Appendix L

Review of Rehabilitation of Mine Waste at Moora Mine

A Report on the Rehabilitation of Mine Waste at the Simcoa Moora Chert Mine based on monitoring in October 2022

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1.0 INTRODUCTION

1.1 Purpose of this report

The purpose of this report is to provide a review of the progress of the rehabilitation of vegetation on mine waste dump areas, at Simcoa Operations Pty Ltd ("Simcoa") in Moora, over the three years to October 2022 and to comment on appropriate future rehabilitation treatments and monitoring. This report is a development of previous reports by Trudgen 2016 & 2020; Trudgen *et al* 2013; Trudgen *et al* 2010; Morgan 2007; Trudgen 2004, and Trudgen *et al* 2001b,.

1.2 Location of the mine and rehabilitation areas

The mine and rehabilitation areas are located about fifteen kilometres north of Moora on the east side of the Midlands road, some 185 km north of Perth (see Figure 1).

1.3 The mine

The Simcoa chert mine is based on chert deposits on Mining Lease M70/191. A second pit was developed in 2004. Waste material includes scalps (chert less than 25 mm diameter), overburden as well as sand and silt from the settling ponds (Parker *et al*. 1998). The overburden can include a range of material up to cobbles and small boulders.

1.4 Vegetation of the Coomberdale Chert - a "Threatened Ecological Community"

The chert ridges being mined lie in the Coomberdale Floristic Region of Griffin (1992a). This floristic/vegetation unit is differentiated from other such units at a regional scale. Unlike the other units described at the same level by Griffin, it is of quite restricted occurrence, being found only on the chert outcrops and associated soils on the adjoining slopes of the Coomberdale Chert. The Coomberdale Floristic Region consists of a series of plant communities and associations often dominated by various mixtures of *Regelia megacephala*, *Kunzea praestans* and *Allocasuarina campestris* frequently with a sparse overstorey of *Allocasuarina huegeliana*, or *Acacia acuminata* (Jam) or *Eucalyptus loxophleba* ssp. *loxophleba* (York Gum). There is much variation, including various combinations of these taxa.

More recently, the heath communities dominated by one or more of *Regelia megacephala*, *Kunzea praestans* and *Allocasuarina campestris* that occur on the Coomberdale Chert ridges and slopes have been classified as a "Threatened Ecological Community" (Hamilton-Brown 2000).

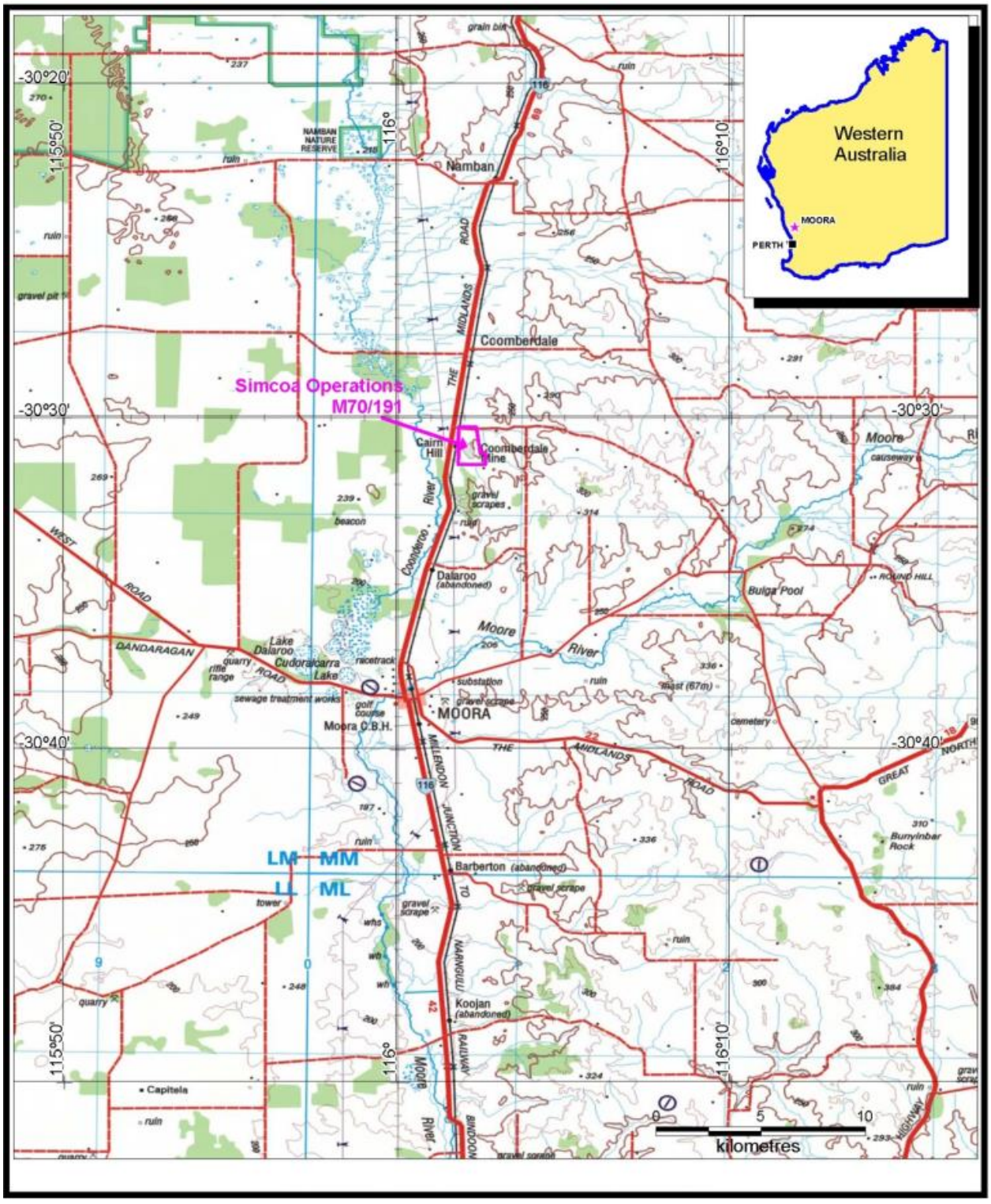

Figure 1: Location of the Simcoa quartzite mine located north of Moora**.**

"Ecological Community" is a catch-all phrase that is applied to various levels of vegetation types or fauna "communities" that are perceived to be rare or in need of protection. The Department of Biodiversity, Conservation and Attractions (formerly the Department of Parks and Wildlife and other titles) manages lists of vegetation types needing special attention for its protection (e.g.,

English and Blyth 1997) and advises the relevant Minister of which should be listed as Threatened Ecological Communities.

Prior to mining, the current Main Pit area had vegetation of *Kunzea praestans* open scrub and *Regelia megacephala* open scrub and two small areas of *Allocasuarina campestris* open scrub (Trudgen 1985). The West Pit area had vegetation of *Kunzea praestans* open scrub and *Regelia megacephala* open scrub (Trudgen *et al*. 2006). The vegetation in both areas vegetation would have been referable to the Coomberdale Chert Threatened Ecological Community.

As well as having restricted vegetation, the Coomberdale Chert Threatened Ecological Community is known to be the habitat a number of Declared Rare and Priority flora species as well as poorly known flora species that are not currently assigned to either of those categories.

1.5 Comparison of the rehabilitation on the waste dumps and the threatened ecological community using floristic analysis

Floristic analyses carried out by Trudgen *et al*. (2001a) included the December 2000 rehabilitation quadrat data allowing the rehabilitation vegetation of the waste dumps to be compared to plots in native vegetation on the chert ridges.

When the weeds were excluded from the floristic analysis, the eight rehabilitation quadrats formed a group separate from the native vegetation on the chert ridges. That is, floristic analyses showed that the vegetation of quadrats in the waste dumps rehabilitation area were most similar to each other, and were quite different to the quadrats of the native vegetation close by, as well as to that of distant chert ridges. More detailed results and discussion of the floristic analyses (including the dendrograms) are given in Trudgen *et al* (2001a). It was not considered useful to repeat such analyses for this update report.

2.0 SIMCOA'S REHABILITATION OBJECTIVES

The objectives for rehabilitation at the Simcoa mine site were noted in the EMMP (Parker *et al*. 1998). They are to:

- Create stable slopes on the waste to minimise erosion,
- Establish a stable vegetation composed of local native plant species;
- Re-establish the geographically restricted species *Regelia megacephala* in appropriate areas.

Subsequently, in 2002 Simcoa undertook to include Declared Rare Flora and Priority Flora in rehabilitation trials as a commitment made as part of the environmental impact assessment procedures carried out for the Western Ridge pit (Strategic Environmental Solutions, 2001).

3.0 BACKGROUND TO SIMCOA WASTE DUMP REHABILITATION

The first rehabilitation carried out at the Simcoa Moora mine site was the establishment (in May 1991) of a native vegetation rehabilitation trial on the western slope of the North Waste Dump (Griffin, 1991). Since then, more than forty-seven (47) separate areas of rehabilitation have been established on the waste dumps, these and the locations of the waste dumps are shown on Figure 2.

Rehabilitation was next undertaken on the north and north-west-facing slopes of the Main Waste Dump (referred to in the January 2001 rehabilitation report (Trudgen *et al*., 2001b) as the West Waste Dump, see Figure 2). Rehabilitation commenced in this area in 1993, with further areas treated in 1994, 1995-96, 1997, 1998, 1999, 2000, 2001, 2002, 2004, 2005, 2006,2007,2008, 2011 and 2013. Rehabilitation treatment typically consisted of battering of the slopes followed by addition of topsoil, chert rubble and scalps. After which *Regelia megacephala*, *Allocasuarina huegeliana* and *Allocasuarina campestris* brush and seed were applied as deemed necessary to assist rehabilitation in areas of low regeneration from topsoil stored seed. A new waste dump was started in 2010. Battering in this area began in 2013 and the lower slopes had topsoil spread in 2015.

More recently, waste from the Main Pit has been used to develop the South-East Waste Dump (see Figure 2). Sections of slopes of the South-East Waste Dump were re-vegetated in 2005 and 2006, as well as a small linear area in 2001. Waste from the more recently developed West Pit has been stockpiled in the Main Waste Dump area (see Figure 2). Sections of slopes of the Main Waste Dump were re-vegetated in 2005 and 2006.

Several earlier reports have provided details of the rehabilitation on the waste from the Moora mine. Griffin reported on the May 1991 rehabilitation trial on the North Waste Dump (Griffin 1991; Griffin 1992b; Griffin 1993). Since then, updated reports of the rehabilitation program have been written in 1995, 1998, 2001, 2004, 2007, 2010, 2014, 2016, and 2020 as part of triennial reports on the mining operation (Parker *et al.*, 1998, Trudgen *et al.* 2001b, Morgan and Trudgen 2004, Trudgen and Hannart 2014, Trudgen 2016, 2020).

The rehabilitation techniques tested in the 1991 rehabilitation treatment on the North Waste Dump were a covering of top soil (stored after being collected during mining operations) over the waste dump slope, with various treatments of combinations of *Regelia* brush (with seed in the capsules which were released on drying of the brush), extra seed (of *Allocasuarina campestris* and

Allocasuarina huegeliana) and areas with and without fertiliser (Griffin 1993 and Parker *et al.* 1998).

The treatments were repeated in areas up-slope and down slope of a centre line across the rehabilitation area, with each sub-area containing two plots of each treatment to give a total of 32 plots (Griffin 1991). The plots were separated by a buffer zone. In reviewing the progress of the trial, Griffin (1993) concluded that the factorial experiment should be considered complete, having demonstrated the basic practicality of establishing native species on the chert wastes and indicating the degree of success of the rehabilitation. The trial had shown that *Regelia megacephala*, *Allocasuarina huegeliana* and *Allocasuarina campestris* could be germinated from seed on the waste dump and could establish in the waste dump soils. As all three species hold their seed in capsules on the shrubs, unless release is triggered by events such as fire or death caused by drought, little seed of these species is found in the top soil where they occur, making seed application a necessary part of re-vegetation. The trial also demonstrated that a range of perennial native species had germinated from seed occurring naturally in the topsoil spread on the trial area. Finally, it was shown that the addition of fertiliser had a limited influence and it was recommended that fertiliser should not be added in future rehabilitation.

In 1993, 45 native plant species were recorded from the trial area, with the greatest vegetation cover due to five species: *Acacia congesta* subsp. *congesta*, *Kennedia prostrata*, *Hibbertia subvaginata*, *Regelia megacephala* and *Allocasuarina huegeliana*. The first three germinated from natural seed stores in the topsoil.

Griffin (1993) noted that a central belt of greatly reduced density and cover ran across the slope. He concluded that although the area coincided with the trial treatment of *Allocasuarina huegeliana* and *Allocasuarina campestris* added seed, the most likely cause was inadequate soil moisture holding capacity. Consequently, Griffin recommended the investigation of construction of the waste dumps to improve their moisture holding capacity.

Griffin (1993) also noted that the three species for which seed was added in the trial, *Regelia megacephala*, *Allocasuarina huegeliana* and *Allocasuarina campestris*, progressively declined in numbers over the three seasons to 1993. On the other hand, *Hibbertia subvaginata* (germinated from seed in top soil) had a big increase in numbers in 1992, but a big decrease in 1993 to lower numbers than in November 1991. Annual native species dramatically declined in numbers of

species found between November 1991 and November 1993. Weeds, though increasing in cover, were considered to have a limited impact. There was little sign of erosion.

Four ten by 10 metre quadrats were established in the 1991 rehabilitation area in 2000 (Trudgen *et al* 2001b) to collect data on ongoing changes in that area in the same size quadrat as used in other areas of the re-vegetation. The sites established by Griffin (see above) were pegged with wooden pegs and these were no longer able to be used to locate his quadrats

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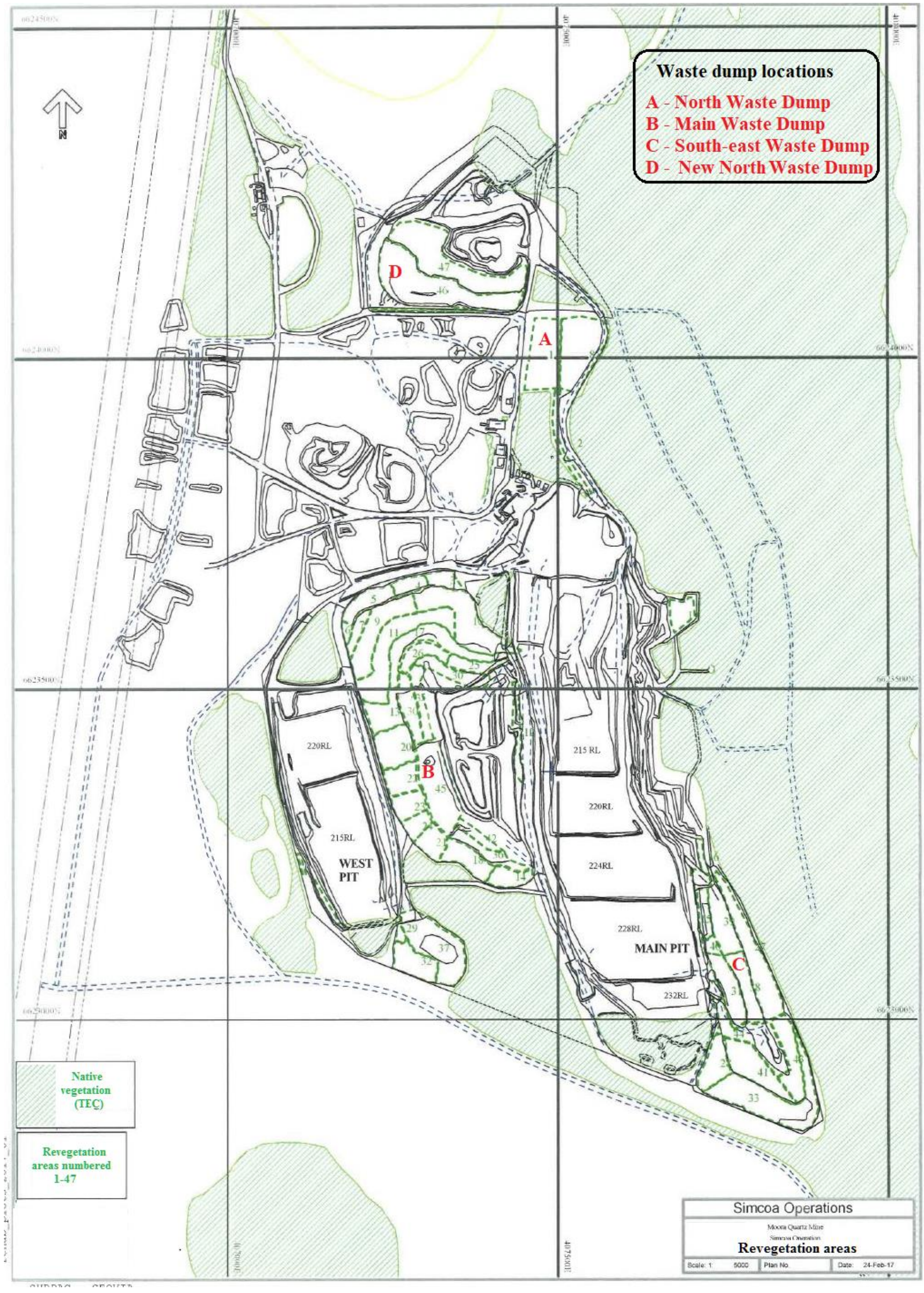

Figure 2: Location of rehabilitation areas and waste dumps

4.0 METHODS OF THE REHABILITATION MONITORING

4.1 Re-scoring of previously established quadrats

The seventeen 10 by 10 metre quadrats re-scored in 2016 and 2019 were rescored in October 2022. This included one in Area 37 not rescored in 2013. In addition two quadrats were installed and recorded on the New North Waste Dump and two quadrats not recorded in 2013, 2016 and 2019 were recorded. The locations of the quadrats are shown on Figure 3 and listed in Table 1 with the years each recorded in. Apart from the two new quadrats the quadrats were established between 2000 and 2010 on waste dump areas treated for rehabilitation between 1991 and 2007 and previously re-scored in 2004, 2007, 2010, 2013 and 2016 (see Table 1) depending on when they were established.

Table 1. Quadrats established on rehabilitation areas from 1991-2007 and years recorded between 2999 and 2019

Quadrat ID	Year area treated	Year quadrat established	Recorded 2004	Recorded 2007	Recorded 2010	Recorded 2013	Recorded 2016	Recorded 2019	Recorded 2022
R91/01	1991	2000	2004	2007	2010	2013	2016	2019	2022
R91/02	1991	2000	2004	2007	2010	2013	2016	2019	2022
R91/03	1991	2000	2004	2007	2010	2013	2016	2019	2022
R91/04	1991	2000	2004	2007	2010	2013	2016	2019	2022
R96/01	1996	2000	2004	2007	2010	2013	2016	2019	2022
R96/02	1996	2000	2004	2007	2010	2013	2016	2019	2022
R98/01	1998	2000	2004	2007	2010	2013	2016	2019	2022
R98/02	1998	2000	2004	2007	2010	2013	2016	2019	2022
R00/01	2000	2004	--	2007	2010	2013	2016	2019	2022
R00/02	2000	2004	--	2007	2010	2013	2016	2019	2022
R01/01	2001	2004	--	2007	2010	--	-	-	2022
R01/02	2001	2004	--	2007	2010	2013	2016	2019	2022
R02	2002	2007	--	--	2010	2013	2016	2019	2022
R04(22)	2004	2007	--	--	2010	2013	2016	2019	2022
R04/(23)	2004	2007	--	--	2010	--	-	-	2022
R05(27)	2005	2007	--	--	2010	2013	2016	2019	2022
Area 33	2005	2010	--	--	--	2013	2016	2019	2022
Area 37	2006	2010	--	--	--	--	2016	2019	2022
Area 41	2007	2010	--	--	--	2013	2016	2019	2022

The detailed data for each quadrat is given in Appendix 1 and include:

- The location of at least the North-East and South-West corners (all four corners are permanently pegged) using a hand-held GPS (accurate to approximately 3 to 5 m). Co-ordinates were recorded in WGS 84, Zone 50 (unless stated otherwise).

- A list of all species present with height, percentage foliage cover estimation and where practicable number of individuals for 2022and (for comparison) the cover for 2016 and 2019;
- A vegetation description based on Aplin's (1979) modification of Specht's classification (see Appendix 2);
- The total cover of annual weeds, total native annuals were recorded where appropriate;
- The number of plants alive and dead was recorded for selected taxa;
- Landform and substrate characteristics;
- Photographs.

For some introduced annual species with numerous small individuals, only estimates of numbers could be made.

4.2 Specimen collection and identification

Any taxon not readily identified in the field was collected, pressed and identified later. A few specimens were of insufficient quality for identification, lacking flowering material. To ensure consistency between years with the naming of specimens, the material from previous years was reviewed in 2016 and 2017 and a small number of corrections made and the taxonomy updated. Collections from 2022 were identified to be consistent with the earlier work. Where taxonomy has changed names have been updated to be consistent with FloraBase.

4.3 Treatment of imprecise cover estimates

When an imprecise percentage estimate was made for percentage foliage cover of species (such as 10-15%), it was converted to a mid-point for calculation purposes. Where other estimates were made an appropriate value was used (e.g. > 10% was converted to 12%, < 10% was converted to 8%, < 5% was converted to 3.5%, < 1% was converted to 0.5%, "+" was converted to 0.1%)

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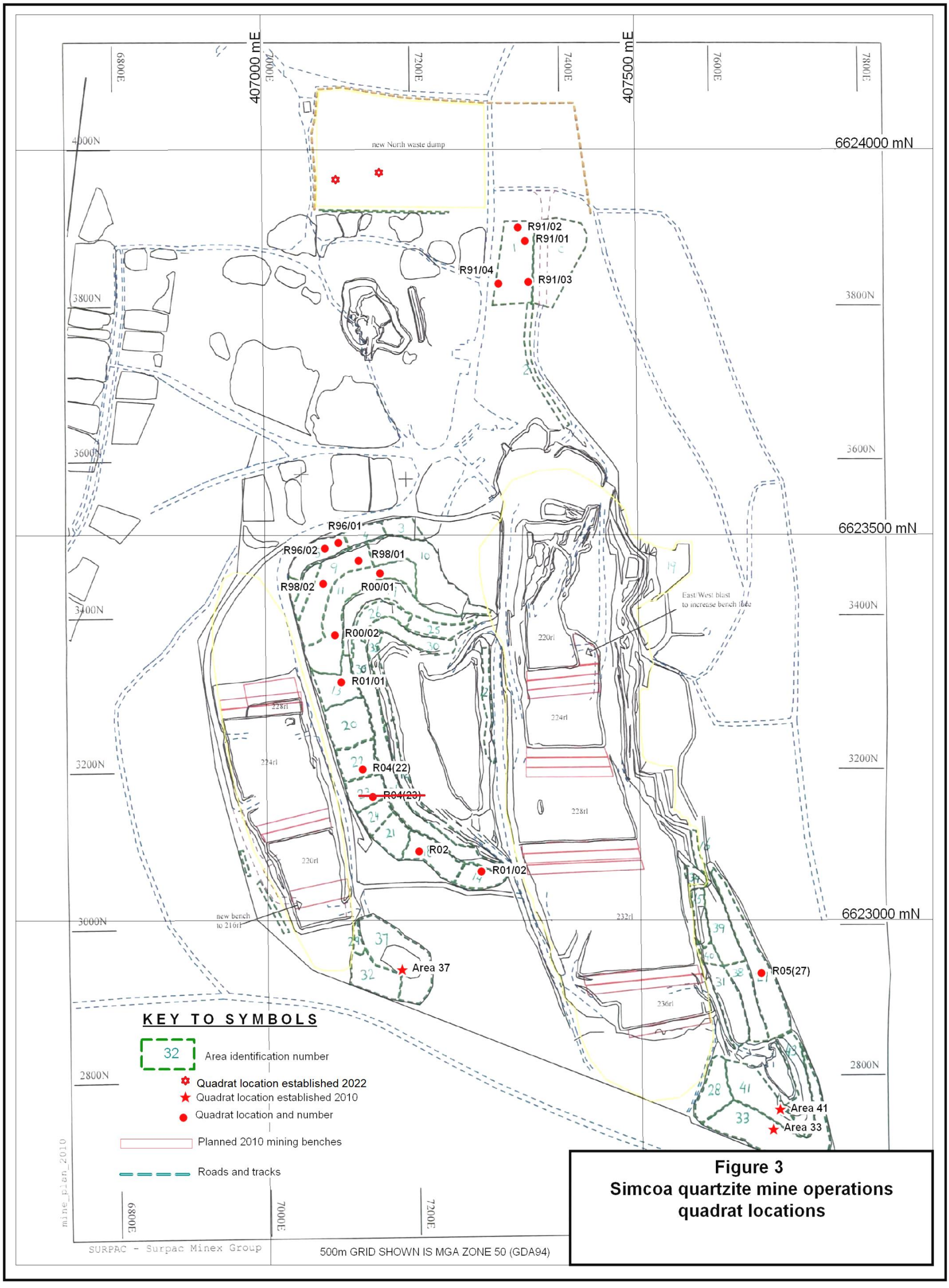

Figure 3: Location of quadrats in the SIMCOA chert mine rehabilitation areas

Notes: Quadrat R04/23 was located in an area that has been re-mined.

5.0 LIMITATIONS OF THE SURVEY AND ANALYSIS

The survey of the rehabilitation areas was limited by the fact that the 10 by 10 metre quadrats used are only a sample of the vegetation in each rehabilitation area. Consequently, the vegetation described in the quadrats is an approximation of the vegetation of each area sampled, not an exact measure. Also, the species list from the quadrats in the rehabilitation areas is not likely to be a complete list of what is in each rehabilitation area or to show the exact state of the whole rehabilitation area. However, given the number of quadrats sampled, these limitations should not significantly affect the results of the survey.

Visits to the quadrats have occurred during different seasons in different years over the period the rehabilitation areas have been monitored. This has caused some difficulty in the cover assessments of some species. This has mainly been the annual weed species, particularly **Hypochaeris glabra* (Flatweed) and **Erodium botrys*, these species die fairly early in the dry season and are then difficult to either count or estimate their cover.

Earlier in the rehabilitation monitoring the juvenile stage of some plant species in the more recently rehabilitated areas made identification of some of the species difficult when some of the quadrats were first established, but this was not a problem in 2016, 2019 and 2022. To ensure consistency of identification of specimens a reference set of specimens was made and new specimens compared to the specimens in it to confirm identifications.

Two quadrats were not recorded in 2013. Quadrat R01/01 on the main waste dump was not found as the geocode was in AGD84, not WGS 84, while Quadrat 04/(23) on the main waste dump had been re-mined for gravel product. The quadrat from “Area 37” on the south waste dump not re-scored in 2013 was re-scored in 2016. Al the previously recorded quadrats were recorded in 2022 and two new ones established on the New North Waste Dump.

6.0 CLIMATE VARIATION IN THE MOORA AREA AND PROBABLE IMPACTS ON THE REHABILITATION

Table 2a gives summary details of the variation in rainfall at Barberton (9.9 km south from Moora) from 1911 to 2022. It shows the lowest annual rainfall recorded at Barberton to be 214 mm and the highest to be 790 mm. However it shows the median to be 438 mm. Comparing the annual rainfall at Barberton from 2009 to 2022 (see Table 2b) to the median, shows that the deviance from the median is much less for those years above the median compared to those years below the median. This deviance is highest for 2019, as the annual rainfall at Barberton in that year was 257 mm.

From the data in the two tables it is reasonably clear that the rehabilitation received lower than median rainfall in seven years over the 14 year period in Table 2b. Also, it is obvious that while in 2019 the rehabilitation received very low rainfall in 2021 and 2022 it received higher than median rainfall.

Table 2a: Monthly and annual rainfall variation for Barberton from 1911 to 2022

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	13.9	16.3	19.4	23.8	56.6	83.0	83.4	64.4	38.2	23.8	13.5	8.9	447.1
Lowest	0.0	0.0	0.0	0.0	1.5	9.0	8.2	10.3	4.7	1.2	0.0	0.0	214.0
5th %ile	0.0	0.0	0.0	0.9	9.0	28.9	31.8	24.6	11.9	3.6	0.0	0.0	311.8
10th %ile	0.0	0.0	0.0	1.8	17.5	40.0	43.8	30.5	15.0	6.4	0.6	0.0	336.8
Median	2.9	6.1	9.4	19.2	54.8	78.5	80.1	63.4	35.7	19.4	9.6	4.3	438.8
90th %ile	38.5	48.8	56.2	50.8	102.0	134.4	125.0	106.4	64.4	46.9	32.9	24.1	566.8
95th %ile	58.0	58.7	67.2	61.0	116.2	151.3	147.9	117.3	71.2	55.6	39.5	30.3	614.7
Highest	157.8	266.0	121.0	120.4	163.0	212.9	216.3	139.0	89.9	101.5	60.2	60.0	790.6

From:http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=008005

Rainfall was extremely poor prior to the 2013 survey (see Table 2b below) with a dry winter (although wetter than in 2010 which was the second driest on record), with June only having 9 mm (Table 2b). The two years before 2010 had higher rainfall and equally importantly no winter month with low rainfall. The dry period extended into 2014 and 2015, with the latter year having much lower rainfall in September than is usual for the area. In contrast, 2016 had higher rainfall, but 36 mm of that occurred in January, when it would have much less effect, because of high evaporation, it also had fairly low rainfall in September and October. 2019 and 2020 had low rainfall, but 2021 and 2022 had higher than median rainfall.

