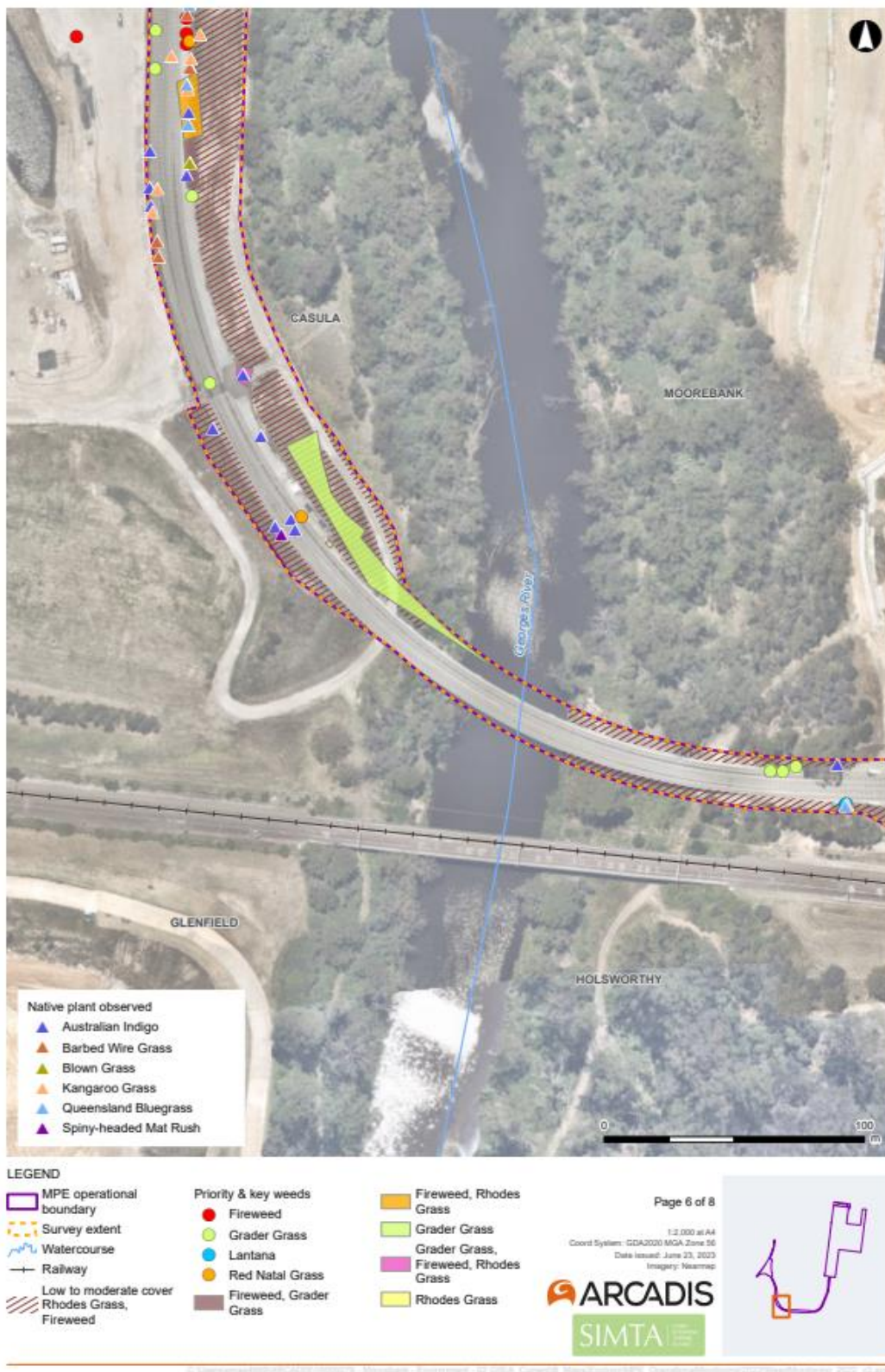


Figure 7. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 6 of 8)

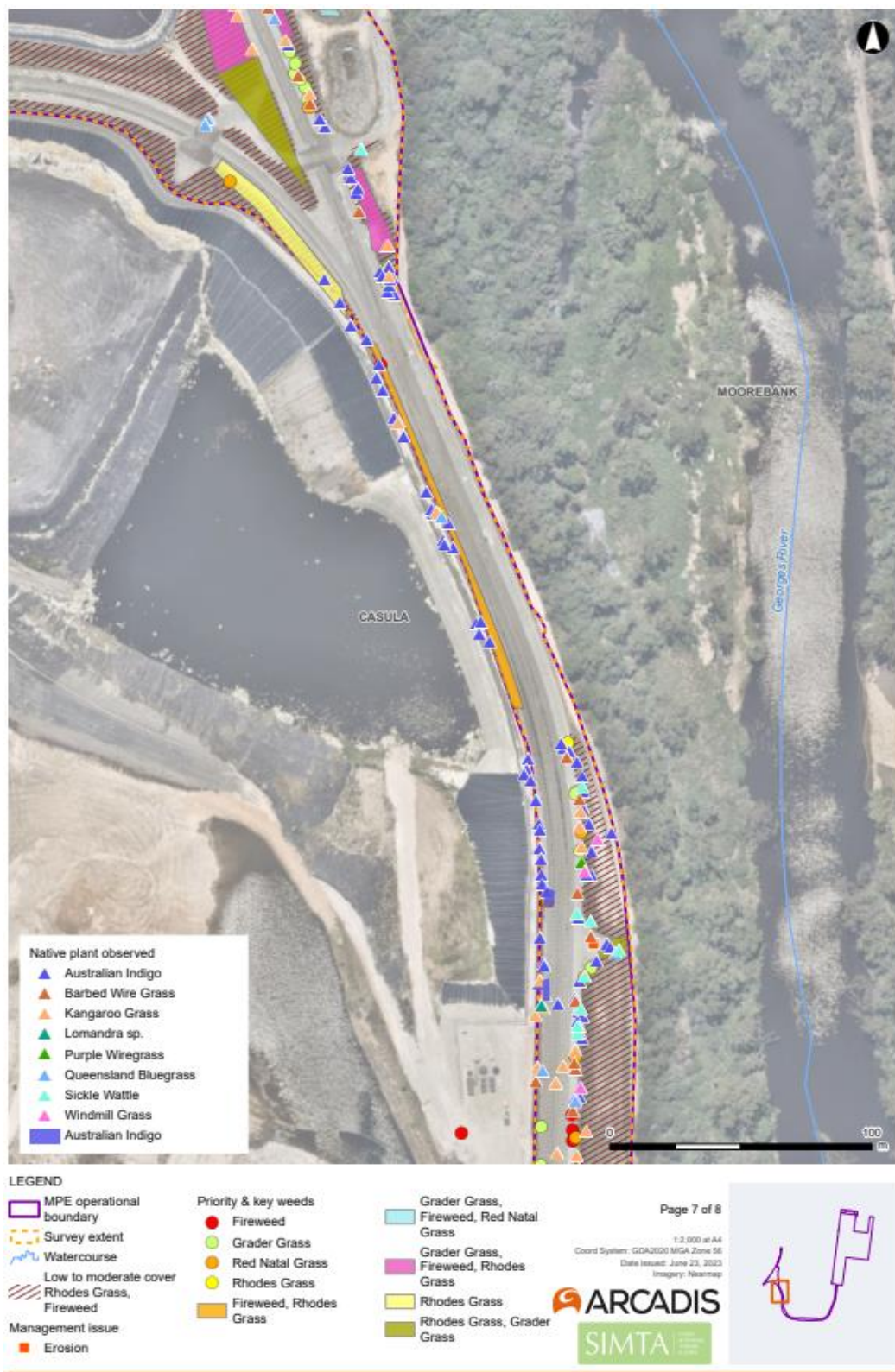


Figure 8. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 7 of 8)

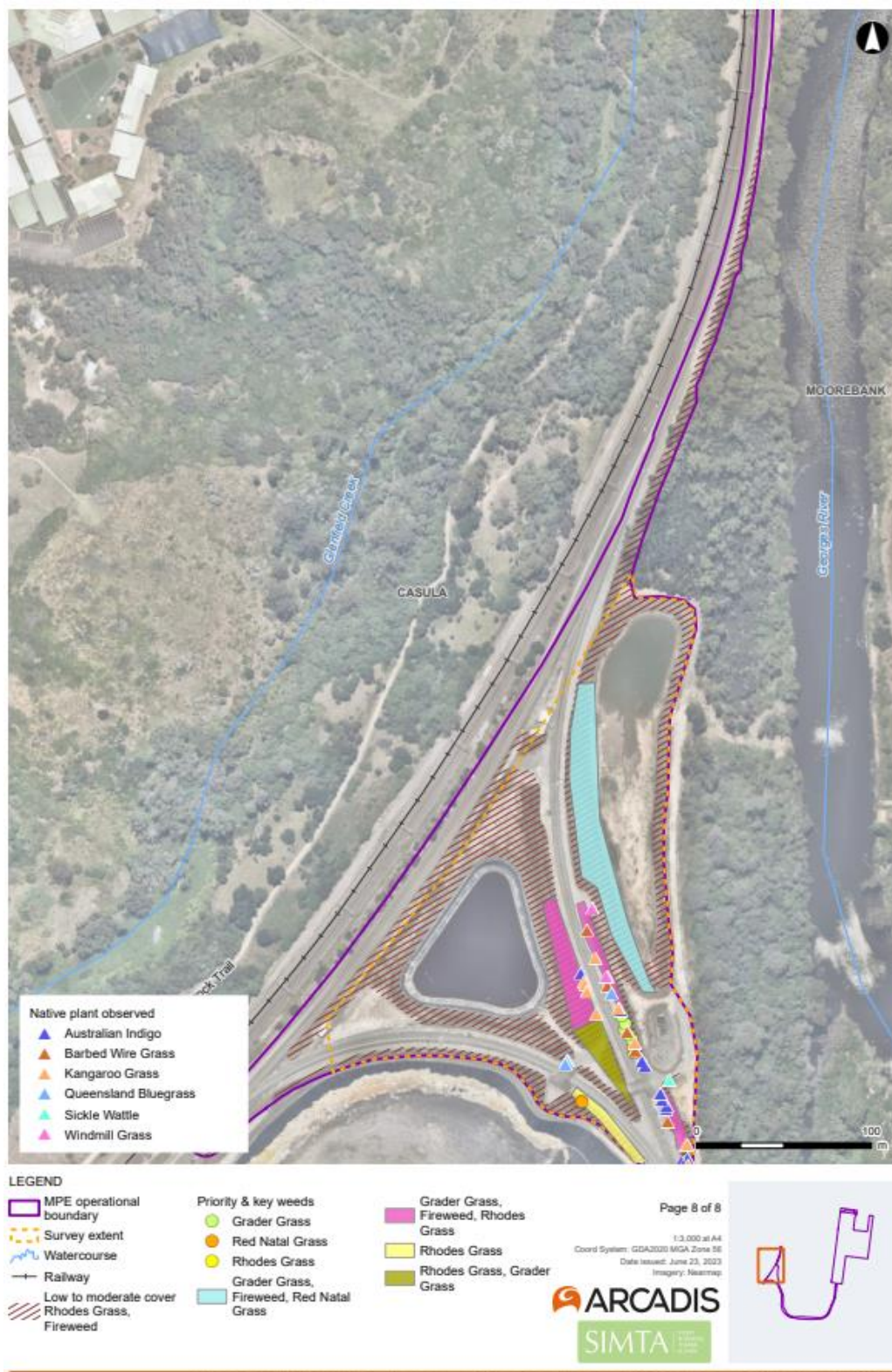


Figure 9. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 8 of 8)

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 July 2022 survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

The majority of weed control and management action recommendations documented in the July 2022 weed monitoring report are still applicable to the 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. However, extreme care must be taken when conducting any weed management along the rail corridor as many native grasses have become established. A suggested process to target weeds along revegetated soft batters is presented in Figure 10. Hand weeding is only feasible on annual species such as Grader Grass and Fireweed.
- Priority and aggressive weed species outside revegetated Rail Link areas should be removed. Weeds that 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 regularly to prevent seeding events (Figure 4, Figure 8). This will reduce the colonisation of these grasses into revegetation areas. However, slashing should only occur when plants are not seeding to prevent further spread. Furthermore, as more native species become established in these areas, slashing may impact their growth; therefore, non-targeted slashing should be avoided.
- Exotic understory vegetation in the two locations outside 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 on 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 on native species which have been observed to be increasing across the site. A suggested process to target weeds within these areas is presented in Figure 11.
- Continue to collect litter from within the Rail Link and in adjacent areas.
- Soft batters within the trunk drainage system and retention basin/swale at the northeastern extent of the facility should be inspected for weed growth. Weed levels should be controlled through 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 to prevent overspray (off-target poisoning). If herbicide application occurs, recommended herbicides for tussock grass, such as Rhodes grass and African Lovegrass, include glyphosate or flupropanate, while plants are actively growing during summer and spring. Native vegetation outside the Rail Link fence must not be impacted by herbicide during weed control works.

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

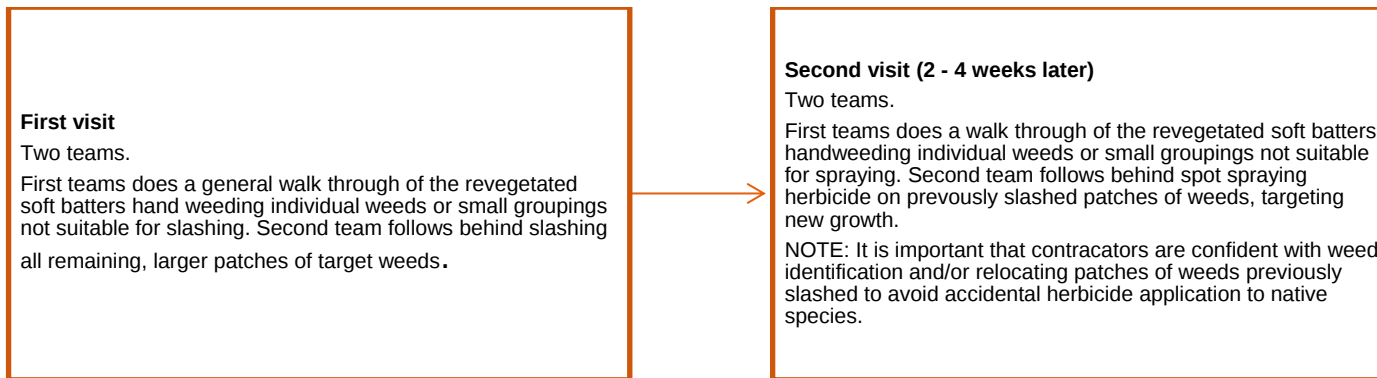


Figure 10. Suggested process to controlling target weeds on revegetated soft batters

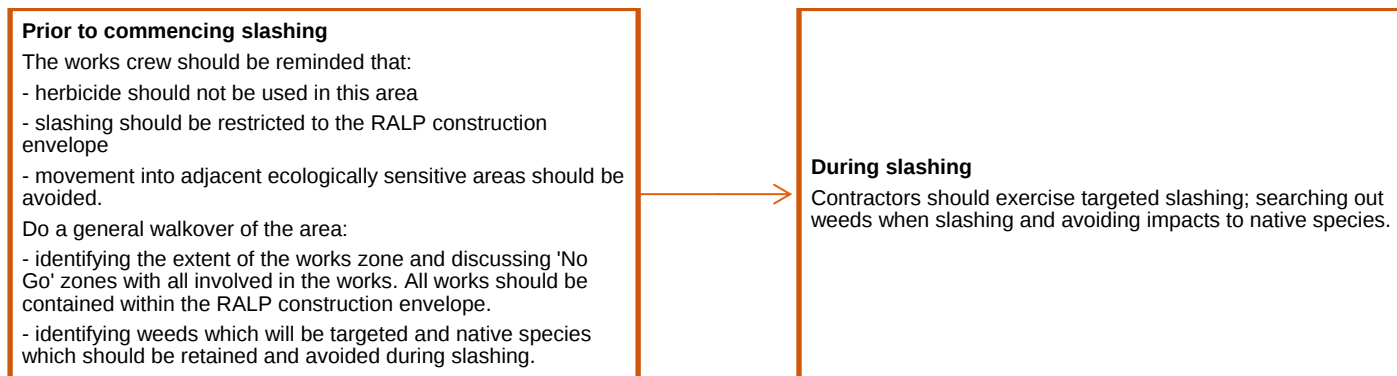


Figure 11. Slashing target weeds within the RALP construction envelope adjacent to ecologically sensitive areas

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 prioritised 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 the 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.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic), should be removed from grassland on 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 the Rail Link corridor fencing. A qualified bush regeneration contractor should be used to avoid impacts on 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 remains in the 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 the spread of these species into ecologically 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.
August 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 weed species should be prioritised for weed control works in coming months to avoid mass seeding events.
	Begin remediation of soft batters which have slipped following extreme rainfall events in recent weeks	Not started	Areas within the operational facility, including a number of areas within the Rail Link, require urgent batter remediation in areas of batter slipping.

APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



December 2021



August 2022



April 2021



December 2021



August 2022



April 2021



December 2021



August 2022



April 2021



December 2021



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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 2021 regarding revegetating 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 the recruitment of native seedlings or impacts on adjacent ecologically 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)	

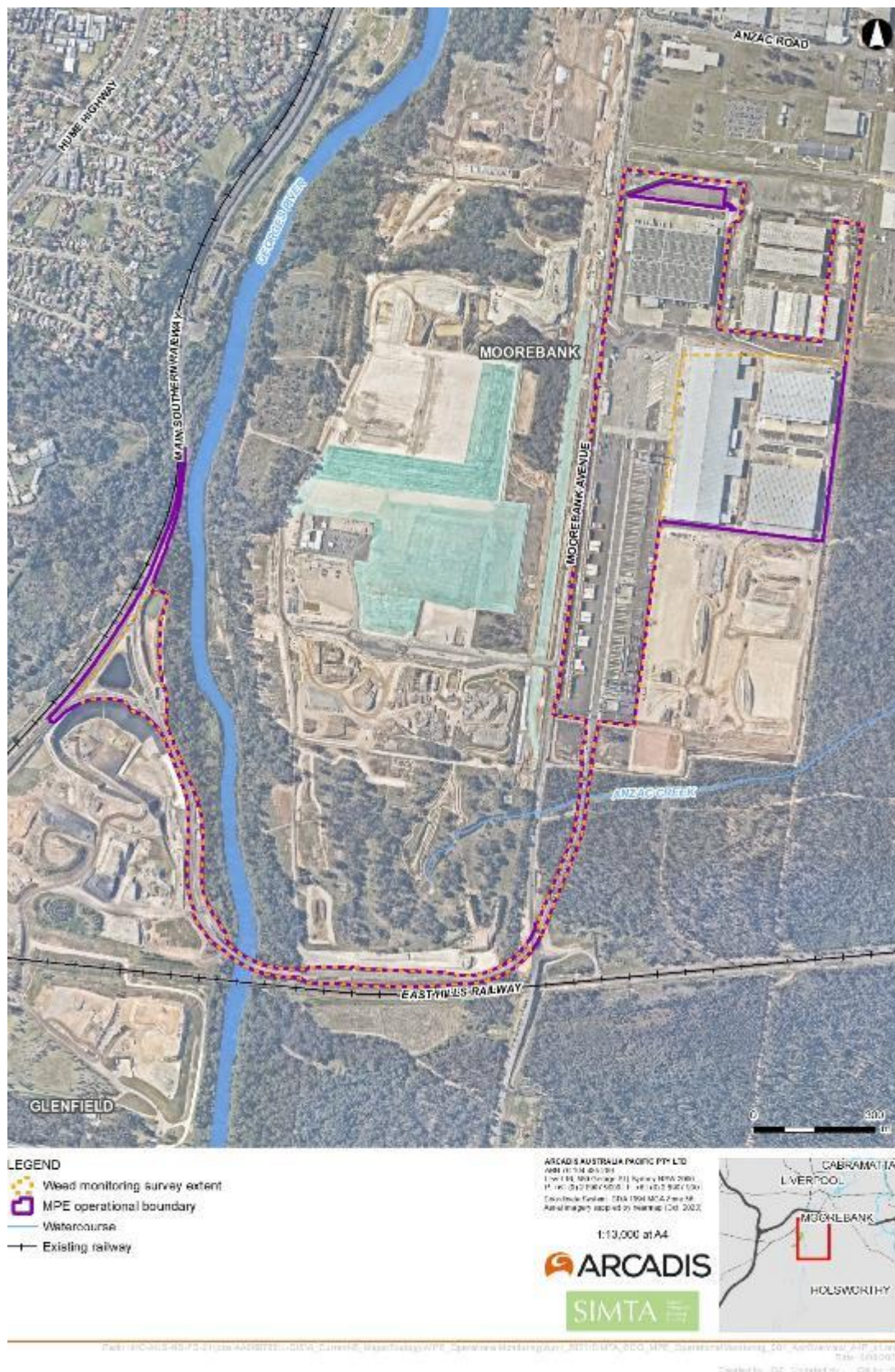
The location of key and priority weed species and observed weed control works were recorded on an Arc-GIS enabled iPad.

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 Thursday, 31 October 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 October 2022 weed monitoring survey are summarised below.

IMEX, warehouses and drainage infrastructure

Weed cover has slightly increased within the MPE operational facility to what was recorded during the August 2022 surveys. While weed cover remains low, the current survey identified new instances of priority weed *Senecio madagascariensis* (Fireweed) (Plate 1). No signs of weed control works (chipping or herbicide spraying of weeds) were observed at the northeastern extent of the facility surrounding drainage basins and swales.

Due to high rainfall across the Sydney region in June and July 2022, instances of erosion and damage to native species *Acacia falcata* (Hickory Wattle) were observed (Plate 2), as highlighted in the August 2022 report. Since the August surveys, no management action has been undertaken to remedy this damage. Several native species are present and continue to grow on soft batters and in the drainage swale, including Hickory Wattle, *Typha orientalis* (Bulrush), *Persicaria decipiens* (Slender Knotweed), *Ficinia nodosa* (Knotted Club-rush) and *Lomandra longifolia* (Mat Rush).



Plate 1. New observations of Fireweed and Catsear in drainage basins



Plate 2. Observation of native plant damage and erosion in drainage basins. Observations were also present in the August 2022 survey.

The soft batters of the northeast trunk drainage system have a low cover of exotic grasses, which are currently acting to stabilise the soil, with some native species, such as Hickory Wattle, persisting. Instances of Fireweed observed in the August 2022 survey persist in the current survey and appear to have increased biomass during the October 2022 survey (Plate 3).



Plate 3 Fireweed growing on soft batters of the northeast trunk drainage system.

No plant growth was observed in the trunk drainage systems at the northernmost point of MPE (Plate 4). The absence of soil or other growing substrate will likely mean a continued lack of vegetation in this area.



Plate 4 Northern drainage area of MPE with lack of any plant growth

Weed cover remains along soft batters in the drainage line running along the western extent of MPE. Generally, these soft batters have a low vegetation cover, with sparse occurrences of native species such as Hickory Wattle and *Davesia ulicifolia* (Gorse Bitter-pea).

Rail Access Land Package (RALP)

No evidence of recent 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 April 2022 inspection.

Most areas of soft batter on either side of the rail link displayed increases in exotic biomass since the previous inspection during the August 2022 survey. An increase in priority and key weed species, including Fireweed, *Chloris gayana* (Rhodes Grass) and *Themeda quadrivalvis* (Grader Grass), was

observed along the entire Rail Link (Plate 5). It is likely that recent climactic variables, including the combination of high rainfall and sunny days, in addition to the lack of weed management, have created favourable conditions for herbaceous and grass weeds to thrive. As the weather continues to warm during spring and summer, there are expected to be many emergent weed species and seeding of established weed species.

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



Plate 5. Exotic species, *Rhodes Grass* and *Fireweed*, continue colonising remediated soft batters within the Rail Link corridor

The new instances of native grasses observed in the August 2022 survey mostly remain intact, with some of the native grasses showing increased biomass and flowering. However, *Cymbopogon refractus* (Barbed Wire Grass) biomass appears to have been stunted potentially due to increased competition from increased weed biomass. New instances of *Lachnagrostis filiformis* (Blown Grass) were observed during the October 2022 survey growing in isolated strips throughout the corridor.

Some hardier native seedlings *Indigofera australis* (Australia Indigo), were observed to be growing unimpeded by increasing weed cover (Plate 6).



Plate 6 Australia indigo observed to be growing despite an increase in exotic biomass



Plate 7 Blown Grass growing in isolated strips among exotic grasses.

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), Fireweed, Rhodes Grass and Grader Grass. The location of priority weeds and areas with high weed cover is included in Figure 2 - Figure 9.

The status of weeds and weed control works observed during the October 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	October '22 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through manual removal and herbicide treatment. Herbicide application should consider timing (i.e., applying herbicide when weeds are actively growing) and best practice methodologies. Areas outlined by coloured polygons in Figure 2 - Figure 9 should be prioritised.	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 9). These should be removed as a priority.
2	Removal of key and aggressive weed species	Key weed species, including African Lovegrass, Rhodes Grass, Paterson's Curse, Coolatai Grass and Grader Grass, should be removed from revegetated areas of soft batter. Aggressive weed species, including Moth Vine and Castor Oil Plant, should be removed from all operational areas using a combination of manual and herbicide control. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Key weed species, including Rhodes Grass, African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass, are increasingly colonising soft batters in the Rail Link. These weeds should be removed. Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link but are likely outside the operational boundary (Figure 2 - Figure 9). Despite this, these weeds should be removed to avoid encroachment into revegetated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and ecologically sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Weed growth is increasing on soft batters adjacent to the biobank site and ecologically sensitive areas. In some instances, exotic species are encroaching into these ecologically sensitive areas. Manual removal, including routine slashing, has not recently been adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent high-value areas (biobank site and ecologically sensitive areas containing threatened plant species). All works should be restricted to the operational area and not extend into the biobank site or identified ecologically sensitive areas. Slashing should only be conducted when weed species are not in flower to prevent further spread.

Priority	Action	Action description	October '22 performance assessment
			Appropriate slashing time is during winter for most species.
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. Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Slashing has not been adopted to manage the 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. However, as native grasses become established, extreme care must be taken, and indiscriminate slashing must be avoided. A contractor with knowledge of native species should be employed to carry out this task.
5	Reduce cover of weeds within the Rail Link	Reduction of weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019). Areas outlined by coloured polygons in Figure 2:Figure 9 should be prioritised.	Works should involve targeted slashing of mature plants and removing flowering and seed heads to minimise seeding. Targeted slashing has been previously employed to control weed colonisation on soft batters. However, it must be continued to limit the re-colonisation of weeds within the Rail Link. No works have been conducted to reduce the cover of weeds within the Rail Link since the August 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 northeastern extent of the MPE operational facility. No signs of weed control works were observed during the recent survey.

Litter

An increased amount of litter was observed within the rail corridor, IMEX, warehouses and drainage infrastructure and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility. Litter was observed within native and exotic vegetation, blocking drainage infrastructure within the rail corridor and the Georges River (Plate 8).



Plate 8. Litter observed within the rail corridor and IMEX, warehouses and drainage infrastructure during the October inspection

Erosion

High rainfall events between April and July 2022 resulted in the slipping of remediated soft batters within the Rail Link corridor (Plate 9). The location of the areas where batter slipping was observed is presented in Figure 6. During the October 2022 survey, no evidence of erosion control or management was put in place. It is recommended that native deep rooted grasses and shrubs be installed along these batter to increase batter stability. *Plantago lanceolata* (Lamb's tongue) was observed recruiting in bare soil exposed by slippage. New instances of the exotic grass *Briza media* (Quaking-Grass) were observed growing around erosion sites.



Plate 9. Batter slumping observed within the Rail Link

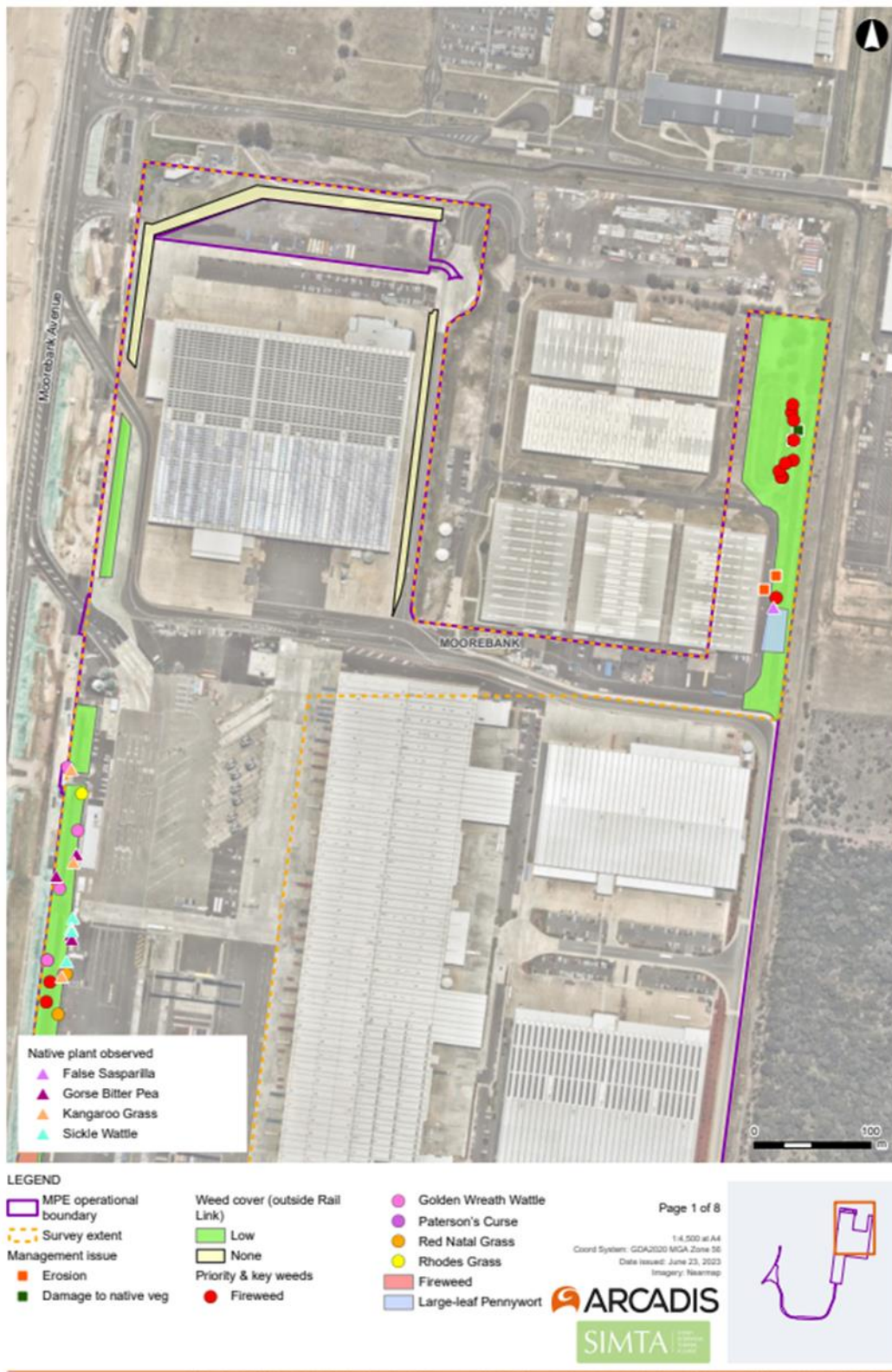


Figure 2 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 8)

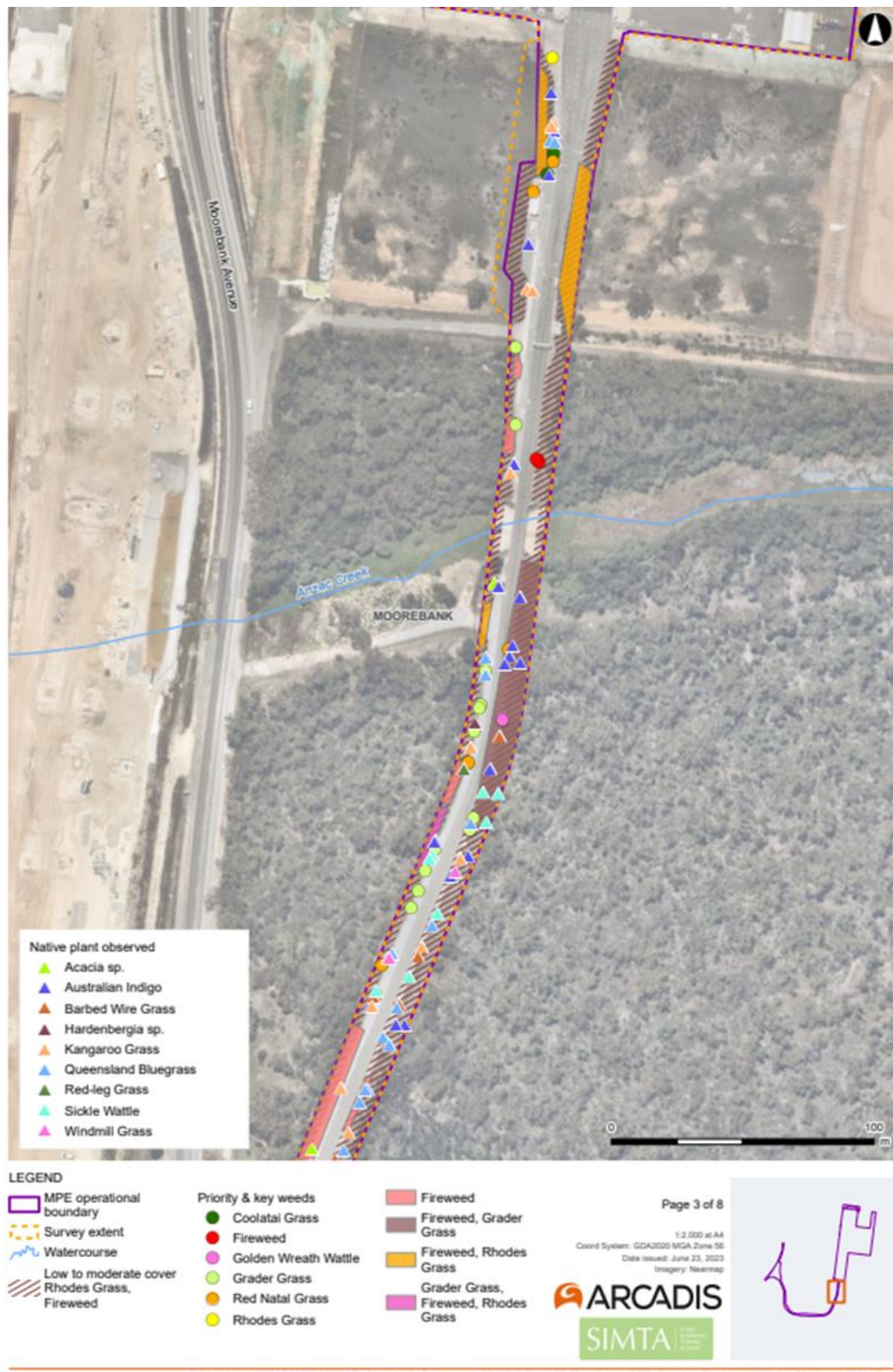
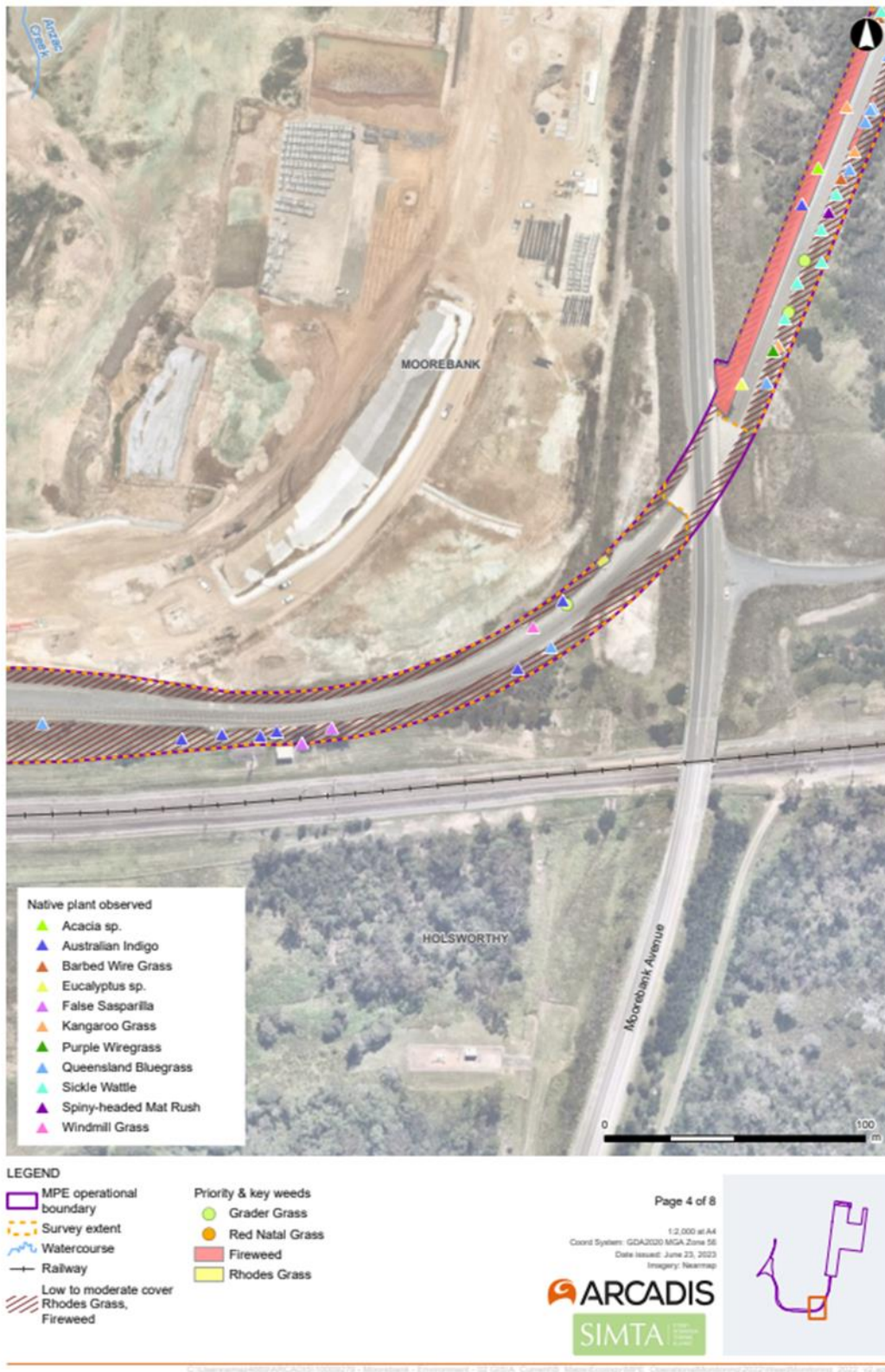