Table 2b: Monthly and annual rainfall for Barberton (9.9 km to Moora) from 2011 to 2022

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2009	3	8.8	1	1.8	29.4	72	116.6	77.8	46	23.6	24.8	0	404.8
2010	0	0	64.8	4.6	58.8	26.4	62.4	47.8	24.8	2.6	5	12.8	310
2011	13.2	37.2	31.4	7.6	55.4	64.6	81.2	47.8	39.4	56.4	15.4	27	476.6
2012	88.8	60.4	0.2	6.6	5.2	98.2	8.2	53.2	64.4	6.4	54.1	14	459.7
2013	31	0	41.4	18	74.6	9	60.2	72.8	64	17.6	0.6	1	390.2
2014	6.6	0	12.2	41.4	80	38.5	73.7	30.8	52.4	14.4	4.6	4.4	359
2015	9	41.6	37.8	12.6	26.6	43.8	90.2	88.6	16	9	14.8	4	394
2016	35.8	0	38	59.8	43.2	90.4	76.2	75.6	31.2	12.4	8.4	9.6	480.6
2017	106.2	48.8	13.6	0.4	17.8	24.6	82.2	93	37.8	16	9.2	16.4	466
2018	60.6	11.2	2.2	1.2	47.6	52.4	120	113.2	16.8	41.6	6.8	4.8	478.4
2019	0.8	0.8	0.4	13.8	5.4	104.2	43.8	51.4	8.6	24.4	2.6	0.8	257
2020	0.4	44.8	5.6	5.6	29.3	41.0	25.0	67.8	24.6	3.1	38.4	1.2	286.8
2021	6.6	57.6	72.4	21.6	56.2	46.4	147.2	47.8	21.8	57.4	13.4	0.0	548.4
2022	0.0	12.8	56.2	70.2	43.0	60.4	57.8	139.0	45.0	19.2	14.0	0.0	517.6

From:http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=008005

From the discussion above, it seems likely that over the long term low rainfall years (interacting with low water retention in the waste) have had an impact on the survival of perennial shrubs In the rehabilitation. The dry years preceding 2016 undoubtedly had a significant impact on the plants in the rehabilitation areas, as did the low rainfall in 2019.

7.0 RESULTS

7.1 Changes in overall species complement in the quadrats between 2013 and 2022

The overall species complement found in the quadrats recorded has changed at each recording from 2013 to 2022. The changes are shown in Table 3, with species presence at a recording year, or more than one year, indicated by colour coding in the table.

The largest group (middle blue in the table) was recorded in all four recording years covered by the table and has sixty-two (62) species, of which twenty-six (26) are weeds. This group includes the main native and weed species in the rehabilitation; that is those that are more common in the quadrats and are more abundant (more individuals of annual species or more cover of perennial species. The comparable group in the 2019 data has lost one native (*Acacia stenoptera*) and two weed species (**Conyza bonariensis* and **Orobanche minor*), however these were species that only occurred infrequently in the rehabilitation.

Table 3 also shows that twenty-four (24) native species have been lost from the rehabilitation quadrats between 2013 and 2022. It is uncommon for species that have been lost to turn up again, but it does happen. *Dryandra sessilis* was recorded in 2013 then not until 2022, however the plant recorded in 2022 was a small seedling and it survival is uncertain. The species that have been lost are ones that have been uncommon in the quadrats, such as *Acacia stenoptera*. The latter species although lost from the quadrats is still present in the rehabilitation with very low occurrence.

Interestingly, while native species have been lost from the quadrats others have spontaneously appeared. The species that have spontaneously appeared have low frequency of occurrence. Some, such as *Dichopogon capillipes* and a *Microtis* species, are gradually becoming more common but are fairly small perennials and will never provide much biomass. Ten species that were not recorded in the previous three recordings were recorded in 2022 (see end of Table 3), however eight of these are very small to small annual species and may be lost again if weed cover increases in the quadrats they were recorded in. Relevant here is that these species were mostly recorded in the younger quadrats that have lower weed cover.

Austrostipa elegantissima and *Thysanotus manglesii* (both native perennials) appear to be exceptions to this trend and to be able to persist (and apparently increase) in quadrats with significant weed levels.

Table 3: Changes in species occurrences in the rehabilitation between 2013, 2016. 2019 and 2022

Notes: The dates indicate which years a species was recorded. Red text means an introduced species. Each colour indicates a different set of years species occurred in (the set years are given in the first row of a group).

Acacia aristulata [2013 only]	*Calytrix* aff. *leschenaultii* (Moora)	**Vulpia myuros*
Billardiera heterophylla	**Centaurea melitensis*	*Wahlenbergia preissii*
Cotula sp.	*Cheilanthes austrotenuifolia*	*Waitzia nitida*
Cryptandra glabriflora	*Comesperma integerrimum*	*Calandrinia calyptrata* [2016 only]
**Cynodon dactylon*	*Desmocladus asper*	*Calandrinia remota*
Guichenotia micrantha	*Dioscorea hastifolia*	*Drosera* sp. (small rosette)
Muehlenbeckia adpressa	**Ehrharta longiflora*	*Grevillea biternata*
Quoya dilatata	**Erodium botrys*	**Lamarkia aurea*
Salsola tragus subsp. *tragus*	*Eucalyptus camaldulensis* var. *obtusa*	*Podotheca* aff. *gnaphalioides* (Moora)
Senecio glossanthus	*Gilberta tenuifolia*	**Trifolium tomentum* var. *tomentum*
Senecio quadridentatus	*Goodenia berardiana*	*Podotheca angustifolia* [2016 & 2022]
Solanum oldfieldii	**Hedypnois rhagadioloides*	*Daviesia hakeoides* ssp. [2016, 2019]
Dryandra sessilis [2013 & 2022]	*Hibbertia subvaginata*	*Aristida contorta* [2016, 2019 & 2022]
**Solanum nigrum*	**Hypochaeris glabra*	*Brunonia australis*
Rytidosperma caespitosum [2013,16]	*Kennedia prostrata*	*Cheilanthes adiantoides*
Millotia tenuifolia var. tenuifolia	*Kunzea praestans*	*Cuscuta* sp.
Alyogyne huegelii v. *grossulariifolia*	*Lepidosperma tenue*	*Dichopogon capillipes*
Daucus glochidiatus [2013,16 & 22]	**Lysimachia arvensis*	*Drosera macrantha*
**Orobanche minor*	Moss sp.	**Lupinus cosentinii*
Acacia stenoptera [2013,16, 2019]	**Parentucellia latifolia*	*Microtis* sp.
**Conyza bonariensis*	**Pentameris airoides*	*Neurachne alopecuroidea*
Acacia acuminata [2013, 16, 19 & 22]	**Petrorhagia dubia*	**Trifolium hirtum*
Acacia congesta subsp. *congesta*	*Podolepis lessonii*	**Wahlenbergia capensis*
Acacia lasiocarpa var. *sedifolia*	*Ptilotus polystachyus* var.	*Apium annuum* [2019 only]
**Aira caryophyllea*	*Regelia megacephala*	*Caladenia flava*
Allocasuarina campestris	**Romulea rosea*	*Pterostylis exserta*?
Allocasuarina huegeliana	*Rytidosperma acerosum*	*Pterostylis* sp. [2019 & 2022]
**Arctotheca calendula*	*Senecio diaschides*	*Crassula colorata var. acuminata*
Austrostipa elegantissima	**Silene gallica* var. *gallica*	*Rhodanthe laevis*
Austrostipa sp. Cairn Hill	**Sonchus oleraceus*	*Phyllangium sulcatum* [2022 only]
Austrostipa trichophylla	*Stylidium caricifolium*	*Euphorbia drummondii* subsp. *drum.*
Austrostipa variabilis	*Thysanotus patersonii*	*Homalosciadium homalocarpum*
**Avena barbata*	*Trachymene cyanopetala*	*Hyalosperma glutinosum* ssp.
Blennospora drummondii	*Trachymene ornata*	*Crassula colorata* var. *colorata*
Bossiaea moylei	*Trachymene pilosa*	*Podolepis canescens*
**Brachypodium distachyon*	**Trifolium arvense* var. *arvense*	*Podotheca gnaphalioides*
**Brassica barrelieri* ssp. *oxyrrhina*	**Trifolium repens* var. *repens*	*Rhagodia preissii* ssp. *preissii*
**Briza maxima*	**Monoculus monstrosus*	*Wahlenbergia gracilenta*
**Bromus diandrus*	**Urospermum picroides*	*Stylidium septentrionale*
**Bromus rubens*	**Ursinia anthemoides*	

7.2 Changes in plant family and species numbers in the rehabilitation

Table 4 gives the changes in the presence of plant families and numbers of species in each plant family in the rehabilitation from 2016 to 2022. It shows that there is some change at the family level with Chenopodiaceae, Loganiaceae and Euphorbiaceae recorded for the first time since before 2013. As the species gained from these families are native species, this is a positive for the rehabilitation. This should be tempered by the fact that two of the species are small annuals and may not survive future increased weed competition. Also, the number of plants is not large so the effect on biomass is limited; still it indicates some ability of native species to spontaneously invade the rehabilitation.

An interesting feature of the information in the table is that some species that were not recorded in 2019 were recorded in the same quadrats they were recorded in in 2016. This appears likely to be due to the fact that 2019 was much drier than 2022. An example of this loss and regain is the occurrence of **Orobanche minor*. This species is an underground root parasite that does not have chlorophyll, what is observed above ground is short lived flowering stems. It appears that conditions were not suitable for flowering in 2019 for this species, so it did not appear above ground. On the other hand conditions in 2022 suited it and more stems were observed than in 2016.

Overall, there were sixteen reoccurrences or new occurrences of native species in 2022 compared to 2019, with only three native species being lost. There were four gains or reoccurrences of weed species. From 2013 to 2022 there has been an increase of native plus weed species from eighty-four (84) to ninety-seven (97), with a drop to seventy-nine in 2019 due to the dry year and a rebound to ninety-seven in 2022 due to the wetter year. There was some small change in the numbers of genera, with part of this being losses and then regains, for example *Goodenia* and *Brunonia* have been lost then regained, while *Homalosciadium* has been gained and *Apium* lost from 2019 to 2022.

Table 4: Losses and gains in species and plant families between 2013 and 2022 in the sixteen quadrats recorded from 2013 on

Notes: Some families no longer separated in recent studies are maintained to allow comparisons with earlier reports in this series (e.g. the Pea family (Papilionaceae) is maintained as separate from the Wattle family (Mimosaceae)). Except for one fern family and one moss, the families are all flowering plants.

Family	**Number species 2013**	**Number species 2016**	**Number species 2019**	**Number species 2022**	**Changes from 2013 to 2022**
Amaranthaceae	1	1	1	1	No change all years.
Apiaceae	1	1	1	2	2019: 1 native species and genus (*Apium*) gained and 1 native species and genus (*Daucus*) lost. 2022: 2 native species gained (*Homalosciadium* & *Daucus*) and *Apium* lost.
Araliaceae	3	3	3	3	2022: No change. Three species of *Trachymene* still

					present
Asparagaceae	1	2	2	2	2016: 1 native species and genus (*Dichopogon*) gained, *Thysanotus* still present. 2022 No change.
Asteraceae	18	16	14	20	2016: Two native Senecio lost and one native Podotheca gained. All annuals. One weed species (a *Cotula*) lost. 2019: 3 native species and 2 genera (*Millotia*, *Podotheca*) lost and 1 native species and genus (*Rhodanthe*) gained. 2022: One weed (**Conyza bonariensis*) and one native (*Podotheca* aff. *gnaphalioides*) lost. Two weeds regained (**Hedypnois rhagadioloides* and **Sonchus oleraceus*) and four natives regained (two *Podotheca*, *Gilberta* and *Podolepis canescens*).
Brassicaceae	1	1	1	1	No change all years.
Moss	1	1	1	1	No change all years.
Campanulaceae	1	2	2	2	2016: One annual species gained. 2019: No change. 2022: No change.
Caryophyllaceae	2	2	2	2	No change all years.
Casuarinaceae	2	2	2	2	No change all years.
Chenopodiaceae	0	0	0	1	2016: One annual native species and genus lost (Salsola). 2022: One species gained (*Rhagodia preissii*).
Convolvulaceae	0	1	1	1	2016: One *Cuscuta* species gained. 2019: No change. 2022: No change.
Crassulaceae	0	0	1	1	2019: 1 species of *Crassula* gained. 2022: Second variety gained,
Cyperaceae	1	1	1	1	No change all years.
Dilleniaceae	1	1	1	1	No change all years.
Dioscoreaceae	1	1	1	1	No change all years.
Droseraceae	0	2	0	1	2016: Two native species gained (two Drosera species). 2019: 2 native species lost and 1 genus (Drosera). 2022: 1 *Drosera* gained.
Euphorbiaceae	0	0	0	1	2022: *Euphorbia drummondii* gained.
Geraniaceae	2	2	2	2	No change all years.
Goodeniaceae	1	2	0	2	2016: One native species and genus gained (*Brunonia*). 2019: One native species and genus lost (*Brunonia*). 2022: *Goodenia* and *Brunonia* regained.
Hemerocallidaceae	1	1	1	0	2022: One species lost (*Chamaescilla corymbosa*).
Iridaceae	1	1	1	1	No change all years.
Loganiaceae	0	0	0	1	2022: One genus and species gained (*Phyllangium*).
Malvaceae	1	0	0	0	2016: One perennial species and genus (*Alyogyne*) lost (but still adjacent to the quadrat). 2022: No change.
Mimosaceae	5	5	4	4	2016: One native species lost & one gained. Both perennial. 2019: One native species lost. 2022: No change.
Myrtaceae	4	4	4	4	No change all years.
Orchidaceae	0	1	4	3	2016: One native species and genus gained (Microtis). 2019: 3 native species and 2 genera gained (*Caladenia* and *Pterostylis*). 2022: *Caladenia* lost.
Orobanchaceae	1	1	0	1	2022: **Orobanche minor* re-appeared.
Papilionaceae	4	7	6	6	2016: Three weed species gained and one genus (*Lupinus*). 2019. 1 species lost. 2022: No change.
Pittosporaceae	1	0	0	0	2016: One native species and genus lost (*Billardiera*).
Poaceae	16	18	17	17	2016: 2 native genera *Neurachne* (perennial) & *Aristida* (annual) gained. 1 weed species and genus (*Cynodon*) lost & one annual weed species & genus (*Lamarkia*) gained. 2019. 1 species and 1 genus (*Lamarkia*) lost. 2022: No change.

Polygalaceae	1	1	1	1	2022: No change.
Polygonaceae	1	0	0	0	2016: One native species and genus lost (*Muehlenbeckia*). 2022: No change.
Portulacaceae	0	2	0	2	2016: Two native species and one genus (*Calandrinia*) gained. 2019. 2 species and 1 genus (*Calandrinia*) lost. 2022: 2 *Calandrinia* regained.
Primulaceae	1	1	0	1	2019. 1 species and 1 genus (*Lysimachia*) lost. 2022: **Lysimachia* regained
Proteaceae	1	0	0	1	2016: One native species and genus lost (Dryandra). 2022: *Dryandra* regained.
Pteridaceae (Ferns)	1	2	2	2	2016: One native species of Cheilanthes gained. 2022: No change.
Restionaceae	1	1	1	1	No change all years.
Rhamnaceae	1	0	0	0	2016: One native species and genus lost (*Cryptandra*).
Scrophulariaceae	0	1	1	1	2016: One weed species and genus (**Parentucellia*) gained. 2022: No change.
Solanaceae	2	0	0	1	2016: One native and one weed species of *Solanum* lost. 2022: One weed gained.
Sterculiaceae	1	0	0	0	2016: One native species and genus lost (*Guichenotia*).
Stylidiaceae	2	2	1	2	2016: 1 *Stylidium* lost & 1 *Stylidium* gained (native perennials). 2019. 1 species lost. 2022: One *Stylidium* regained.
Verbenaceae	1	0	0	0	2016: One native species and genus lost (*Quoya*). 2022: No change

7.3 Families and genera with the most species

The two families with the most species recorded in 2022 are the same as in all previous years; Poaceae (Grass family) and Asteraceae (Daisy family). Of interest is that these two families have different stability in their species numbers in the rehabilitation. The Poaceae have been almost stable from 2013, while the Asteraceae have fluctuated significantly in species numbers. While the Poaceae had sixteen species in 2013 and increased to eighteen in 2016 since then it has been stable on seventeen species. Over the same period the Asteraceae had eighteen in 2013, dropped to sixteen in 2016 and fourteen in 2019. It then rebounded to 2022. This family is apparently more influenced by seasonal conditions than the Poaceae. Both of these families have a mixture of weeds and native species in the quadrats.

The next most speciose family in the quadrats is the Papilionaceae (Pea family) with six species, the same as in 2019. This family increased from four to seven species in 2016, but has had six since 2019. The Mimosaceae (Wattle family) had five species in 2013 and 2016 dropped to four in 2019 and has stayed there.

Three of the four genera with the most species (Table 5) are native genera. *Acacia* (Mimosaceae, Wattle family) a genus of woody shrubs and trees, *Austrostipa* (Poaceae, Grass family) a genus of mostly small tussock grasses and *Trachymene* a genus of small herbaceous annuals belonging to the

Araliaceae. **Trifolium* (Clovers, Pea family) is the other genus with several species in the rehabilitation and had four species recorded in 2016, up from two in 2013 and dropping to three in 2019 and 2022.

Table 5: Genera with the highest number of taxa recorded in 2022

Genus	**Number of species in the rehabilitation**
Acacia (native)	4 (two lost since 2013)
Austrostipa (native)	4 (same as 2013 on)
**Trifolium* (weed)	3 (2 in 2013, 4 in 2016, 3 in 2019 on)
Trachymene (native)	3 (same as 2013, 2016, 2019 and 2022)

7.4 Frequently recorded species in quadrats – changes from 2013 to 2022

The species most frequently recorded in the quadrats recorded are a combination of native species and weeds. At previous recordings, the native species (particularly the perennial ones) were gradually declining in their presence in quadrats while the weeds were gradually increasing in presence. The wet year in 2022 (and possibly the year before) has to some degree reversed this. However, the reversal is significantly in seedlings and juvenile plants of native species and these have to establish, including survive the 2022/2023 summer. The changes from 2013 through to 2022 for frequently recorded species are shown in Table 6.

The four largest native perennial species that are more common in the quadrats are *Regelia megacephala* (a Priority 4 native shrub), *Allocasuarina huegeliana* (a tree Sheoak), *Allocasuarina campestris* (a shrub Sheoak) and *Acacia congesta* subsp. *congesta*. The most frequently occurring smaller shrub is *Hibbertia subvaginata*.

In a turnaround since 2019, *Acacia congesta* subsp. *congesta* was recorded at eleven quadrats up from six in 2019. However, at five quadrats only seedlings or juvenile plants were recorded in 2022 and it remains to be seen if they can survive to be adults. Of interest is that three of the quadrats with *Acacia congesta* seedlings are from the oldest (1991, North Waste Dump) group of quadrats that have high weed invasion and high *Allocasuarina huegeliana* cover. As 2019 was dry year and 2022 a wetter year, it seems likely that rainfall differences are the cause of the drop in the number of quadrats with *Acacia congesta* in 2019 and the increase in 2022.

Allocasuarina huegeliana has remained present in all quadrats from 2013 to 2022, although there have been some changes in the numbers of individuals in quadrats. After declining to present in

nine quadrats in 2016 *Allocasuarin*a *campestris* increased presence in one quadrat in each of 2019 and 2022.

The total number of plants of *Allocasuarina campestris* declined, mostly due to the drop from ca. 300 plants in 2019 to ca. 120 plants in 2022 in quadrat 98/01. However, there were some small drops in numbers of plants in other quadrats. *Allocasuarina huegeliana* had small drops in numbers in some quadrats but also had a large drop in quadrat 98/02 where juvenile plants recorded in 2019 largely did not survive to 2022. However, three plants had established in this quadrat, a more sustainable number.

Regelia megacephala was present in eleven quadrats in 2022, down from twelve in 2019. The number of individual *Regelia* plants dropped from ca. 289 in 2019 to 73 in 2022, this was largely the loss of unsustainable density of young plants in some quadrats.

Hibbertia subvaginata was presence in twelve quadrats in 2019 dropping to eleven in 2022, the total number of *Hibbertia* plants dropped from ca. 356 in 2019 to ca. 233 in 2022 this was largely the loss of smaller plants from quadrats where more plants than sustainable germinated. *Thysanotus patersonii/manglesii* two closely related climbers were present in quadrats in six quadrats in 2019 increasing to nine in 2022. This species pair (which are difficult to tell apart if not in flower) is unusual in that they appear to be able to invade fairly weedy sites and increase their presence in them.

Austrostipa trichophylla is a small perennial native grass that increased slightly in the number of quadrats it occurred in between 2013 and 2016, but declined between 2016 and 2019 and again between 2019 and 2022.

Of the three native annuals in the most frequently occurring species, two (*Trachymene cyanopetala* and *Ptilotus polystachyus* var. *polystachyus*) both occurred in more quadrats in 2016 than in 2019 and then occurred in more quadrats in 2022. The third species (the annual daisy *Podolepis lessonii*) increased between 2013 and 2016 and again between 2016 and 2019 but then was lost from one quadrat in 2022. This species tends to be fairly abundant in the native vegetation stands it occurs in and it may continue to increase where weeds are less abundant. However, it may decline if weed levels continue to increase.

Table 6: The most frequently recorded species in the quadrats in 2013, 2016 and 2019

Notes: To maintain valid comparison with 2013, the 16 quadrats recorded then and in 2016 are used (one recorded in 2016 but not 2013 is omitted). An * denotes a weed species. Grey highlight means a decrease in the number of quadrats a native species was recorded in. Blue highlight means an increase for native species, light brown an increase for a weed and green a decrease for a weed.

Species [Highlighted species are annuals]	**2013 # of quadrats occurred in**	**2016 # of quadrats occurred in**	**2019 # of quadrats occurred in**	**2022 # of quadrats occurred in**
Acacia congesta subsp. *congesta*	6	9	6	11
Allocasuarina campestris	11	9	10	11
Allocasuarina huegeliana	16	16	16	16
Austrostipa trichophylla	10	10	7	7
Hibbertia subvaginata	13	11	12	11
Podolepis lessonii	4	9	12	11
Ptilotus polystachyus var. polystachyus	1	6	2	6
Regelia megacephala	14	11	12	11
Thysanotus patersonii	4	3	6	9
Trachymene cyanopetala	7	10	8	9
**Arctotheca calendula*	9	11	10	15
**Avena barbata*	15	14	15	15
**Brachypodium distachyon*	5	7	6	8
**Briza maxima*	12	12	11	5
**Bromus rubens*	1	4	6	6
**Ehrharta longiflora*	15	15	15	15
**Erodium botrys*	12	8	9	11
**Hypochaeris glabra*	16	15	16	16
**Lupinus cosentinii*	0	3	7	2
**Pentameris airoides*	12	13	6	7
**Trifolium arvense* var. *arvense*	12	12	7	8
**Monoculus monstrosus*	0	10	11	11
**Urospermum picroides*	13	14	8	10
**Ursinia anthemoides*	16	16	16	16
**Vulpia myuros*	16	15	16	11

Several of the most commonly occurring weed species occur in most of the quadrats (see Table 6 above). Several of these species, including **Arctotheca calendula*, **Brachypodium distachyon* and **Urospermum picroides* have invaded more quadrats by 2022 than in 2019. Others that are in most of the sixteen quadrats have maintained the number they were recorded in in 2019, while three were recorded in fewer quadrats. Two of this three, **Briza maxima* and **Vulpia myuros* are smaller annuals and may be being out-competed by the larger weed grasses. The notable decrease was **Lupinus cosentinii*, this robust annual seemed from previous data likely to increase, but was lost from five quadrats. It may be just a random variation, or may reflect the fact that the species prefers less harsh sites, such as lower slopes in the New North Waste Dump.

7.5 Losses and gains of native species at quadrats by life form

While losses and gains of the most commonly recorded species give one view of what is happening in the regeneration, overall losses and gains of species of different life forms gives a further

understanding of the evolution of the composition of the rehabilitation vegetation. Table 7 shows the losses and gains of native species of different life forms from the sixteen quadrats recorded in 2013, 2016, 2019 and 2022.

There was no change in the tree life form, with *Allocasuarina huegeliana* in all quadrats, *Eucalyptus camaldulensis* (River Red Gum) in three and *Acacia acuminata* (Jam) in one. For the four large shrubs, *Acacia congesta* subsp. *congesta* was gained at five quadrats (but mostly seedlings) and *Allocasuarina campestris* at one. While *Regelia megacephala* was lost at one quadrat and *Kunzea praestans* was not changed. There are few species of small shrubs in the rehabilitation (which is a feature of the natural vegetation of the chert vegetation), with *Hibbertia subvaginata* the only such species common in the rehabilitation, it was lost at one quadrat in the 2022 data. Two other small shrubs that are present in the rehabilitation are *Calytrix* aff. *leschenaultii* (Moora) and *Bossiaea moylei*, which were both lost at one quadrat.

At the 2019 recording the two shrub categories (see Table 7) had more losses than gains, continuing the trend in the 2016 results. This was taken to indicate that the loss of shrubs seen in the oldest rehabilitation (the 1991 area) was also happening in the younger areas. At the 2022 recording there has been some reversal in the large shrub category. In 2022 *Acacia congesta* subsp. *congesta* was recorded at five quadrats it was not recorded at in 2019, while *Allocasuarina campestris* and *Dryandra sessilis* were each recorded at one additional quadrat. *Kunzea praestans* was unchanged and *Regelia megacephala* was lost at one quadrat. However, the gains were of seedlings and juveniles and may or may not survive to become adults.

The small shrub category unfortunately has lost three species from one quadrat each (*Calytrix* aff, *leschenaultii*, *Acacia lasiocarpa* and *Acacia stenoptera*) and has gained a new species (*Rhagodia preissii*) at one quadrat. These species are not common in the rehabilitation, but the losses do show a continuation of a trend. On the other hand *Hibbertia subvaginata* has maintained presence in all the eleven quadrats it was recorded at in 2019.

Perennial herbs were gained at nine quadrats and lost at three in 2022, compared to gained at five and lost at 2 quadrats in 2019. The species involved are all quite small but include two (*Dichopogon capillipes* and a *Microtis*) that seem able to survive and invade weedy areas. The contribution of these taxa to the rehabilitation at this stage is quite small.

Native climbing and running species were gained at eight quadrats at the 2022 recording, up from six at in 2019. In contrast to 2019, there were no losses of this life form. The most common species in this group are Thysanotus patersonii and Thysanotus manglesii, which are both climbers that have annual stems and perennial tubers.

There are two small Cheilanthes (Rock Ferns) that occur in the rehabilitation (and in the Chert native vegetation), they were gained at six quadrats and lost in none at the 2022 recording. This is of the change from 2016 to 2019 where there were five losses and two gains.

There was minor change in the perennial grasses, with the somewhat surprising loss of *Austrostipa elegantissima* from two quadrats. Other changes were the loss of *Austrostipa trichophylla* from one quadrat and the loss of *Rytidosperma acerosum* from one quadrat and gain at another. The only native annual grass in the rehabilitation is *Aristida contorta* which was gained at three quadrats. This species was recorded at one quadrat in 2016, but not in 2019.

The largest numbers of gains of native species at quadrats was for annual herbs, as was the case at the 2016 and 2019 recordings. The gain of a species at quadrats 43 times is quite significant with the loss of species at quadrats ten times somewhat less so. Most of the gains were at quadrats with lower weed cover (usually in younger areas of the rehabilitation. The larger numbers of losses and gains in this category compared to other categories is a reflection of the fact that it has the most species. The most significant aspect of the gains is that species that were not recorded in the rehabilitation before or not since 2013 were recorded.

The totals at the bottom of Table seven show that gains of species at quadrats in 2022 was nearly four times as high as losses. This is a reversal from the 209 recording when losses outnumbered gains and a higher proportion of gins than in 2016. It seems likely that the dry year in 2019 (and some other years) suppressed species and there has been some recovery. However, as the gains have mostly been in annual herbs the long term impact on rehabilitation success is not as great as it at first seems.

Table 7: Losses and gains of native species at quadrats by life form
Notes: The table covers the 16 quadrats recorded in 2013, 2016, 2019 and 2022.

Life form	Species gained at number of quadrats in 2016	Species lost at number of quadrats in 2016	Species gained at number of quadrats in 2019	Species lost at number of quadrats in 2019	Species gained at number of quadrats in 2022	Species lost at number of quadrats in 2022
Trees	1	1	2	0	0	0
Large shrubs	3	6	0	3	7	1
Small/medium shrubs	5	10	1	2	1	3
Perennial grasses	8	11	3	5	2	3
Annual grasses	1	0	0	1	3	0
Annual herbs	35	11	17	26	43	10
Perennial herbs	3	1	5	2	9	3
Ferns	6	0	1	4	6	0
Climber/creeper[#]	4	11	6	5	8	0
Totals	**66**	**51**	**35**	**49**	**79**	**20**

#All climbers except *Kennedia prostrata*.

7.6 Losses and gains of weed species at quadrats by life form

The range of life forms in the weed species in the rehabilitation is less than in the native species, with only three weed species present in the rehabilitation not being either an annual herb or an annual grass. Table 8a shows the numbers of weed species lost and gained at quadrats by life form between 2013 and 2016, 2016 and 2019 and 2019 to 2022.

Table 8a: Losses and gains of weed species at quadrats by life form
Notes: The table covers the 16 quadrats recorded in 2013, 2016 and 2019.

Life form	Number of quadrats species gained at 2016	Number of quadrats species lost at 2016	Number of quadrats species gained at 2019	Number of quadrats species lost at 2019	Number of quadrats species gained at 2022	Number of quadrats species lost at 2022
Annual herbs	56	12	10	47	44	13
Annual grasses	10	6	8	18	5	18
Small short lived shrub (**Solanum nigrum*[#])	0	1	-	-	1	0
Perennial root parasite (**Orobanche minor*)	3	0	0	5	0	1
Perennial herb (*Romulea rosea)	0	1	1	0	1	1

[#] **Solanum nigrum* often behaves as an annual in dryer habitats.

Table 8a shows that for annual grass weeds the rate of invasion of quadrats (quadrats gained at) dropped in 2019 and then dropped further in 2022. This is probably simply due to the number of quadrats the members of this group of species were not already in being low. On the other hand the number of quadrats where members of this group were lost increased to eighteen in 2019 and stayed at eighteen in 2022. This is a reflection of the fact that the smaller grass weeds were in many quadrats before the weed cover became high and as it has increased they have been out-competed by larger other weed species (both grasses and herbs).

The gains in the annual herb category has shown more response to seasonal conditions, with a drop from 56 to ten between 2016 and 2019 and then a rise between 2019 and 2022 of 44 species at quadrats. The loss in this category shows the reverse, in 2016 the loss was 12 and in 2019 it was 47, but it then drops to 13 in 2022, this is again probably a result of the dry year in 2019.

Some of the introduced grasses, particularly **Ehrharta longiflora* and to a lesser degree **Brachypodium distachyon* increased significantly in cover in some quadrats between 2016 and 2019. However, between 2019 and 2022 the changes were mixed, with a few sites showing increase in cover of **Ehrharta longiflora* and others showing decreases or little change. The data for **Brachypodium distachyon* is similar with two sits showing a significant decrease and others either little change or reappearance at low cover after being lost in 2019. Table 8b shows the cover and estimated number of plants of **Ehrharta longiflora* at the 2016, 2019 and 2022 recordings of the quadrats, with overall losses and gains of species.

Table 8b: Changes in cover and number of individuals of **Ehrharta longiflora* at quadrats and overall loss and gains of species

Notes: The quadrats are in age sequence with the oldest four (1991) at the top and the youngest (2007) at the bottom. The table includes all the 17 quadrats recorded in 2016 and 2019. The columns with highlighted header cells related to **Ehrharta longiflora*.

Quadrat	Species	Cover 2016	Cover 2019	Cover 2022	Est. number plants 2016	Est. number plants 2019	Est. number plants 2022	# species lost (gained) 2016/19	# species lost (gained) 2019/22
R91/01	Ehrharta longiflora	< 10%	> 25%	< 5%	> 400 small plants	> 1500 plants (most small).	Ca. 200	13 (3)	5 (10)
R91/02	Ehrharta longiflora	> 20%	> 25%	20%	> 300 plants	> 500 plants.	> 1,000	10 (4)	2 (9)
R91/03	Ehrharta longiflora	15%	≤ 30%	> 25%	> 500 plants	> 1,500 plants	> 1,500 plants	10 (1)	6 (10)
R91/04	Ehrharta longiflora	15%	35%	> 35%	> 600 plants	> 2,000 plants	> 2,000 plants	10 (1)	5 (5)
R96/01	Ehrharta longiflora	>10%	10%	≤10%	> 400 plants	> 4500 plants	Ca. 1,000	10 (2)	0 (7)
R96/02	Ehrharta longiflora	5-10%	5-10%	< 5%	> 150 plants	> 150 plants.	> 150 plants.	5 (3)	1 (7)

R98/01	Ehrharta longiflora	3-5%	+	+	>150 plants	1 plant!	[Few]	7 (6)	6 (9)
R98/02	Ehrharta longiflora	≥ 4%	≥ 4%	5%	> 200 plants.	> 200 plants.	> 500 plants	4 (0)	0 (10)
R00/01	Ehrharta longiflora	≤ 10%	≤ 5%	2%	> 500 plants.	> 500 plants.	> 200 plants	10 (2)	6 (7)
R00/02	Ehrharta longiflora	≥ 3%	1-2%	10%	> 300 plants.	> 300 plants.	> 500 plants	10 (7)	8 (10)
R01/02	Ehrharta longiflora	< 5%	< 5%	1%	> 200 plants.	> 500 plants.	< 100 plants	4 (2)	2 (9)
R02	Ehrharta longiflora	5%	5%	</= 5%	> 400 plants.	> 400 plants.	> 400 plants	9 (5)	6 (11)
R04(22)	Ehrharta longiflora	4%	5%	5%	> 100 plants.	> 100 plants.	> 1,000 plants	5 (1)	1 (6)
R05(27)	Ehrharta longiflora	1-2%	1-2%	< 3%	> 100 plants.	> 100 plants.	> 400 plants	3 (7)	3 (10)
Area 33	Ehrharta longiflora	1-2%	< 1%	1-2%	> 100 plants.	> 100 plants?	> 200 plants	3 (2)	2 (14)
[!]Area 37	Ehrharta longiflora	2%	< 1%	< 1%	> 150 plants	< 100 plants	< 50 plants	9 (3)	2 (1)
[#]Area 41	[Not present]	-	-		-	-	-	4 (8)	6 (6)

[#]This quadrat had low weed cover in both recording years, but is very exposed with a rocky surface and also has low overall cover. [!]This quadrat also has a rocky surface and low weed cover, but has high cover of native species.

The right hand column of Table 8b gives the number of species (native and weeds combined) lost and gained between 2016 and 2019. At 2019, the overall trend was of more species lost and fewer gained in older quadrats than younger ones that correlates with higher cover and number of individuals of **Ehrharta longiflora*. However, in the 2022 data three pf the older quadrats had high gains although the highest gins were in the younger quadrats. The results may be partly due to a "bounce back" from the dry period at 2019, as the older quadrats had high losses of species in that period.

The variation seems be largely due to variation in the material underlying quadrats (and possibly their degree of slope), which (with an overlay of age that becomes more significant as quadrats age) appears to favour different weed species (and survival/regeneration of native species). There is then likely to be some interaction (competition) between weeds species.

7.7 Species richness for the different ages of the rehabilitation

The species richness (number of species in a quadrat) of the different ages of the rehabilitation (see Table 9 below) has varied quite markedly. While the data is such that it is not easy to be definitive about trends it is apparent that native species diversity (especially perennial species) has generally declined and weed diversity has increased as quadrats become older. Overlain on this is a drop in both native and weed species in the 2019 data due to the dry period around that year and some

recovery in the number of both categories in the 2022 data. It remains to be seen whether or not the drop in 2019 actually masked some overall (native plus weed) increase in diversity.

The recovery in native species is largely of annual species and cryptophytes (species with perennial below ground organs (bulbs etc.) and annual above ground stems. However, there has been sporadic germination of native perennial species as well. It seems that factors like slope and rehabilitation material have a significant effect, with the latter possibly being more significant.

Table 9: Species richness in the rehabilitation quadrats for 2013, 2016, 2019 and 2022

Notes: The table covers the 16 quadrats recorded in 2013, 2016, 2019 and 2022 and the quadrat from Area 37 not recorded in 2013. Note the different number of quadrats for different ages, the numbers are averages when there is more than one quadrat for an establishment year (highlighed pale blue years). The numbers in red are the number of years since areas were regenerated.

Year quadrats established and codes	**Number of quadrats**	**2013 Total # species & % weed species**	**2016 Total # species & % weed species**	**2019 Total # species & % weed species**	**2022 Total # species & % weed species**
1991 R91 quadrats	4	37 species [22yrs] 17 weeds (46%)	50 species [25yrs] 26 weeds (52%)	31 species [28yrs] 15 weeds (48.4%)	24 species [31yrs] 10 weeds (45%)
1996 R96 quadrats	2	27 species [17yrs] 22 weeds (81.5%)	27 species [20yrs] 20 weeds (74%)	20 species [23yrs] 14 weeds (70%)	23 species [26yrs] 15 weeds (65%)
1998 R98 quadrats	2	25 species [15yrs] 11 weeds (44%)	29 species [18yrs] 17 weeds (59%)	24 species [21yrs] 12 weeds (50%)	24 species [24yrs] 15 weeds (60%)
2000 R00 quadrats	2	23 species [13yrs] 14 weeds (70%)	40 species [16yrs] 21 weeds (52.5%)	34 species [19yrs] 16 weeds (47%)	27 species [22yrs] 13 weeds (48%)
2001 R01 quadrat	1	13 species [12yrs] 9 weeds (69%)	21 species [15yrs] 14 weeds (67%)	16 species [18yrs] 11 weeds (68.8%)	23 species [21yrs] 13 weeds (57%)
2002 R02 quadrat	1	35 species [11yrs] 14 weeds (40%)	39 species [14yrs] 17 weeds (44%)	35 species [17yrs] 13 weeds (37%)	40 species [20yrs] 15 weeds (38%)
2004 R04 quadrat	1	32 species [9yrs] 17 (53%)	27 species [12yrs] 16 weeds (59%)	20 species [15yrs] 13 weeds (65%)	26 species [18yrs] 17 weeds (65%)
2005 qdts R05 & Area 33	2	33 species [8yrs] 13 weeds (39.4%)	36 species [11yrs] 14 weeds (38.9%)	37 species [14yrs] 14 weeds (37.8%)	37 species [17yrs] 13 weeds (35%)
2006 Area 37 qdt	1	Not recorded.	33 species [7yrs] 12 weeds (36%)	28 species [10yrs] 10 weeds (35.7%)	29 species [13yrs] 11 weeds (38%)
2007 Area 41 qdt	1	15 species [6yrs] 9 weeds (60%)	21 species [9yrs] 10 weeds (48%)	23 species [12yrs] 10 weeds (43.5%)	22 species [15yrs] 8 weeds (36%)

7.8 Records of Declared rare, priority and other significant flora in the rehabilitation

The species of particular conservation interest recorded in the rehabilitation quadrats in 2022 were *Regelia megacephala* (Priority 4), *Bossiaea moylei* (Priority 2) and a geographically restricted unnamed species of *Calytrix* (a Starflower) related to *Calytrix leschenaultii* (called here *Calytrix* aff. *leschenaultii* (Moora)). The latter species has only been recognised as distinct, it is fairly common

in the Chert Threatened Ecological Community, but is geographically quite restricted (it is also very pretty when in flower). It is likely to be given a Priority Flora designation in due course.

Two other species of significant flora that were recorded in in the quadrats in 2103 (and earlier years), the Declared Rare Flora species *Acacia aristulata* (found in two quadrats in 2013) and the Priority 2 species *Cryptandra glabriflora* were no longer present in 2016. The record of *Cryptandra glabriflora* in 2013 at one quadrat in the area rehabilitated in 2002 was the only record for this species in the rehabilitation quadrats. Prior to 2013, *Acacia aristulata* has also been lost from rehabilitation areas established in 1991 and 1996, in locations where it had been previously recorded. Another declared rare flora species *Daviesia dielsii* had been recorded before 2013 in the rehabilitation areas established in 1996 and 1998, but has not reappeared. It is possible that some seed of *Daviesia dielsii* and *Acacia aristulata* may be present in the seed bank in the rehabilitation areas; if that is the case then the species may appear after fire or in better years. The records of relevant species are shown in Table 10 for 2013 on.

The grass Tree (*Xanthorrhoea*) that is common in the vegetation of the Chert Threatened Ecological Community is now considered to be a distinct species that it is restricted to that vegetation and is another geographically restricted species. It has previously been referred to *Xanthorrhoea drummondii*, a name that has been misapplied to several undescribed taxa as well as applied to the real entity (which occurs further south). It has not yet been recorded in the rehabilitation.

Table 10: Declared rare, priority and other significant flora in the rehabilitation 2013 to 2022
Note: DRF = Declared Rare Flora; P2, P4 = Priority Flora 2, 4: Geog Restr. = Geographically Restricted. Plants in quadrats lost between two years highlighted grey. Plants present in a highlighted pale green. NN01 and NN02 are the two quadrats installed and recorded on the "New North" waste dump in 2022.

Species and status	**Quadrat**	**Presence/ absence 2013**	**Presence/ absence 2016**	**Presence/ absence 2019**	**Presence/ absence 2022**
Acacia aristulata Declared Rare	R04(22)	Present	Lost	-	-
	R05(27)	Present	Lost	-	-
	NN01	Not relevant	Not relevant	Not relevant	Present
	NN02	Not relevant	Not relevant	Not relevant	Present
Calytrix aff. Leschenaultii (Moora) Geographically restricted	Area 33	Present	Present	Present	Present
	R02	Present	Lost	-	-
	Area 37	(Quadrat not recorded in 2013)	Present	Present	Present
	R05(27)	Not present	Present	Present	Present
Cryptandra glabriflora Priority 2	R02	Present	Lost	-	-

Regelia megacephala Priority 4	R91/02	Present	Present	Present	Present
	R91/03	Present	Present	Present	Present
	R91/04	Present	Present	Present	Present
	R96/01	Present	Lost	-	-
	R96/02	Present	Present	Present	Present
	R98/01	Present	Present	Present	Present
	R98/02	Present	Present	Present	Present
	R00/01	Present	Present	Present	Lost
	R00/02	Present	Present	Present	Present
	R01/02	Present	Present	Present	Present
	R02	Present	Present	Present	Present
	R04(22)	Present	Present		
	R05(27)	Present	Lost	-	-
	Area 33	Present	Present	Present	Present
	Area 37	(Quadrat not recorded in 2013)	Present	Present	Present
Bossiaea moylei Priority 2	R00/02	Lost	Present	-	-
	R04(22)	Present	Present	Present	Present
	Area 37	(Quadrat not recorded in 2013)	Present	Present	Present

A number of other priority flora or DRF species, including: *Baeckea* sp. Moora (P1), *Goodenia arthrotricha* (P1), *Nemcia acuta* (P3), and *Tricoryne arenicola* (P2) are known from the Coomberdale Chert Threatened Ecological Community. Their absence from the rehabilitation is probably due to them being unevenly spread in the TEC and seed not being present in the areas topsoil was obtained from. The low occurrence of these species in the TEC is probably due to being restricted to very specific habitats (especially soil profile characteristics).

The rehabilitation progress to date has shown that the Priority 4 species *Regelia megacephala* can be successfully germinated and grown on the waste dumps when new areas are rehabilitated. However, there has been a general decline in the abundance of the species correlated with increased cover of *Allocasuarina huegeliana* and increase in weed cover. There have been exceptions to this in quadrats with low weed cover when old plants have died, their retained seed has fallen and conditions have suited germination and establishment. One event different to this is that in quadrat R91/04, which has moderate to high cover of weeds and moderate cover of *Allocasuarina huegeliana* had a young *Regelia* in 2022, the first young plant of this species in the four 1991 quadrats for quite some years.

7.9 Changes in the vegetation of the 1991 rehabilitation on the North Waste Dump

The 1991 rehabilitation area is the oldest, but the current set of quadrats was established in 2000 as earlier wooden pegs were no longer identifiable. Before 2000, the 1991 area was invaded by the native tree *Allocasuarina huegelii* (the winged seed of which can be wind distributed). The subsequent development of low woodland to low open forest of this species in the area has affected the survival of other species. The density and age of the *Allocasuarina* in this area is not typical of other rehabilitation areas, this is probably partly due to the different age of stands and partly due to different slopes and soil conditions. However, this does not mean that the processes affecting the vegetation in this area do not have similarities to the processes in the other areas. More attention is given to this area because it is the oldest area of the rehabilitation and therefore should offer insight to what long term outcomes for the rehabilitation will be. In addition, it is the only area with four quadrats, making the analyses for this area somewhat more robust statistically.

7.9.1 Changes in cover of tree and shrubs species in the 1991 rehabilitation

Figure 4 shows the changes in the average cover in the four quadrats since 2000 of the five perennial species that are or have been most significant in the vegetation structure developed in the 1991 rehabilitation on the North Waste Dump.

Prior to the 2016 recording, the tree species *Allocasuarina huegelii* had been increasing in cover, but in the 2016 data there was a fairly dramatic. There was then a slight increase in and a moderate increase in 2022. The large shrub *Regelia megacephala* had shown a drop in cover from 2000 to 2010 and then a slight rise to 2013, since then it has declined significantly. However, in 2022 there was one young plant suggesting that limited recovery is possible for this species. *Allocasuarina campestris* had stabilised at about 10% average cover in the four quadrats between 2010 and 2013, dropped in cover in 2016 and has increased somewhat since then. Acacia congesta had been recorded in three of the quadrats, but by 2010 had decreased to virtually no cover. In 2022 there were four juvenile plants in one quadrat and two seedlings in another, indicating that there is sol stored seed of this species. *Hibbertia subvaginata* has also dropped to very low cover, although there was a slight increase in 2022.

It seems likely that the dry years in 2109 and prior to 2016 (see climate section) caused parts of the drops in cover of species in the 1991 rehabilitation area, but that it effected different species somewhat differently.

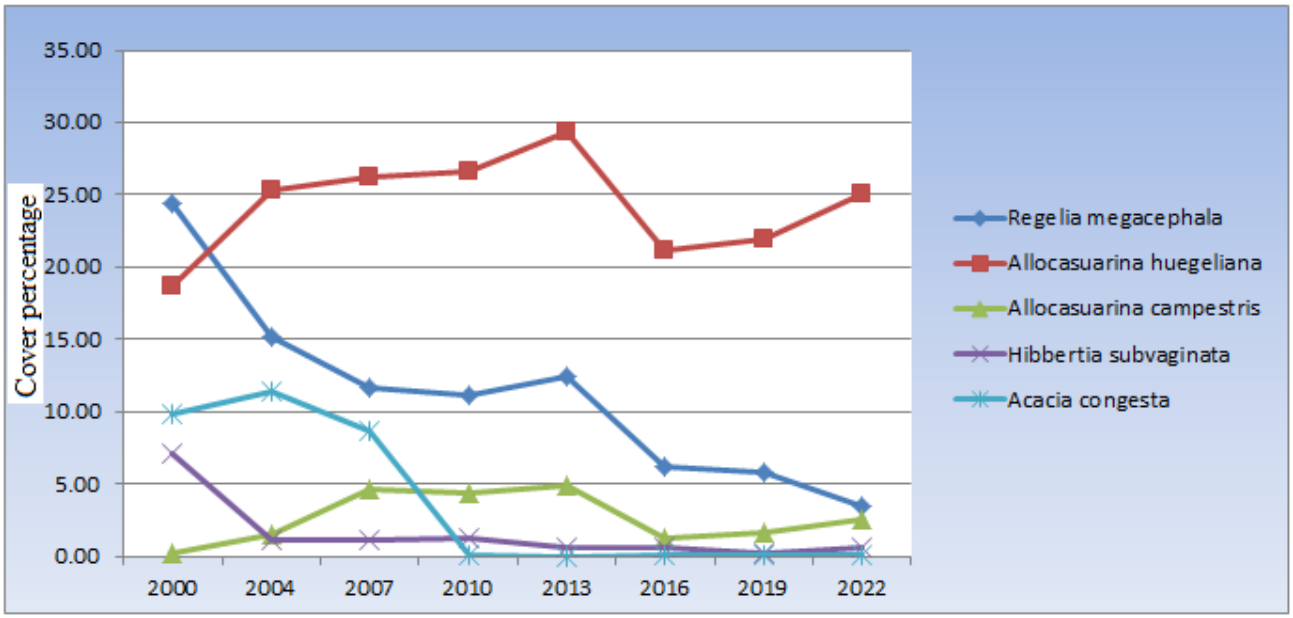

Figure 4: Average percentage cover of five perennial species in the four quadrats in the 1991 rehabilitation on the North Waste Dump

Figure 5 (see below) shows the average number of live and (recently) dead *Regelia megacephala* plants in the four quadrats in the 1991 area rehabilitation. While both categories show a downward trend, there has been significant germination of the *Regelia* at times; with many of the individuals that have been recorded in different years being seedling (which if they die soon after a recording may no longer be available to score as "dead" at the next recording). It is likely that the main reason none of these young *Regelia* plants have established is because the *Allocasuarina huegeliana* is too strong a competitor for water in the summers after germination. There were two juveniles of the *Regelia* in one of the quadrats at the 2019 recording and one young plant in one in 2022.

Acacia congesta subsp. *congesta*, the only *Acacia* species recorded in all four quadrats in the north waste dump rehabilitation in the 2000-2007 surveys, had almost completely disappeared from the 1991 quadrats by 2010. In that year, it was only present in quadrat R91/04 with cover recorded as "+" (= much less than 1% cover). In the 2016 data it was present as seedlings in two of the four quadrats, in 2019 was not present, but in 2022 was present in two quadrats as either juveniles or seedlings. It seems there is soil stored seed of this species in the 1991 area, but that survival through summer is a barrier to successful establishment.

The smaller shrub *Hibbertia subvaginata*, which is common in the Chert Threatened Ecological Community, was present in three quadrats in 2013 at low cover; by 2016 it was only present in two quadrats but had increased in cover at one of these. At the 2019 recording the *Hibbertia* was still

present in two quadrats with one plant in each with cover of < 1% and 1-2%. In 2022 only change for this species was a slight drop in cover.

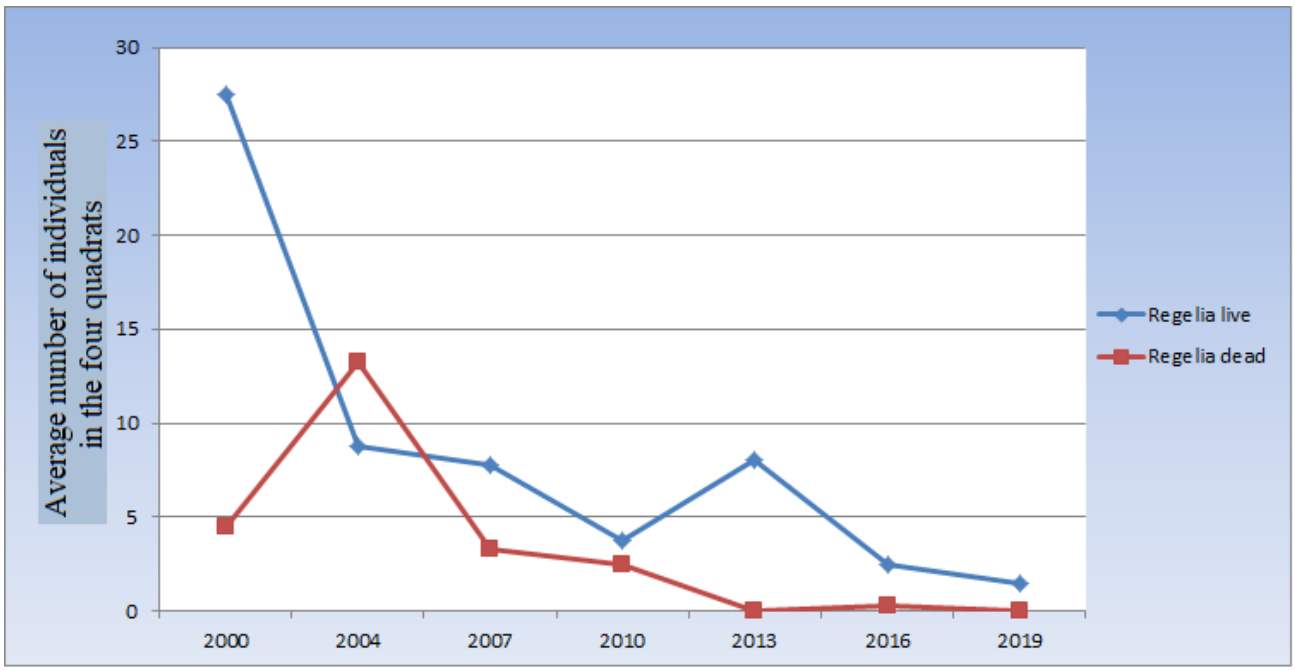

Figure 5: Average number of live and dead *Regelia megacephala* plants in the four quadrats in the 1991 rehabilitation on the North Waste Dump

It seems likely that the loss in cover of perennial species between 2013 and 2019 has been caused by a combination of the rainfall being little over the median to well below it (see Table 2a and Table 2b above) and the effect of the tree *Allocasuarina huegelii* on the other species discussed. This may partially be reversed if there are a series of good years (at least for those species with soil stored seed), but there is a likelihood that *Allocasuarina huegelii* will be the perennial species that is able to take most advantage of any series of good years. If the area is burnt, it is likely that some of the species will regenerate from seed. However, the same process, invasion of *Allocasuarina huegeliana* followed by displacement of the others species would probably recur.

7.9.2 Changes in average and total number of native species and weed species in the 1991 rehabilitation

The average numbers of species of native perennial, native annual and weeds in the four 1991 rehabilitation quadrats has changed with some parallels between the categories over the period of the recordings. The three groups increased in parallel between 2010 and 2016 and then all three declined. The reasons for this similarity in changes have probably changed somewhat over time due to changes in species composition (particularly changes in the *abundance* of possibly allelopathic weeds). The very low rainfall in 2019 is likely to have had a significant impact on that years data,

but there is no similar effect in 2016 from the dryer years in 2014 and 2015, so the impact of dry years has some limitations.

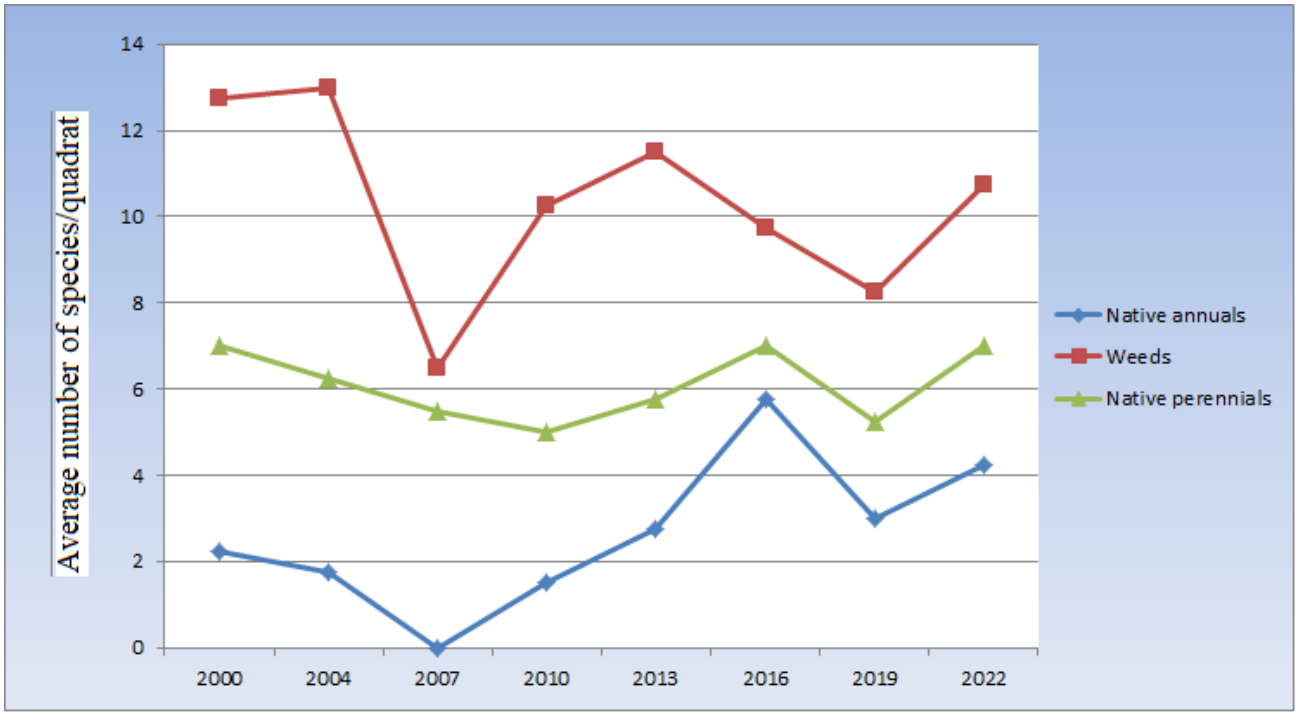

Figure 6: Average number of species of native perennial, native annual and weeds in the four 1991 rehabilitation year quadrats

It is important to realise that the averaged figures in Figure 6, while important to show overall trends, do not show the detail of what has happened. The drop in the two categories of native species in the figure has been caused by twenty-five (25) occurrences of species recorded at a quadrat in 2016 not being recorded in that quadrat in 2019. Similarly, the drop in the average number of weeds per quadrat has been caused by eighteen (18) occurrences of species recorded at a quadrat in 2016 not being recorded in that quadrat in 2019. Similar levels of change were observed between the presences and absences of annual species in 2019 and 2022. It seems that there is significant variation in the annual species that appear in these quadrats (possibly responding to climate factors) from year to year, with some species invading and some possibly still present as weed, but not germinating.