Figure 4. Native species, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 3 of 8)



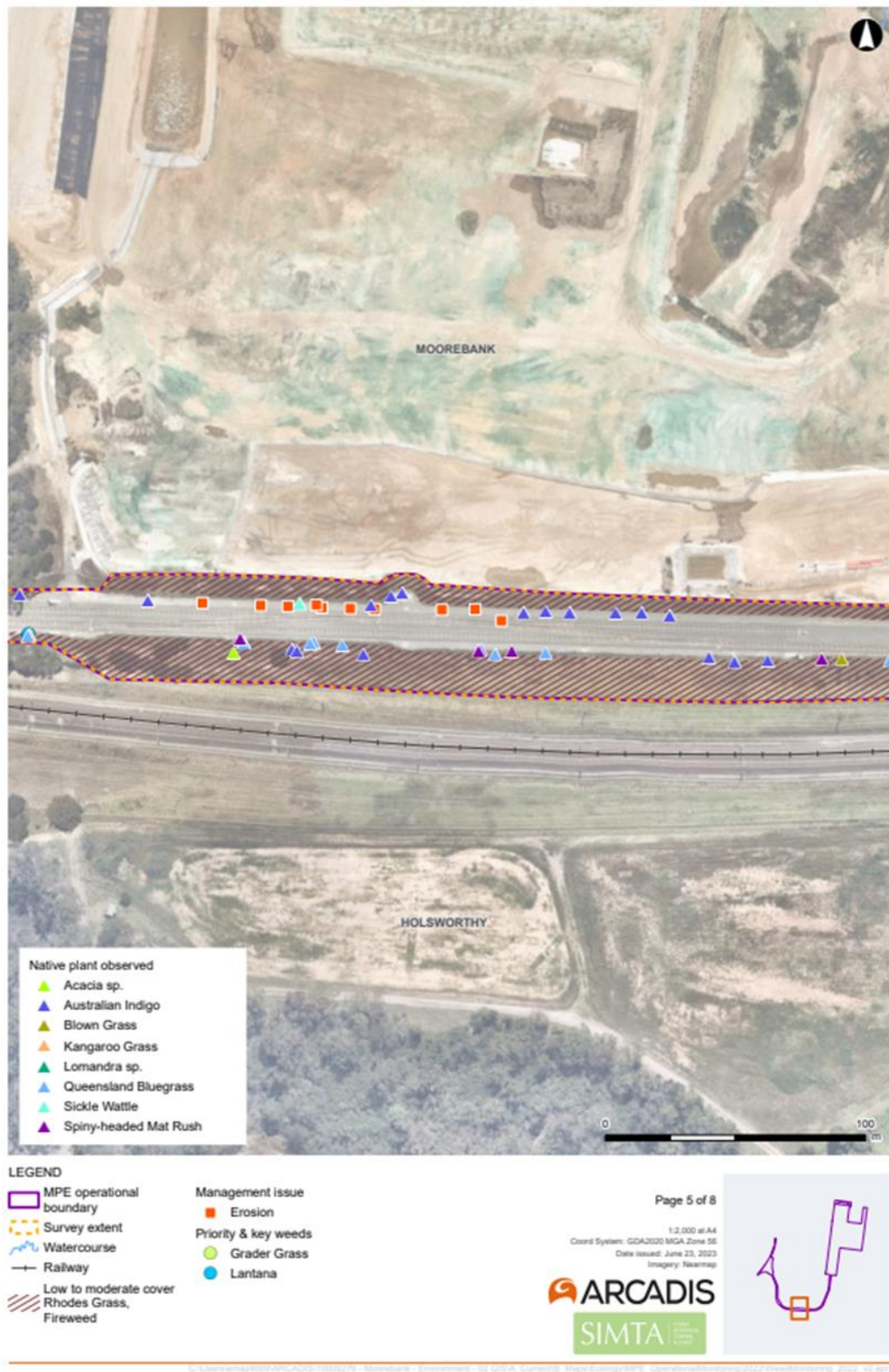


Figure 6. Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 8)

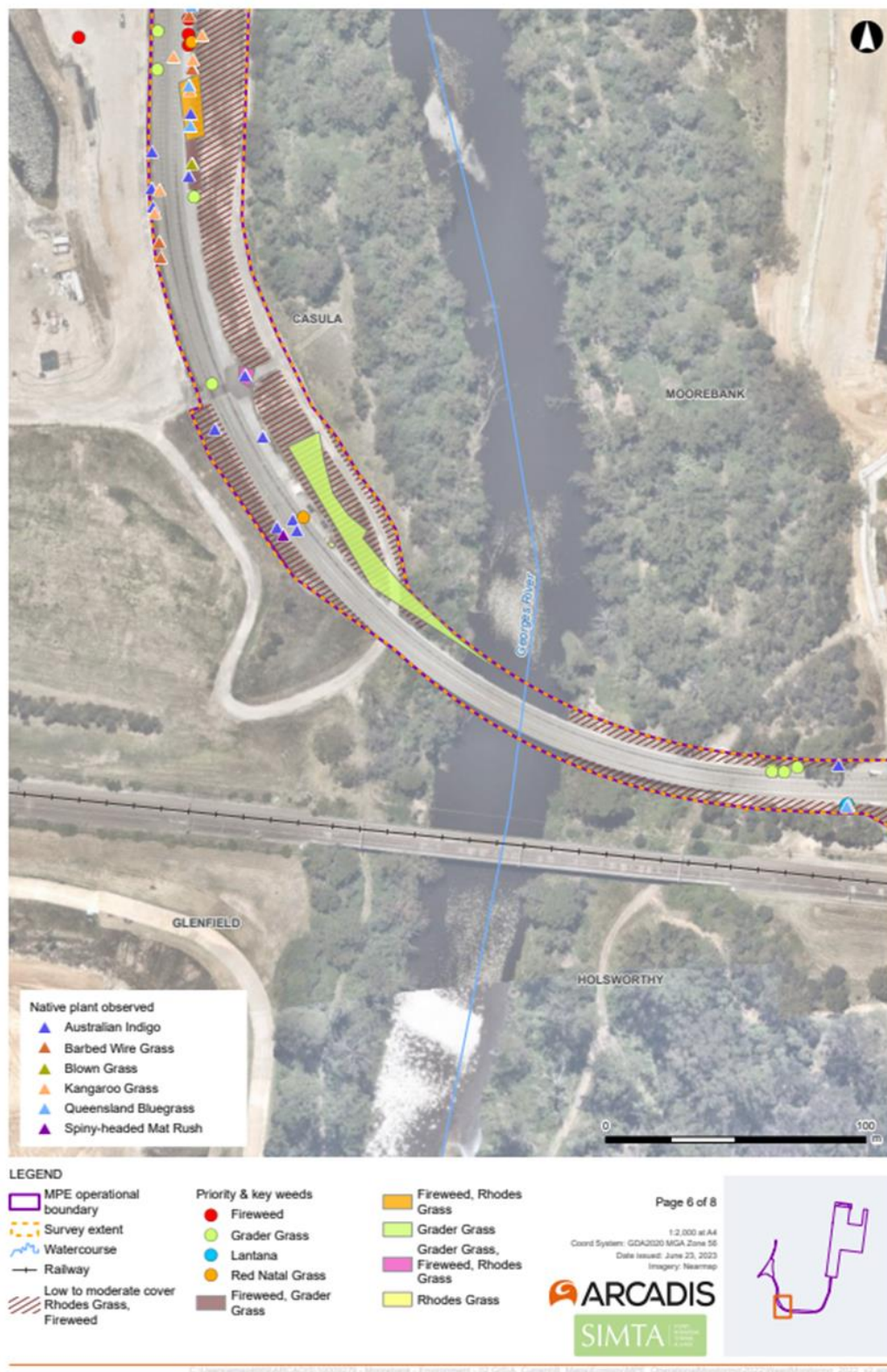


Figure 7. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 6 of 8)

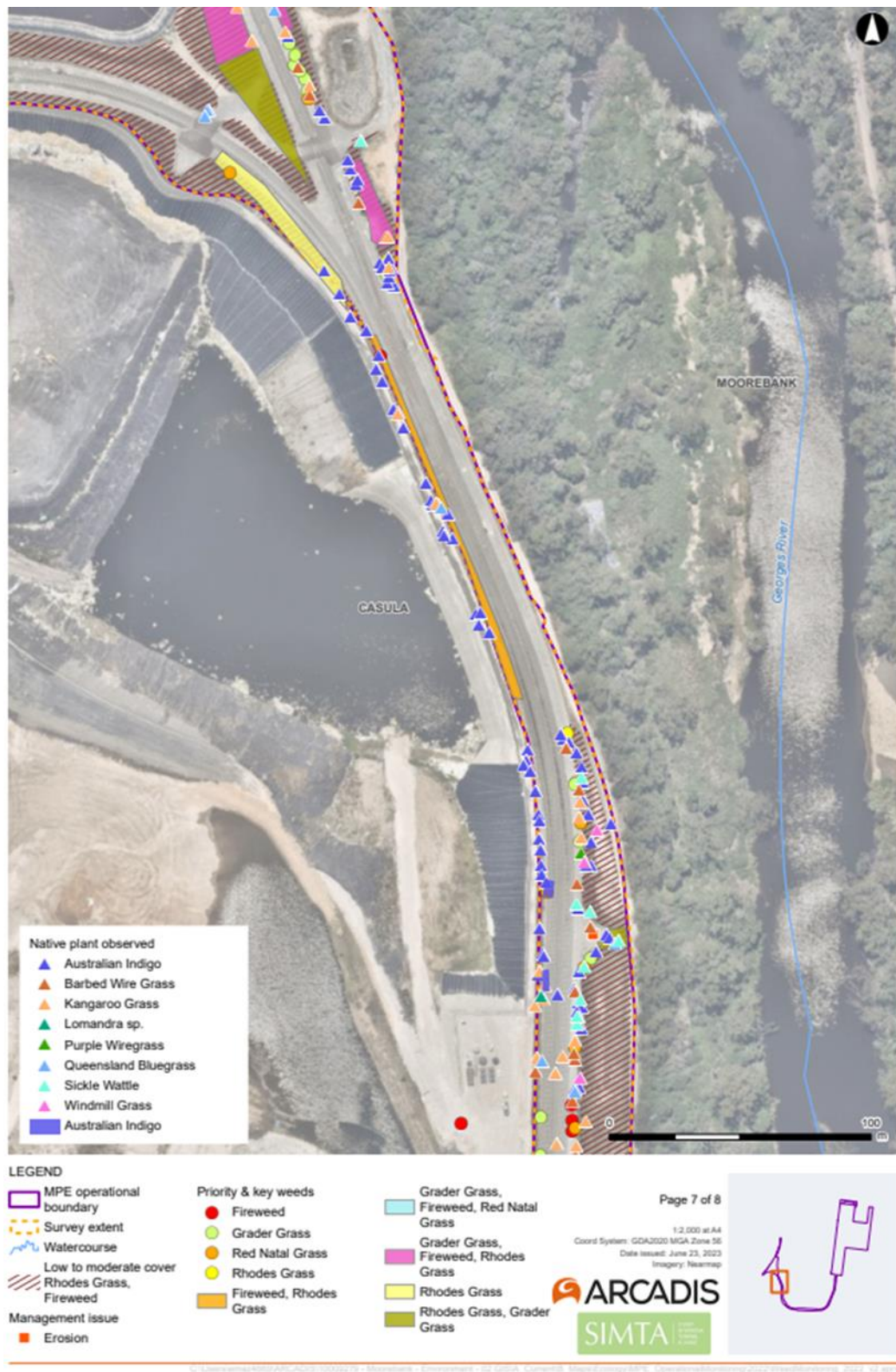


Figure 8. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 7 of 8)

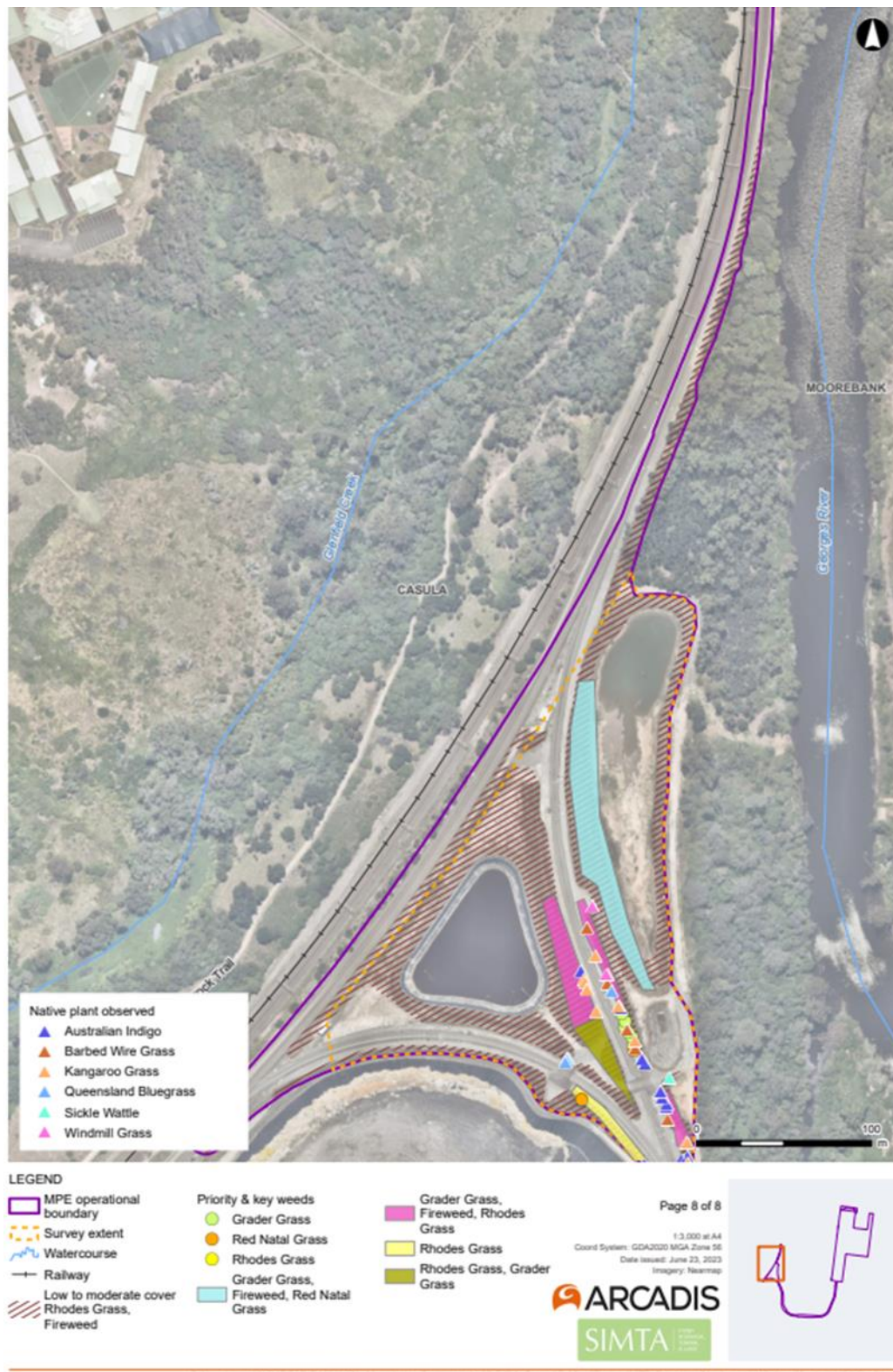


Figure 9. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 8 of 8)

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 August 2022 survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

The majority of weed control and management action recommendations documented in the August 2022 weed monitoring report are still applicable to the 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 slashing and herbicide spraying should be adopted to target larger patches of weeds. However, extreme care must be taken when conducting any weed management along the rail corridor, as many native grasses have become established. A suggested process to target weeds along revegetated soft batters is presented in Figure 10. Hand weeding is only feasible on annual species such as Grader Grass and Fireweed.
- Priority and aggressive weed species outside revegetated Rail Link areas should be removed. Weeds that 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 regularly to prevent seeding events (Figure 4, Figure 8). This will reduce the colonisation of these grasses into revegetation areas. However, slashing should only occur when plants are not seeding to prevent further spread. Furthermore, as more native species become established in these areas, slashing may impact their growth; therefore, non-targeted slashing should be avoided.
- Exotic understory vegetation in the two locations outside 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 on 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 on native species that have been observed to increase across the site. A suggested process to target weeds within these areas is presented in Figure 11.
- Continue to collect litter from within the Rail Link and in adjacent areas.
- Soft batters within the trunk drainage system and retention basin/swale at the northeastern extent of the facility should be inspected for weed growth. Weed levels should be controlled through 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 to prevent overspray (off-target poisoning). If herbicide application occurs, recommended herbicides for tussock grass, such as Rhodes grass and African Lovegrass, include glyphosate or flupropanate while plants are actively growing during summer and spring. Native vegetation outside the Rail Link fence must not be impacted by herbicide during weed control works.

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

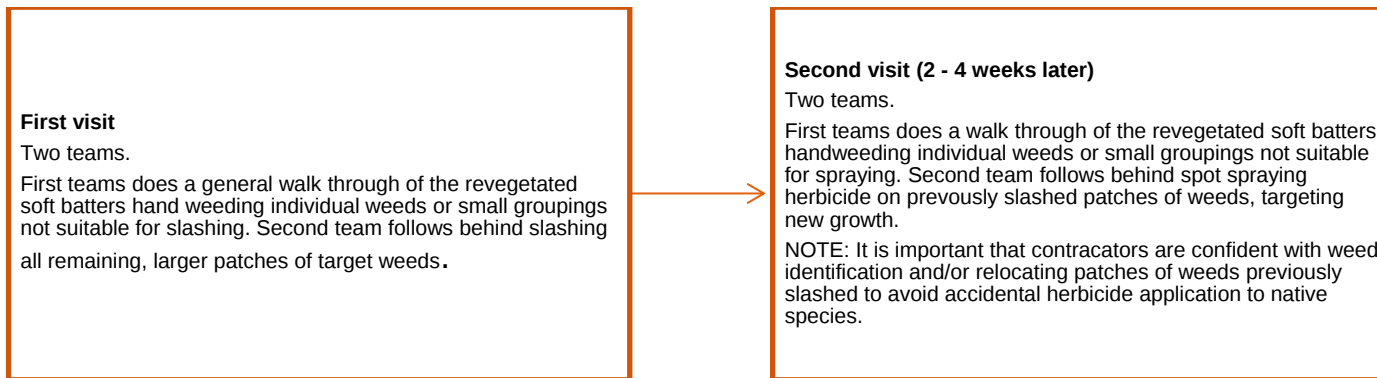


Figure 10. Suggested process to controlling target weeds on revegetated soft batters

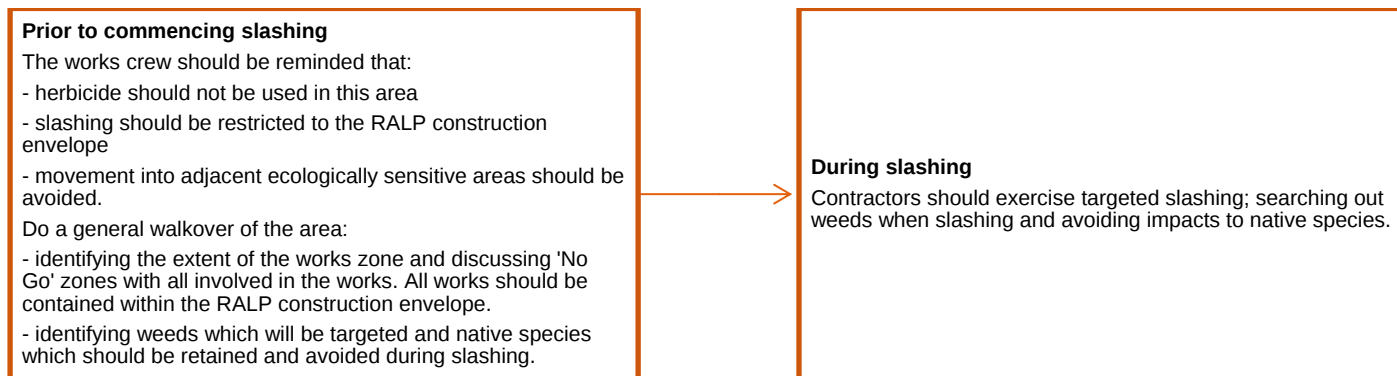


Figure 11. Slashing target weeds within the RALP construction envelope adjacent to ecologically sensitive areas

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 prioritised 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 the 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). 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.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic), should be removed from grassland on 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 the Rail Link corridor fencing. A qualified bush regeneration contractor should be used to avoid impacts on 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 remains in the 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 the spread of these species into ecologically 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.
August 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 weed species should be prioritised for weed control works in coming months to avoid mass seeding events.
	Begin remediation of soft batters which have slipped following extreme rainfall events in recent weeks	Not started	Areas within the operational facility, including a number of areas within the Rail Link, require urgent batter remediation in areas of batter slipping.

APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



December 2021



October 2022



April 2021



December 2021



October 2022



April 2021



December 2021



October 2022



April 2021



December 2021



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Subject MPE operational facility – Weed monitoring report December 2022

Introduction

Arcadis has 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 following:

- 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 has been monitoring the MPE operational facility for weed occurrence since April 2020. High levels of weed cover within the Rail Link have been observed across most of the monitoring period, except for during weed monitoring events immediately following remediation works undertaken in Spring 2020. Routine weed remediation works have commenced as of December 2022 along the rail link corridor with future remediation works planned.

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 on either side of the Rail Link have had varying levels of exotic cover. A number of weed remediation events have occurred since the inception of weed monitoring, detailed below:

- 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.
- In December 2021, a meeting was held 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 for the Rail Link will align with the decided-upon management actions. The monitoring methodology for the Rail Link has been included below.
- In December 2022, weed remediation works were initiated throughout the Rail Link, with plans to continue these and other ongoing works into 2023. Aims of these works were to target key and

priority weeds within the rail corridor for removal, and bring down the biomass of exotic species to promote the continued growth of native seedlings within the area.

Methodology

Arcadis ecologists Thea Kane and Kate Mauger attended the MPE operational facility on Wednesday, 7 December 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 2.

The weather on the survey day was sunny, with a maximum temperature of 27.3 °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 remediation 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 remediation works were recorded on an Arc-GIS enabled iPad.

Rail Link

Following the meeting held in December 2021 regarding revegetating 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 the recruitment of native seedlings or impacts on adjacent ecologically 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 remediation 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 Wednesday, 7 December 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.

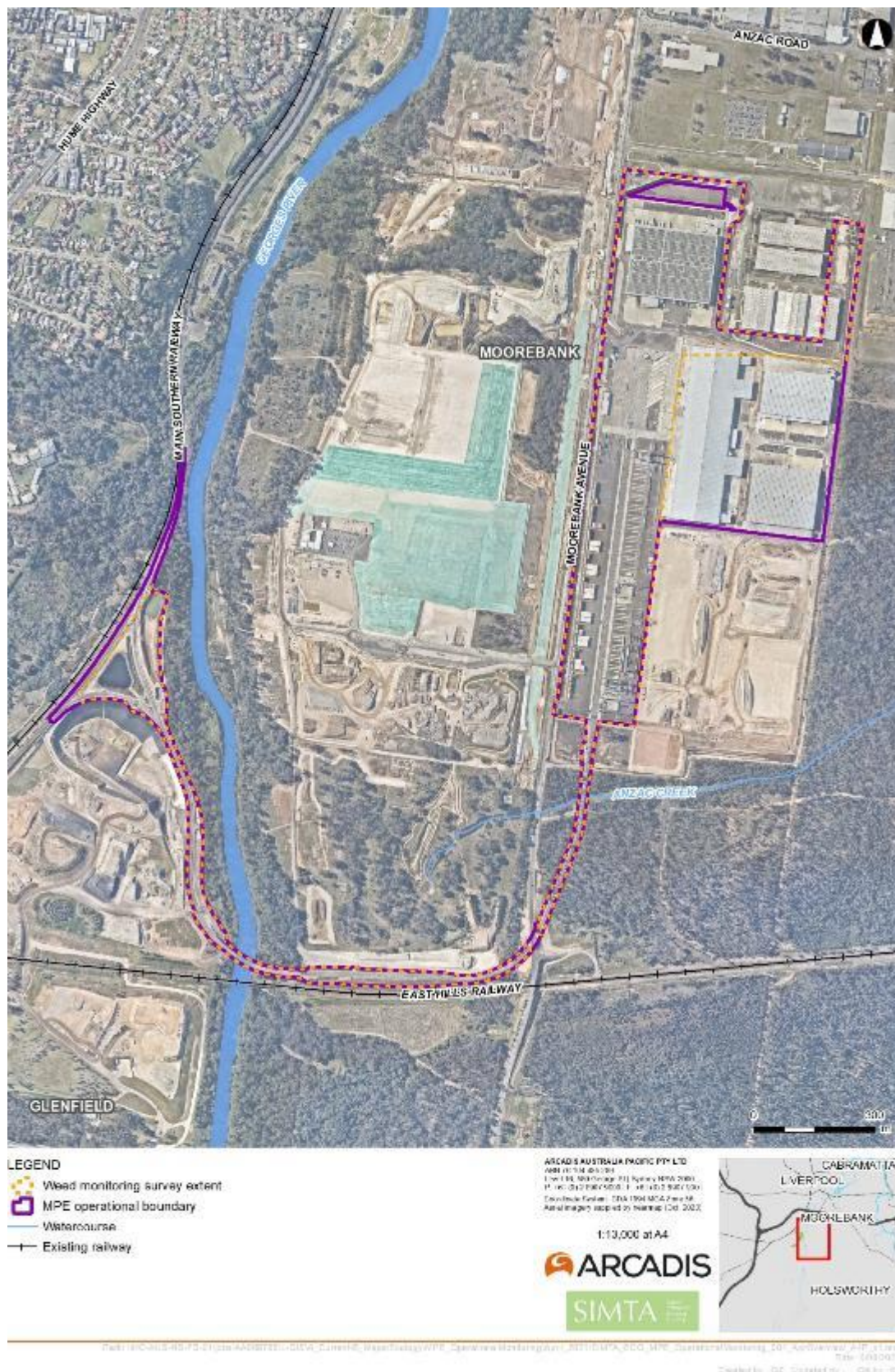


Figure 1. Survey extent within the MPE operational facility

Results

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

IMEX, warehouses and drainage infrastructure

Weed cover has slightly increased within the MPE operational facility to what was recorded during the October 2022 surveys. While weed cover remains low, the current survey identified new instances of priority weed *Senecio madagascariensis* (Fireweed) (Plate 1). No signs of weed remediation works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales.

Due to high rainfall across the Sydney region in June and July 2022, instances of erosion and damage to native species *Acacia falcata* (Hickory Wattle) were observed (Plate 2). These issues were again observed during the December survey. Several native species are present and continue to grow on soft batters and in the drainage swale, including Hickory Wattle, *Typha orientalis* (Bulrush), *Persicaria decipiens* (Slender Knotweed), *Ficinia nodosa* (Knotted Club-rush) and *Lomandra longifolia* (Mat Rush).



Plate 1. New observations of Fireweed and Catsear in drainage basins



Plate 2. Observation of native plant damage and erosion in drainage basins.

The soft batters of the trunk drainage system along Moorebank Avenue have a low cover of exotic grasses, which are currently acting to stabilise the soil, with some native species, such as Hickory

Wattle, persisting. Instances of Fireweed observed in the October 2022 survey persist in the current survey and appear to have increased biomass during the December 2022 survey (Plate 3).



Plate 3 Fireweed, Flee Bane and Rhodes grass growing on soft batters of the northeast trunk drainage system.

No plant growth was observed in the trunk drainage systems at the northernmost point of MPE (Plate 4). The absence of soil or other growing substrate will likely mean a continued lack of vegetation in this area.

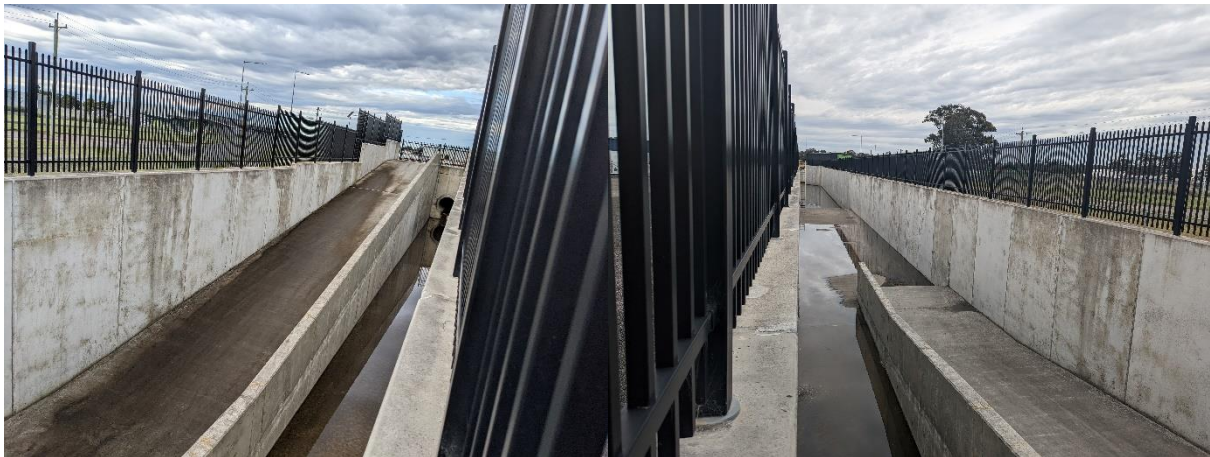


Plate 4 Northern drainage area of MPE with lack of any plant growth

Rail Access Land Package (RALP)

Weed remediation works have commenced along RALP as of the December 2022 survey. The weed remediation works were overseen by Arcadis personnel and restricted to the gravel and ballast areas within RALP. Weed control works on the soft batters have occurred during December 2022 and is planned to continue in January 2023.

Remediation works occurred over three days starting on 5/12/2022 and finishing on 7/12/2022. Remediation works were isolated to the RALP within MPE on gravelled and ballast areas. All plants located growing on the gravel and ballast areas along the RALP were slashed and had herbicide applied as presence of plants in these areas is considered a safety hazard to operating trains and were predominantly weed species. Further, trees obscuring the vision of train operators were trimmed back or removed to prevent vision impediment of train operators. Tree trimming and removal occurred in gravel areas, ballast areas and circumstances where tree branches encroached from the biobank sites and were considered to obscure the vision of train operators.

Table 3 Climatic conditions experienced on site during weed remediation works.

Date	Average temperature	Average relative humidity	Average wind speed	Wind direction	Key and priority species targeted	Actions taken
5/12/2022	31.6	34.7	18.2	Southeast	All plants within ballast and gravel area	Slashing and tree removal and branch trimming
6/12/2022	20.4	62.3	17.5	Southeast	All plants within ballast and gravel area	Slashing
7/12/2022	27.3	29.7	21.3	Northeast	All plants within ballast and gravel area	Herbicide (Roundup 200mL/1L water) application via garden sprayer at



Plate 5 P&E Group personnel applying herbicide (Roundup) on gravel area following trimming

One large Golden Wreath wattle, considered a weed species, was from the soft batter due to its presence obstructing the view of traffic signals (Plate 9). Other instances of larger woody vegetation were removed from the gravel and ballast areas as they were encroaching on the rail line. Instances of excessive vegetation overhang from adjacent BioBank areas were trimmed back to the fenceline by P&E Services under the supervision of Arcadis Ecologists Thea Kane and Kate Mauger (Plate 10). Future works to include weed remediation works along soft batters of RALP are planned throughout 2023.



Plate 6 Instance of Golden Wreath Wattle removal due to location of tree impeding vision of traffic signal



Plate 7 Instance of tree branch removal encroaching from biobank site.

Most areas of soft batter on either side of the rail link displayed increases in exotic biomass since the previous inspection during the October 2022 survey. An increase in priority and key weed species, including Fireweed, *Chloris gayana* (Rhodes Grass) and *Themeda quadrivalvis* (Grader Grass), was observed along the entire Rail Link (Plate 5). 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. As the weather continues to warm during spring and summer, there are expected to be an increase in emergent weed species and seeding of established weed species.



Plate 8. Exotic species continue colonising remediated soft batters within the Rail Link corridor

The new instances of native grasses observed in the October 2022 survey mostly remain intact, with some of the native grasses showing increased biomass and flowering. However, *Cymbopogon refractus* (Barbed Wire Grass) biomass appears to have been stunted potentially due to increased competition from increased weed biomass. New instances of *Lachnagrostis filiformis* (Blown Grass) were observed during the current survey growing in isolated strips throughout the corridor.

Some hardier native seedlings *Indigofera australis* (Australia Indigo) and *Acacia falcata* (Hickory Wattle), were observed to be growing unimpeded by increasing weed cover.

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 *Lantana camara* (Lantana), *Olea europaea* subsp. *cuspidata* (African Olive), Fireweed, Rhodes Grass and Grader Grass.

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

Table 4. Weed remediation works tracking

Priority	Action	Action description	December '22 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through manual removal and herbicide treatment. Herbicide application should consider timing (i.e., applying herbicide when weeds are actively growing) and best practice methodologies. Areas outlined by coloured polygons in Figure 3 - Figure 10 should be prioritised.	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 3 - Figure 10). These should be removed as a priority.
2	Removal of key and aggressive weed species	Key weed species, including African Lovegrass, Rhodes Grass, Paterson's Curse, Coolatai Grass and Grader Grass, should be removed from revegetated areas of soft batter. Aggressive weed species, including Moth Vine and Castor Oil Plant, should be removed from all operational areas using a combination of manual and herbicide control. Areas outlined by coloured polygons in Figure 3 :Figure 10 should be prioritised.	Key weed species, including Rhodes Grass, African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass, are increasingly colonising soft batters in the Rail Link. These weeds should be removed. Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link but are likely outside the operational boundary Figure 3 - Figure 10). Despite this, these weeds should be removed to avoid encroachment into revegetated areas.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and ecologically sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations. Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Weed growth is increasing on soft batters adjacent to the biobank site and ecologically sensitive areas. In some instances, exotic species are encroaching into these ecologically sensitive areas. Manual removal, including routine slashing, has not recently been adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent high-value areas (biobank site and ecologically sensitive areas containing threatened plant species). All works should be restricted to the operational area and not extend into the biobank site or identified ecologically sensitive areas. Slashing should only be conducted when weed species are not in flower to prevent further spread.

Priority	Action	Action description	December '22 performance assessment
			Appropriate slashing time is during winter for most species.
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. Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Slashing has been adopted to manage the regrowth of invasive grasses (African Lovegrass, Grader Grass) within the Rail Link in ballast and gravel areas. Slashing should be used to manage large expanses of exotic grassland to prevent seeding events. However, as native grasses become established, extreme care must be taken, and indiscriminate slashing must be avoided. A contractor with knowledge of native species should be employed to carry out this task, in failing that, an ecologist should be on site to monitor weed remediation.
5	Reduce cover of weeds within the Rail Link	Reduction of weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019). Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Works should involve targeted slashing of mature plants and removing flowering and seed heads to minimise seeding. Targeted slashing has been previously employed to control weed colonisation on soft batters. However, it must be continued to limit the re-colonisation of weeds within the Rail Link. Weed remediation works have commenced as of December 2022 in gravel and ballast areas. 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.

Priority	Action	Action description	December '22 performance assessment
			No signs of weed remediation works were observed during the recent survey in these areas.

Litter

An increased amount of litter was observed within the rail corridor, IMEX, warehouses and drainage infrastructure and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility, likely to due recent high wind weather conditions. Litter was observed within native and exotic vegetation, blocking drainage infrastructure within the rail corridor and the Georges River (Plate 6).



Plate 9. Litter observed within the rail corridor and IMEX, warehouses and drainage infrastructure during the December inspection

Erosion

High rainfall events between April and July 2022 resulted in the slipping of remediated soft batters within the Rail Link corridor. The location of the areas where batter slipping was observed is presented in Figure 7. These locations were observed to be in a similar state during the current survey. It is recommended that native deep rooted grasses and shrubs be installed along these batter to increase batter stability. Exotic *Plantago lanceolata* (Lamb's tongue) was observed recruiting in bare sold exposed by slippage. New instances of the exotic grass *Briza media* (Quaking-Grass) were observed growing around erosion sites. These species are shallow root annual species, and while supplying some soil stabilisation, should be progressively replaced with deeper rooted native species.