Figure 7 shows the total number of species in four categories (weeds, native annuals, native perennials and total natives) in the four 1991 rehabilitation year quadrats. This is done to allow for the fact that differential loss and gain in different quadrats *might* mask trends to some degree. However, this somewhat different view of the data simply shows that the trends are the same as for the averaged data. The inclusion of a combined category for all native species does highlight that the trends are the same for native and introduced (weed) species.

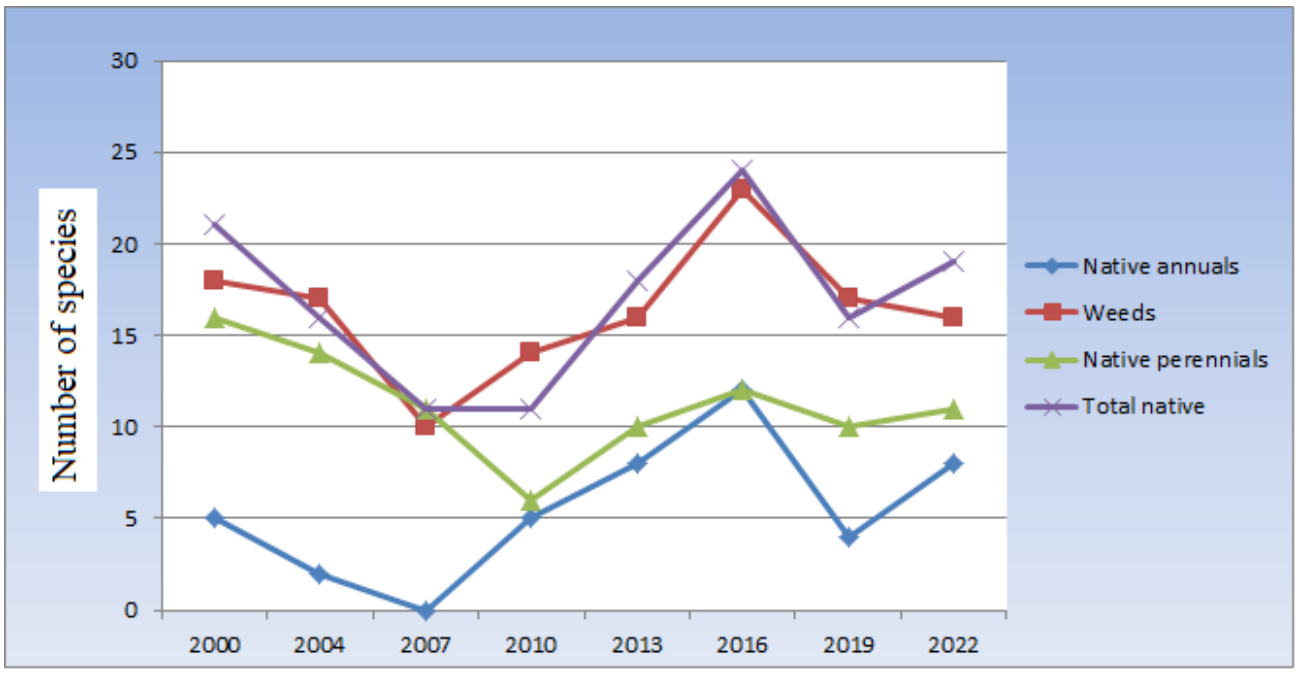

Figure 7: Total number of species in the 1991 rehabilitation for weeds, all native species, native perennial species and native annual species.

The overall result for the 1991 year rehabilitation is that the tree layer (*Allocasuarina huegeliana*) is affected by annual rainfall, but recovers from dry years. On the other hand the large shrub layers is decreasing in cover and diversity. In contrast to these patterns, the mostly annual lower layer is fluctuating in diversity of native species with recovery in 2022 from a drop in 2019. The weed component is showing similar fluctuation to the native annuals, but this may change if more aggressive species come to dominate.

7.9.3 Changes in average cover of native species and weeds in the 1991 rehabilitation

With the exception of 2007, there has been a fairly steady increase in the average cover of weeds in the 1991 rehabilitation area since 2000. In contrast, the average cover of native species has fluctuated (Figure 8) being highest in 2007, dropping to 2013 and then fluctuating. The weed cover has increased even in 2019, a dry year, when the height estimates of weed species was usually less than in 2016.

The increase in the cover of native species in 2016 was mainly due to increased cover of native annual species, particularly *Podolepis lessonii*. While the latter species did still increase in cover between 2016 and 2019 this was offset by decreases in the cover of other native species. Unfortunately this species decreased in cover between 2019 and 2022.

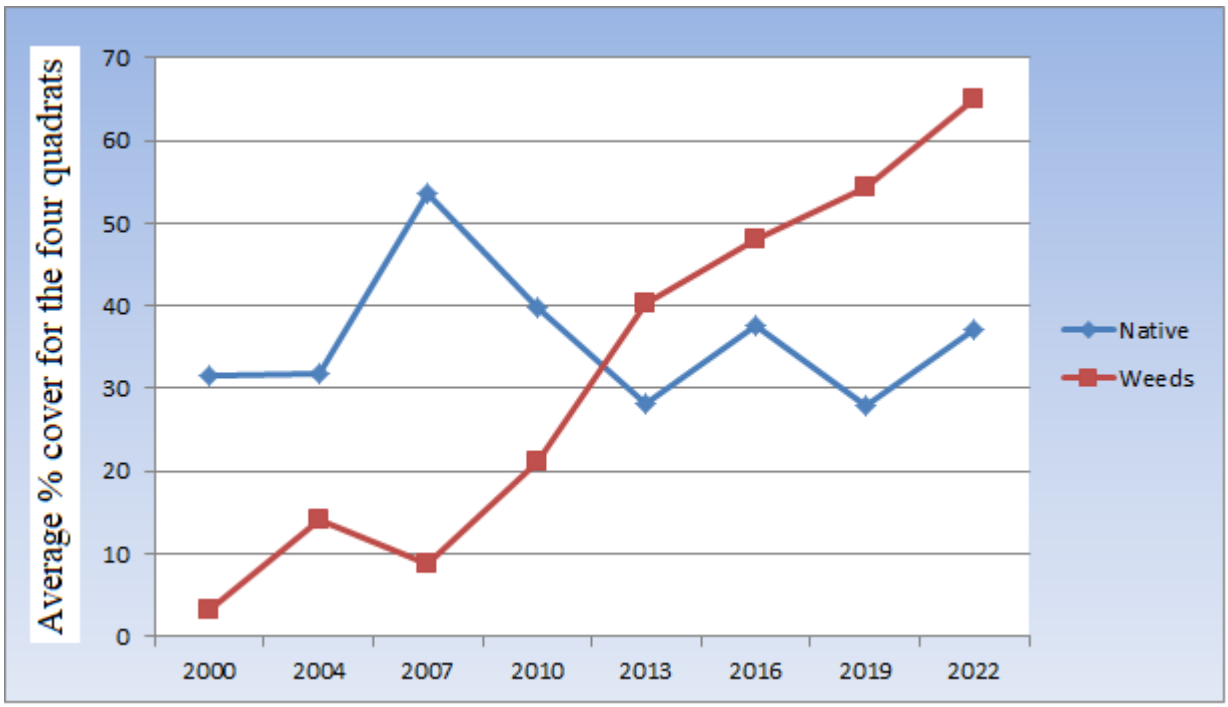

Figure 8: Average cover from 2000 to 2022 of native and weed species in the 1991 rehabilitation

7.10 Changes in the vegetation of the 1996 rehabilitation area on the Main Waste Dump

The 1996 rehabilitation area is the second oldest, with the recording of the two quadrats beginning in 2000. After initially rising, the average number of native perennials in this area has gradually dropped, with the loss of both *Acacia congesta* and *Hibbertia subvaginata* from both quadrats over time and the loss of *Regelia megacephala* from one quadrat in 2016 and a drop from two to one plants in the other in 2022. . There were no further losses of native perennial species at the 2019 recording, although one native annual (*Calandrinia* sp.) was lost, but reappeared in 2022.

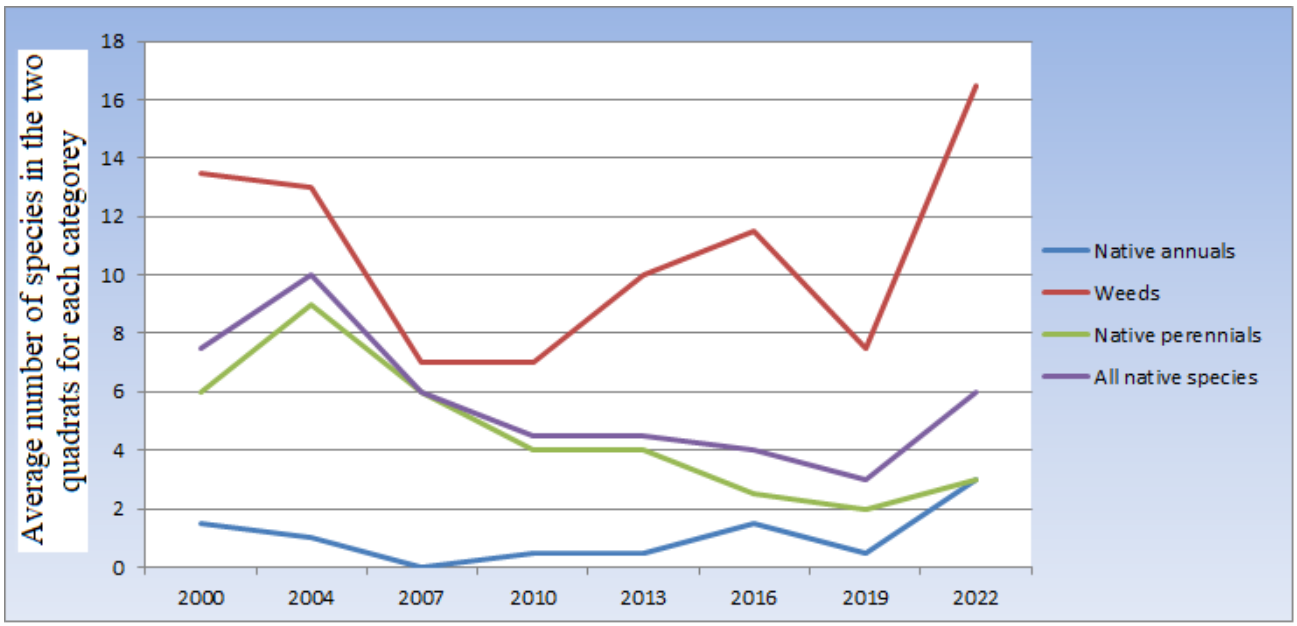

Figure 9: Average numbers of species in the 1996 rehabilitation for all weeds, all native species, native perennial species and native annual species

In contrast, the number of weed species (all annuals) at first dropped and has then risen at the 2013 and 2016 recordings before dropping in 2019 and increasing significantly in 2022. The drop in 2019 was presumably due to that being a dry year and the rise in 2022 because of that and the preceding year having higher rainfall. *Lupinus cosentinii* was first recorded in one of the quadrats in 2019, but was not in it in 2022, although it was observed outside the quadrat. This species appears to be spread in animal droppings, it has large seeds and occurrences in the rehabilitation on the main waste dump are mostly small. This weed may be restricted in abundance by the hard soil surface on much of the rehabilitation.

The number of native annual species has always been low, but after dropping in the 2004 and 2007 data increased slightly in 2016, dropped again in 2019 and then increased. In fact only two occurrences of native annuals were recorded in 2019, for an average of one species per quadrat. In 2022, two more annuals were recorded in one of the quadrats (*Aristida contorta* and *Calandrinia colorata* var. *colorata*).

The cover of *Regelia megacephala* was originally high (Figure 10) as this species was seeded into the rehabilitation by spreading brush containing the fruit. After a steep decline in cover it increased somewhat in 2007 before declining as young plants recorded in 2010 failed to survive the series of dry years before 2016. This trend has continued to the 2019 recording when only two plants were recorded in quadrat R96/02 down from four plants in 2016. By 2022 this had dropped to one plant.

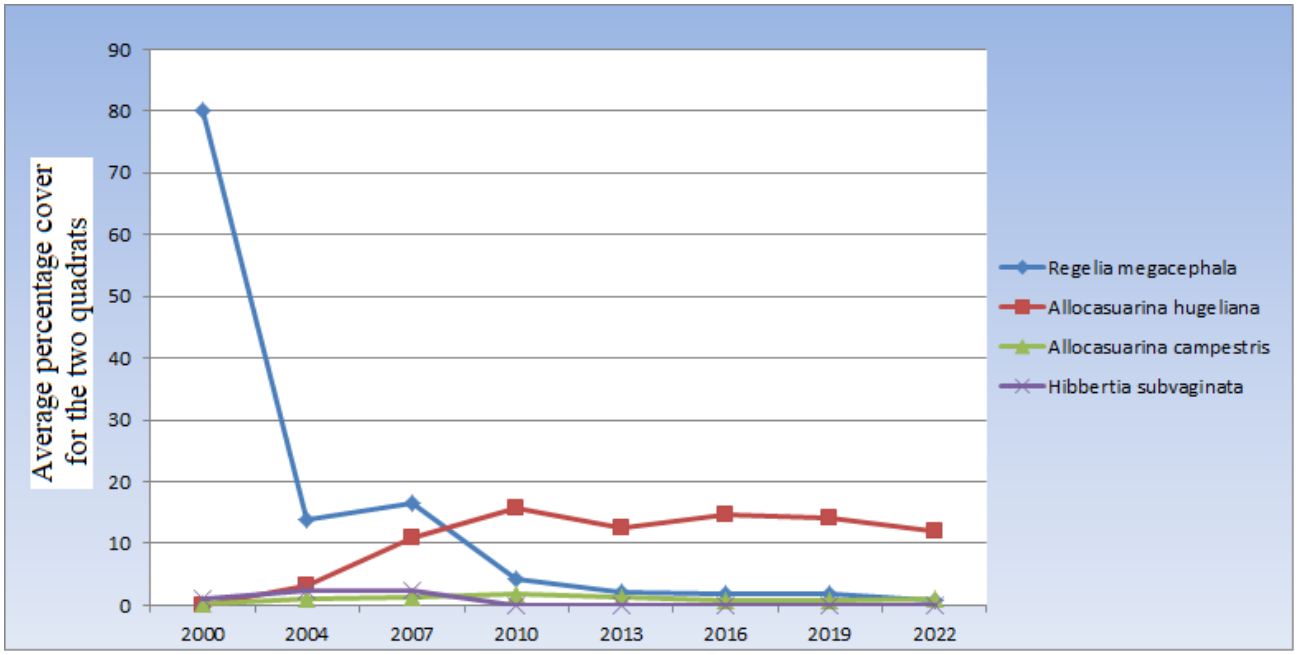

Figure 10: Average percentage cover of selected native perennial species in the 1996 area rehabilitation.

The drop in the average number of native perennial species has been paralleled by a drop in the cover of these species. Only *Allocasuarina huegeliana* has significantly increased in cover, but this species has also declined slightly in 2022. Unfortunately, the cover of weed species has increased over time to the point that the two quadrats had average weed cover of about 75% in 2016. This has stayed the same with average cover of 75.6% for the two quadrats in 2019. This seems to have occurred in a particularly dry year because although the individual plants of the weeds were smaller than in other years, *there were many more of most them*. By 2022, the average cover of weeds (noting that there is more than one overlapping layer) was 114%, but was much higher in one of the quadrats that in the other.

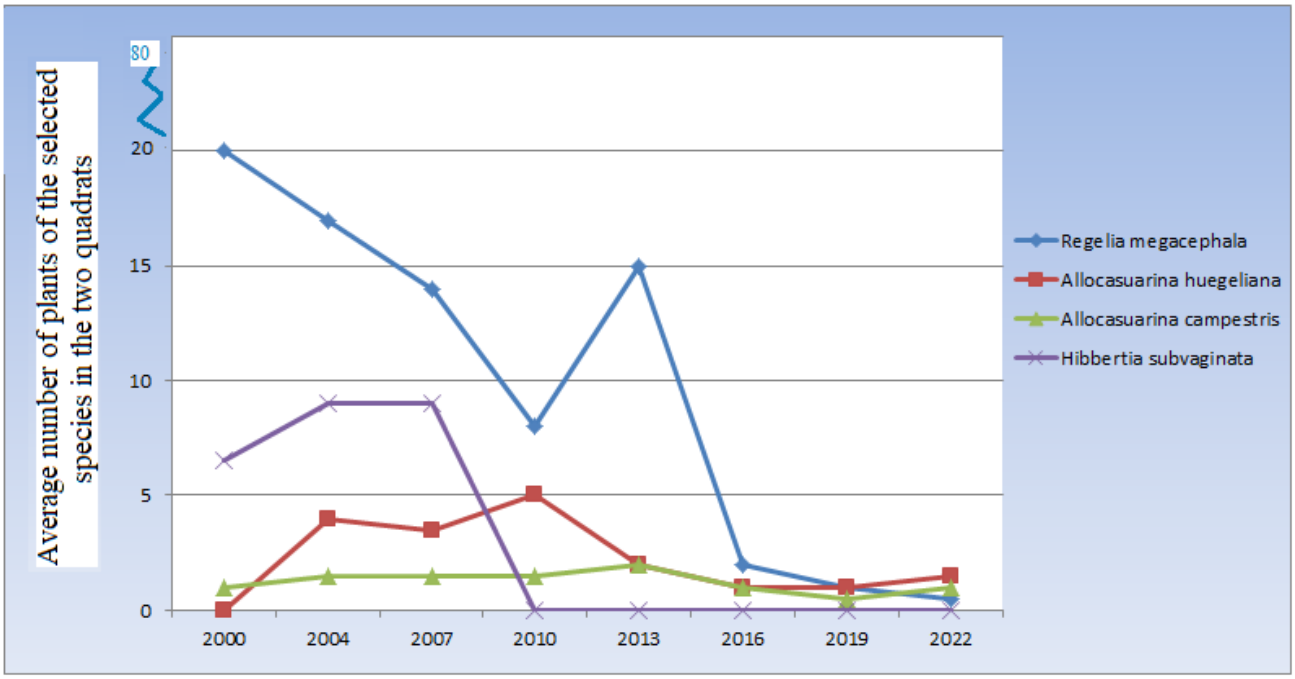

Figure 11: Average number of plants of larger perennial native species in the 1996 area rehabilitation.

The weed species with highest cover in 2016 were **Arctotheca calendula* (Capeweed), **Avena barbata* (Wild Oats), **Ehrharta longiflora* (an annual Veldt grass) and **Hypochaeris glabra* (Flatweed), all fairly aggressive species. The same species mostly had high covers in 2019, although the cover of **Arctotheca calendula* dropped significantly and **Vulpia myuros* increased significantly. These changes probably reflect the effect of the low rainfall in 2019 on the differential success of different weed species. By 2022 the situation was similar except that **Erodium cicutarium* and **Erodium botrys* also had high cover. The high cover of weeds in this pair of quadrats is probably inhibiting the germination and establishment of native species.

Figure 11 shows the average number of plants of the larger species in the two 1996 quadrats, they are all shrubs except for *Allocasuarina huegelii*, which is a tree. This figure clearly shows that re-establishment of most species is not occurring, although the more detailed numbers of plants (see Table 11) show that *Regelia megacephala* goes through bouts of germination, but that the individuals do not survive to become adult plants. The series of dry years prior to 2016 have had some impact on that (especially the large drop in numbers of *Regelia megacephala* from 2013 to 2016). However, it is likely that the surface and slope of the rehabilitation areas is a significant factor in limiting re-establishment of species from seed, with high weed cover levels another significant factor.

Table 11 also shows the loss of the two conservation species *Daviesia dielsii* and *Acacia aristulata* after 2007, and also the loss of the small shrub species *Acacia lasiocarpa* and *Acacia stenoptera*. It is possible that there is seed of these species in the soil and that they could re-appear after fire (all have long lived seed); however the soil surface is likely to limit this as is the high cover of weeds.

Table 11: Average number of plants of selected taxa recorded in the 1996 area quadrats from 2000 to 2019

Species ⇩ Year ⇨	**2000**	**2004**	**2007**	**2010**	**2013**	**2016**	**2019**	**2022**
Regelia megacephala	78	17	14	8	15	2	1	0.5
Allocasuarina huegeliana	0	4	3.5	5	2	1	1	1[#]
Allocasuarina campestris	1	1.5	1.5	1.5	2	1	0.5	0.5[#]
Hibbertia subvaginata	6.5	9	9	0	0	0	0	0
Acacia congesta	2	3	2	0	0	0	0	0
Acacia aristulata	1	2	2	0	0	0	0	0
Acacia stenoptera	1	1	0	0	0	0	0	0
Daviesia dielsii	1	1	1	0	0	0	0	0
Acacia lasiocarpa	0	1	0	0	0	0	0	0
# In 2022, *Allocasuarina campestris* had one plant in and one overhanging and *Allocasuarina huegeliana* had two plants in and one overhanging.								

7.11 Changes in the vegetation of the 1998 rehabilitation area on the Main Waste Dump

The 1998 rehabilitation area is the third oldest, with the recording of the two quadrats beginning in 2000.

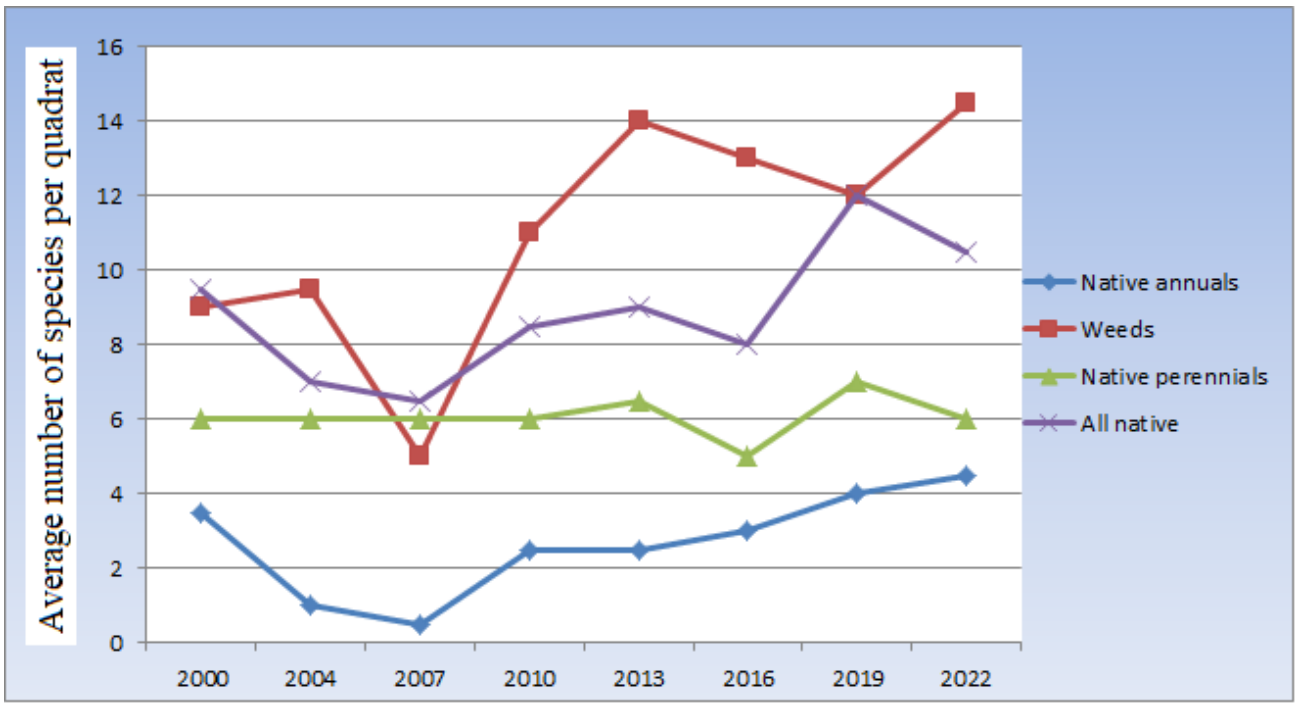

Figure 12: Average number of species in the 1998 rehabilitation for all weeds, all native species, native perennial species and native annual species

After staying constant until 2010, the average number of native perennials in this area rose slightly and then dropped slightly and has risen slightly and dropped again (see Figure 12). In contrast, the average number of weed species (those present are all annuals) dropped to five in 2007 and then rose to fourteen in 2013 before dropping to thirteen in the 2016 data, dropping to twelve in the 2019 data before rising to nearly fifteen in 2022. As in other areas of the rehabilitation, there have been losses and gains between recordings of species that are apparently partly driven by dryer and wetter years and partly by competition between species.

After dropping between 2000 and 2007, the average number of native annuals returned to three species in 2016, and four in 2019, then nearly five in 2022. The native annuals include small species that may not survive in the quadrats if weed cover increases; in fact one was lost in 2022.

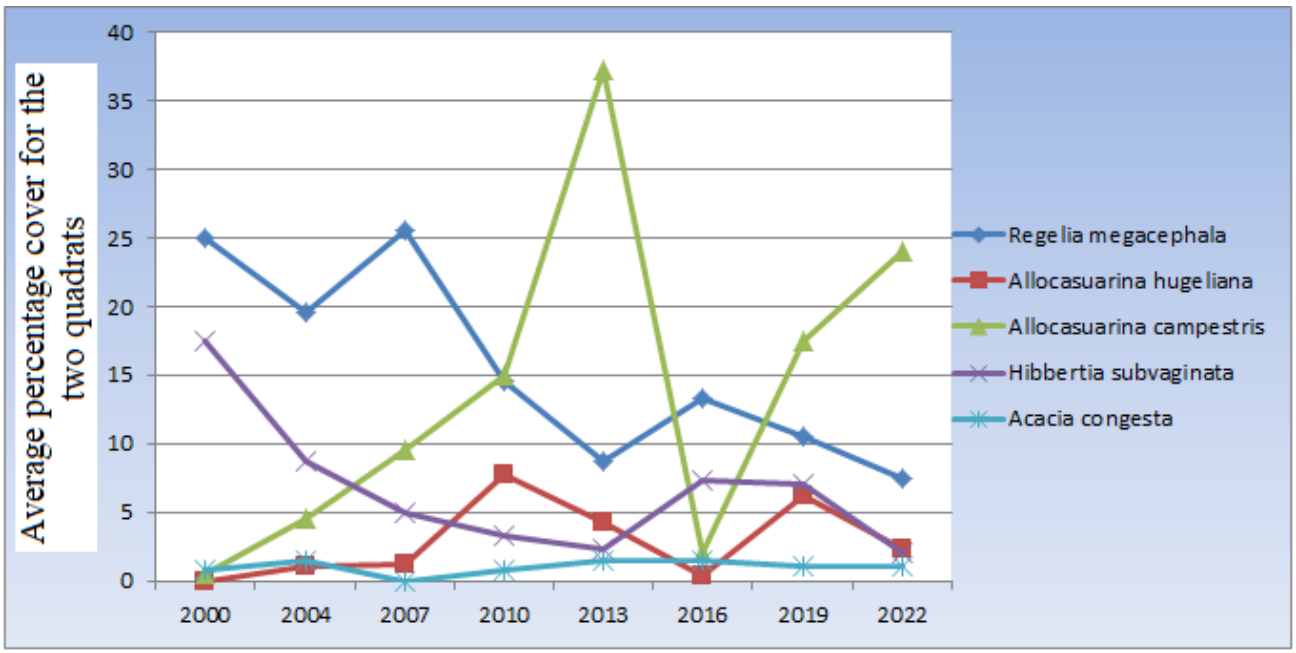

Figure 13: Average percentage cover of the larger perennial species in the two 1998 area quadrats

Figure 13 shows the average percentage cover in the two 1998 rehabilitation area quadrats of the tree *Allocasuarina huegeliana* and the larger native shrubs including *Regelia megacephala* and *Allocasuarina campestris*. *Regelia megacephala* gradually declined in cover until 2013 except for 2007, but by 2016 increased in cover before dropping again by 2022. *Hibbertia subvaginata* has declined in cover from 200 to 2013 then risen to about 7% cover in 2016, maintained this cover to 2019 and then dropped to low cover again in 2022.

In contrast to this *Allocasuarina campestris* has had a boom and bust performance history in regard to average cover in the two quadrats. Its cover dropped precipitously between 2013 and 2016, but rose just as quickly between 2016 and 2019 before just rising slightly to 2022. This sequence of events is related to significant germination events (giving the peaks) and the failure of the seedlings to persist to adult size (giving the troughs). *Allocasuarina huegeliana* has had similar, but less pronounced, changes in cover until dropping to low cover in 2022.