Plate 10 Batter slumping observed within the Rail Link

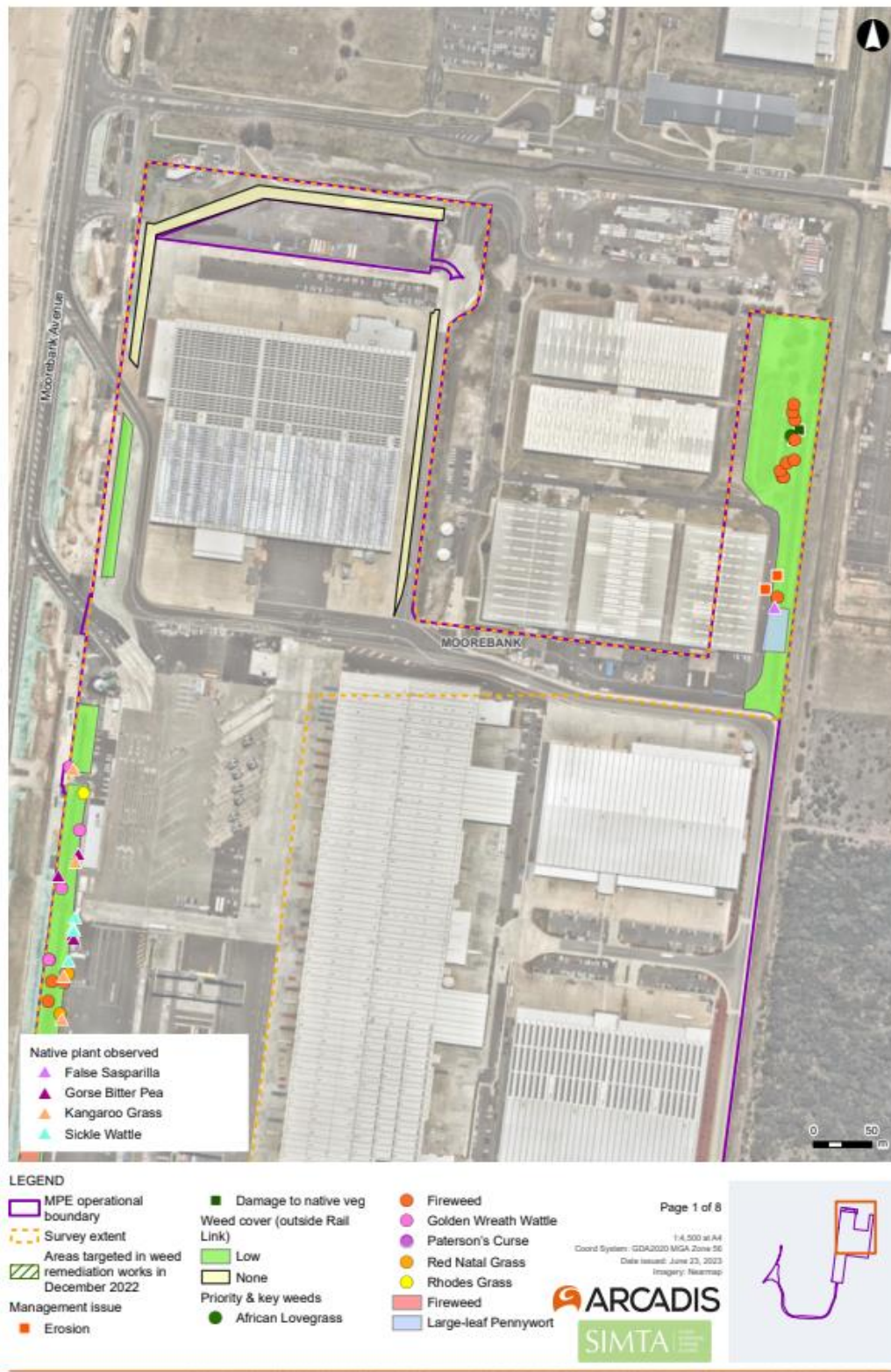


Figure 2 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 8)

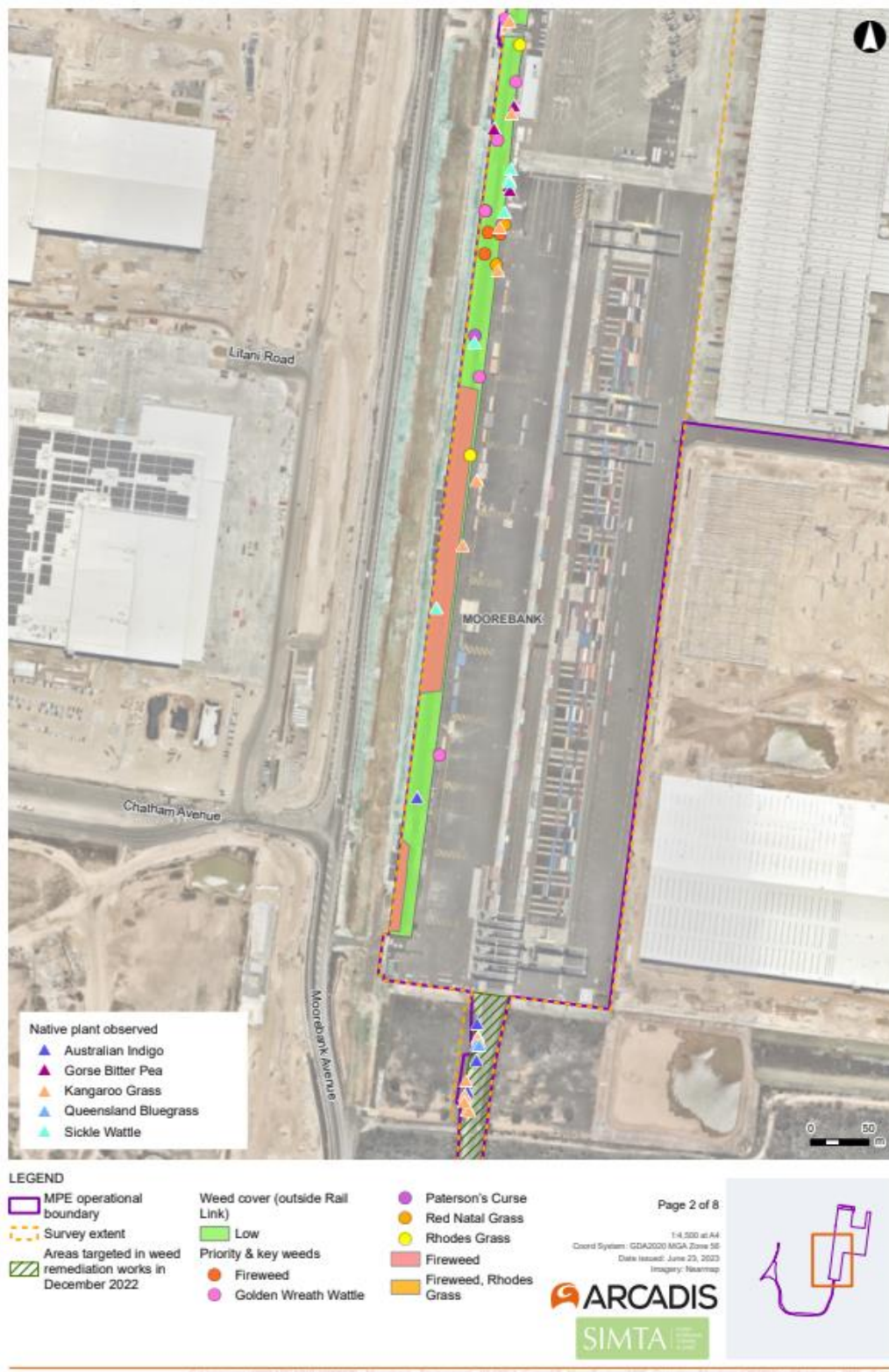


Figure 3. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 2 of 8)

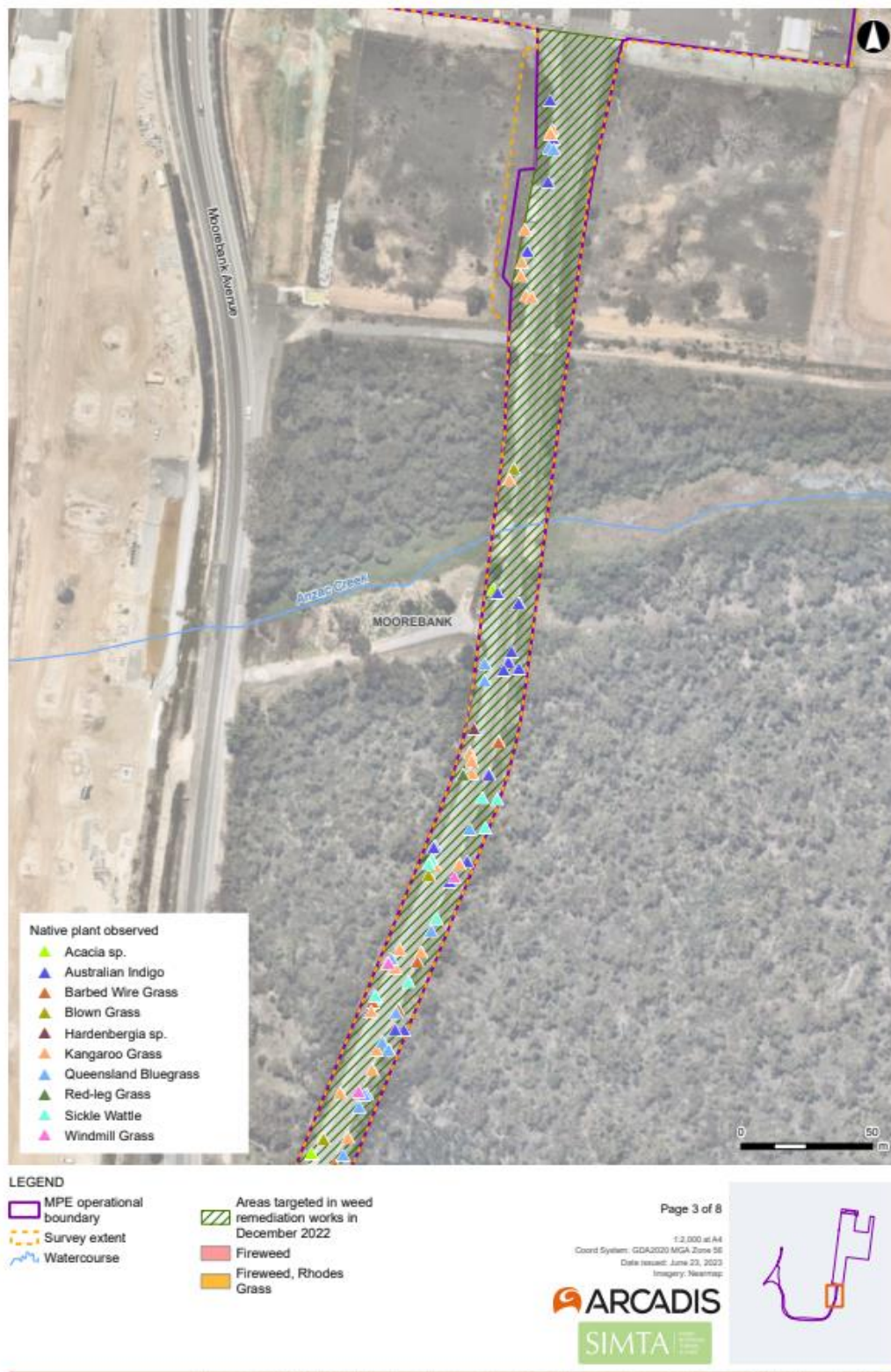


Figure 4. Native species, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 3 of 8)

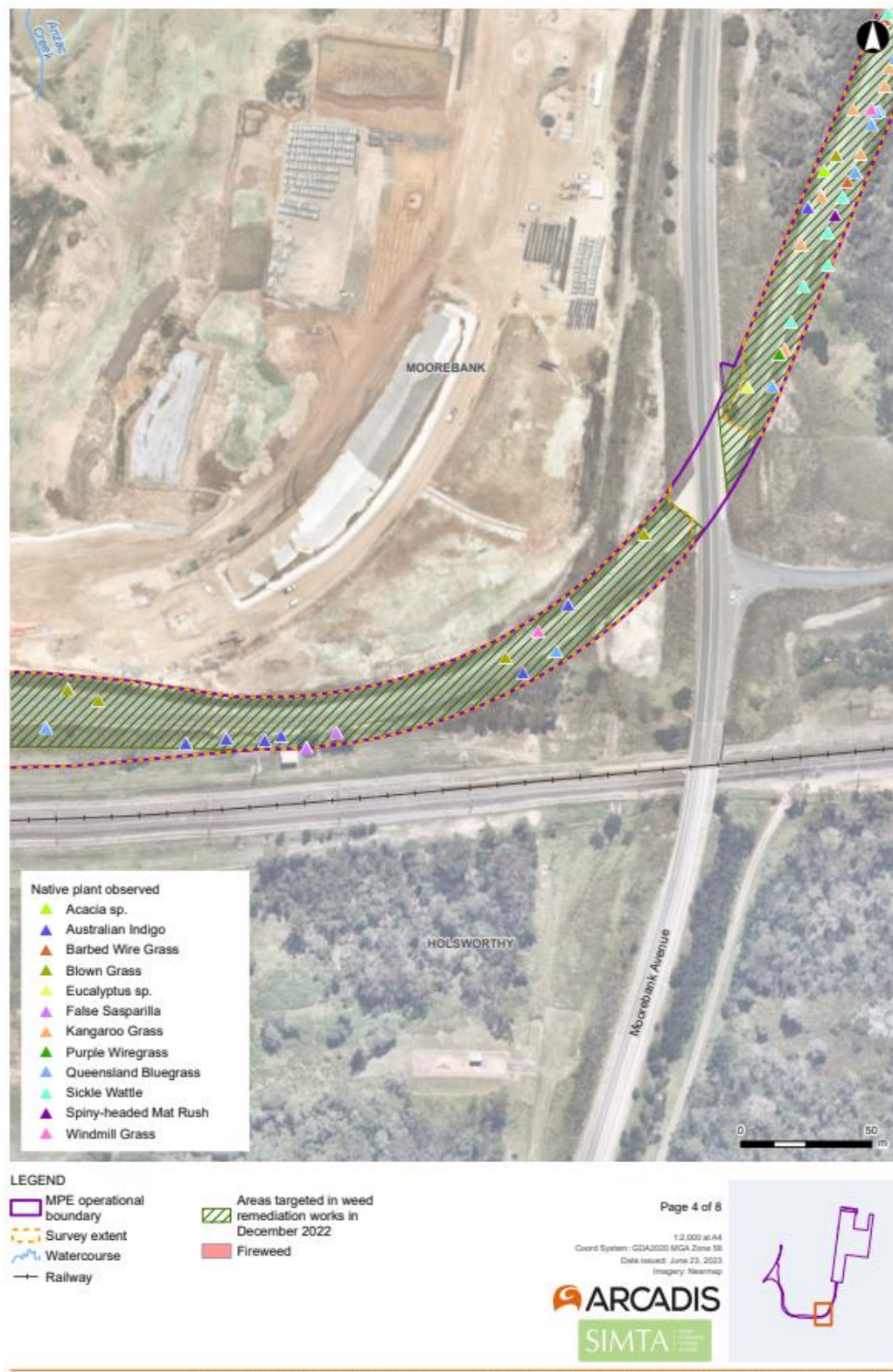


Figure 5 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 8)



Figure 6. Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 8)

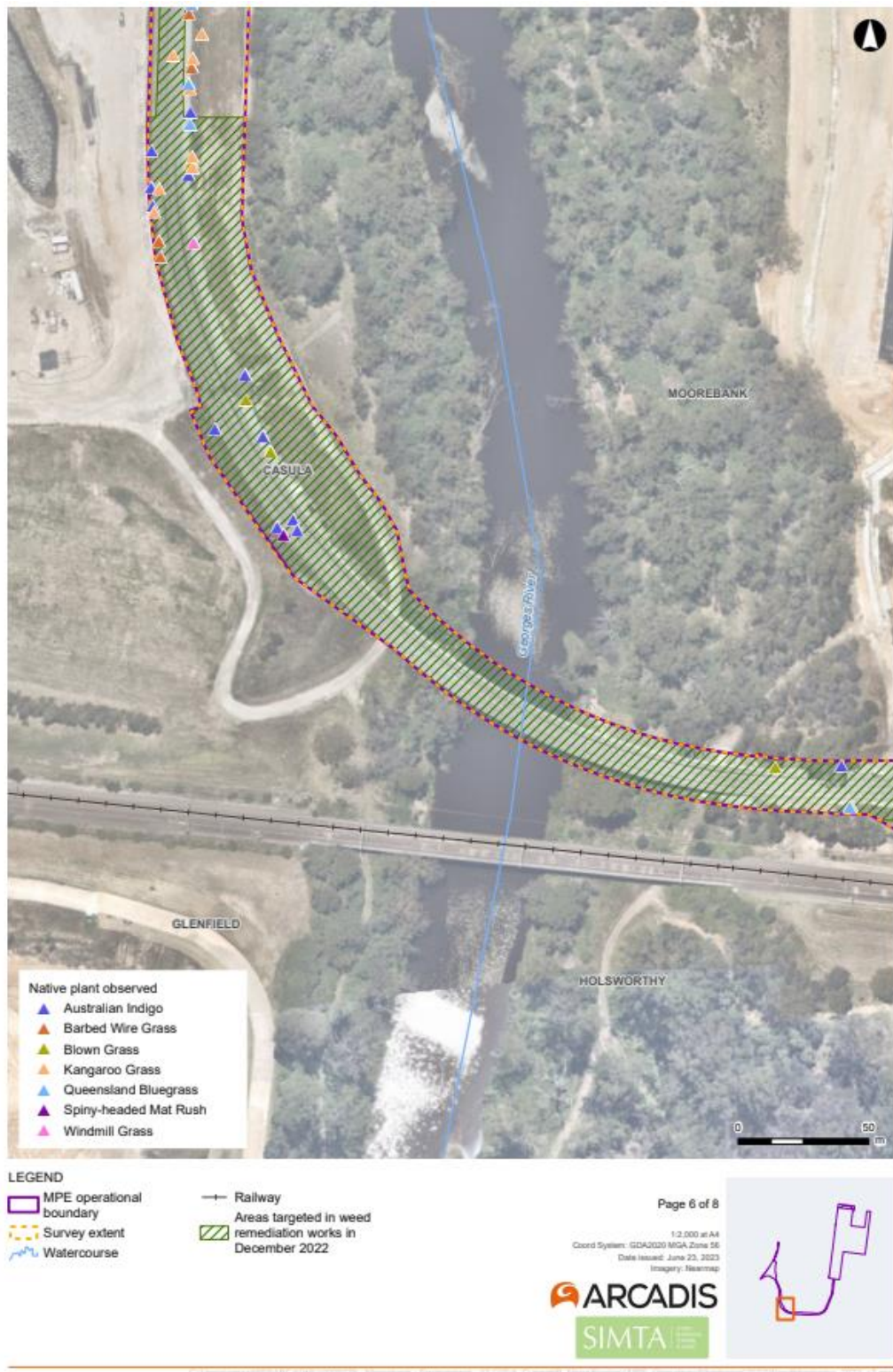


Figure 7. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 6 of 8)

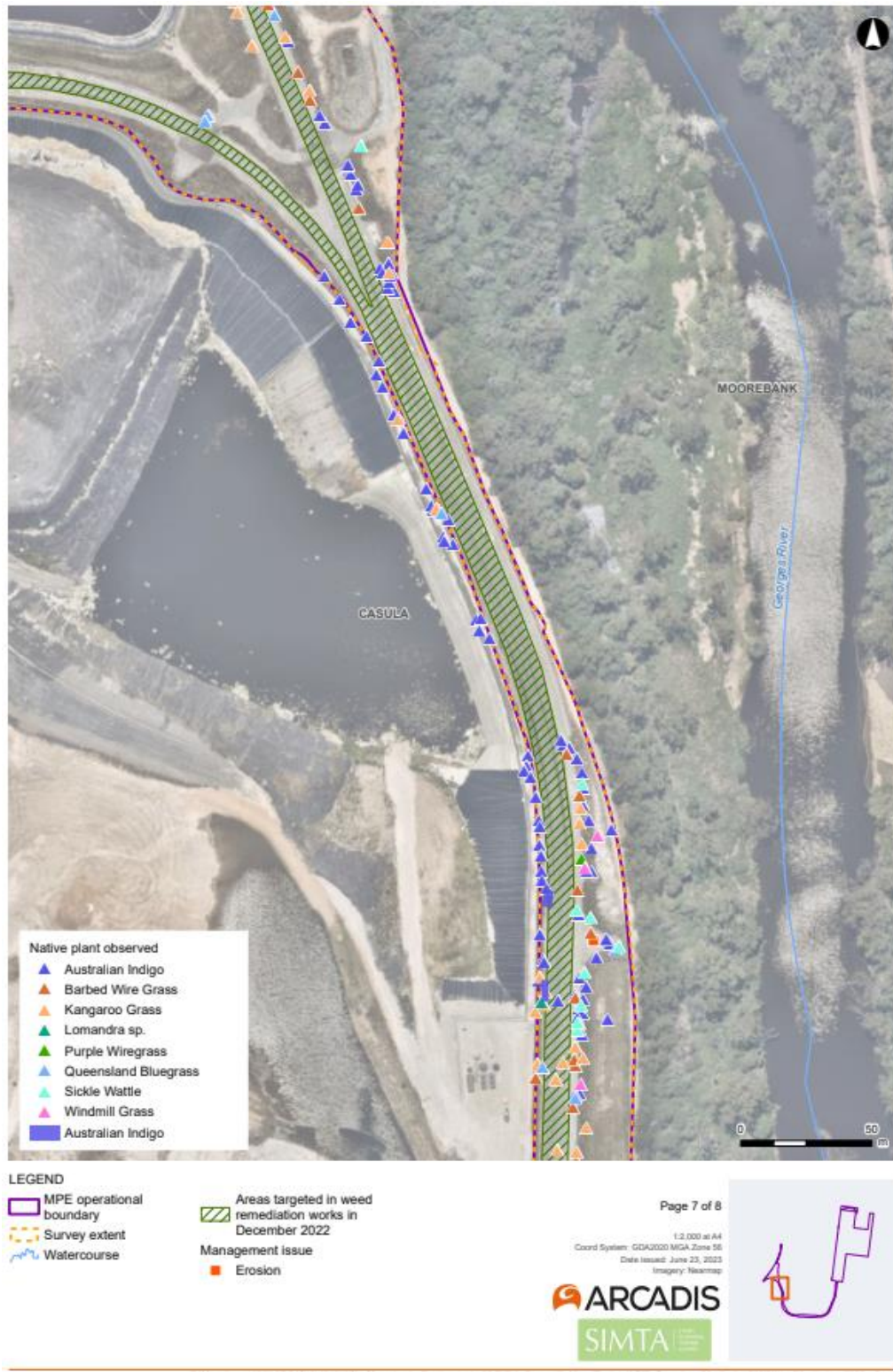


Figure 8. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 7 of 8)