The remaining species, *Acacia congesta* has had low cover since 2000 and was almost absent in 2007, but regained some cover and has maintained that to 2022.

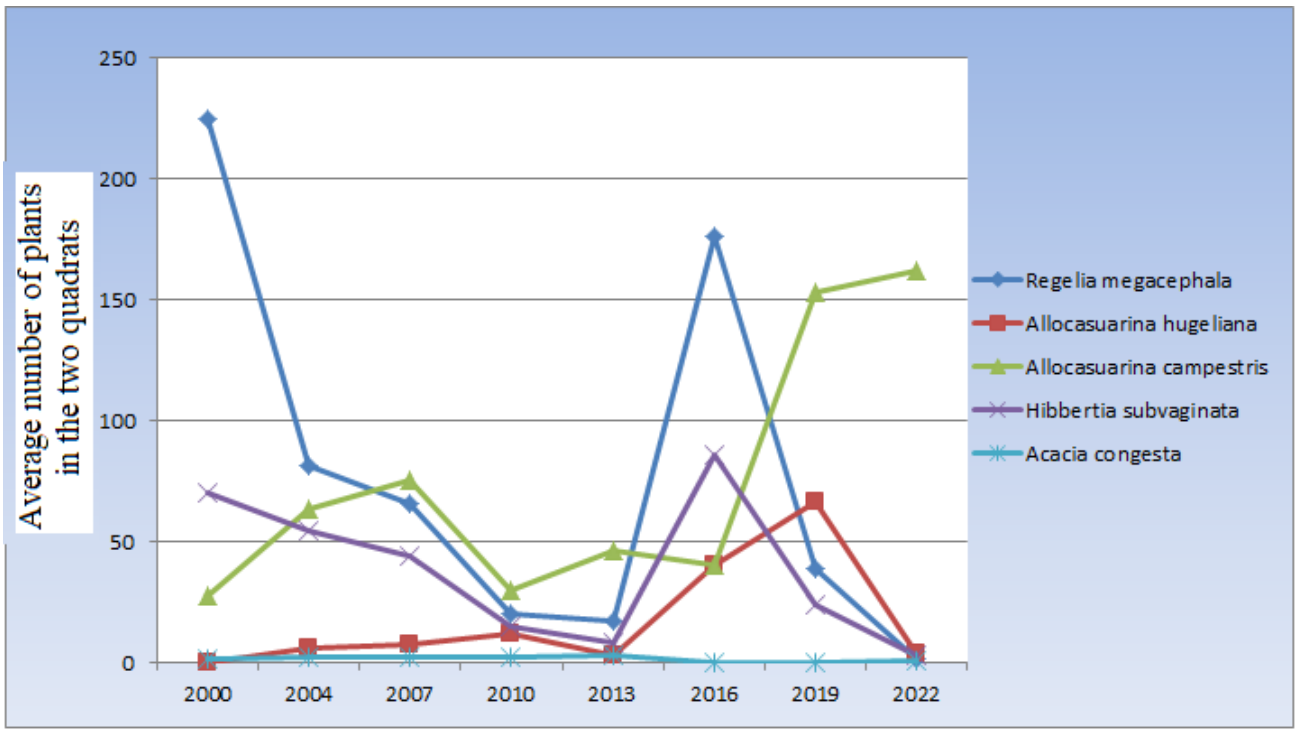

Figure 14: Average number of plants of the larger perennials in the two 1998 area quadrats

Comparing Figure 13 to Figure 14 shows (as noted above for *Allocasuarina campestris*) that the observed booms and busts in species occurrences is largely based on successive germination events and die-offs following them, as much of the cover in 2013 and 2016 of the *Allocasuarina campestris*, *Regelia megacephala* and *Allocasuarina huegeliana* is due to large numbers of juvenile plants. This is again the case in the 2019 data for which these three species again have large numbers of juvenile plants. However by 2022 *Hibbertia subvaginata*, *Allocasuarina huegeliana* am *Regelia megacephala* had dropped significantly in numbers as many juvenile plants had not survived. [Note that a correction has been made to the *Allocasuarina* data for 2016 as it was apparent in the field in 2019 that *Allocasuarina* seedlings had been mis-identified in the field in 2016.]

As the area has not been burnt, the boom and bust in seedling/juvenile numbers suggests that water availability in summer is driving lack of survival to larger size (and higher age, which would mean more seed) in these species. Also noteworthy, is that *Acacia congesta* in this area, as in some others, starts with low numbers of individuals, and stays at low numbers (or sometimes dies out), presumably because seed does not build up in the soil due to the often smooth surface and slopes .

7.12 Changes in the vegetation of the 2000 rehabilitation area on the Main Waste Dump

The 2000 area rehabilitation is the fourth oldest, with the recording of the two quadrats (R00/01 and R00/02) beginning in 2004. The average percentage cover in the two quadrats of the six largest species in this area is shown in Figure 15. These include the trees *Allocasuarina huegeliana* and *Eucalyptus camaldulensis* (which grows naturally nearby, near the southern end of its limit in Western Australia), and four shrubs that occur in most of the rehabilitation areas.

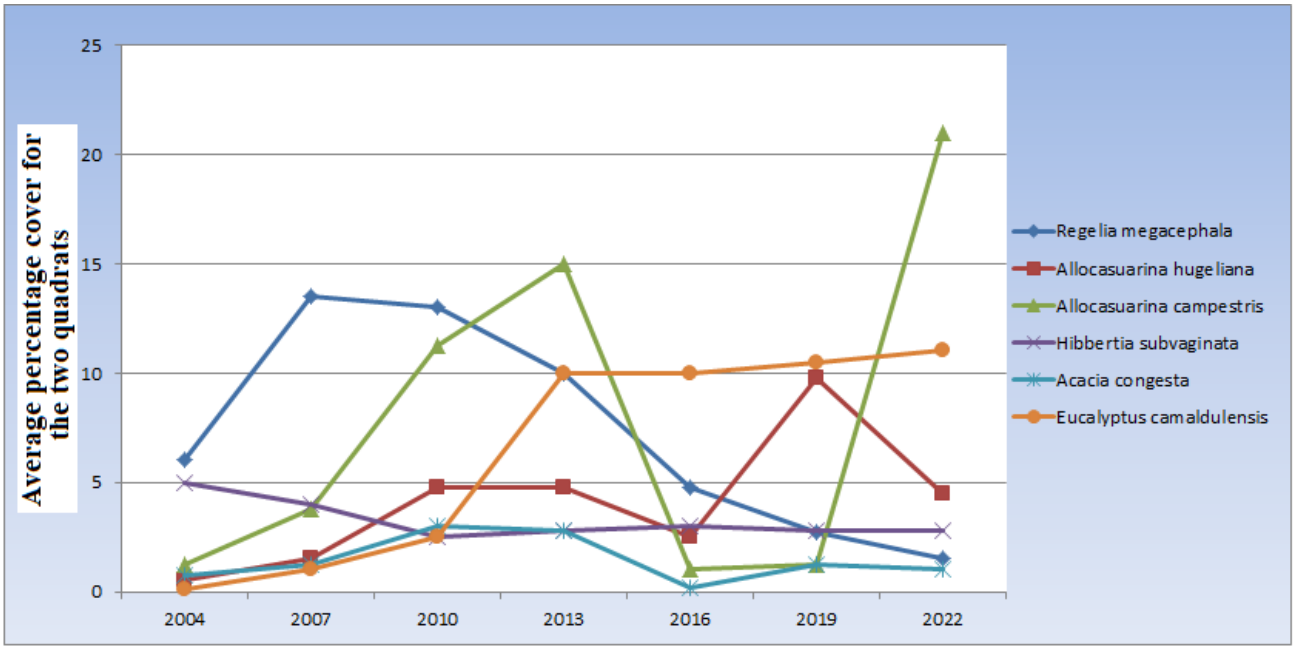

Figure 15: Average percentage cover of the larger perennial species in the two 2000 area quadrats

Figure 15 is somewhat misleading at first sight, as the "dramatic" changes are actually much less than they first appear as most of the cover averages are below 15% cover. However, the changes graphed for the two quadrats are real and the overall situation is evident from combining the information in Figure 15 and Figure 16. The latter figure shows the average number of individuals in the two 2000 area quadrats that average cover is given for in the former.

The two quadrats had steadily improving average cover until 2013 and then the average cover drops, presumably due to the dry years preceding 2016. Even the one moderate sized *Eucalyptus camaldulensis* stalled in growth in cover over this period before slightly increasing in cover to 2019 and 2022. The moderate rainfall in 2017 and 2018 combined with the low rainfall in 2019 is presumably responsible for the continuing fall in the cover of *Regelia megacephala*, although this has continued to 2022 in spite of higher rainfall. *Allocasuarina huegeliana* has increased significantly in cover in the same period until 2019 after which it dropped in cover. There has been a significant recruitment of *Allocasuarina campestris* between 2019 and 2022; following death of

older plants prior to the 2019 recording (the seed held on the older plats would have been released when they died).

Hibbertia subvaginata dropped greatly in number of plants but less in cover from 2004 to 2010, but has since stayed fairly constant, except for more plants in 2016 after which it has dropped somewhat. *Acacia congesta* has had low numbers since 2004, but as the plants can be quite wide had modest cover between 2010 and 2013 after which it has been quite low.

Regelia megacephala also drops until 2010 in numbers of plants, but then rises in 2013 before steadily dropping to 2022. However, the cover of the species has dropped more slowly as the plants can become quite large. The other species have all had relatively low numbers since 2004, but are all still present in spite of the dry years.

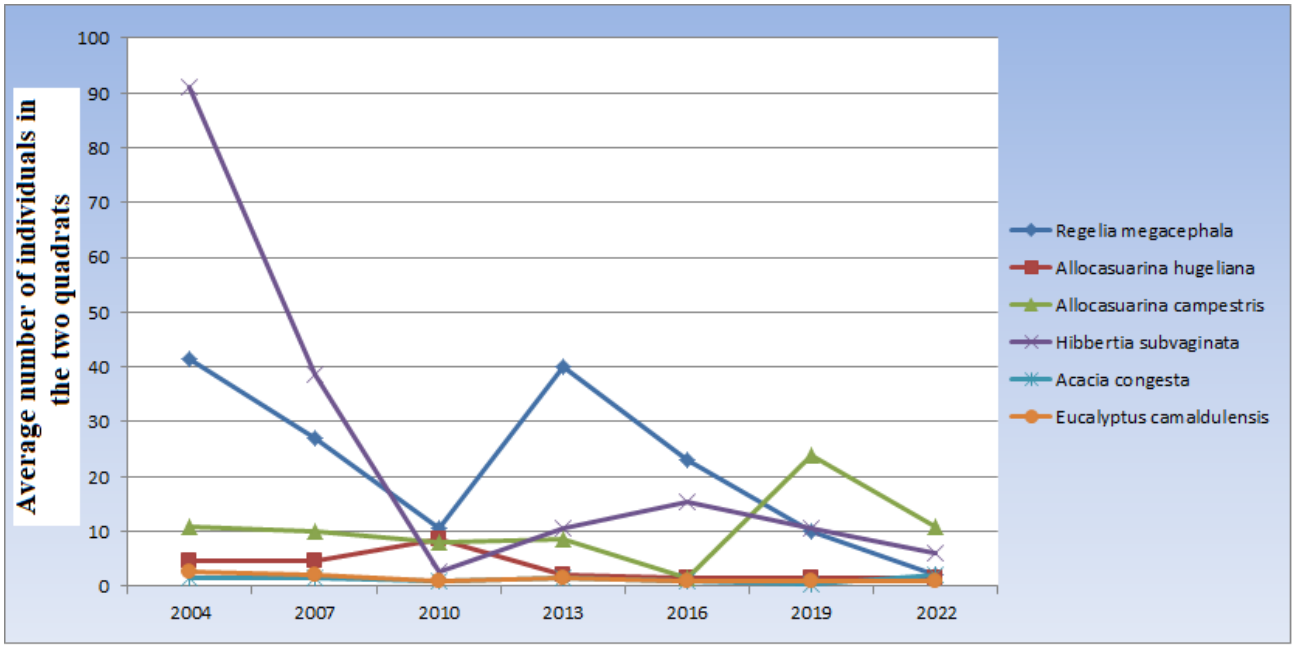

Figure 16: Average number of plants of the larger perennials in the two 2000 area quadrats
Note: The line for *Acacia congesta* is largely obscured by that for *Eucalyptus camaldulensis*, but the *Acacia* remains present into 2022.

Table 12 (see below) shows the numbers of native perennials, native annuals and weeds (the weeds are all annuals, except for *Romulea rosea* which is a small cryptophyte) present in the two year 2000 quadrats for the first two years and last three years of recording. The table shows that the number of native annuals has declined from six species to three species then risen to nine species in 2022. Native perennials have increased from eleven to eighteen species. Two of these (a *Pterostylis* species – a small orchid – and the grass *Rytidosperma acerosum*) are quite small and are unlikely to

survive as weed cover increases. On the other hand, *Austrostipa elegantissima* and *Thysanotus patersonii* are perennials and both can survive in fairly weedy areas.

Interestingly, the weeds have increased, decreased then increases in the number of species present. This is apparently partly due to variation in rainfall (and its timing) and partly due to competition between species.

Table 12: Numbers of native annual, native perennial and weed species in the 2000 area rehabilitation for selected years

Category	**2004**	**2006**	**2016**	**2019**	**2022**
Native annuals	6	6	4	3	9
Native perennials	11	13	13	14	18
Weed	15	21	18	15	24

7.13 Changes in the vegetation of the younger rehabilitation areas on the Main Waste Dump and smaller waste dumps

There are a number of quadrats in areas rehabilitated after 2000 that either have one quadrat, are not very old or for various reasons (including parts of the waste dump having been re-mined for gravel) have not been recorded in every third year. Only brief comments will be made on them here as the sample sizes (number of quadrats and duration of recording) are not long enough to make graphing or other analyses worthwhile, particularly give the other records analysed above that give an adequate account of the progression of the rehabilitation.

Quadrat R01/02

Quadrat R01/02 is located in the area rehabilitated in 2001. It had ≤ 30% cover of *Allocasuarina huegeliana* in 2002, an increase from ≤ 20% cover in 2019, 15% in 2016 and 5-6% in 2013. It had 2-3% cover of *Regelia megacephala* in 2019, the same as in 2016, which is less than in 2013 (5-6%), but had dropped to 1-2% in 2022. There were seven young *Regelia* plants in 2019, but only two plants in 2022. This quadrat had four native perennial species present in both 2016 and 2019, but six in 2022. The two new perennial species were *Thysanotus manglesii* and *Dichopogon capillipes*. Weed cover had increased significantly between 2016 and 2019 with **Brachypodium distachyon* increasing from 10% to ≥ 20%. However, this species dropped to > 5% cover in 2022, some other weed species also dropped in cover.

Quadrat R02

Quadrat R02 is located in the area rehabilitated in 2002. This quadrat has quite high diversity of native species, with sixteen (16) native perennial species and nine (9) native annual species including *Aristida contorta* and *Hyalosperma glutinosum* subsp. *glutinosum* which had not been recorded in the quadrat before. *Crassula colorata* and *Waitzia nitida*, both recorded in the quadrat in 2019 but not in 2016 were again absent from the quadrat. Unfortunately the weeds were also diverse, with fifteen (15) species in 2022 down from eighteen in 2016 and up one from 2019.

The cover of **Brachypodium distachyon* dropped from 50-60% cover in 2016 to 30% in 2019 and 20% in 2022. *Regelia megacephala* increased from 15% cover to 20% cover. *Cheilanthes austrotenuifolia* was present after being absent in 2019, while *Chamaescilla corymbosa* var. *corymbosa*, which is common in parts of the native vegetation but rare in the rehabilitation, was lost.

Quadrat R04(22)

Quadrat R04(22)is located in the area rehabilitated in 2004. It had five native perennials in 2016 and the same five in 2019. However, in 2022 it had juveniles of two more perennial native species: *Acacia congesta* subsp. *congesta* and *Allocasuarina campestris*. The largest change in the cover of the native perennials was an increase in the cover of *Allocasuarina huegeliana* from $\geq$ 15% in 2016 to $\geq$ 20% in 2019 and $\geq$ 30% in 2022. There were three annual native species present in 2016, but none were recorded in 2019, while two were in 2022.

One good outcome for this quadrat in 2022 was the persistence of *Bossiaea moylei* (the new name for *Bossiaea* sp. Cairn Hill) a priority two species with three plants present (down from four in 2019). There were fifteen weed species present in 2019 with two others having been lost since 2016 and *Bromus rubens* having been gained. One of the weeds present in 2019 was lost in 2022, but two others were gained.

Quadrat R05(27)

Quadrat R05(27) is located in an area treated for rehabilitation in 2005 on the main waste dump. While *Acacia congesta* decreased from $\leq$ 20% in 2016 to 8% in 2019, it increased to 12% in 2022. Similarly, *Allocasuarina campestris* declined from $\leq$ 20% in 2016 to 15% in 2019, but increased back to $\leq$ 20% in 2022. In contrast to those two species, *Allocasuarina huegeliana* increased from $\leq$ 10% in 2016 to 15% in 2019 and to $\leq$ 25% in 20122. Ten native perennials were present in quadrat

R05in 2016 and 2019, with one lost (*Austrostipa trichophylla*) and one gained (*Comesperma integerrimum*) between these years. By 2022 there were eleven native perennials, but three had been some change in the species. Four native annual species were present in the quadrat in 2016 and six in 2019. The six present in 2019 were still present in 2022 with a further six.

Twelve weed species were present in 2016 with thirteen present in 2022 after some minor changes. None of the weeds had high cover in 2019, with **Hypochaeris glabra* at < 5% cover being the highest. This species increased to ≤ 10% cover in 2022 while **Ehrharta longiflora* had 3% and **Vulpia myuros* had 2% cover. The others had < 1% or just "+" cover.

Quadrat in Area 33

This quadrat is in an area treated for rehabilitation in 2005 on the south-east waste dump and has previously only been recorded in 2010, 2013, 2016 and 2019. Eleven perennial native species were present in 2016, 2019 and 2022. Two others were present in 2016, but one of these was lost in 2019, while one was gained in 2022.

The only significant change in cover in the eleven species was that the cover of *Acacia congesta* dropped from 50% in 2016 to 20% in 2019, but it stayed at that level to 2022. It seems likely that the drop was largely due to the low rainfall in 2019, but some *Acacia* species are not long-lived and that cannot be discounted. Of interest is the increase in the cover of *Thysanotus patersonii* (a native climbing lily) from 2% in 2016 to 5% in 2019; however it did not increase further by 2022. This species is gradually increasing in cover and presence in quadrats and may come to be more significant.

Five native annual species were present in from 2016 to 2022, with a further seven present in 2022. This big increase is a reflection of the low weed cover and therefore a lack of suppression.

Eight weed species were present from 2016 to 2022. Another was lost in 2019, but appeared again in 2022. Three others were gained in 2022.

Quadrat in Area 37

This quadrat is located in an area treated for rehabilitation in 2006 and that had *Regelia* brush applied in 2007. It is on the small south-west waste dump and previously has only been recorded in 2010, 2016 and 2019.

Nine perennial species were recorded from 2016 to 2022, four others were recorded only in 2016 and one 2016 and 2019. Three more were recorded only in 2019 and three only in 2022. The loss of *Acacia congesta* subsp. *congesta*, *Grevillea biternata* and *Acacia lasiocarpa* var. *sedifolia* after 2016 is significant as these are medium sized to large shrubs. The loss was offset to some degree by the recruitment of *Allocasuarina campestris* another large shrub. The priority two species *Bossiaea moylei* (previously *Bossiaea* sp. Cairn Hill) has maintained two individuals in the quadrat, although its cover has decreased.

Six native annual species were recorded in the quadrat in 2016, of which three were also recorded in 2019 and 2022. Only one additional native annual was recorded in 2022, the daisy *Podotheca angustifolia*.

Eight weed species were present in the quadrat in from 2016 to 2022, two others were present in 2016 and 2019, one only in 2019, one in 2016 and 2022 and two only in 2022. Unlike other quadrats in the rehabilitation, there had been no significant increase in weed cover. In fact several species had lower cover in 2019 and 2022 than in 2016. *Brachypodium distachyon*, which has increased significantly in some other quadrats maintained low cover, probably due to soil characteristics.

Quadrat in Area 41

This quadrat is in an area treated for rehabilitation in 2007 and in 2010 a direct planting trial of approximately 100 plants of *Allocasuarina campestris,* and *Allocasuarina huegeliana* was carried out as this site was barren of other plants. It is on the south-east waste dump and has previously only been recorded in 2010, 2013, 2016 and 2019.

Three native perennial species were recorded in the quadrat in Area 41 in 2016 that were also recorded in 2019 and 2022. One other was only recorded in 2016 and one only in 2019. One was recorded in 2019 and 2022, while three were only recorded in 2022 (including a seedling of Dryandra sessilis).

Three native annual species were recorded in 2016, two of which were not recorded in later years and one that was also recorded in 2019. One was only recorded in 2019, two in 2019 and 2022 and two only in 2022.

Seven weed species (all annuals) present in 2016 were also present in 2019 and 2022, three others were present in 2016 and 2019, one was only present in 2016, one only in 2019 and one only in 2022. The increases in weed cover in 2022 compared to earlier years is fairly low, except for **Ursinia anthemoides* (< 10%) and **Hypochaeris glabra* (< 5%).

8.0 DISCUSSION

The major aim of the rehabilitation: to establish vegetation on the waste dumps comprised of native species found in the Coomberdale Chert Threatened Ecological community, especially those prominent in its vegetation, is being met to a moderate degree. However:

- The vegetation structure developed is less than desirable in many areas, often lacking the high cover of large shrubs found in natural *Regelia megacephala* and *Allocasuarina campestris* stands. Also in many quadrats the *Regelia* is losing cover and number of individuals (although there are episodes of recruitment);

- The stability of the vegetation (resistance to dry periods) is less than that of the natural stands (although some of those have also declined), and the cover of the larger shrubs is likely to continue to suffer in low rainfall periods;

- The average diversity of native species in individual quadrats is less than desirable. Although there is ongoing recruitments of native species in some quadrats this is mostly either annual species unlikely to survive increasing weed levels, or smaller perennial species.

- In many places the cover of weeds is higher than desirable. A feature of the recording has been that in many of the quadrats weed cover has increased significantly often even in dryer years.

The problems apparent in the rehabilitation are based in two main facts. Firstly the waste is unlike the substrate of the Coomberdale Chert Threatened Ecological Community (TEC) which is quite different to the waste in structure. Where *Regelia megacephala* is dominant in the TEC the substrate is massive chert, not highly broken up chert material. Where other species, such as *Allocasuarina campestris* are dominant in natural stands the substrate is less massive, but is still not so broken up and has more water retaining capacity. The second major problem is that the waste areas (and the TEC) are in a highly fragmented environment with many weed species present in the paddocks surrounding them. Other factors that complicate the effects of these two main factors are that some of the slopes of the waste material are steeper than in the TEC and decreasing and more erratic rainfall due to climate change and land clearing.

These factors have continued to interact in the period between the 2019 and 2022 recordings to result in ongoing loss of *Regelia megacephala*, one of the defining species of the Coomberdale Chert Threatened Ecological Community and a priority species for the rehabilitation. On the other

hand, earlier decline of *Allocasuarina campestris*, the other main large shrub species in the TEC, has on balance stopped (as it had in 2019). In fact this species has increased in some quadrats.

In the older quadrats there is usually some loss of native species although some species continue to invade, but these are (almost entirely) either annual species or smaller perennial species. In tandem with this (and probably the main cause of it) there is a general increase in weed cover and often in the number of species. However, where weed cover is quite high the more aggressive weeds are causing the loss of the smaller less aggressive weeds.

While *Allocasuarina huegeliana* has been seen as not desirable, as it is not one of the main species that has been used in the definition of the TEC, it does occur in the TEC and is dominant in some areas of it. Thus if it dominates some areas of the waste dumps over time, this should be seen as a good thing, as it means more diversity in vegetation structure on the waste. If it dominated all the waste areas, this would not be desirable, but this seems unlikely at the current time.

The changes in the presence and absence of native species in the quadrats, i.e. the loss of some species from the quadrats and the gains of others, is of significant interest from the point of view of the diversity of the rehabilitation and the life forms of the species present. It seems that there is an ongoing process of winnowing out of species (perennial and annual) not suited to the waste material (or outcompeted by weeds) and the appearance of others that are suited. The loss of some species of perennials may be apparent; they may be present as seed and reappear after fire or when conditions suit

It seems likely that the native flora part of the floristic composition of the rehabilitation will take a considerable time to reach stability, and that the final composition will be affected by seed mobility (the ability of species to migrate into the waste areas from areas of the TEC), the ability to survive there and competition from weeds. Application of seed of selected species from the TEC would improve the rate of movement of native species into the TEC, this should be a mixture of annual species and perennial species that are not present in the rehabilitation (or only have low numbers) and which would improve the structure of the rehabilitation vegetation. Two species that have been observed to have good survival in more disturbed areas of the TEC should be included in this: *Calytrix* aff. *leschenaultii* and *Kunzea praestans*.

It is clear from the 2016, 2019 and 2022 data from the quadrats that weed cover is increasing, sometimes markedly, although is some quadrats there have been decreases of more prolific species

such as **Brachypodium distachyon*. The worst weeds include **Hypochaeris glabra* (Flatweed), **Erodium botrys* and the annual grasses **Brachypodium distachyon, *Ehrharta longiflora* (an annual Veldt Grass) and **Avena barbata* (Wild Oats). The ability of these species to seed profusely, germinate in numbers and survive to seed in different seasons ("dry" or "wet") at a range of sizes make them aggressive competitors. Several of the other weed species are also increasing in number and spread over the rehabilitation, including **Monoculus monstrosus* and **Bromus rubens*. The latter species is likely to become significant in future years.

Where weed cover is high it is very likely to be inhibiting germination and establishment of native species and further increases in weed cover is likely to become more problematic in affecting the ongoing germination and establishment of native species in the rehabilitation areas. Given the range of species of weeds present there are practical limitations to what can be done about this. However, selective control of the grass (Poaceae) species is possible and may have little impact on the native grasses. To be successful, this would need to be done consistently for several years to prevent these species building up again while giving native species an opportunity to build up in abundance.

The other major group in the weeds is the Daisy family (Asteraceae), selective control of these without affecting native species is much less likely to be possible, but their control needs to be investigated.

9.0 RECOMMENDATIONS

The recommendations made in the earlier rehabilitation reports (e.g. Morgan and Trudgen, 2004; Trudgen and Hannart 2013) are still applicable to the ongoing rehabilitation of Simcoa's waste dumps and are therefore repeated below with some minor additions.

Recommendation 1. The following set of points should be accepted as the aims for rehabilitation at the Simcoa Moora Chert mine:

- Where possible, the location of waste dumps and subsequent establishment of rehabilitation vegetation should be planned to ameliorate degradation of the areas of the Coomberdale Chert threatened ecological community adjacent to mining areas;

- Rehabilitation should aim for the establishment of a stable vegetation composed of local native plant species on waste dumps and other areas affected by mining;

- Where appropriate the geographically restricted species *Regelia megacephala* and other species of priority and declared rare flora should be included in the rehabilitation;

- Waste dump slopes should be stable and erosion minimised by adequate density of rehabilitation vegetation and by avoiding steep slopes.

Recommendation 2. The various rehabilitation quadrats should be recorded at appropriate intervals and in the appropriate season.

The rehabilitation monitoring would record better data if conducted during late September or early October. [The 2019 recording was in mid-late October in a dry year and this was somewhat later than desirable.] [The 2022 recording was carried out in early to mid-October and some quadrats were somewhat dryer than desirable, but most were not.]

Recommendation 3. Waste dump construction should include sufficient fine material to ensure that the density (cover) of the rehabilitation vegetation attainable is not significantly below that of nearby areas of native vegetation, and the surface of the waste dumps should be appropriately roughened to ensure that infiltration of rainwater is sufficient to recharge subsoil water storage.

Lack of subsoil water storage has been identified as a probable limiting factor on the density of the older rehabilitation stands. The only way to rectify this in waste dumps in the future is to include fine material (slimes etc.) to increase subsoil water storage.

Recommendation 4. The seed mix going into rehabilitation areas (including seed from brush) should be continually reviewed as rehabilitation stands are assessed, to further improve the rehabilitation. Additional species that should be added in oncoming years include *Calytrix* aff. *leschenaultii*, *Kunzea praestans*, *Dryandra sessilis* and a range of annual species.

Recommendation 5. The seed applied to regeneration areas should continue to be sourced locally (i.e. within a few kilometres of the mine and preferably from areas of the Coomberdale Chert Threatened Ecological Community).

Recommendation 6. Stock should continue to be excluded from the rehabilitation areas.

Recommendation 7. Similar quantities of *Regelia megacephala* brush should be used in future rehabilitation areas to that used in most of the past areas. The seed from brush should be supplemented by seed collected from a range of species.