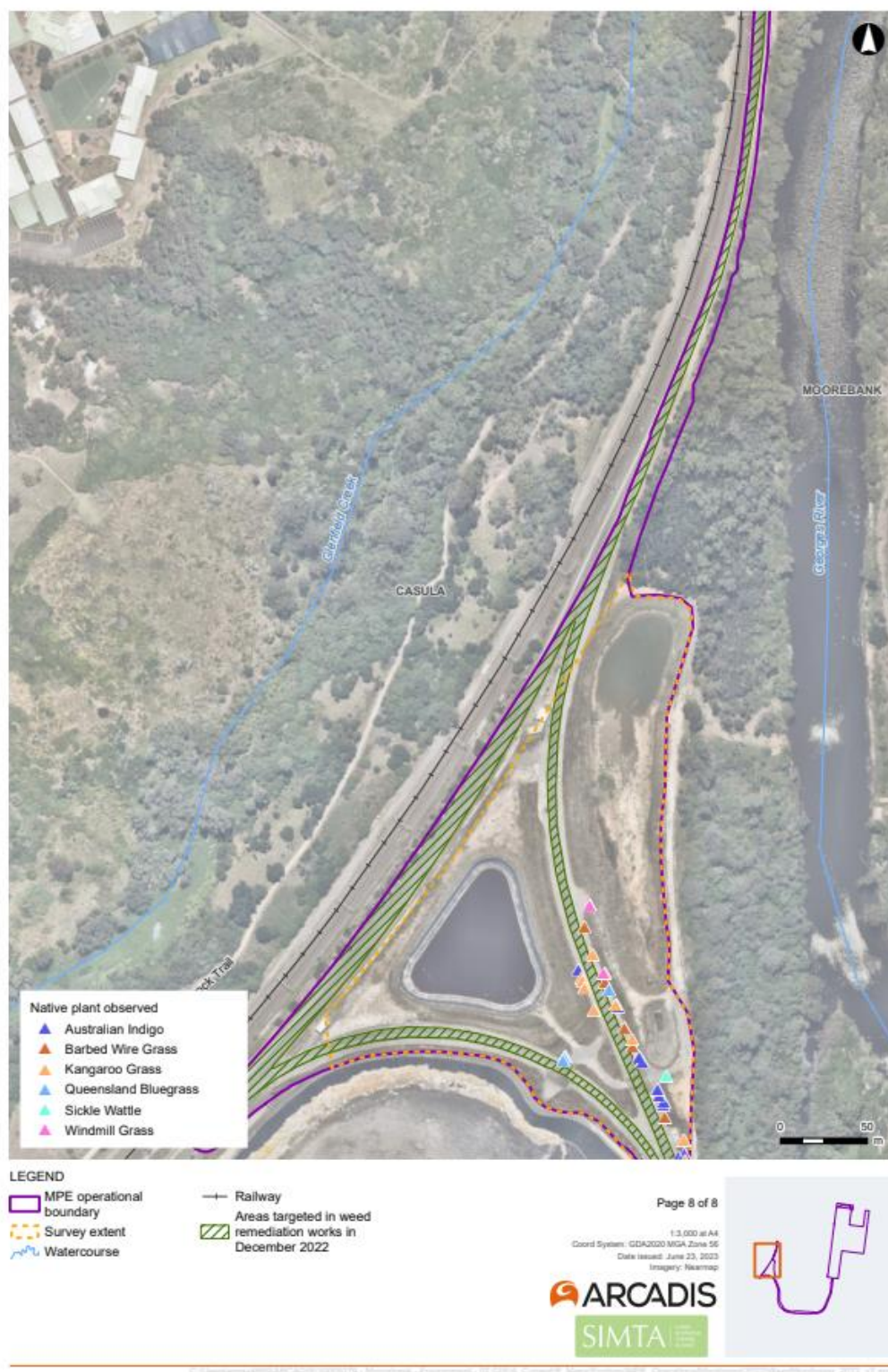


Figure 9. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 8 of 8)

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 2022 survey and the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

The majority of weed remediation and management action recommendations documented in the October 2022 weed monitoring report are still applicable to the management of the site. These include:

- Targeted weed remediation works along revegetated soft batters. Weed remediation works will focus on controlling priority and key weed species. Hand weeding should be conducted for individuals, whereas slashing and herbicide spraying should be adopted to target larger patches of weeds. However, extreme care must be taken when conducting any weed management along the rail corridor, as many native grasses have become established. A suggested process to target weeds along revegetated soft batters is presented in the methodology section of this report and Figure 11. Hand weeding is only feasible on annual species such as Grader Grass and Fireweed due to relatively small root system.
- Priority and aggressive weed species outside revegetated Rail Link areas should be removed. Weeds that 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 regularly to prevent seeding events (Figure 4, Figure 9). This will reduce the colonisation of these grasses into revegetation areas. However, slashing should only occur when plants are not seeding to prevent further spread. Furthermore, as more native species become established in these areas, slashing may impact their growth; therefore, non-targeted slashing should be avoided.
- Exotic understory vegetation in the two locations outside 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 on 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 on native species that have been observed to increase across the site. A suggested process to target weeds within these areas is presented in the methodology section of this report and Figure 12.
- Continue to collect litter from within the Rail Link and in adjacent areas.
- Soft batters within the trunk drainage system and retention basin/swale at the northeastern extent of the facility should be inspected for weed growth. Weed levels should be controlled through herbicide application, slashing and hand weeding. Weed remediation 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 to prevent overspray (off-target poisoning). If herbicide application occurs, recommended herbicides for tussock grass, such as Rhodes grass and African Lovegrass, include glyphosate or flupropanate while plants are actively growing during summer and spring. Native vegetation outside the Rail Link fence must not be impacted by herbicide during weed remediation works.

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

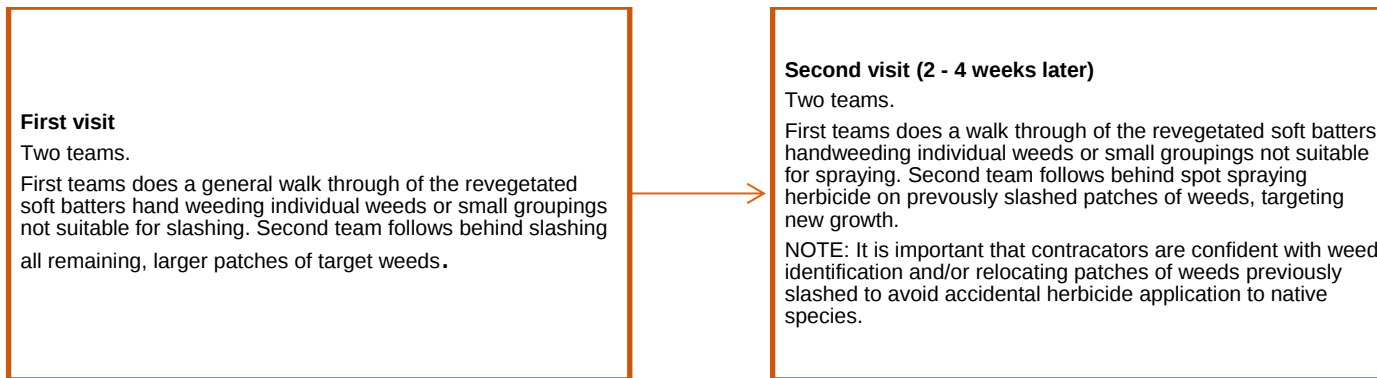


Figure 10. Suggested process to controlling target weeds on revegetated soft batters

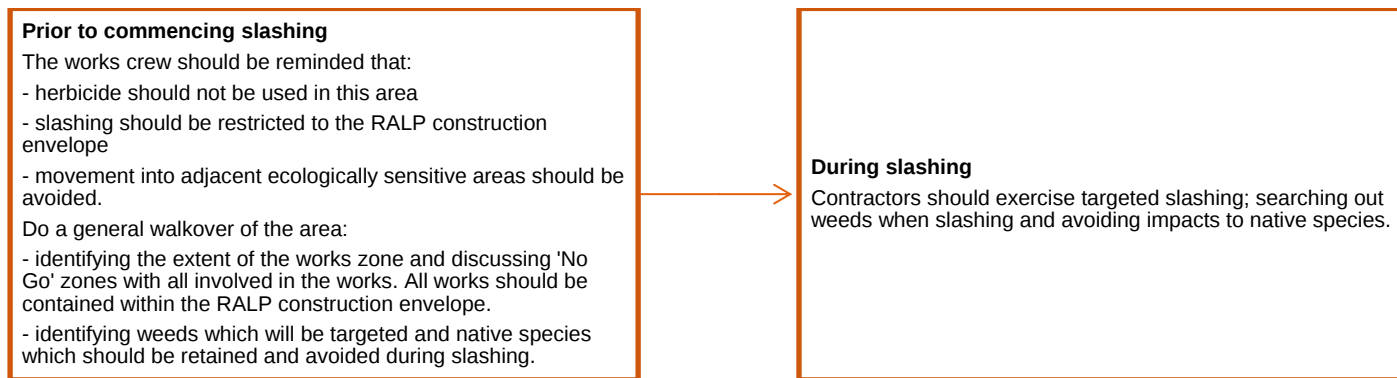


Figure 11. Slashing target weeds within the RALP construction envelope adjacent to ecologically sensitive areas

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 prioritised 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 the 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.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic), should be removed from grassland on 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 the Rail Link corridor fencing. A qualified bush regeneration contractor should be used to avoid impacts on 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 remains in the 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 the spread of these species into ecologically 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.
August 2022	Prioritise weed remediation 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 weed species should be prioritised for weed remediation works in coming months to avoid mass seeding events.
	Begin remediation of soft batters which have slipped following extreme rainfall events in recent weeks	Not started	Areas within the operational facility, including a number of areas within the Rail Link, require urgent batter remediation in areas of batter slipping.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
December 2022	Begin weed remediation of gravel and ballast areas along Rail link	Commenced	Removal of all vegetation in gravel and ballast areas due along Rail Link corridor using slashing and herbicide due to safety concerns of train operators and prevent spread of weeds.
December 2022	Continue weed remediation works along the soft batters within the Rail Link corridor.	Not started	Future weed remediation works should include targeted slashing and spraying of priority and key weed species, whilst avoiding native species by hand weeding within a one metre buffer zone of native individuals.

APPENDIX B. REMEDIATION PROGRESS PHOTOGRAPHS



April 2021



December 2021



December 2022



April 2021



December 2021



December 2022



April 2021



December 2021



December 2022



April 2021



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Subject MPE operational facility – Weed monitoring report February 2023

Introduction

Arcadis has 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 following:

- 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 has been monitoring the MPE operational facility for weed occurrence since April 2020. High levels of weed cover within the Rail Link have been observed across most of the monitoring period, except for during weed monitoring events immediately following remediation works undertaken in Spring 2020. Routine weed remediation works have commenced as of December 2022 along the rail link corridor, with future remediation works planned.

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 on either side of the Rail Link have had varying levels of exotic cover. A number of weed remediation events have occurred since the inception of weed monitoring, detailed below:

- 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.
- In December 2021, a meeting was held that 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 for the Rail Link will align with the decided-upon management actions. The monitoring methodology for the Rail Link has been included below.
- In December 2022, weed remediation works were initiated throughout the Rail Link, with plans to continue these and other ongoing works into 2023. The aims of these works were to target key and priority weeds within the rail corridor for removal and bring down the biomass of exotic species to

promote the continued growth of native seedlings within the area. Remediation works have continued into February 2023.

Methodology

Arcadis ecologist Kate Mauger attended the MPE operational facility on Friday, 24 February 2023. 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 2.

The weather on the survey day was sunny, with a maximum temperature of 25.8 °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 remediation 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 remediation works were recorded on an Arc-GIS enabled iPad.

Rail Link

Following the meeting held in December 2021 regarding revegetating 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 the recruitment of native seedlings or impacts on adjacent ecologically 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)

Priority weed species	Key weed species
<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 remediation 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 Friday, 24 February 2023.

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 February 2023 weed monitoring survey are summarised below.

IMEX, warehouses and drainage infrastructure

Weed cover has increased within the MPE operational facility to what was recorded during the December 2022 surveys. Noticeable biomass increases have occurred with increased planted trees and native and exotic grassy vegetation (Plate 1). While weed cover remains low, the current survey identified new instances of priority weed *Senecio madagascariensis* (Fireweed) (Plate 1). Fireweed appears to be going to seed which will result in further spread of the weed if remediation is not implemented. No signs of weed remediation works (chipping or herbicide spraying of weeds) were observed at the north-eastern extent of the facility surrounding drainage basins and swales.

Due to high rainfall across the Sydney region in June and July 2022, instances of erosion and damage to native species *Acacia falcata* (Hickory Wattle) were observed (Plate 2). Since these rain events the Hickory Wattle appears to have died due to erosion damage. Instances of previously observed erosion have not been addressed, and with continued rain events in late 2022 and early 2023, erosion has increased and will likely cause further plant and infrastructure damage.

Several native species are present and continue to grow on soft batters and in the drainage swale, including Hickory Wattle, *Chloris truncata* (Windmill Grass), *Typha orientalis* (Bulrush), *Persicaria decipiens* (Slender Knotweed), *Ficinia nodosa* (Knotted Club-rush) and *Lomandra longifolia* (Mat Rush).



Plate 1. New observations of Windmill Grass (left) and Fireweed (right) in drainage basins



Plate 2. Observation of native plant damage and erosion in drainage basins.

The soft batters of the trunk drainage system along Moorebank Avenue have a low cover of exotic grasses, which are currently stabilising the soil, with some native species, such as Hickory Wattle, persisting. Instances of Fireweed observed in the December 2022 survey persist in the current survey and appear to have increased biomass during the February 2023 survey (Plate 3). Large *Themeda quadrivalvis* (Grader Grass) tussocks have emerged and are in seed (Plate 3).



Plate 3 Fireweed, Grader Grass and Rhodes Grass growing on soft batters of the northeast trunk drainage system.

No plant growth was observed in the trunk drainage systems at the northernmost point of MPE (Plate 4). The absence of soil or other growing substrate will likely mean a continued lack of vegetation in this area.

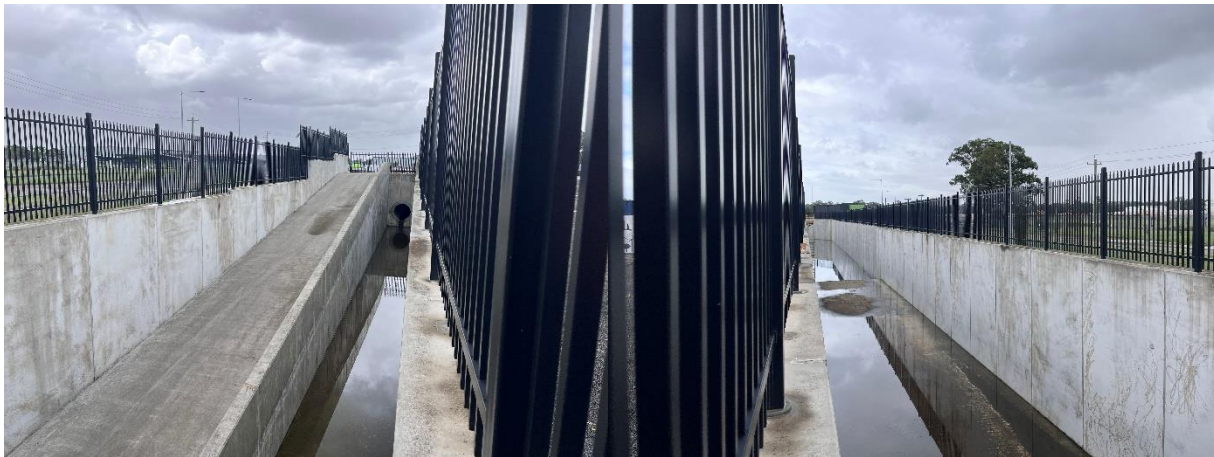


Plate 4 Northern drainage area of MPE with lack of any plant growth

Rail Access Land Package (RALP)

Weed remediation works have commenced along RALP as of the December 2022 survey. The weed remediation works were overseen by Arcadis personnel and restricted to the gravel and ballast areas within RALP. Weed control works on the soft batters occurred during February 2023 and are planned to continue in 2023 (Plate 6). Weed remediation of the soft batters is still needed in some areas on the northern side of the rail track beyond the Georges River bridge.

Remediation works undertaken between the December 2022 Weed Monitoring Report and the February 2023 Weed Monitoring Report occurred over six days, starting on 4/2/2023 and finishing on 23/2/2023. Remediation works were undertaken in all areas within the Rail Link.

Table 3 Climatic conditions experienced on-site during weed remediation works.

Date	Average temperature (°C)	Max wind speed (km/h)	Wind direction	Actions taken
4 February 2023	21.1	44	WNW	Slashing of all weeds and hand weeding around marker flags
5 February 2023	21.3	35	E	
6 February 2023	24.7	35	E	
7 February 2023	24.4	33	SE	
8 February 2023	22.8	37	SSE	
23 February 2023	19.1	41	NE	

The areas flagged off by ecologists to mark the location of native species have been avoided by the weed remediation team (Plate 5). The decreased competition for the native species due to the remediation works removing the weed biomass will allow the native species to produce more biomass, facilitate seed growth and open space for native recruitment. The increased native biomass will eventually act as effective competition, preventing weed recruitment, limiting dependence on herbicides and slashing. However, the continued human intervention must be maintained in order to reach a point where native species restrict weed recruitment.

Large areas with very low density of native species were slashed within the corridor and large trees have been removed (Plate 6).



Plate 5 Pink flagging tape marking the location of native species to be retained during the remediation works.



Plate 6 Evidence of continued weed removal (left) and tree removal (right) remediation works as of February 2023.

In areas without remediation works, there have been increases in exotic biomass since the previous inspection during the December 2022 survey. In these areas, an increase in priority and key weed species, including Fireweed, *Chloris gayana* (Rhodes Grass) and Grader Grass, was observed (Plate 7). Likely, recent climactic variables, including the combination of high rainfall and warm conditions, have created favourable conditions for herbaceous and grass weeds to thrive. As the temperatures begin to decrease into Autumn, there is expected to be a plateau in emergent weed species.