Recommendation 8. Depending on the amounts and species available, seed of the declared rare and priority flora species found in the Coomberdale Chert Threatened Ecological Community should be included in seed applied to rehabilitation areas. Assistance with glasshouse germination trials of the seed of the DRF and priority species should be sought from an appropriate body.

Recommendation 9. An ongoing seed collection program should be carried out to ensure that sufficient quantities and diversity of seed from native species found on the Coomberdale Chert Threatened Ecological Community are available for the rehabilitation program.

Recommendation 10. A suitable person/company should be engaged to supply nursery-raised seedlings (or plants grown from cuttings) of Declared Rare and Priority Flora species from the Coomberdale Chert Threatened Ecological Community for the rehabilitation.

Recommendation 11: A standard ‘best practice’ rehabilitation treatment should be applied whenever possible. This would currently include:

- The battering of slopes and across slope ripping and preparation of the area (slopes should not be so steep that this cannot be safely undertaken);

- The application of topsoil;

- The application of *Regelia megacephala* brush mixed with low amounts of *Allocasuarina campestris* brush;

- Hand planting of seedlings of Declared Rare and Priority Flora; and

- Direct seeding of a general mix of native species seed from the Coomberdale Chert Threatened Ecological Community (seed of *Allocasuarina huegeliana* should be avoided or only used in very small quantities).

Recommendation 12: Harvesting of topsoil should be given high importance to ensure that as much as possible is obtained. The machinery available to harvest this important resource should be reviewed to ensure that it is suitable. Topsoil harvesting and spreading should be included in the mine planning to ensure that it occurs at the best time and is applied as quickly as possible after harvesting.

Recommendation 13: Training of mine staff not currently familiar with the rehabilitation treatments and standards should be carried out to ensure there is a 'knowledge bank' at the mine. A Rehabilitation Procedures Manual should be part of this, if it does not already exist.

Recommendation 14: Seed of *Acacia acuminata* (Jam) should be included in the seed applied to new areas of rehabilitation, and also in some trial areas of existing rehabilitation to assess the capacity of this species to suppress weed germination or establishment. [It should be noted that where weeds are already established, that suppression might be limited.]

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11.0 APPENDICES

Appendix 1: Data for quadrats rescored in 2022

Notes: To allow comparison of cover and species changes between 2016, 2019 and 2022 the cover for each year is included in the table for the quadrats. If there is a cover for 2016, it implies the species was recorded in that year, other data for the 2016 recording is available in Trudgen (2016). The dates below are for the 2022 recording, dates for the early visits are given in the earlier reports (Trudgen 2016, 2020). The soil and habitat data is from the earlier reports (there has been no significant change except possibly a small increase in litter in some quadrats). Geocodes were checked in the field in 2022.

Pale blue highlight of a species indicates that it was recorded in 2022 in a quadrat, but not in 2016 or 2019. Changes in species composition between earlier years (2013-2016 and 2016-2019) are indicated in text for quadrats.

Site: R91/01

Described by: Malcolm Trudgen **Date:** 06/10/2022 **Type:** Quadrat
Location: North Waste dump. **Geocode:** Zone 50 6624050 S, 407489 E [WGS84]
Habitat: West facing moderate slope of ridge.
Soil: Topsoil returned over mine waste. Gravelly, pebbly, cobbly, grey silt with some fine sand.

Vegetation: Allocasuarina huegeliana low open woodland over Allocasuarina campestris high open shrubland; over *Avena barbata,*Ehrharta longiflora grassland; over *Vulpia myuros, *Pentaschistis airoides, *Erodium botrys, *Hypochaeris glabra, Podolepis lessonii grass/herbland.

Vegetation change 2016-2019: Not significant. **Species changes 2013-2016:**Species lost Blennospora drummondii; Hibbertia subvaginata; Ptilotus polystachyus; Lupinus cosentinii; Tripteris clandestina; Orobanche minor; Podotheca aff. gnaphalioides (Moora WDM1-65); & Goodenia berardiana. **Species changes 2016-2019:** Thirteen species recorded in 2016were not recorded in 2016. Of these eight were native species(mostly annual species, some may have been missed due to the dry conditions).Two native species were recorded that were not recorded in 2016. See table for species.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
*Arctotheca calendula	-	-	-	Not recorded.	2-3%	5-15 cm	First recording.
Acacia congesta	+	-	-	Not recorded.	+	5-15 cm	2 seedlings.
Allocasuarina campestris	4%	4%	2-3 m	1 live, 1 dead.	>/= 5%	2.4 m	One plant.
Allocasuarina huegeliana	8%	8%	6 m	3 live (1 large and two young).	</= 10%	3.5(6) m	One + 1 overhanging.
Austrostipa trichophylla	< 5%	< 1%	20 cm	10 plants.	< 1%	40 cm	15-20 plants.
*Avena barbata	-	> 10%	15-50 cm	> 600 plants.	10-15 %	30-70 cm	> 600 plants.
*Brachypodium distachyon	< 1%	-	-	Not recorded.	1-2%	15-25 cm	> 200 plants.
*Briza maxima	+	> 5%	20 cm	> 600 plants.	-	-	Not seen.
*Bromus diandrus	+	-	-	Not recorded.	-	-	Not seen.
Cheilanthes austrotenuifolia	+	-	-	Not recorded.	+	15 cm	2 plants.

Cuscuta sp.	-	+	10 cm	1 plant.	-	-	Not seen.
*Ehrharta longiflora	< 10%	> 25%	10-30 cm	>1500 plants (mostly small).	< 5%	10-25 cm	About 200 plants.
*Erodium botrys	5%	< 5%	5-10 cm	> 300 plants.	> 5%	5-15cm	> 500 plants?
Euphorbia drummondii subsp. drummondii	-	-	-		+	3-6 cm	> 30 plants.
Gilberta tenuifolia	+	-	-	Not recorded.	-	-	Not seen.
Goodenia berardiana	1%	-	-	Not recorded.	< 1%	15-35 cm	10-20 plants.
*Hypochaeris glabra	≥ 20%	> 10%	5 cm	> 500 plants.	< 20%	5-15 cm	> 1500 plants?
Kennedia prostrata	+	-	-	Not recorded.	+	5-10 cm	19 plants.
*Lupinus cosentinii	+	+	10-20 cm	18 plants; most died before fruiting.	+	30 cm	3 plants.
Moss sp.	1-2%	-	-	Not recorded.	+	1 cm	A patch.
*Orobanche minor	+	-	-	Not recorded.	-	-	Not seen.
*Pentameris airoides	2%	< 2%	5-10 cm	~ 200 plants.	-	-	Not seen.
Podolepis canescens	-	-	-	-	< 1%	20-40 cm	20 plants.
Podolepis lessonii	10%	>10%	10-15 cm	> 500 plants.	1%	10-30 cm	About 40 plants.
Podotheca aff. gnaphalioides (Moora WDM1-65)	+	-	-	Not recorded.	-	-	Not seen.
Ptilotus polystachyus var. polystachyus	1%	-	-	Not recorded.	-	-	Not seen.
Rytidosperma acerosum	+	+	15 cm	1 plant.	-	-	Not seen.
*Sonchus oleraceus	-	-	-	-	+	15 cm	1 plant.
Thysanotus patersonii	+	+	20 cm	2 plants.	-	-	Not seen.
Trachymene cyanopetala	-	+	5 cm	-	1-2%	5-10 cm	2-300 plants.
*Trifolium arvense var. arvense	-	+	8 cm	< 5 plants.	< 1%	8 cm	33 plants.
*Monoculus monstrosus	+	+	15 cm	> 20 plants.	+	40 cm	14 plants.
*Urospermum picroides	> 1%	-	-	Not recorded.	+	10-35 cm	-
*Ursinia anthemoides	5%	<	10-15 cm	1 plant.	2%	10-50 cm	About 200 plants
*Vulpia myuros	10%	> 25%	5-10 cm	~ 1500 plants.	+	20 cm	1 plant
Waitzia nitida	+	-	-	Not recorded.	+	25 cm	2 plants.

Quadrat R91/01 in 2004 from NW corner

Quadrat R91/01 in 2007 from SE corner

Quadrat R91/01 in 2010.

Quadrat R91/01 in 2013.

Quadrat R91/01 in 2016 (from NW corner).

Quadrat R91/01 in 2019 (from SW corner).


Quadrat R91/01 in 2019 (from NW corner).


Quadrat R91/01 in 2022 (from NW corner).


Quadrat R91/01 in 2022 (from south side).


Quadrat R91/01 in 2022 (from SW corner).

Site: R91/02

Described by: Malcolm Trudgen **Date**: 06/10/2022 **Type**: Quadrat
Location: North Waste dump. Geocode: Zone 50 6624060 S, 407478 E [WGS84]
Habitat: West facing mid-slope of a waste dump slope.
Soil: Mine waste with some topsoil returned. Pale grey gravelly to cobbly(+) fine silty sand.
Rock Type: Chert mine waste.
Vegetation: Allocasuarina huegeliana low open forest; over Regelia megacephala, Allocasuarina campestris high shrubland; over *Avena barbata, *Ehrharta longiflora and *Hypochaeris glabra open grassland.
Notes: Species lost since 2013: Acacia congesta subsp. congesta; *Lysimachia arvensis. Species gained since 2013: Trachymene cyanopetala; Waitzia nitida; Brunonia australis; *Monoculus monstrosus; Kennedia prostrata; Gilberta tenuifolia. There were some large *Brassica plants nearby and a patch east of the quadrat.

NOTES: Part of the large *Regelia megacephala* had fallen, it was sprouting but not rooting.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
*Aira caryophyllea	5%	< 2%	5-8 cm	> 200 plants	+	15 cm	5 plants
Allocasuarina	1%	2-3%	3-3.5 m	2 live plants.	4-5%	3-4 m	4 live plants

campestris							and one dead.
Allocasuarina huegeliana	40%	45%	6(8)m	Cover estimate imprecise.	40%	(4)8 m	9 live plants and five dead.
*Arctotheca calendula	-	0.3%	15 cm	14 plants	2-3%	15-20 cm	> 30 plants.
Austrostipa trichophylla	-	-	-	Not recorded.	+	5-15 (35) cm	6 plants.
*Avena barbata	15%	20%	10-30(40) cm	> 500-1,000 plants	< 20%	40-70 cm	>1,000 plants
*Briza maxima	+/- 2%	< 5%	15-20 cm	> 500 plants	-	-	Not seen.
*Bromus diandrus	-	+	20 cm	< 10 plants	-	-	Not seen.
Brunonia australis	+	-	-	Not recorded.	-	-	Not seen.
Calandrinia sp.	-	-	-	-	+	5-8 cm	About 10 plants.
Cheilanthes adiantoides	-	-	-	-	+	15 cm	Two plants
Cheilanthes austrotenuifolia	+	-	-	Not recorded.	+	15 cm	One plant.
Daucus glochidiatus	+	-	-	Not recorded.	-	-	Not seen.
*Ehrharta longiflora	> 20%	> 25%	10-25 cm	> 500 plants.	> 20%	10-45 cm	> 1,000 plants
*Erodium botrys	-	+	3 cm	5 plants.	2%	3-10 cm	> 80 plants.
Euphorbia drummondii subsp. drummondii	-	-	-	-	+	3-8 cm	10 plants.
Gilberta tenuifolia	+	-	-	Not recorded.	-	-	Not seen.
Goodenia berardiana	2%	-	-	Not recorded.	+	20 cm	16 plants.
*Hypochaeris glabra	5%	≤ 5%	5 cm	> 200 plants.	> 15%	5 cm	> 1,000 plants.
Kennedia prostrata	+	+	5 cm	2 plants.	+	5-10 cm	6 planta
*Lupinus cosentinii	-	+	30 cm	2 plants.	+	40 cm	1 plant.
Moss sp.	-	≤ 1%	2 cm	Several patches.	> 4%	1 cm	Several patches.
*Pentameris airoides	< 5%	-	-	Not recorded.	-	-	Not seen.
Podolepis lessonii	-	2%	5-15 cm	> 400 plants	+	5-15 cm	3 plants.
Ptilotus polystachyus	-	-	-	-	+	7 cm	One plant.
Regelia megacephala	8%	8%	4 m	1 live plant.	< 5%	4 m	1 live plant.
*Romulea rosea	+	-	-	Possibly missed as very fine.	-	-	Not seen.
Rytidosperma acerosum	1%	1%	20 cm	20 plants.	1%	5-10 cm	About 20 plants
*Sonchus oleraceus	-	-	-	-	+	10-18 cm	4 plants.
Thysanotus patersonii	1%	1-2%	1 m	10-15 plants (climber,	> 2%	1-1.7 m	7 plants.

				intermixed).			
Trachymene cyanopetala	1-2%	1-2%	5-8 cm	> 100 plants	-	-	Seen just out.
Trachymene pilosa	+	-	-	Not recorded.	-	-	Not seen.
*Trifolium arvense var. arvense	+	-	-	Not recorded.	-	-	Not seen.
*Monoculus monstrosus	+	< 1%	8-15 cm	> 50 plants.	+	50 cm	One plant.
*Urospermum picroides	3%	-	-	Not recorded.	+	8-20 cm	< 20 plants.
*Ursinia anthemoides	5%	> 15%	10-20 cm	> 500-1,000 plants	> 20%	10-60 cm	> 1,000 plants
*Wahlenbergia capensis	-	-	-	-	+	25 cm	One plant
*Vulpia myuros	1%	1%	10 cm	> 200 plants.	-	-	Not seen.
Waitzia nitida	+	+	10 cm	1 plant	-	-	Seen just out.

Quadrat R91/02 in 2004

Quadrat R91/02 in 2007

Quadrat R91/02 in 2010

Quadrat R91/02 in 2013


Quadrat R91/02 in 2013 (from NW corner).


Quadrat R91/02 in 2019


Quadrat R91/02 in 2022 from NW corner.


Quadrat R91/02 in 2022 from west side.

Site: R91/03

Described by: Malcolm Trudgen **Date:** 06/10/2022 **Type:** Quadrat **Location:** North Waste dump.
Geocode: Zone 50 6623992 S, 407493 E [WGS84]
Habitat: Moderate west facing mid-slope.
Soil: Overburden over mine waste. Some fine silty soil present.
Rock Type: Chert mine waste.
Vegetation: Allocasuarina huegeliana low woodland over Regelia megacephala high open shrubland over Hibbertia subvaginata low scattered shrubs over *Avena barbata, *Ehrharta longiflora, *Ursinia anthemoides, *Hypochaeris glabra, *Vulpia myuros annual grassland/herbland.
Notes: Plants gained since 2013: Arctotheca calendula; Podolepis lessonii; Cheilanthes adiantoides; Monoculus monstrosus; Orobanche minor; Kennedia prostrata; Acacia stenoptera; Petrorhagia dubia. Plants lost since 2013: Silene gallica var. gallica;

NOTES: 2019: The Ehrharta was small, except where under the cover of *Regelia*. Total weed cover was > 50%.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta	-	-	-	-	+	10 cm	2 seedlings.
Acacia stenoptera	+	-	-	Not recorded.	-	-	Not seen
Allocasuarina huegeliana	20-25%	20-25%	8 m	3 live plants, 1 overhanging in	>/= 30%	8 m	3 live plants, 1 overhanging

				SE corner & 1 dead (old).			in SE corner, 1 dead (old).
*Arctotheca calendula	+	≤ 2%	5 cm	> 100 plants, all small.	> 20%	5-20 cm	> 1,000 plants
Austrostipa trichophylla	2-3%	+	10 cm	1 plant (60 - plants in 2016).	+	10-38 cm	13 plants
*Avena barbata	≥ 10%	5%	25-90 cm	> 500 plants.	5%	25-90 cm	4-500 plants
*Briza maxima	1%	2%	10-20cm	> 200 plants.	-	-	Not seen.
Cheilanthes adiantoides	+	-	-	Not recorded.	-	-	Not seen.
*Ehrharta longiflora	15%	≤ 30%	30-70 cm	> 1,500 plants.	> 25%	30-130 cm	> 1,500 plants
*Erodium botrys	> 5%	< 5%	7 cm	> 200 plants	1%	34 cm	< 50 plants.
Goodenia berardiana	+	-	-	Not recorded.	-	-	Not seen.
Hibbertia subvaginata	< 1%	< 1%	60 cm	1 large plants (no dead ones seen).	< 1%	60 cm	1 large plant.
*Hypochaeris glabra	> 15%	≤ 5	10 cm	> 200 plants.	< 10%	10 cm	> 500 plants.
Kennedia prostrata	+	-	-	Not recorded.	+	-	7 plants.
Lepidosperma tenue	+	+	35 cm	1 large, 1 small	+	35 cm	1 large plant.
*Lupinus cosentinii	-	+	25Cm	1 plant.	-	-	Not seen.
Moss sp.	+	+	2 cm	-	-	-	Not seen.
*Orobanche minor	+	-	-	Not recorded.	+	-	7 plants.
*Pentameris airoides	1%	-	-	Not recorded.	-	-	Not seen.
*Petrorhagia dubia	+	-	-	Not recorded.	+	20 cm	-
Podolepis canescens	-	-	-	-	+	20 cm	1 plant.
Podolepis lessonii	1-2%	2-3%	10-20 cm	> 250 plants.	+	10-30 cm	13 plants.
Podotheca gnaphalioides	-	-	-	-	+	15 cm	1 plant
Ptilotus polystachyus	-	-	-	-	+	10-30 cm	10-15 plants
Regelia megacephala	-	≥ 8%	2 m	1 large plant in NE corner.	> 8%	2 m	1 large plant in NE corner.
Rytidosperma acerosum	-	-	-	-	+	10 cm	1 plant
*Sonchus oleraceus	-	-	-	-	+	10 cm	Juvenile.
Trachymene cyanopetala	+	-	-	Not recorded.	-	-	Not seen.
*Trifolium arvense var. arvense	1-2%	-	-	Not recorded.	+	10-15 cm	7 plants.
*Monoculus monstrosus	+	1%	80 cm	> 50 plants.	1%	60-90 cm	> 50 plants.
*Urospermum picroides	2%	-	-	Not recorded.	-	-	Not seen.
*Ursinia anthemoides	5%	2%	10-15 cm	> 300 plants	2%	10-45 cm	> 200 plants.
*Vulpia myuros	< 10%	+	10-20 cm	< 500 plants.	-	-	Not seen.
Waitzia nitida	+	+	15 cm	1 plant.	-	-	Not seen.

Quadrat R91/03 in 2004

Quadrat R91/03 in 2007

Quadrat R91/03 in 2010 (from NW corner)

Quadrat R91/03 in 2013

Quadrat R91/03 in 2016 (from NW corner)

Quadrat R91/03 in 2019 (from NW corner)


Quadrat R91/03 in 2022 (from NW corner)


Quadrat R91/03 in 2022 (from north side).

Site: R91/04

Described by: Malcolm Trudgen **Date:** 06/10/2022 **Type:** Quadrat

Location: North Waste dump. **Geocode:** Zone 50 6623993 S, 407455 E [WGS84]
Habitat: Moderate to steep, west-facing lower slope of waste dump.
Soil: Mine waste with some topsoil returned. Pale grey gravelly to cobbly fine silty sand.
Rock Type: Chert waste
Vegetation: Allocasuarina huegeliana low woodland over Regelia megacephala high shrubland over Hibbertia subvaginata low scattered shrubs over *Avena barbata, *Pentaschistis airoides, *Briza maxima, *Vulpia myuros, *Hypochaeris glabra, *Ehrharta longiflora open herbland/grassland.
Notes: Only seedlings were present in 2013 & 2016, so there was no establishment from the 2013 germination. Plants gained since 2013: Monoculus monstrosus; Waitzia nitida; Bromus rubens; Petrorhagia dubia; Comesperma integerrimum; Sonchus oleraceus; Lupinus cosentinii; Brassica barrelieri; Arctotheca calendula; Senecio diaschides.

NOTES 2019: Total weed cover ~ 65%. Photo five from SW corner, six from W side. The *Cuscuta* record is the first for the Moora Chert survey area.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	+	-	-	Not recorded.	+	20 cm	4 juvenile plants in a cluster.
Allocasuarina huegeliana	12%	12-15%	7-8 m	Two large live plants (1 overhanging?).	15%	7-8 m	Two large live plants (& 2 overhanging).
*Arctotheca calendula	+	-		Not recorded.	-	-	Not seen.
*Avena barbata	10%	> 10%	20-40 (100) cm	> 600 plants.	> 10%	20-90 (120) cm	> 700 plants
*Brassica barrelieri	+	+	15 cm	1 dead plant (with seed).	+	30 cm	On west edge of quadrat.
*Briza maxima	< 1%	< 1%	10-15 cm	< 100 plants	-	-	Not seen.
*Bromus rubens	+	-	-	Not recorded.	-	-	Not seen.

Cheilanthes austrotenuifolia	+	+	10 cm	Two plants?	+	10 cm	2 plants.
Comesperma integerrimum	+	-	-	Not recorded.	< 1%	70 cm	1 plant.
Cuscuta sp.	-	+	10 cm	Growing over several species.	+	10 cm	2 patches.
*Ehrharta longiflora	15%	35%	10-50	> 2,000 plants.	> 35%	10-50 (105) cm	> 2,000 plants.
Hibbertia subvaginata	1-2%	≤ 1%	95 cm	1 plant.	1-2%	1 m	2 plants.
*Hypochaeris glabra	> 20%	< 15%	5 cm	> 400 plants	15-20%	5-10 cm	> 1,000 plants.
Kennedia prostrata	1-2%	+	4 cm	5 plants.	+	5-10 cm	14 plants
*Lupinus cosentinii	+	+	20 cm	4 dead plants.	-	-	Not seen.
Moss sp.	2%	-	-	Not recorded.	+	2 cm	In patches.
*Pentameris airoides	+	-	-	Not recorded.	-	-	Not seen.
*Petrorhagia dubia	+	-	-	Not recorded.	-	-	Not seen.
Podolepis lessonii	> 5%	10-15%	7-15 cm	> 600 plants.	2%	10-20 cm	> 200 plants.
Regelia megacephala	12%	< 6%	(0.55)2 m	2 adults, 2 juveniles.	1%	(0.55)2 m	1 adult and 1 young plant.
Rhagodia preissii ssp. preissii	-	-	-	-	+	40 cm	1 plant.
Senecio diaschides	+	-	-	Not recorded.	-	-	Not seen.
*Sonchus oleraceus	+		-	Not recorded.	+	10 cm	2 plants
Trachymene cyanopetala	+	+	7 cm	~ 20 plants.	-	-	Not seen.
*Trifolium arvense var. arvense	+	-	-	Not recorded.	-	-	Not seen.
*Monoculus monstrosus	+	+	10-15 cm	> 10 plants	-	-	Not seen.
*Urospermum picroides	3-4%	< 1%	10 cm	< 30 plants.	< 1%	10-25 (60) cm	< 25 plants.
*Ursinia anthemoides	>10%	< 10%	10-35cm	> 500 plants.	< 5%	15-40 cm	> 300 plants.
*Vulpia myuros	+	5%	10 cm	> 800 plants	-	-	Not seen.
Waitzia nitida	+	+	20-30 cm	2 plants.	+	25 cm	1 plant.

Quadrat R91/04 in 2004

Quadrat R91/04 in 2007

Quadrat R91/04 in 2010

Quadrat R91/04 in 2013

Quadrat R91/04 in 2016 (from near NE corner).

Quadrat R91/04 in 2019 (from west side).


Quadrat R91/04 in 2022 (from east side).


Quadrat R91/04 in 2022 (from SE corner).

Site: R96/01

Described by: Malcolm Trudgen Date: 07/10/2022 Type: Quadrat
Location: Main Waste dump. Geocode: Zone 50 6623639 S, 407225 E [WGS84]
Habitat: North facing moderate to steep lower slope of waste dump.
Soil: Gravelly, fine silty pale brown sand with chert boulders. Topsoil thin, returned over mine waste.
Rock Type: Chert mine waste.
Vegetation: Allocasuarina huegeliana low open woodland; over Regelia megacephala and Allocasuarina campestris open shrubland; over *Ehrharta longiflora, *Ursinia anthemoides, *Erodium cicutarium, *Avena barbata open grassland; over, *Vulpia myuros, *Hypochaeris glabra very open herbland.
Notes: Species lost between 2013 and 2016: Ptilotus polystachyus var. polystachyus; Regelia megacephala (all dead); Solanum nigrum; Sonchus oleraceus. Species gained between 2013 & 2016: Monoculus monstrosus; Lamarckia aurea; Trifolium hirtum; Calandrinia sp.; Bromus rubens.

Notes 2019: Total weed cover 65-75%.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Allocasuarina campestris	1-2%	2%	2 m	1 live plant and 1 overhanging.	2%	2.2 m	1 live plant and 1 overhanging.
Allocasuarina huegeliana	10-12%	10-12%	6-7 m	1 live	< 10%	6-7 m	1 live and 2 overhanging.
*Arctotheca calendula	35%	≤ 1	5-10 cm	> 700 plants	> 30%	5-10 cm	> 700 plants.
Austrostipa trichophylla	< 1%	+	10 cm	3 plants (height is leaves).	< 1%	10 cm	3 plants.
*Avena barbata	< 10%	≤ 10%	20-90 cm	> 500 plants.	5-10%	20-90 cm	> 500 plants.
*Brachypodium distachyon	+	-	-	Not recorded.	< 1%	50 cm	-
*Brassica barrelieri subsp. oxyrrhina	+	-	-	Not recorded.	< 1%	50-75 cm	4 plants.
*Bromus diandrus	-	< 1%	15-20	> 30 plants.	< 1%	40 cm	> 30 plants.

			cm				
*Bromus rubens	< 1%	< 0.5%	15-25cm	> 20 plants.	5%	15-25 cm	> 200 plants
Calandrinia sp.	< 1%	-	-	Not recorded.	+	5 m	Edge SW corner.
*Centaurea melitensis	<1%	-	-	Not recorded.	> 15%	30-70 cm	-
Cheilanthes austrotenuifolia	-	-	-	-	+	12 cm	-
Crassula colorata var. acuminata	-	-	-	-	+	2-5 cm	> 100 plants
*Ehrharta longiflora	>10%	10%	20-40 cm	> 4500 plants	</= 10%	20-40 cm	Ca. 1,000 plants.
*Erodium cicutarium	≥ 5%	> 15%	10-30 cm	> 500 plants	25%	10-30 cm	>/= 1,000 plants.
*Hedypnois rhagadioloides	< 5%	-	-	Not recorded.	< 10%	15-60 cm	-
*Hypochaeris glabra	> 20%	< 5%	5-10 cm	< 300 plants	> 40%	5-10 cm	> 1,000 plants.
*Lamarckia aurea	+	-	-	Not recorded.	-	-	Not seen.
Moss sp.	+	-	-	Not recorded.	-	-	Not seen.
*Orobanche minor	+	-	-	Not recorded.	+	20 cm	5 stems.
*Pentameris airoides	+	-	-	Not recorded.	-	-	Not seen.
Ptilotus polystachyus	-	+	15-30 cm	3 plants.	+	15-30 cm	6 plants, SW corner.
*Silene gallica var. gallica	+	+	10 cm	1 plant.	>/= 1%	10 cm	> 30 plants.
*Trifolium arvense var. arvense	1%	< 1%	5-10 cm	~ 10 plants.	2%	10-25 cm	Ten plants.
*Trifolium hirtum	+	0.5%	8-15 cm	> 50 plants.	> 5%	10-20 cm	> 100 plants.
*Monoculus monstrosus	+	+	15-50 cm	-	3%	30-70 cm	Ca. 100 plants.
*Urospermum picroides	-	-	-	Not recorded.	-	-	Not seen.
*Ursinia anthemoides	1-2%	5%	10-25 cm	< 200 plants.	1%	25 cm	< 100 plants.
*Vulpia myuros	+	20%	8-15 cm	> 1,500 small plants.	+	30 cm	< 10 plants.

Quadrat R96/01 in 2004

Quadrat R96/01 in 2007

Quadrat R96/01 in 2010

Quadrat R96/01 in 2013

Quadrat R96/01 in 2016 (from NE corner)

Quadrat R96/01 in 2019 (from NE corner)

Quadrat R96/01 in 2022 (from near NE corner).

Quadrat R96/01 in 2022 (from SE corner).