Plate 7. Exotic species continue to colonise remediated soft batters within the Rail Link corridor (right)

The new instances of native grasses observed in the December 2022 survey mostly remain intact, with some of the native grasses showing increased biomass and flowering. Some hardier native seedlings, *Indigofera australis* (Australia Indigo) and *Acacia falcata* (Hickory Wattle), were observed to be growing unimpeded by increasing weed cover.

The status of weeds and weed remediation works observed during the February 2023 monitoring survey has been compared against a series of recommended actions developed during the baseline monitoring survey (Table 3).

Table 4. Weed remediation works tracking

Priority	Action	Action description	February '23 performance assessment
1	Eradicate 'priority' weeds	Target 'priority' weed species through manual removal and herbicide treatment. Herbicide application should consider timing (i.e., applying herbicide when weeds are actively growing) and best practice methodologies. Areas outlined by coloured polygons in Figure 3 - Figure 10 should be prioritised.	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 3 - Figure 10). These should be removed as a priority. Progress has been made through remediation works within the Rail link corridor. Continued management must be undertaken to work towards eradication.
2	Removal of key and aggressive weed species	Key weed species, including African Lovegrass, Rhodes Grass, Paterson's Curse, Coolatai Grass and Grader Grass, should be removed from revegetated areas of soft batter. Aggressive weed species, including Moth Vine and Castor Oil Plant, should be removed from all operational areas using a combination of manual and herbicide control. Areas outlined by coloured polygons in Figure 3 :Figure 10 should be prioritised.	Key weed species, including Rhodes Grass, African Lovegrass, Coolatai Grass, Paterson's Curse and Grader Grass, are colonising soft batters in the Rail Link. These weeds should be removed. Scattered individuals of Golden Wreath Wattle, Moth Vine and Castor Oil Plant remain within the Rail Link but are likely outside the operational boundary Figure 3 - Figure 10). Despite this, these weeds should be removed to avoid encroachment into revegetated areas. Progress has been made through remediation works within the Rail link corridor. Continued management must be undertaken to work towards eradication.
3	Suppress further colonisation of environmental weeds and encroachment into areas of bushland	Control of exotic species adjacent to the biobank site and ecologically sensitive areas. Manual removal should be adopted in areas adjacent to threatened flora locations. Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Weed growth is increasing on soft batters adjacent to the biobank site and ecologically sensitive areas. In some instances, exotic species are encroaching into these ecologically sensitive areas. Manual removal, including routine slashing, has not recently been adopted to prevent present weeds from reaching seeding maturity and further encroaching on adjacent high-value areas (biobank site and ecologically sensitive areas containing threatened plant species). All works should be restricted to the operational area and not extend

Priority	Action	Action description	February '23 performance assessment
			into the biobank site or ecologically sensitive areas. Slashing should only be conducted when weed species are not in flower to prevent further spread. Appropriate slashing time is during winter for most species.
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. Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Slashing has been adopted to manage the regrowth of invasive grasses (African Lovegrass, Grader Grass) within the Rail Link in ballast and gravel areas. Some areas beyond the Georges River bridge are yet to be managed. Slashing should be used to manage large expanses of exotic grassland to prevent seeding events. However, as native grasses become established, extreme care must be taken, and indiscriminate slashing must be avoided. A contractor with knowledge of native species should be employed to carry out this task, in failing that, an ecologist should be on site to monitor weed remediation.
5	Reduce cover of weeds within the Rail Link	Reduction of weed cover by applying control methods commensurate with the Operational Flora and Fauna Management Plan (Arcadis 2019). Areas outlined by coloured polygons in Figure 3:Figure 10 should be prioritised.	Works should involve targeted slashing of mature plants and removing flowering and seed heads to minimise seeding. Targeted slashing has been previously employed to control weed colonisation on soft batters. However, it must be continued to limit the re-colonisation of weeds within the Rail Link. Weed remediation works have commenced as of December 2022 in gravel and ballast areas and have continued in February 2023. 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.

Priority	Action	Action description	February '23 performance assessment
6	Remove herbaceous and woody weeds 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 remediation works were observed during the recent survey in these areas.

Litter

A decreased amount of litter was observed within the rail corridor, IMEX, warehouses and drainage infrastructure and in adjacent areas at the western extent of the Qube Rail Link nearest Glenfield waste facility compared to the December 2022 survey. Litter was observed within native and exotic vegetation (Plate 6).



Plate 8. Litter observed within the rail corridor during the February inspection

Erosion

High rainfall events between April and July 2022 resulted in the slipping of remediated soft batters within the Rail Link corridor (Plate 9). The location of the areas where batter slipping was observed is presented in Figure 7. These locations were observed to be in a similar state during the current survey. It is recommended that native deep-rooted grasses and shrubs be installed along these batters to increase batter stability. Cracking of the ground platform along the Rail Link corridor has

been observed to be increasing in size, likely to due recent heavy rains and excessive weight from concrete barriers in the area (Plate 9).



Plate 9 Batter slumping observed within the Rail Link (left) and concrete platform cracking (right)

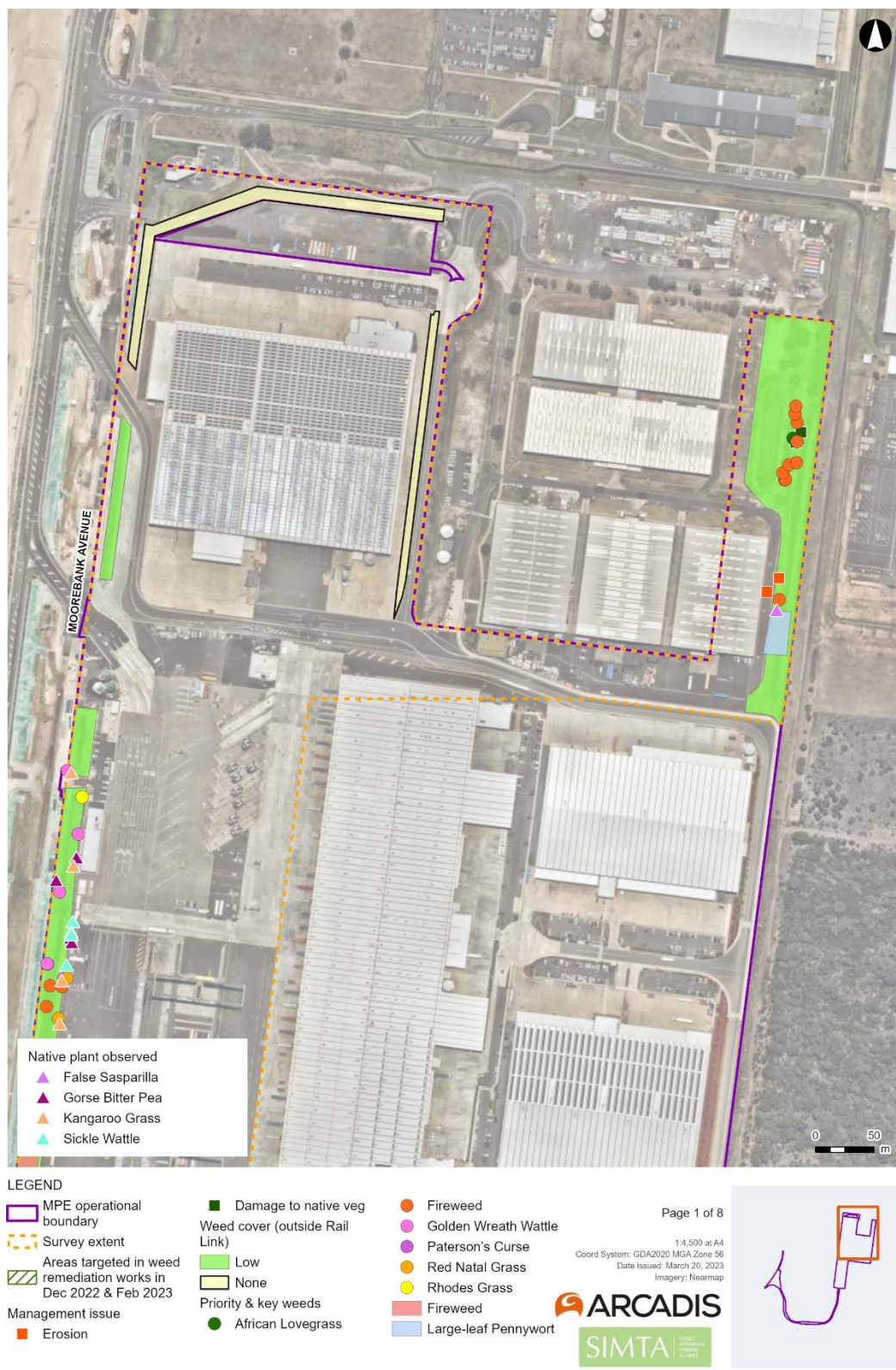


Figure 2 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 1 of 8)

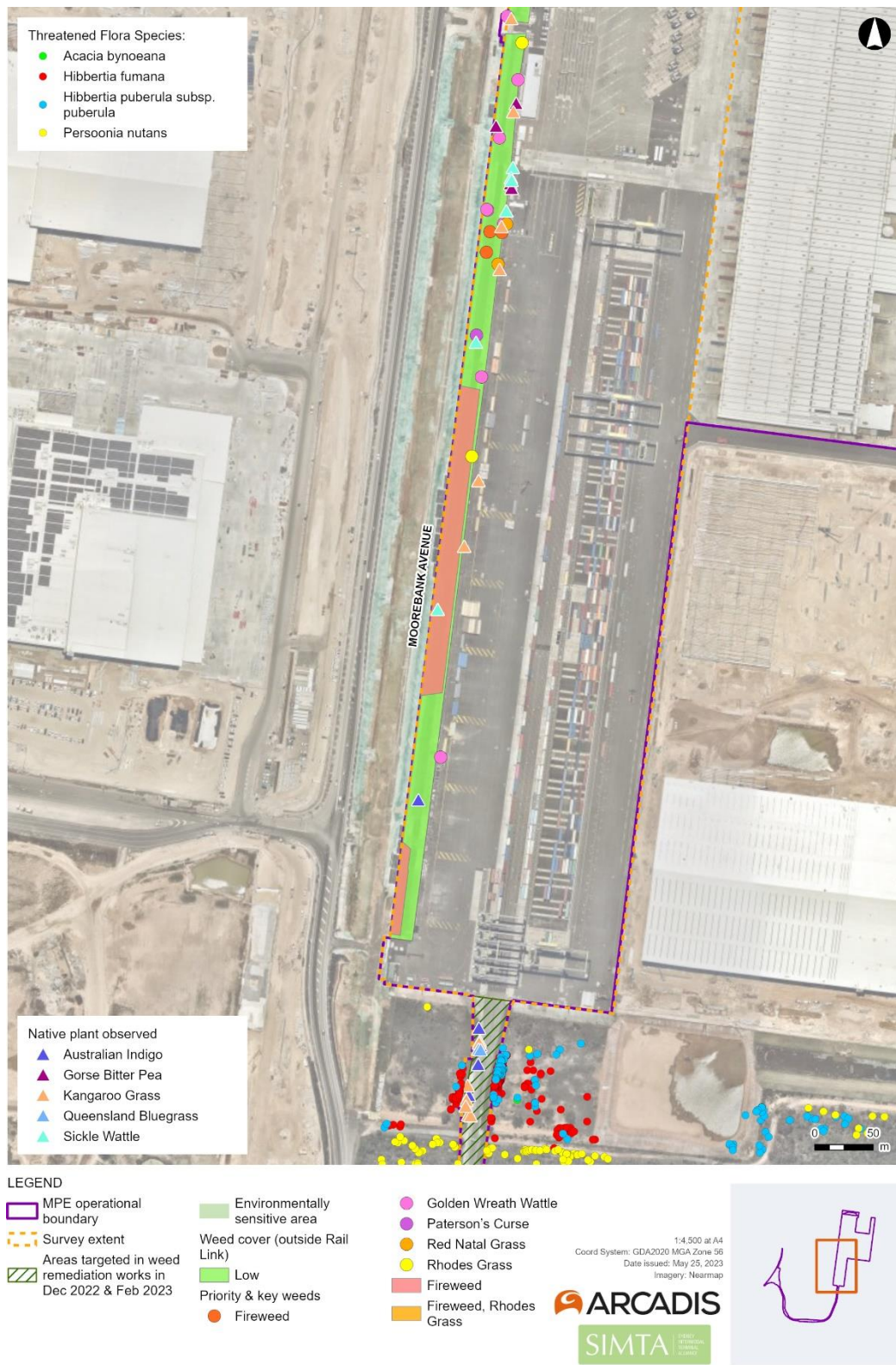


Figure 3. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 2 of 8)

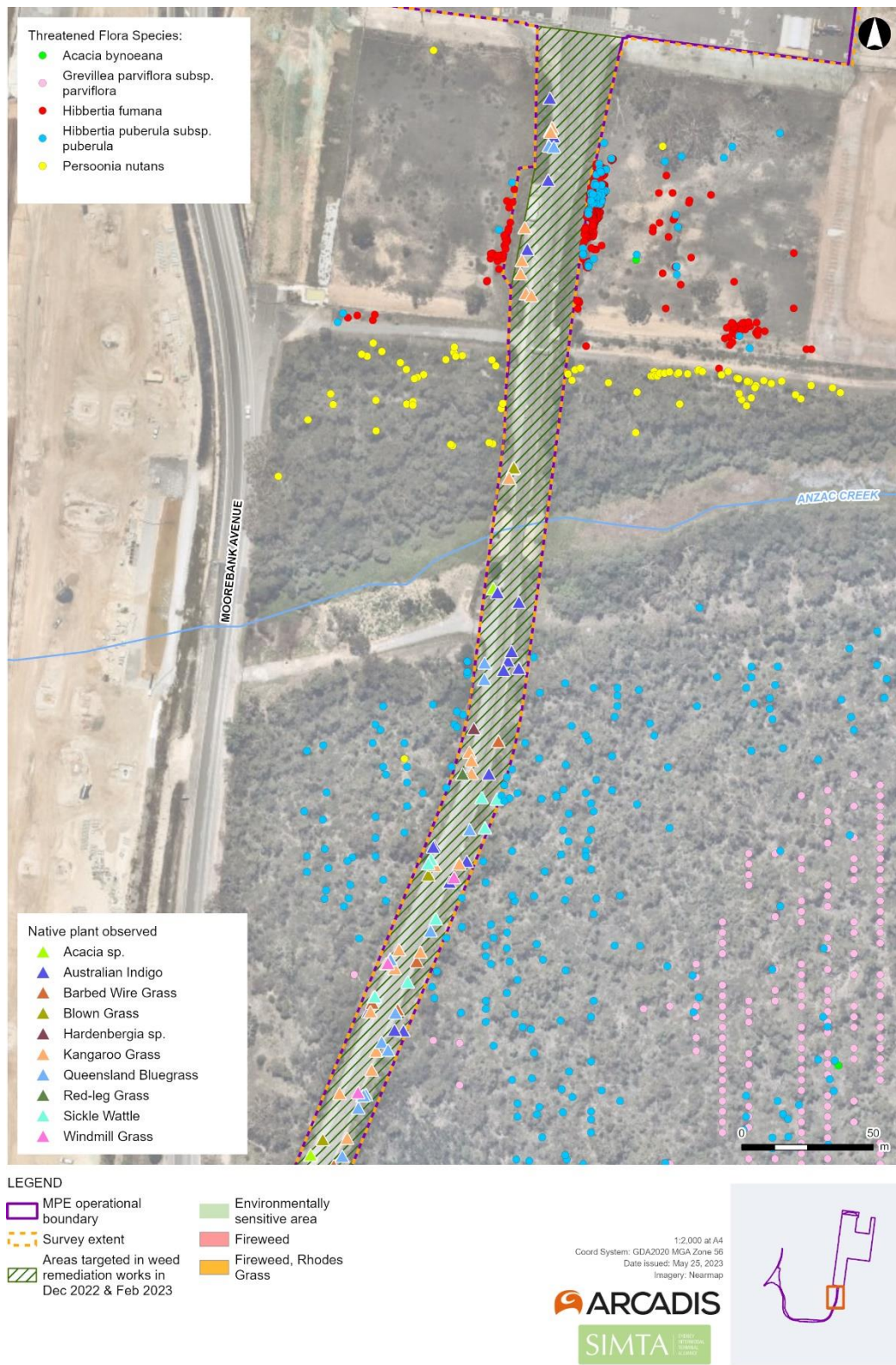


Figure 4. Native species, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 3 of 8)

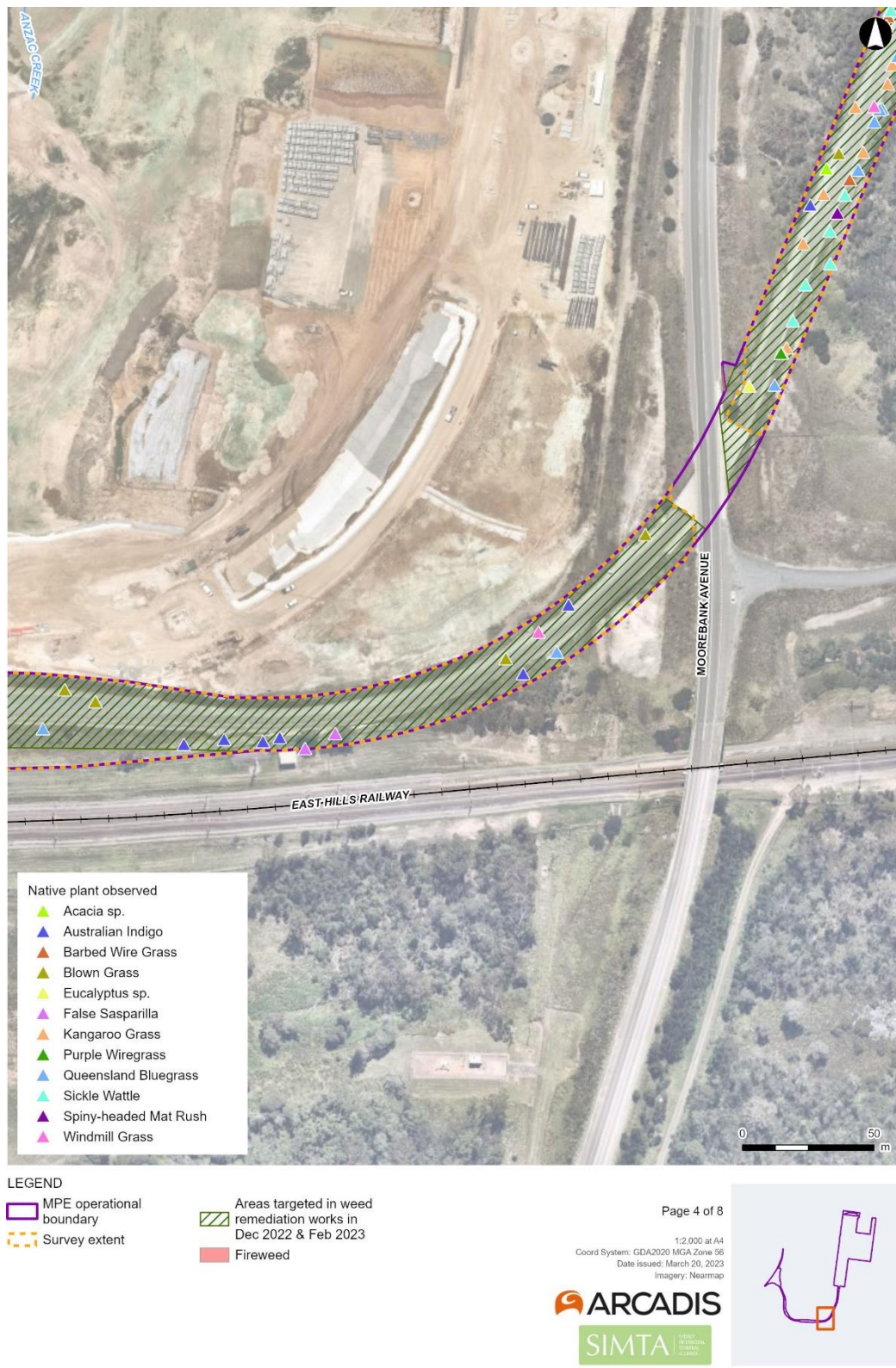


Figure 5 Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 4 of 8)



Figure 6. Native plant, weed covers and aggressive weeds identified across the MPE operational facility (Map 5 of 8)

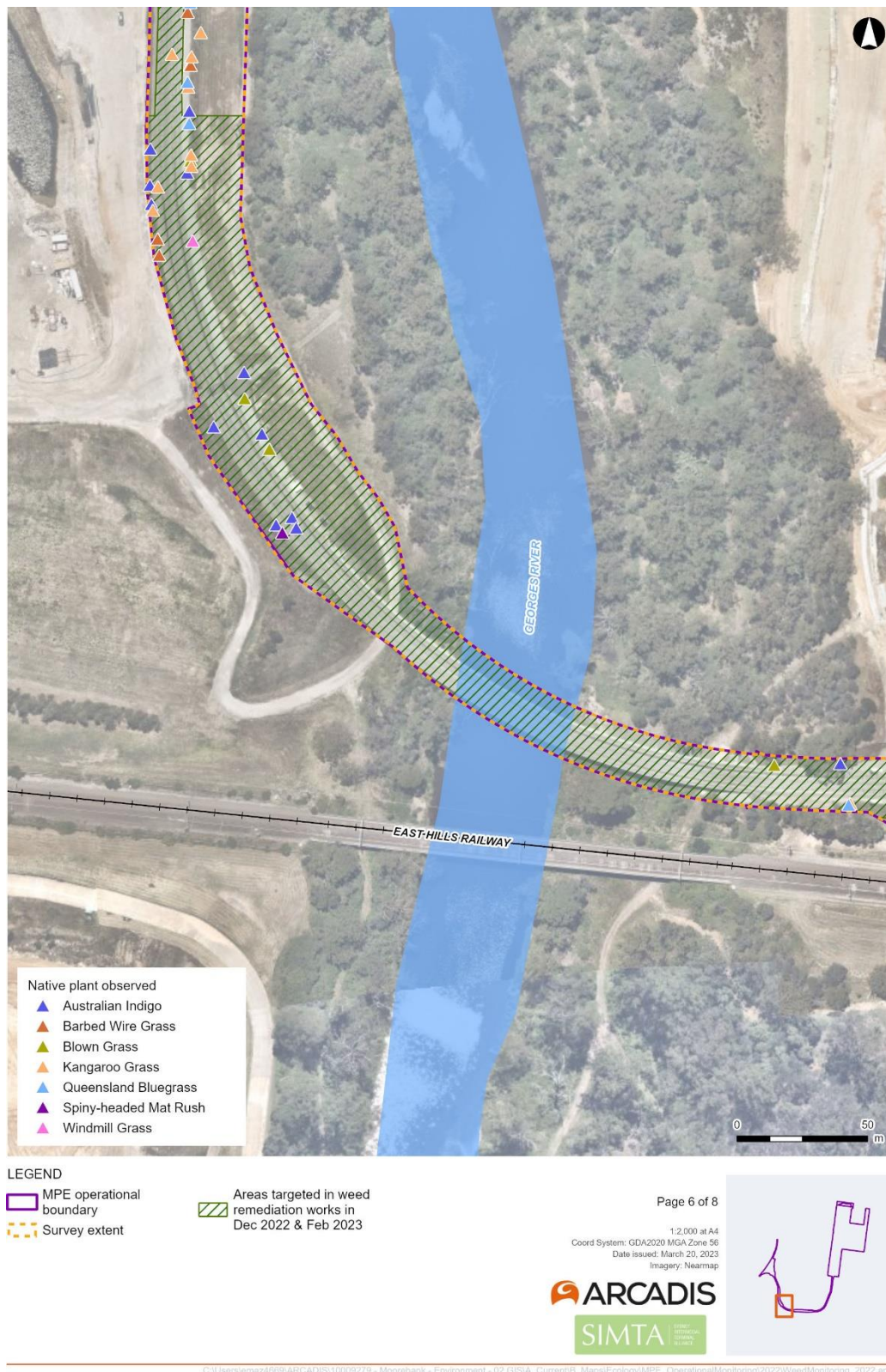


Figure 7. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 6 of 8)

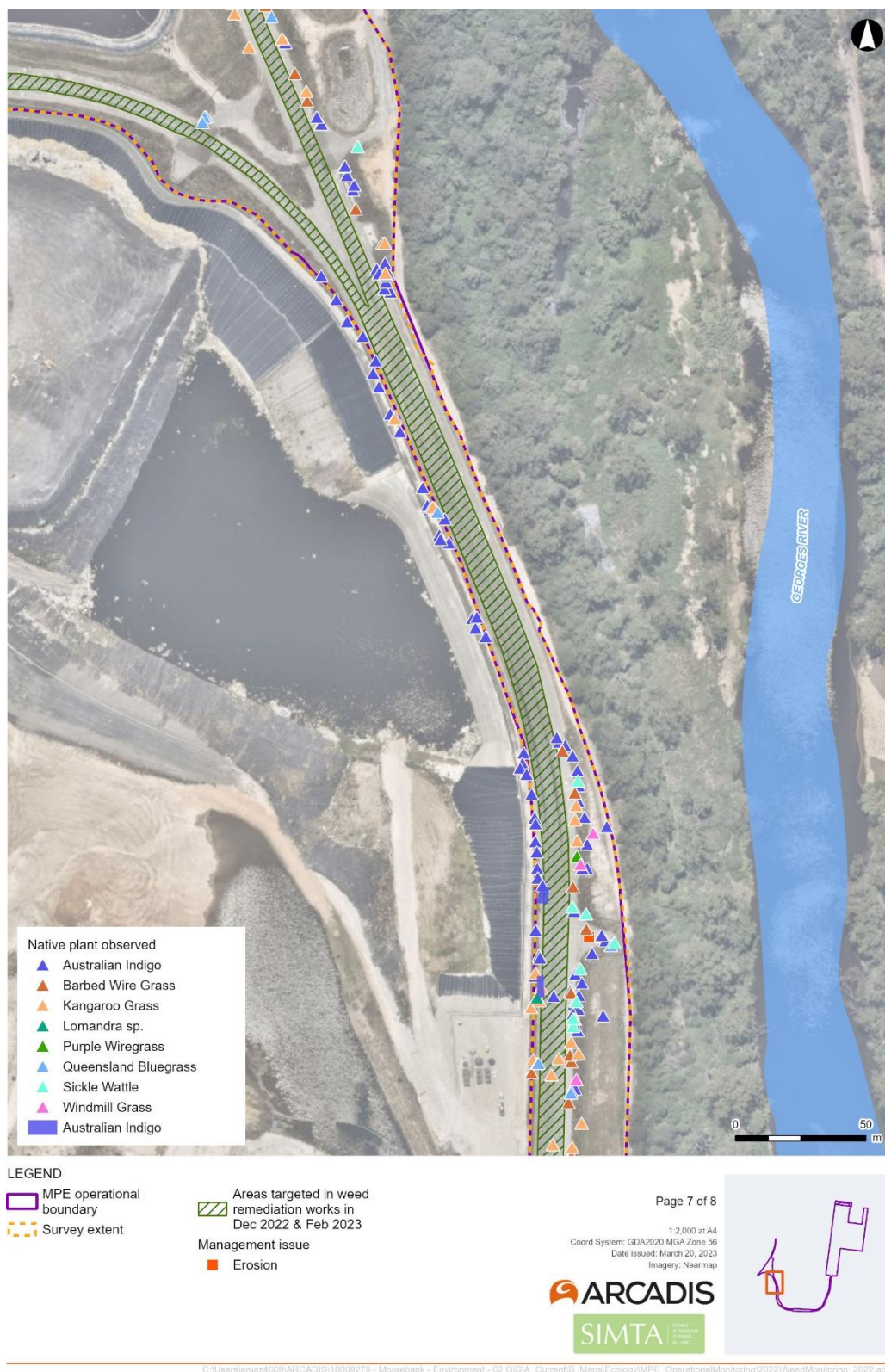


Figure 8. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 7 of 8)

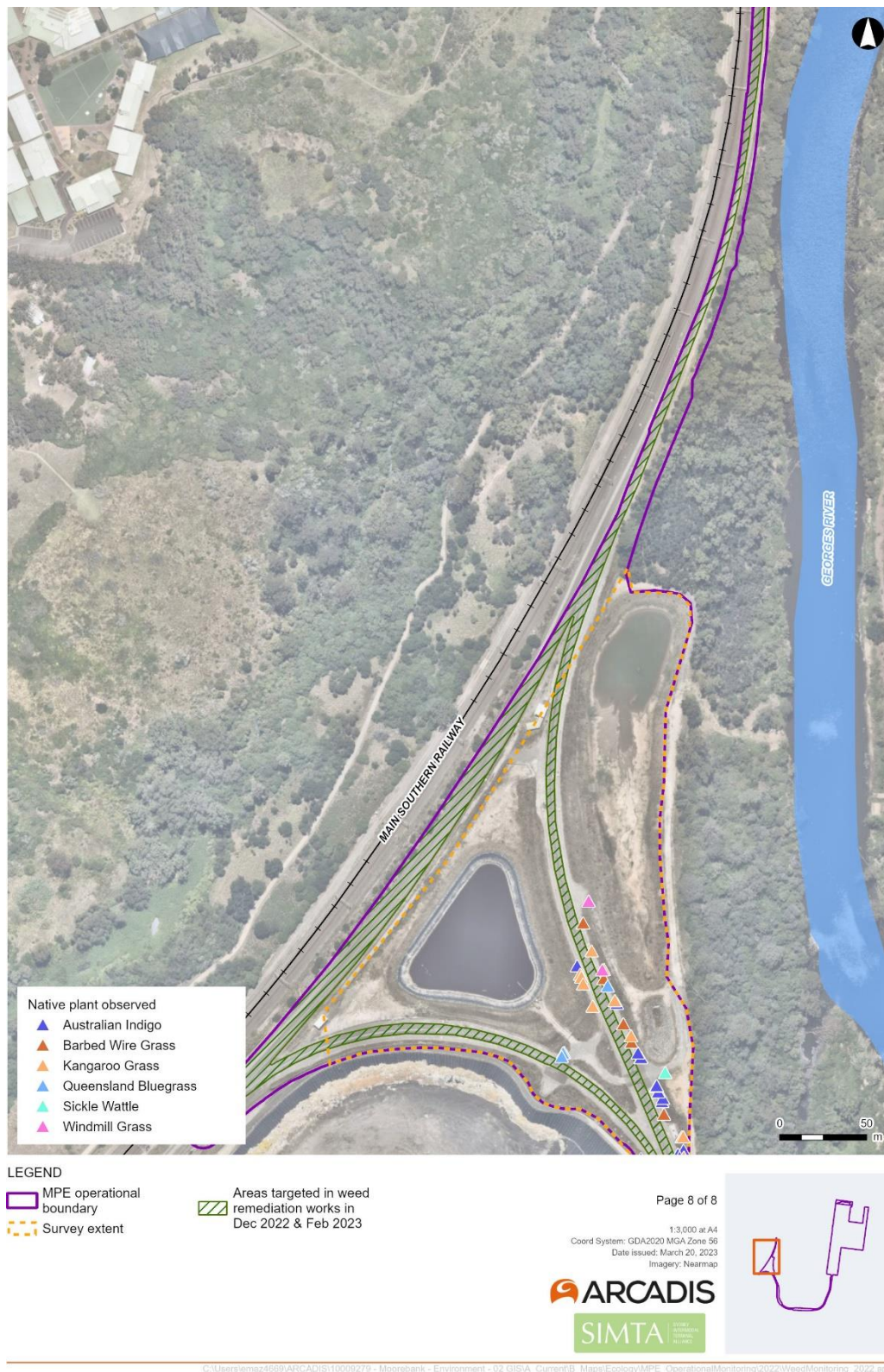


Figure 9. Native plants, weed covers and aggressive weeds identified across the MPE operational facility. The coloured areas under the "Priority & key weeds" legend area areas that have high-density weeds (Map 8 of 8)

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 which have been completed and is considerate of the revegetation methodology proposed by Spray Grass Solutions and Cumberland Plain Seeds.

The majority of weed remediation and management action recommendations documented in the December 2022 weed monitoring report are still applicable to the management of the site. These include:

- Targeted weed remediation works to continue along revegetated soft batters. Weed remediation works will focus on controlling priority and key weed species. Hand weeding should be conducted for individuals, whereas slashing and herbicide spraying should be adopted to target larger patches of weeds. However, extreme care must be taken when conducting any weed management along the rail corridor, as many native grasses have become established. A suggested process to target weeds along revegetated soft batters is presented in the methodology section of this report and Figure 11. Hand weeding is only feasible on annual species such as Grader Grass and Fireweed due to their relatively small root system.
- Priority and aggressive weed species outside revegetated Rail Link areas should be removed. Weeds that 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 regularly to prevent seeding events (Figure 4, Figure 9). This will reduce the colonisation of these grasses into revegetation areas. However, slashing should only occur when plants are not seeding to prevent further spread. Furthermore, as more native species become established in these areas, slashing may impact their growth; therefore, non-targeted slashing should be avoided.
- Continue to collect litter from within 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 controlled through herbicide application, slashing and hand weeding. Weed remediation works should be conducted in accordance with the approved Weed Management Plan.
- Plants damaged due to high water flows following large rain events, and erosion should be assessed for management strategies to remedy the damage. If possible, measures should be put in place to assist the plant's recovery, such as providing structural support in the form of wooden stakes to prop up fallen plants.

Application of herbicide within the Rail Link and in areas adjacent to the Moorebank biobank site should be conducted to prevent overspray (off-target poisoning). If herbicide application occurs, recommended herbicides for tussock grass, such as Rhodes grass and African Lovegrass, include glyphosate or flupropanate, while plants are actively growing during summer and spring. Native vegetation outside the Rail Link fence must not be impacted by herbicide during weed remediation works.

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

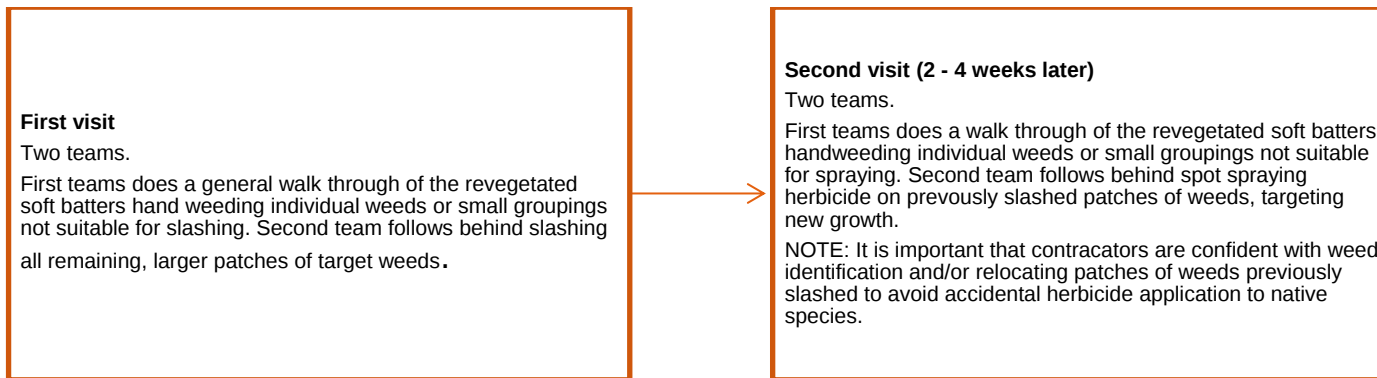


Figure 10. Suggested process to controlling target weeds on revegetated soft batters

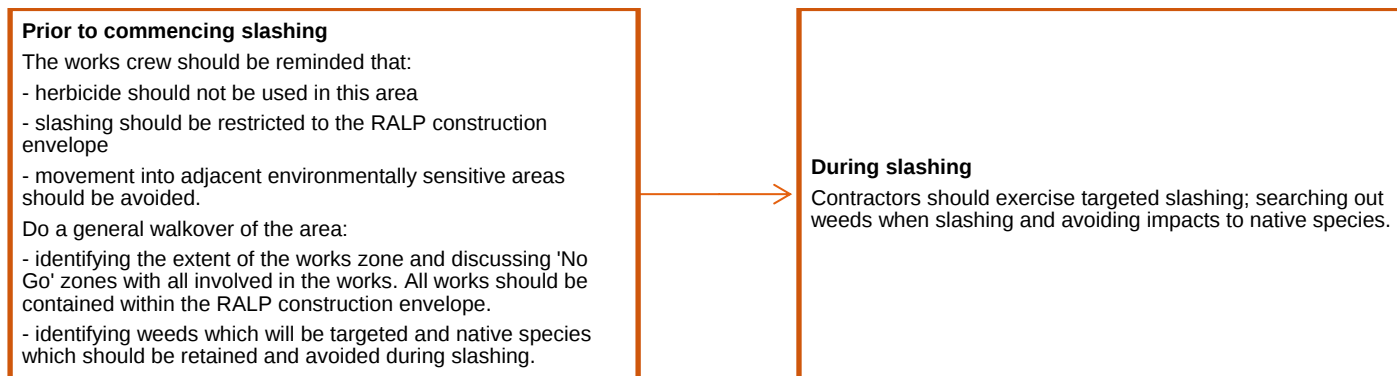


Figure 11. Slashing target weeds within the RALP construction envelope adjacent to ecologically sensitive areas

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

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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 prioritised 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 the 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). 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.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
August 2020	Exotic species, specifically <i>Medicago polymorpha</i> (Burr medic), should be removed from grassland on 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 the Rail Link corridor fencing. A qualified bush regeneration contractor should be used to avoid impacts on 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	Commenced	Litter remains in the Rail Link corridor and adjacent areas.
October 2021	Control aggressive weed species Coolatai Grass and Paterson's Curse within the Rail Link	Commenced	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 the spread of these species into ecologically sensitive areas ecologically 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.
August 2022	Prioritise weed remediation works for priority and key weed species which have experienced accelerated growth in recent months.	Commenced	Areas of particularly high biomass of priority and key weed species should be prioritised for weed remediation works in coming months to avoid mass seeding events.
	Begin remediation of soft batters which have slipped following extreme rainfall events in recent weeks	Not started	Areas within the operational facility, including a number of areas within the Rail Link, require urgent batter remediation in areas of batter slipping.

Month of logging	Recommended action	Status (Not started, Commenced, Complete)	Comments
December 2022	Begin weed remediation of gravel and ballast areas along Rail link	Commenced	Removal of all vegetation in gravel and ballast areas due along Rail Link corridor using slashing and herbicide due to safety concerns of train operators and prevent spread of weeds.
December 2022	Continue weed remediation works along the soft batters within the Rail Link corridor.	Commenced	Future weed remediation works should include targeted slashing and spraying of priority and key weed species, whilst avoiding native species by hand weeding within a one metre buffer zone of native individuals.
February 2023	Continue weed remediation works along the soft batters within the Rail Link corridor beyond Georges River bridge.	Not started	Future weed remediation works should include targeted slashing and spraying of priority and key weed species, whilst avoiding native species by hand weeding within a one metre buffer zone of native individuals.