Site: R96/02

Described by: Malcolm Trudgen **Date**: 07/10/2022 **Type**: Quadrat
Location: Main Waste dump. **Geocode**: Zone 50 6623623 S, 407199 E [WGS84]
Habitat: Moderate, north facing lower slope.
Soil: Limited, returned over mine waste.
Vegetation: Allocasuarina huegeliana low woodland; over Allocasuarina campestris scattered shrubs; over Regelia megacephala regeneration low open shrubland; over *Avena barbata, *Ehrharta longiflora, *Erodium botrys *Vulpia myuros, *Arctotheca calendula open grassland.
Notes: Species lost between 2013 & 2016: Allocasuarina campestris; Austrostipa sp.; Brachypodium distachyon; Conyza bonariensis; Sonchus oleraceus; Trifolium repens var. repens. Species gained between 2013 and 2016: Ptilotus polystachyus var. polystachyus.,

Notes 2019: Total weed cover 40-50%. The *Arctotheca* changed significantly in cover.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Allocasuarina huegeliana	15-20%	15%	6m	1 plant (spreading tree, some dead branches).	15%	6m	1 plant (spreading tree, some dead branches).
*Arctotheca calendula	35-40%	5-10%	5-10 cm	~ 500 plants (mostly dead).	> 20%	15 cm	Ca. 500 plants (mostly dying).
Aristida contorta	-	-	-	-	+	15 cm	11 plants in SW corner.
*Avena barbata	< 5%	5-10%	20-90 cm	~ 400 plants.	< 5%	40-110 cm	Ca. 400 plants.
*Bromus diandrus	-	1%	20 cm	~ 50 plants.	< 1%	20 cm	Ca. 50 plants.
*Bromus rubens	-	+	10-15 cm	30-50 plants.	1-2%	10-25 cm	30-50 plants.
Crassula colorata var. colorata	-	-	-	-	</= 1%	2-6 cm	> 500 60 1,,000 plants.
*Ehrharta longiflora	5-10%	5-10%	10-20 cm	> 150 plants.	< 5%	10-20 cm	> 150 plants.
*Erodium botrys	10-15%	≤ 15%	10-25 cm	> 400 plants (some large).	Ca. 20%	10-35 cm	> 400 plants (some large).
*Hypochaeris glabra	5-10%	10%	5-25 cm	> 400 plants.	50%	5-25 cm	> 400 plants.
*Lupinus cosentinii	-	+	20 cm	4 plants.	-	-	Just out.
Moss	-	-	-	-	</= 1%	2 cm	-
*Orobanche minor	+	-	-	Not recorded.	</= 1%	10-30 cm	> 40 stems.
*Pentameris airoides	< 1%	-	-	Not recorded.	+	15 cm	-
Ptilotus polystachyus var. polystachyus	+	+	40 cm	2 plants.	1%	40-100 cm	8 plants.
Regelia megacephala	3-4%	4	0.8-2.2 m	2 plants, no seedlings.	1-2%	1.2 m	1 plant, no seedlings
*Silene gallica var. gallica	+	-	-	Not recorded.	1%	30-45 cm	In NE corner.
*Trifolium arvense var. arvense	< 1%	-	-	Not recorded.	+	10-15 cm	-
*Monoculus monstrosus	< 1%	< 1%	20-40 cm	-	2%	20-40 cm	-

*Urospermum picroides	1-2%	1%	10-30 cm	> 50 plants	1%	10-55 cm	> 70 plants.
*Ursinia anthemoides	< 1%	< 5%	10-20 cm	> 400 plants.	5%	10-20 cm	> 400 plants.
*Vulpia myuros	-	> 20%	10-20 cm	> 2,000 plants.	> 10%	10-20 cm	500-1,000 plants.

Quadrat R96/02 in 2004

Quadrat R96/02 in 2007

Quadrat R96/02 in 2010

Quadrat R96/02 in 2013 (from SW corner).

Quadrat R96/02 in 2016 (from SW corner).

Quadrat R96/02 in 2019 (from SW corner).


Quadrat R96/02 in 2022 (from SW corner).


Quadrat R96/02 in 2022 (from NW corner).

Site: R98/01

Described by: Malcolm Trudgen **Date:** 07/10/2022 **Type:** Quadrat

Location: Main Waste dump. **Geocode:** Zone 50 6623614 S, 407248 E [WGS84]
Habitat: Gentle, NW facing slope (from crest of waste dump).
Soil: Surface of fine-medium gravel and cobbles.
Rock Type: Chert mine waste.
Vegetation: Allocasuarina campestris, Acacia congesta subsp. congesta open shrubland over Hibbertia subvaginata low shrubland; over *Avena barbata, *Vulpia myuros, *Ursinia anthemoides, *Urospermum picroides, Trachymene cyanopetala annual grass/herbland

Notes: Species lost since 2013: Allocasuarina huegeliana (some seedlings counted as Allocasuarina campestris may be A. huegeliana); Austrostipa elegantissima; Blennospora drummondii; Senecio glossanthus; Wahlenbergia preissii. Species gained since 2013: Arctotheca calendula; Hypochaeris glabra; Aira caryophyllea.

Notes 2019: A big germination of Allocasuarina huegeliana. Six species, five native, gained since 2016. The *Lupinus* likely to increase in cover. Many juvenile *Allocasuarina*.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	3%	2%	1.3 m	1 plant, 2 m across.	3%	1.7 m	1 plant, 2 m across & a 7 cm seedling.
*Aira caryophyllea	+	+	5-10 cm	> 100 plants.	-	-	Not seen
Allocasuarina campestris	< 5 %	25-35%	(0.1)1.2-2.3 m	4 adult plants (3%) and ca. 300 juveniles 10-70 cm.	30%	30-140 cm & 2.2 m	3 adult (2.2 m) & 100-120 young 30-140 cm
Allocasuarina huegeliana	-	2-3%	0.8-1.7 m	11 plants, all juvenile.	2-3%	1.7-3 m	4 young plants.
*Arctotheca calendula	-	-	-	-	< 1%	5-10 cm	-
Aristida contorta	-	-	-	-	+	10 cm	> 20 plants.
*Lysimachia arvensis var. arvensis	3%	-	-	Not recorded.	+	10-15 cm	-
Apium annuum	-	+	1.5 cm	> 50 plants.	-	-	Not seen.
*Arctotheca calendula	3%	+	3 cm	< 10 plants.	+	3 cm	< 10 plants.

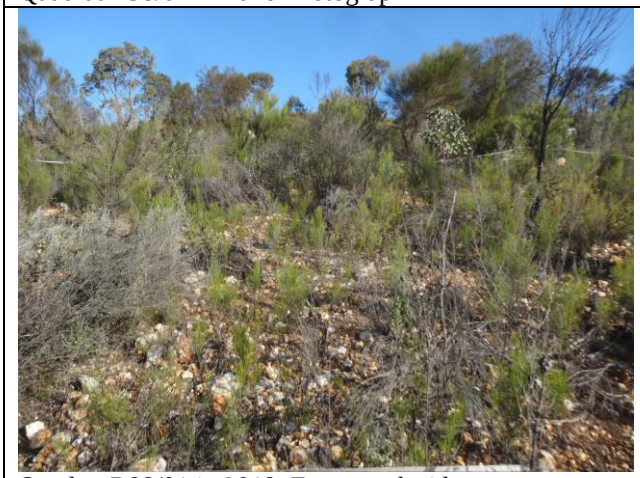
Austrostipa trichophylla	+	-	-	Not recorded.	-	-	Not seen.
*Avena barbata	+	+	10-20 cm	50-100 plants.	-	-	1 plant just out.
*Brassica barrelieri subsp. oxyrrhina	+	-	-	Not recorded.	-	-	Not seen.
Blennospora drummondii	-	+	5 cm	> 50 plants.	-	-	Not seen.
*Briza maxima	+	-	-	Not recorded.	-	-	Not seen.
*Bromus diandrus	+	-	-	Not recorded.	-	-	Not seen.
*Bromus rubens	-	-	-	-	+	10-15 cm	-
*Centaurea melitensis	-	-	-	-	</= 1%	10-20 cm	> 200 plants.
Crassula colorata var. colorata	-	-	-	-	+	2-7 cm	< 20 plants.
*Ehrharta longiflora	3-5%	+	20 cm	1 plant!	+	10-60 cm	-
*Erodium botrys	-	-	-	-	+	10-25 cm	+
Eucalyptus camaldulensis?	-	< 1%	1.6 m	1 plant, juvenile.	1%	2.8 m	1 young tree.
*Hedypnois rhagadioloides	-	-	-	-	2%	15-30 cm	> 20 plants
Hibbertia subvaginata	10-12%	10%	< 10-50 cm	29 adult and 5 juvenile (≤ 10 cm) plants	2%	80-130 cm	4 plants.
*Hypochaeris glabra	5%	1-2%	5 cm	~ 200 plants.	> 5%	5 cm	> 1,000 plants
*Lupinus cosentinii	-	+	25 cm	4 plants.	-	-	Not seen.
*Pentameris airoides	< 1%	-	-	Not recorded.	-	-	Not seen.
Ptilotus polystachyus var. polystachyus	+	-	-	Not recorded.	-	-	Not seen.
Podotheca gnaphalioides	-	-	-	-	+	7-18 cm	5 plants.
Regelia megacephala	5-10%	1%	0.2-1.5 m cm	2 sub-mature (1.5 m) and 5 juvenile (20-50 cm).	+	1.6 m	1 plant.
Thysanotus patersonii	-	+	60 cm	1 plant.	+	60-130 cm	5 plants.
Trachymene cyanopetala	+	1%	5-8 cm	> 500 plants.	3%	5-8 cm	> 1,000 plants
Trachymene ornata	+	+	5 cm	5+ plants.	+	5-7 cm	Ca. 64 plants
*Trifolium arvense var. arvense	+	+	5-10 cm	2 plants.	+	10 cm	2 plants
*Urospermum picroides	1%	+	5-8 cm	< 50 plants.	-	-	Not seen
*Ursinia anthemoides	1%	3%	8-12 cm	> 800 plants.	2-3%	20-40 cm	> 400 plants.
*Vulpia myuros	1%	≤ 5%	7-10 cm	> 1,000 plants.	+	10 cm	1 plant

Quadrat R98/01 in 2004

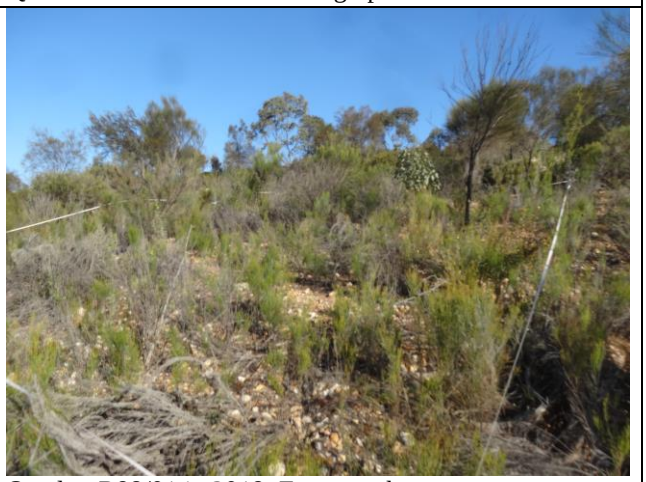
Quadrat R98/01 in 2013

Quadrat R98/01 in 2016 Photograph 1

Quadrat R98/01 in 2016 Photograph 2



Quadrat R98/01 in 2019: From north side



Quadrat R98/01 in 2019: From north-west corner


Quadrat R98/01 in 2022: From north side.


Quadrat R98/01 in 2022: From north-west corner.

Site: R98/02

Described by: Malcolm Trudgen **Date:** 07/10/2022 **Type:** Quadrat
Location: Main Waste dump. **Geocode:** Zone 50 6623601 N, 407214 E [WGS84]
Habitat: Upper moderate slope of waste dump, NW facing.
Soil: Gravelly, cobbly silty sand. Lots of surface rock.
Rock Type: Chert mine waste
Vegetation: Regelia megacephala, (Allocasuarina huegeliana) high shrubland; over Allocasuarina campestris shrubland; over Hibbertia subvaginata open shrubland; over *Avena barbata, *Ehrharta longiflora *Vulpia myuros very open grassland.
Notes: Species lost since 2013: Bromus diandrus; Cotula sp.; Silene gallica var. gallica; Wahlenbergia preissii. Species gained since 2013: Erodium botrys; Petrorhagia dubia; Trachymene cyanopetala; Podolepis lessonii; Ptilotus polystachyus var. polystachyus; Austrostipa trichophylla; and Arctotheca calendula. There has been confusion between 2016 and 2019 identifying the juvenile *Allocasuarina*. This has been sorted out and most individuals are (and were) *Allocasuarina campestris* [corrected in table[#]].

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Allocasuarina campestris	3-4%	[#]10-12%	1-1.9 m	2 large (1.2-1.6 m). Juveniles assigned to this species in 2016 should have been assigned to Allocasuarina huegeliana.	</= 20%	(5)40-120 cm & 2 m	Two plants 2 m tall rest mostly 40-120 cm, a few ca. 5 cm.
Allocasuarina huegeliana	< 1%	[#]1-2%	0.2-1.6 m	ca. 120 juveniles	>/= 1%	(1.3)2.5-2.8 m	Three plants.
*Arctotheca calendula	+	-	-	Not recorded.	< 1%	5 cm	30-50 plants.
Austrostipa trichophylla	+	-	-	Not recorded.	-	-	Not seen.
*Avena barbata	1-2%	1-2%	20-50 cm	100-200 plants.	2%	20-50 cm	> 300 plants.
*Brachypodium distachyon	-	-	-	-	+	7 cm	One plant.

*Ehrharta longiflora	≥ 4%	≥ 4%	10-45 cm	> 200 plants.	5%	10-75 cm	> 500 plants.
*Erodium botrys	+	+	5 cm	5 plants.	1%	5 cm	Ca. 100 plants.
Hibbertia subvaginata	3-4%	4%	50-1400 cm	13 plants.	2%	110 cm	2 plants.
*Hypochaeris glabra	10%	> 5%	5-10 cm	> 500 pants (? > 1,000) [impossible to estimate number of plants.	> 15%	5-10 cm	Ca. 1,000 plants, but dead so difficult to assess.
*Lysimachia arvensis	-	-	-	-	+	7 cm	-
Moss sp.	+	-	-	Not recorded.	-	-	Not seen.
*Pentameris airoides	1%	1%	5 cm	> 100 plants.	1%	5 cm	> 100 plants.
*Petrorhagia dubia	+	-	-	Not recorded.	+	40 cm	4 plants.
Podolepis lessonii	+	+	15 cm	1 plant.	+	15 cm	Ca. 15 plants
Podotheca gnaphalioides	-	-	-	-	-	-	Just out.
Ptilotus polystachyus var. polystachyus	+	-	-	Not recorded.	-	-	Not seen.
Regelia megacephala	20%	20%	0.2-3 m	19 “large” plants (> 1.2 m) and 49 smaller plants (most > 35 cm).	15%	< 60 cm -	2 plants: 12 < 60 cm others 1-2.8 m.
*Silene gallica ssp. gallica	-	-	-	-	+	15 cm	< 5 plants
Thysanotus patersonii	-	-	-	-	+	90 cm	1 plant.
Trachymene cyanopetala	+	-	-	Not recorded.	+	5 cm	-
*Trifolium arvense var. arvense	1%	+	5-12 cm	< 30 plants.	2%	5-12 cm	>/= 200 plants.
*Trifolium hirtum	-	-	-	-	+	10 cm	< 20 plants.
*Monoculus monstrosus	-	-	-	-	+	15-40 cm	< 30 plants.
*Urospermum picroides	1-2%	+	5-6 cm	< 30 plants.	+	10-50 cm	< 30 plants.
*Ursinia anthemoides	+	1%	15 cm	> 400 plants.	1%	8-25 cm	< 200 plants.
*Vulpia myuros	1%	1-2%	5-10 cm	> 500 plants.	+	10 cm	< 20 plants.
*Wahlenbergia capensis	-	-	-	-	+	7-10 cm	> 100 plants.

Quadrat R98/02 in 2004

R98/02 in 2007

Quadrat R98/02 in 2010

Quadrat R98/02 in 2013

Quadrat R98/02 in 2016 (from NE corner).

Quadrat R98/02 in 20109 (from NE corner).

Quadrat R98/02 in 2022 (from SE corner)

Quadrat R98/02 in 2022 (from NE corner).

Site: R00/01
Described by: Malcolm Trudgen **Date:** 07/10/2022 **Type:** Quadrat
Location: Main Waste dump. **Geocode:** Zone 50 6623607 S, 407293 E [WGS84]
Habitat: North-facing mid-slope of tall waste dump.
Soil: Chert mine waste including some brown, silty fine sand with lots of gravel, cobbles, rocks and boulders.
Vegetation: Allocasuarina huegeliana scattered low trees over Regelia megacephala, Allocasuarina campestris high open shrubland over Hibbertia subvaginata low open shrubland over *Erodium botrys, *Hypochaeris glabra, *Ehrharta longiflora, *Avena barbata open herbland/grassland.
Notes: Species added since 2013: Brachypodium distachyon; Trachymene cyanopetala; Trachymene ornata; Sonchus oleraceus; Petrorhagia dubia; Urospermum picroides; Briza maxima; Eucalyptus camaldulensis (probably, juvenile); Monoculus monstrosus; Orobanche minor; Centaurea melitensis; Ptilotus polystachyus var. polystachyus; Austrostipa elegantissima. Species lost since 2013: Bromus diandrus. There was probably confusion in 2019 between *Allocasuarina campestris* and *Allocasuarina huegeliana*.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	< 1%	< 1%	80 cm	1 plant.	2%	1.4 m	1 plant
Allocasuarina campestris	2%	2-3%	1.6 m	2 plants, 1 juvenile. 4 older dead (1.5 m +).	>/= 20%	0.5-2 m	22 plants
Allocasuarina huegeliana	2%	15-20%	(0.3)4.5 m	1 large plant (4.5 m) and 46 younger (0.3-1.5 m) 1 large plant (4.5 m) and 46 younger (0.3-1.5 m)	2-3%	1.6-2.8 m	2 plants. Ah & Ac were confused in the 2019 data. Corrected in 2022.
*Arctotheca calendula	-	+	5 cm	1 plant.	+	5 cm	< 20 plants.
Austrostipa elegantissima	1%	1%	70 cm	2 plants.	-	-	Not recorded
Austrostipa sp.	+	-	-	Not recorded.	-	-	Not seen
Austrostipa trichophylla	+	+	7 cm	2 plants (height is leaves).	-	-	Not seen
*Avena barbata	15%	5-8%	10-30 cm	> 500 plants.	>/= 5%	10-90 cm	> 500 plants.
*Brachypodium distachyon	+	+	-	Not recorded.	-	-	Not seen
*Briza maxima	+	+	10-20 cm	< 10 plants.	-	-	Not seen
*Centaurea melitensis	+	-	-	Not recorded.	-	-	Not seen
Dichopogon capillipes	-	-	-	-	+	10 cm	1 plant.
*Ehrharta longiflora	10%	≤ 5%	10-25 cm	> 500 plants.	2%	10-60 cm	> 200 plants.
*Erodium botrys	> 5%	< 1%	8-15 cm	< 100 plants.	3%	8-15 cm	> 200 plants.
Eucalyptus camaldulensis	+	< 1%	1.4 m	1 juvenile.	2%	2.5 m	1 young plant.
Goodenia berardiana	-	-	-	-	+	25 cm	3 plants.
Hibbertia subvaginata	2%	3%	80-120	7 plants.	2%	100-	2 plants.

			cm			130 cm	
*Hypochaeris glabra	3-5%	1%	5-8 cm	> 100 plants.	> 15%	5-8 cm	> 800 plants.
Microtis sp.							
*Monoculus monstrosus	+	-	-	Not recorded.	1%	20-50 cm	> 30 plants
*Orobanche minor	+	-	-	Not recorded.	-	-	Not seen
*Pentameris airoides	+	+	5-10 cm	> 100plants.	-	-	Not seen
*Petrorhagia dubia	+	-	-	Not recorded.	+	25 cm	1 plant.
Podolepis lessonii	1-2%	3-4%	5-15 cm	> 500 plants.	4%	10-25 cm	> 300 plants
Ptilotus polystachyus var. polystachyus	+	-	-	Not recorded.	-	-	Not seen
Regelia megacephala	6%	2%	150-200cm	2 adult plants + 1 overhanging and 1 young plant (50 cm).	-	-	All dead.
*Silene gallica var. gallica	-	-	-	Not recorded.	< 1%	45 cm	> 30 plants.
*Sonchus oleraceus	+	-	-	Not recorded.	+	35 cm	-
Thysanotus patersonii	-	+	50 cm	1 plant	+	1.4 m	2 plants.
Trachymene cyanopetala	+	+	5 cm	1 plant.	+	5 cm	1 plant.
Trachymene ornata	+	-	-	Not recorded.	+	3-6 cm	> 30 plants.
*Urospermum picroides	1-2%	+	5-8 cm	40-50 plants.	< 5%	12-30 cm	> 400 plants.
*Ursinia anthemoides	+	< 1%	5-15 cm	> 200 plants.	1%	20 cm	> 20 plants.
*Vulpia myuros	< 1%	2-3%	5-12 cm	> 500 plants.	-	-	Not seen
*Wahlenbergia capensis	-	+	12 cm	1 plant.	+	20 cm	5 plants


Quadrat R00/01 in 2004


Quadrat R00/01 in 2007


Quadrat R00/01 in 2010


Quadrat R00/01 in 2013


Quadrat R00/01 in 2016.


Quadrat R00/01 in 2019 (from SW corner).


Quadrat R00/01 in 2022 (from south side).


Quadrat R00/01 in 2022 (from SW corner).

Site: R00/02

Described by: Malcolm Trudgen **Date:** 11/10/2022 **Type:** Quadrat
Location: Main Waste dump. **Geocode:** Zone 50 6623528 S, 407224 E [WGS84]
Habitat: Moderate, west-facing slope.
Soil: Chert mine waste including some brown, silty fine sand with lots of gravel, cobbles, rocks and boulders.
Rock Type: Chert mine waste
Vegetation: Eucalyptus camaldulensis var. obtusa, Allocasuarina huegeliana scattered trees; over Regelia megacephala high open shrubland over Hibbertia subvaginata, Acacia congesta subsp. congesta low open shrubland; over *Avena barbata, *Briza maxima *Hypochaeris glabra,*Trifolium arvense var. arvense, *Vulpia myuros annual open grass/herbland.

Notes: Species gained since 2013: Acacia lasiocarpa var. sedifolia; Bossiaea moylei; Sonchus oleraceus; Trachymene ornata; Cheilanthes adiantoides; Trachymene cyanopetala; Microtis sp.; Goodenia berardiana; Monoculus monstrosus; Arctotheca calendula. Species lost since 2013: Rytidosperma sp.; Parentucellia latifolia

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	+	-	-	Not recorded.	+	7-12 cm	3 seedlings.
Acacia lasiocarpa var. sedifolia	+	+	80 cm	1 plant, ca. 5 years old.	-	-	Not seen.
*Aira caryophyllea	< 1%	> 1%	8-10 cm	> 500 plants.	-	-	Not seen.
Allocasuarina huegeliana	3%	2%	4.2 m	1 plant.	6%	5-6 m	1 plant & 1 overhanging.
*Arctotheca calendula	+	+	5 cm	1 plant.	+	15 cm	2 plants.
Austrostipa variabilis	< 5%	+	8-10 cm	16 plants (height is leaves, 2 taxa?).	< 1%	10-15 cm.	23 plants.
*Avena barbata	2%	1-2%	15-45cm	> 350 plants	3%	45-115 cm	> 350 plants.
Blennospora drummondii	-	+	1-5 cm	> 50 plants.	-	-	Not seen.
Bossiaea moylei	+	-	-	Not recorded.	-	-	Not seen.
*Brachypodium distachyon	-	+	20 cm	< 30 plants	+	20-35 cm	< 20 plants.
*Briza maxima	+	+	10-15cm	> 100 plants.	-	-	Not seen.
*Bromus diandrus	+	-	-	Not recorded.	-	-	Not seen.
*Bromus rubens	-	+	12 cm	8-10 plants.	-	-	Not seen.
Cheilanthes adiantoides	+	+	8 cm	3 small patches.	+	10 cm	3 small patches.
*Ehrharta longiflora	≥ 3%	1-2%	10-35 cm	> 300 plants.	10%	10-75 cm	> 500 plants
*Erodium botrys	3%	≤ 2%	5-10 cm	> 300 plants.	</= 5%	5-20 cm	> 400 plants.
Eucalyptus camaldulensis var. obtusa	20%	20%	7 m	1 plant.	20%	7+ m	1 plant, very open.
Goodenia berardiana	+	-	-	Not recorded.	-	-	Not seen.
Hibbertia subvaginata	-	2-3%	15-145 cm	14 plants, most fairly old.	3-4%	70-150 cm	9 adults and 1 juvenile.
*Hypochaeris glabra	> 5%	< 5%	5-10 cm	> 700 plants	> 30%	5-10 cm	> 2,000 plants.
Microtis sp.	+	-	-	Not recorded.	+	-	10 stems in 2 groups.
*Monoculus monstrosus	+	+	10-20 cm	> 10 plants.	< 1%	10-20 cm	> 70 plants.
*Parentucellia latifolia	-	+	7 cm	< 10 plants.	+	4-9 cm	< 10 plants.
*Petrorhagia dubia	+	-	-	Not recorded.	-	-	Not seen.
Podolepis lessonii	5%	< 5%	5-15 cm	> 1,000 plants	> 5%	5-15 cm	> 1,500 plants
Podotheca	-	-	-	-	+	15 cm	1 plant.

gnaphalioides							
Pterostylis sp.	-	+	8 cm	1 plant.	-	-	Not seen.
Ptilotus polystachyus	-	-	-	-	+	35 cm	1 plant.
Regelia megacephala	7%	≥ 3%	20 cm - 2+ m	3 adults (2-6 m, 1 on edge of quadrat) & 11 juveniles (30-50 (100) cm) and 3 seedlings.	< 3%	1-1.6 m	3 young adult plants and one juvenile (20 cm).
Rytidosperma acerosum	-	+	15 cm	7 plants.	+	8 cm	9 plants.
*Silene gallica var. gallica	+	-	-	Not recorded.	+	-	A few plants
*Solanum nigrum	-	-	-	-	+	15 cm	1 plant.
*Sonchus oleraceus	+	-	-	Not recorded.	+	7-30 cm	2 plants.
Thysanotus manglesii	-	-	-	-	+	60-140 cm	3 plants.
Trachymene cyanopetala	< 1%	-	-	Not recorded.	+	2-5 cm	> 30 plants
Trachymene ornata	+	-	-	Not recorded.	+	3-5 cm	11 plants.
*Trifolium arvense var. arvense	<1%	+	5-8 cm	30-40 plants.	+	5-8 cm	25-35 plants.
*Urospermum picroides	1%	+	15 cm	> 40 plants.	</= 1%	10-20 cm	> 70 plants.
*Ursinia anthemoides	+	≤ 1%	8-25 cm	> 200 plants.	< 5%	10-35 cm	> 200 plants.
*Vulpia myuros	< 1%	< 1%	8-12 cm	< 100 plants.	-	-	Not seen.

Quadrat R00/02 in 2004

Quadrat R00/02 in 2007


Quadrat R00/02 in 2010


Quadrat R00/02 in 2013


Quadrat R00/02 in 2019 (from NW side)


Quadrat R00/02 in 2019 (from NE corner).


Quadrat R00/02 in 2022 (from SE corner).


Quadrat R00/02 in 2022 (from NE corner).

Site: R01/02

Described by: Malcolm Trudgen **Date**: 13/10/2022 **Type**: Quadrat
Location: Main Waste dump. **Geocode**: Zone 50 6623221 S, 407438 E [WGS84]
Habitat: Moderate, south-facing slope of waste dump.
Soil: Very gravelly, pebbly brown silty fine sand with rocks and boulders
Rock Type: Chert Mine waste
Vegetation: Allocasuarina huegeliana, Regelia megacephala high shrubland over Hibbertia subvaginata open shrubland to low shrubland; over *Erodium botrys herbland with *Ehrharta longiflora, *Avena barbata, *Brachypodium distachyon, *Romulea rosea open grassland.
Notes: There was better (more) Regelia regeneration outside the quadrat than in it. Acacia stenoptera dead in 2013, also in 2016 (same plants?). Species lost since 2013: Hibbertia subvaginata. Species gained since 2013: Pentameris airoides; Hypochaeris glabra; Monoculus monstrosus; Cheilanthes

adiantoides; Trifolium arvense var. arvense; Sonchus oleraceus.

NOTES 2019: At the 2022 recording the quadrat had a lot of *Allocasuarina* litter that made cover assessment of the smaller plants difficult.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
*Arctotheca calendula	-	-	-	-	+	8 cm	14 plants.
Allocasuarina huegeliana	15%	≤ 20%	5-6 m	2 trees and 1 overhanging.	</= 30%	6-8 m	2 trees & 3 overhanging.
Austrostipa sp. Cairn Hill (M.E. Trudgen 21176)	> 2-3%	< 1%	10-12 cm	5 plants (height is for leaves).	+	10-12 cm	5 plants.
*Avena barbata	10%	≤ 10%	15-60 cm	500-1,000 plants.	< 5%	15-60 cm	< 1,000 plants.
*Brachypodium distachyon	10%	≥ 20%	10-15 cm	> 2,000 small plants.	> 5%	10-50 cm	</= 1,500 plants.
*Briza maxima	< 1%	< 1%	6-12 cm	Ca. 100 plants.	+	10 cm	< 20 plants.
*Bromus rubens	-	-	-	-	+	20 cm	1 plant.
Cheilanthes adiantoides	+	+	15 cm	1 plant SW corner of quadrat.	+	7-15 cm	5 plants.
Dichopogon capillipes	-	-	-	-	+	5 cm	4 plants.
Ehrharta longiflora	< 5%	< 5%	10-90 cm	> 500 plants.	1%	10-70 cm	< 100 plants
Erodium botrys	< 20%	≥ 2%	5-20 cm	> 200 small plants.	< 2%	5-10 cm	< 200 small plants
Hypochaeris glabra	60%	< 5%	5-10 cm	Ca. 1,000 very small plants.	15%	3 cm	> 2,000 very small plants.
Lupinus cosentinii	-	+	10 cm	1 plant, dead, did not fruit.	-	-	Not seen.
Monoculus monstrosus	+	+	8-10 cm	< 20 plants.	< 1%	10-50 cm	> 30 plants.
Moss sp.	+	-	-	Not recorded.	+	1 cm	A patch.
Pentameris airoides	+	-	-	Not recorded.	+	10-20 cm	-
Podolepis lessonii	-	+	10 cm	1 plant, fruiting.	-	-	Not seen.
Regelia megacephala	1-2%	3%	1-1.5 m	7 young plants.	1-2%	2 m	2 plants.
Romulea rosea	5%	< 5%	10-20 cm	> 800 plants	< 5%?	10-20 cm	> 1,000 plants.
Senecio diaschides	-	-	-	-	+	12 cm	1 juvenile.
Sonchus oleraceus	+	-	-	Not recorded.	+	10-30 cm	2 plants.
Thysanotus manglesii	-	-	-	-	+	50 cm	1 plant
Trifolium arvense var. arvense	+	-	-	Not recorded.	-	-	Not seen.
Urospermum picroides	+	-	-	Not recorded.	+	5-10 cm	9 plants.
Ursinia anthemoides	< 1%	1%	10-15 cm	> 250 plants	1%	10-35 cm	< 100 plants.
Vulpia myuros	< 1%	> 3%	10-15cm	> 1,000 plants	> 3%	10-15 cm	< 1,000 plants.

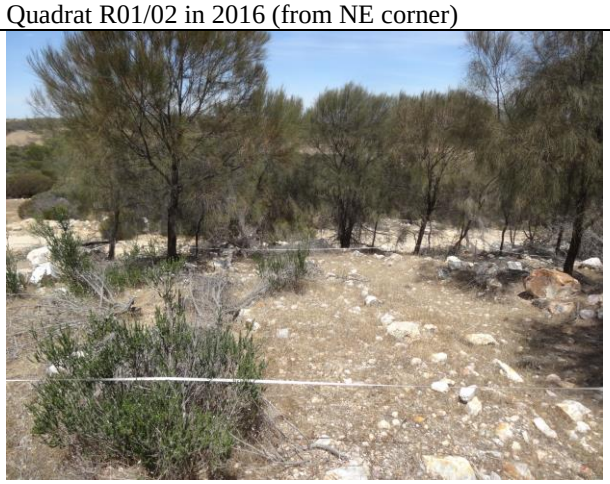
Quadrat R01/02 in 2007

Quadrat R01/02 in 2010

Quadrat R01/02 in 2013

Quadrat R01/02 in 2016 (from NE corner)

Quadrat R01/02 in 2019 (from NE corner)



Quadrat R01/02 in 2019 (from north side)

Quadrat R01/02 in 2022 (from NE corner)

Quadrat R01/02 in 2022 (from north side)


Quadrat R01/02 in 2022 (from NW corner)

Site: R02

Described by: Malcolm Trudgen **Date:** 11/10/2022 **Type:** Quadrat
Location: Main Waste dump. **Geocode:** Zone 50 6623264 S, 407343 E [WGS84]
Habitat: Mid to upper, south-facing slope of waste dump
Soil: sandy, gravelly, cobbly, rocky waste dump material
Vegetation: Allocasuarina huegeliana low open woodland over Regelia megacephala, Acacia congesta subsp. congesta, Allocasuarina campestris, Kunzea praestans shrubland over Hibbertia subvaginata open shrubland over Brachypodium, distachyon, Ehrharta longiflora, Hypochaeris glabra, Ursinia anthemoides, *Avena barbata open grassland over *Erodium botrys, *Hypochaeris glabra annual grass/herbland
Notes: Species gained since 2013: Arctotheca calendula; Daucus glochidiatus; Goodenia berardiana; Trifolium arvense var. arvense; Cheilanthes adiantoides; Monoculus monstrosus; Neurachne alopecuroidea; Drosera macrantha; Centaurea melitensis; Parentucellia latifolia. Species lost since 2013: Calytrix aff. leschenaultii (Moora); Cryptandra glabriflora; Dryandra sessilis; Guichenotia micrantha; Hedypnois rhagadioloides; Senecio quadridentatus; Trachymene pilosa.
Notes 2019: It seems likely the *Brachypodium* is wiping out other species.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	1%	2%	50-80 cm	2 plants, one 50 cm & one 80 cm.	1-2%	80-110 cm	3 plants.
Acacia stenoptera	+	+	40 cm	1 live and1 dead plant.	-	-	Not seen.
*Aira caryophyllea	+	+	10 cm	< 100 plants	+	10 cm	< 20 plants.
Allocasuarina campestris	6-7%	8-10%	5 m	3 plants.	>/= 12%	(1)2.2-5 m	2 large in & 1 overhanging & 1 small
Allocasuarina huegeliana	5%	5%	3-5 m	2 plants (1 3 m and 1 5 m tall).	6%	5-6 m	2 plants.
*Arctotheca calendula	+	< 1%	5 cm	> 70 plants.	< 1%	5 cm	10-15 plants.
Aristida contorta	-	-	-	-	+	20 cm	1 plant.
Austrostipa elegantissima	-	+	30 cm	1 plant (height is leaves).	+	20 cm	1 plant.
Austrostipa trichophylla	1-2%	+	15 cm	3 plants.	+	15 cm	4 plants.

*Avena barbata	2%	≤ 2%	20-50 cm	> 200 plants.	< 2%	20-90 cm	> 200 plants.
Blennospora drummondii	+	< 1%	5-8 cm	> 50 plants	+	5-8 cm	2 plants.
*Brachypodium distachyon	50-60%	30%	10-15 cm	> 2,000 plants.	20%	10-15 cm	> 2,000 plants.
*Briza maxima	1%	< 1%	5-20 cm	< 100 plants.	< 1%	5-20 cm	< 100 plants.
*Bromus rubens	-	+	7 cm	2 plants.	-	-	Not seen.
*Centaurea melitensis	+	-	-	Not recorded.	-	-	Not seen.
Chamaescilla corymbosa var. corymbosa	-	+	?	1 plant. Leaves gone (in fruit).	-	-	Not seen.
Cheilanthes adiantoides	+	+	10 cm	8 plants.	</= 1%	10 cm	12 plants.
Cheilanthes austrotenuifolia	+	-	-	Not recorded.	+	10 cm	3 plants.
Comesperma integerrimum	+	-	-	Not recorded.	-	-	Not seen.
Crassula colorata var. acuminata	-	+	3 cm	1 plant.	-	-	Not seen.
Daucus glochidiatus	+	-	-	Not recorded.	+	25 cm	1 plant.
Desmocladus asper	+	+	15 cm	2 plants.	+	15-20 cm	3 plants.
Dichopogon capillipes	-	+	45 cm	2 plants (height is for inflorescence).	+	12 cm	4 plants.
Dioscorea hastifolia	+	+	0.3-1.2 m	4 plants.	+	0.3-1.2 m	8 plants.
Drosera macrantha	+	-	-	Not recorded.	+	15 cm	2 plants.
*Ehrharta longiflora	5%	5%	15-60 cm	> 400 plants.	</= 5%	15-60 cm	> 400 plants.
*Erodium botrys	2%	< 2%	5 cm	> 300 plants.	< 1%	5 cm	< 100 plants.
Goodenia berardiana	+	-	-	Not recorded.	+	10-30 cm	Ca 15 plants.
Hibbertia subvaginata	10%	10-12%	0.2-1.5 m	28 plants.	10-12%	50-130 cm	24 plants.
Hyalosperma glutinosum ssp. glutinosum	-	-	-	-	+	12 cm	1 plant.
*Hypochaeris glabra	20%	20%	5 cm	> 800 plants.	</= 1%	5 cm	Ca. 100 plants.
Kunzea praestans	1%	> 1%	2.4 m	1 plant.	1.5%	3 m	1 plant.
*Lysimachia arvensis	1%	-	-	Not recorded.	+	5-10 cm	3 plants.
*Monoculus monstrosus	+	+	15 cm	< 10 plants.	+	10-50 cm	10-20 plants.
Moss sp.	+	-	-	Not recorded.	+	1 cm	-
Neurachne alopecuroidea	+	+	8 cm	1 plant (height is the leaves).	+	8 cm	1 plant.
*Parentucellia latifolia	+	-	-	Not recorded.	-	-	Not seen.
*Pentameris airoides	-	-	-	-	+	10-15 cm	> 40 plants

Podolepis lessonii	+	≥ 1%	5-20 cm	> 300 plants.	+	10-20 cm	3 plants.
Regelia megacephala	15%	20%	(0.1)0.9-2.5 m	6 adults (1.5-2.5 m) and 170 seedlings to juveniles (10-90 cm).	20%	(0.1)0.6-3 m	4 large (1.5-3 m), 8 medium (70-150 cm) and 42 small (10-60 cm) plants
*Romulea rosea	1%	1-2%	10-15 cm	> 300 plants.	1%	10-15 cm	Ca. 200 plants.
*Silene gallica var. gallica	+	-	-	Not recorded.	-	-	Not seen.
Thysanotus patersonii	1%	1%	0.3-1.2 m	10 plants (in fruit).	+	30-60 cm	5 plants.
Trachymene cyanopetala	< 1%	+	5-10 cm	2 plants.	+	5-10 cm	Ca. 50 plants.
Trachymene ornata	-	-	-	-	+	5-7 cm	Ca. 50 plants.
*Trifolium arvense var. arvense	+	+	13 cm	2 plants.	-	-	Not seen.
*Urospermum picroides	+	-	-	Not recorded.	+	5-15 cm	< 20 plants.
*Ursinia anthemoides	3%	5%	10-15 cm	> 500 plants.	1%	10-35 cm	< 100 plants.
*Vulpia myuros	2-3%	2-3%	7-10 cm	> 600 plants	+	7-10 cm	Ca. 10 plants.
Waitzia nitida	-	+	8 cm	1 plant	-	-	Not seen.

Quadrat R02 in 2006

Quadrat R02 in 2010


Quadrat R02 in 2013


Quadrat R02 in 2016 (from SW corner)


Quadrat R02 in 2019 (from SW corner)


Quadrat R02 in 2019 (from west side)


Quadrat R02 in 2022 (from SW corner)


Quadrat R02 in 2022 (from west side)

Site: R04(22)

Described by: Malcolm Trudgen **Date:** 17/10/2016 **Type:** Quadrat
Location: Main Waste dump. **Geocode:** Zone 50 6623344 S, 407273 E [WGS84, SE peg]
Habitat: Moderate, west-facing mid slope of waste dump.
Soil: Silty, sandy, gravelly, cobbly, rocky waste material
Vegetation: Allocasuarina huegeliana low woodland over Regelia megacephala open shrubland over Hibbertia subvaginata low open shrubland over *Brachypodium distachyon, *Ehrharta longiflora, *Trifolium arvense var. arvense, *Hypochaeris glabra, *Erodium botrys annual grass/herbland

Notes: Species gained since 2013: Parentucellia latifolia; Aristida contorta. Species lost since 2013: Acacia aristulata; Acacia lasiocarpa var. sedifolia; Acacia stenoptera; Allocasuarina campestris; Alyogyne huegelii (was overhanging, has receded but still alive); Lysimachia arvensis; Goodenia berardiana; Guichenotia micrantha; Hedyotis sp.; Romulea rosea; Stylidium caricifolium; Sonchus oleraceus;
NOTES 2019: Very difficult to estimate covers. Total weed cover 25-35%. Photos from NW corner and West side.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	-	-	-	-	+	15 cm	1 Juvenile.
Allocasuarina campestris	-	-	-	-	< 1%	1.5 m	1 plant.
Allocasuarina huegeliana	≥ 15%	≥ 20%	(0.5)4-7 m	4 adult plants (4-7 m) and 4 juvenile (50 cm) and 1 overhanging on west side of quadrat.	>/= 30%	6-8 m	4 adult plants, 1 overhanging on west side of quadrat.
*Arctotheca calendula	-	-	-	-	+	5-15 cm	9 plants.
Aristida contorta	+	-	-	Not recorded.	-	-	Not seen.
Austrostipa trichophylla	<1%	+	8-15 cm	11 plants. Height is leaves.	+	8-15 cm	5 plants.
*Avena barbata	3-4%	< 5%	20-60 cm	> 500 plants.	</= 5%	20-90 cm	> 700 plants.
Bossiaea moylei	1%	< 1%	25-30 cm	4 plants.	1%	20-60 cm	3 plants.
*Brachypodium distachyon	15-20%	< 10%	0.10-0.25m	~ 2,000 plants.	< 10%	7-15 cm	> 2,000 plants.
*Briza maxima	+	-	-	Not recorded.	-	-	Not seen.
*Bromus rubens	-	+	12 cm	> 40 plants.	+	8 cm	Ca. 10 plants.
*Centaurea melitensis	+	2%	6-10 cm	> 100 plants.	< 5%	6-10 cm	> 600 plants.
*Ehrharta longiflora	4%	5%	15-55 cm	> 100 plants.	5%	15-55 cm	> 1,000 plants.
*Erodium botrys	5%	2-3%	5-7 cm	> 200 plants.	2-3%	5-15 cm	> 400 plants.
Goodenia berardiana	-	-	-	-	+	20 cm	6 plants.
Hibbertia subvaginata	5-6%	≤ 5%	40-100 cm	10 plants.	2%	40-90 cm	5 plants.
*Hypochaeris glabra	30%	30%	5-20 cm	> 1,000 plants	</= 40%	5-20 cm	> 3,000 plants.
*Lysimachia arvensis	-	-	-	-	+	-	< 10 plants.
*Monoculus monstrosus	-	-	-	-	+	15-35 cm	-
*Parentucellia latifolia	+	+	10 cm	> 20 plants.	-	-	Not seen.
*Pentameris airoides	1%	2%	5-10 cm	> 400 plants	+	5-10 cm	Ca. 20 plants.
*Petrorhagia dubia	+	-	-	Not recorded	-	-	Not seen.

Ptilotus polystachyus	+	-	-	Not recorded	+	30 cm	1 plant.
Regelia megacephala	2-3%	< 1%	90 cm	2 young plants in west of quadrat.	< 1%	30-160 cm	1 young plant and 1 overhanging.
*Silene gallica var. gallica	< 1%	+	8-10 cm	< 100 plants	</= 1%	8-10 cm	> 150 plants.
Trachymene cyanopetala	+	-	-	Not recorded	-	-	Not seen.
*Trifolium arvense var. arvense	15%	2%	5-10 cm	> 100 plants.	2%	5-10 cm	> 200 plants.
*Trifolium repens var. repens	1%	+	10 cm	> 20 plants.	< 4%	10 cm	> 200 plants.
*Urospermum picroides	< 1%	< 1%	6-10 cm	> 50 plants.	1-2%	6-20 cm	> 150 plants.
*Ursinia anthemoides	1-2%	1%	8-12 cm	> 250 plants.	>/= 5%	8-12 cm	Ca. 1,000 plants
*Vulpia myuros	1%	≤ 10%	15 cm	> 2,000 plants	< 10%	15 cm	> 2,000 plants.

Quadrat R04/22 in 2006 (year established)

Quadrat R04/22 in 2010

Quadrat R04/22 in 2013

Quadrat R04/22 in 2016


Quadrat R04/22 in 2019 (from NW corner)


Quadrat R04/22 in 2019 (from west side)


Quadrat R04/22 in 2022 (from NW corner)


Quadrat R04/22 in 2019 (from west side)

Site: R05(27)

Described by: Malcolm Trudgen **Date: 18/10/2019 Type:** Quadrat
Location: South Eastern Waste dump. **Geocode:** Zone 50 6623088 S, 407806 E [WGS84]
Habitat: Moderate, east-facing slope of waste dump
Soil: silty, pebbly, cobbly, rocky waste dump material
Rock Type: Chert Mine waste
Vegetation: Allocasuarina huegeliana, Regelia megacephala high shrubland; over Allocasuarina campestris, Acacia congesta subsp. congesta, Acacia lasiocarpa var. sedifolia Hibbertia subvaginata (Kunzea praestans) open heath; over *Avena barbata, *Briza maxima *Hypochaeris glabra, *Vulpia myuros very open herbland.
Notes: Species lost since 2013: Acacia aristulata; Rytidosperma acerosum; Gilberta tenuifolia; Regelia megacephala; Silene gallica var. gallica; Trifolium arvense; Wahlenbergia preissii. Species gained since 2013: Arctotheca calendula; Podolepis lessonii; Blennospora drummondii; Monoculus monstrosus.

Notes 2019: General observations from data: 2019 records for weeds tend to be shorter, but more individuals. Where weeds are low, native plants can invade, but then as weeds increase, are lost again.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	≤ 20%	8%	90cm	4 plants (1 in poor condition).	12%	0.5-2 m	2 live & 1 dead plants
Acacia lasiocarpa var. sedifolia	1-2%	1-2%	50-110 cm	3 plants.	1-2%	(0.05)0.4-1.3 m	2 adult and two seedlings.
Allocasuarina campestris	≤ 20%	15%	(0.5)1.5-2.2 m	8 plants (1 stunted, in poor condition).	</= 20%	2-2.5 m	6 plants.
Allocasuarina huegeliana	≤ 10%	15%	4.5-5 m	3 plants.	</= 25%	6-7 m	3 plants.
*Arctotheca calendula	+	+	5 cm	> 20 plants.	+	5-10 cm	< 50 plants.
Austrostipa elegantissima	-	≤ 1%	1 m	1 plant.	</= 1%	90 cm	2 plants.
Austrostipa trichophylla	+	-	-	Not recorded.	-	-	Not seen.
*Avena barbata	+	+	10-30 cm	Ca. 50 plants	< 1%	10-70 cm	Ca. 100 plants.
Blennospora drummondii	+	+	2-3 cm	Ca. 10 plants.	+	2-3 cm	> 50 plants.
*Briza maxima	+	< 1%	5-15 cm	Ca 200 plants	< 1%	5-10 cm	< 50 plants.
*Bromus rubens	+	+	8-15 cm	5 plants.	+	15 cm	1 plant.
Brunonia australis	-	-	-	-	+	15 cm	3 plants.
Calytrix aff. leschenaultii (Moora)	-	+	10 cm	1 plant.	-	-	Not seen.
Comesperma integerrimum	-	+	70 cm	1 plant.	+	50 cm	1 plant.
*Ehrharta longiflora	1-2%	1-2%	10-25 cm	> 100 plants.	< 3%	10-25 cm	> 400 plants.
Gilberta tenuifolia	-	-	-	-	+	8-12 cm	> 40 plants.
Hibbertia subvaginata	8-10%	10%	60-140 cm	46 plants, some senescent.	15%	60-140 cm	14 plants.
*Hypochaeris glabra	< 5-10%	< 5%	5 cm	> 500 plants.	</= 10%	5 cm	> 1,000 plants.
Kunzea praestans	< 1%	≤ 1%	1.8 m	1 plant.	1-25	2.3 m	1 plant.
Lawrencella rosea	-	+	20 cm	2 plants.	+	20 cm	1 plant.
*Lysimachia arvensis	+	-	-	Not recorded.	+	6 cm	1 plant.
Microtis sp.	-	-	-	-	+	15 cm	1 plant.
Millotia tenuifolia var. tenuifolia	+	-	-	Not recorded.	-	-	Not seen.
*Monoculus monstrosus	+	+	20 cm	2 plants.	+	10-35 cm	> 20 plants.
Moss	-	-	-	-	2-3%	1 cm	Patches.
Parentucellia latifolia	-	-	-	-	+	5 cm	< 20 plants.
*Pentameris airoides	> 1%	> 1%	5-10 cm	> 500 plants.	+	5-10 cm	< 30 plants.
Podolepis lessonii	< 1%	1-2%	8-15 cm	> 300 plants.	+	10-15	5 plants.

						cm	
Podotheca gnaphalioides	-	-	-	-	+	8 cm	1 plant.
Pterostylis exserta?	-	+	7 cm	1 plant.	-	-	Not seen.
*Romulea rosea	+	+	8-15 cm	? [not recorded].	+	8-15 plants.	-
Stipa elegantissima	-	-	-	-	</= 1%	90 cm	2 plants.
Stylidium caricifolium	-	-	-	-	+	35 cm	1 plant.
Trachymene cyanopetala	-	+	3-5 cm	> 100 plants.	+	5 cm	11 plants.
Trachymene ornata	+	+	7 cm	24 plants.	+	6 cm	13 plants.
Trachymene pilosa	-	-	-	-	+	4-12 plants	> 30 plants.
*Trifolium hirtum	-	+	2-5 cm	30-40 plants.	+	2-5 cm	20-15 plants.
*Urospermum picroides	+	+	5-12 cm	> 40 plants.	-	-	Not recorded.
*Ursinia anthemoides	1%	> 2%	7-15 cm	> 400 plants.	1%	7-15 cm	</= 200 plants.
*Vulpia myuros	2%	> 3%	7-10 cm	> 1,000 plants.	2%	7-10 cm	> 500 plants.
Wahlenbergia gracilenta	-	-	-	-	+	12 cm	1 plant.
Waitzia nitida	-	+	6-12 cm	Ca. 35 plants.	+	12 cm	1 plant.

Quadrat R05(27) in 2006 (year established)

Quadrat R05(27) in 2010 (from SW corner)

Quadrat R05(27) in 2013

Quadrat R05(27) in 2019 (from NE corner)


Quadrat R05(27) in 2019 (from near SE corner)


Quadrat R05(27) in 2019 (from south side)


Quadrat R05(27) in 2022 (from SE corner)


Quadrat R05(27) in 2022 (from east side)

Site: Area 33
Described by: Malcolm Trudgen **Date:** 18/10/2019 **Type:** Quadrat
Location: South-east waste dump. **Geocode:** Zone 50 6622882 S, 407822 E [WGS84]
Habitat: Southerly facing moderate to steep slope.
Soil: Mixed chert gravel to boulders, some fines.
Vegetation: Allocasuarina huegeliana low open woodland over Regelia megacephala high open shrubland over Acacia congesta subsp. congesta (Allocasuarina campestris) open heath over Hibbertia subvaginata (Acacia lasiocarpa var. sedifolia) low shrubland over *Aira caryophyllea, *Vulpia myuros, *Hypochaeris glabra open annual grassland/herbland
Notes: Species gained since 2013: Lysimachia arvensis; Austrostipa elegantissima; Brachypodium distachyon; moss sp.; Trachymene pilosa; Podolepis lessonii; Drosera sp.; Blennospora drummondii;

Acacia restiacea. Species lost since 2013: Lepidosperma sp.; Sollya heterophylla;

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia acuminata	+	+	2.2 m	1 plant.	< 1%	3.4 m	1 plant.
Acacia congesta subsp. congesta	50%	20%	1.4-1.8 m	6 older plants (2 senescent) and 1 seedling (3 cm).	20%	5 cm & 1.3-1.6 m	Three plants, 1 a seedling.
Acacia lasiocarpa var. sedifolia	3%	> 2%	1.4 m	3 plants.	< 1%	6 cm & 1.2 m	2 plants, 1 a seedling.
*Aira caryophyllea	≥ 10%	< 5%	5-8 cm	> 1,000 plants.	< 2%	5-8 cm	< 500 plants.
Allocasuarina campestris	4%	7%	1.1-2 m	5 [6] plants.	>/= 10%	1-1.2 m	6 plants.
Allocasuarina huegeliana	9%	10-12%	(1.3)5-6 m	6 plants, 1 a juvenile 1.3 m tall.	15%	(1.7)5-6 m	6 plants.
*Arctotheca calendula	-	-	-	-	+	10 cm	1 plant.
Austrostipa elegantissima	+	2-3%	1-1.2 m	4 plants, height is for the panicles.	5-10%	8? plants	1 m
Austrostipa trichophylla	+	+	10 cm	2 plants.	+	10 cm	1 plant.
*Avena barbata	-	-	-	-	+	20-95 cm	Ca. 50 plants.
Blennospora drummondii	+	+	2-3 cm	> 200 plants.	+	2-3 cm	> 100 plants.
*Brachypodium distachyon	+	1%	8-12 cm	> 50 plants	< 1%	15-35 cm	50-100 plants.
*Briza maxima	-	+	8-15 cm	> 100 plants.	+	8-15 cm	> 100 plants.
Calytrix aff. leschenaultii (Moora)	+	+	40 cm	2 plants.	+	50-110 cm	3 plants
Comesperma integerrimum	-	-	-	-	+	1 m	+
Crassula colorata var. colorata	-	-	-	-	+	2-5 cm	< 10 plants.
Daucus glochidiatus	-	-	-	-	+	12 cm	1 plant.
Dichopogon capillipes	-	-	-	-	+	15 cm	1 plant.
Daviesia hakeoides subsp. subnuda	1.5%	1.5%	80 cm	1 plant. Erroneously referred to Acacia restiacea in earlier reports.	-	-	Not seen.
Drosera sp.	+	-	-	Not recorded.	-	-	Not seen.
*Ehrharta longiflora	1-2%	< 1%	10-20 cm	> 100 plants?	1-2%	12-45 cm	> 200 plants.
*Erodium botrys	-	-	-	-	+	1 cm	1 plant.
Hibbertia subvaginata	15-20%	≤ 20%	0.3-1.4 m	41 plants.	< 20%	(7)30-150 cm	39 plants & 4 seedlings
Homalosciadium homalocarpum	-	-	-	-	+	4 cm	4 plants.

*Hypochaeris glabra	-	2%	3 cm	> 500 plants, height is for the leaves.	5%	3 cm	> 1,000 plants.
*Lysimachia arvensis	+	-	-	Not recorded.	+	4-7 cm	7 plants.
Microtis sp.	_-	-	-	-	+	25 cm	10 stems.
Moss sp.	4%	4%	2 cm	-	4%	2 cm	Patches.
Phyllangium sulcatum	-	-	-	-	+	5 cm	1 plant.
Podolepis lessonii	+	+	8-15 cm	> 20 plants.	+	8-12 cm	16 plants
Podotheca angustifolia	-	-	-	-	+		10 plants.
Regelia megacephala	6-7%	5%	2-3.7 m	5 adult plants.	55	2-3.7 m	3 adult plants.
*Romulea rosea	-	+	15 cm	> 50 plants.	< 1%	15 cm	> 100 plants.
Thysanotus patersonii	2%	5%	0.5-1.2 m	> 20 plants? [Not countable.]	5%	0.5-1.2 m	> 20 plants? [Not countable.]
Trachymene cyanopetala	+	+	2-8 cm	> 40 plants.	+	4-20 cm	> 50 plants.
Trachymene ornata	-	+	4 cm	< 30 plants.	-	-	Not seen.
Trachymene pilosa	+	+	2 cm	< 20 plants.	+	5-10 cm	< 20 plants.
*Urospermum picroides	-	-	-	-	+	10 cm	3 plants.
*Ursinia anthemoides	< 1%	< 1%	10-20 cm	> 100 plants	1-2%	10-30 cm	> 400 plants.
*Vulpia myuros	2%	2%	10-15 cm	> 500 plants	< 1%	10-15 cm	< 150 plants.
Wahlenbergia gracilenta	-	-	-	-	+	10-15 cm	> 50 plants.

Quadrat Area 33 in 2013

Quadrat Area 33 in 2016


Quadrat Area 33 in 2019 (from NW corner)


Quadrat Area 33 in 2019 (from south side)


Quadrat Area 33 in 2022 (from NW corner)


Quadrat Area 33 in 2022 (from south side)

Site: Area 41
Described by: Malcolm Trudgen **Date:** 18/10/2019 **Type:** Quadrat
Location: South-east waste dump. **Geocode:** Zone 50 6622903 S, 407834 E [WGS84]
Habitat: Moderate to steep southerly facing slope.
Soil: Mixed chert (quartz) silt to boulders
Rock Type: Mixed chert (quartz) silt to boulders, mine waste.
Vegetation: Allocasuarina huegeliana low woodland over Acacia congesta low scattered shrubs over Hibbertia subvaginata scattered low shrubs Kennedia prostrate scattered creepers over *Conyza bonariensis, *Senecio diaschides, *Pentameris airoides low open annual grassland/herbland
Notes: Species lost since 2013: Ptilotus polystachyus var. polystachyus; Salsola tragus subsp. tragus; Sonchus oleraceus. Species gained since 2013: Bromus rubens; Silene gallica var. gallica; Wahlenbergia capensis; Allocasuarina campestris; Acacia congesta subsp. congesta; Microtis sp.; Wahlenbergia preissii; Millotia tenuifolia var. tenuifolia; Petrorhagia dubia.

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	1%	≥ 10%	-	1 large plant (spreading, height ca. 1.3 m?) and 1 juvenile (15 cm).	15-20%	(3)50-150 cm	8 shrubs (4 stressed) & 1 seedling.
Allocasuarina	+	+	45 cm	1 plant, juvenile	1%	1.3 m	1 plant.

campestris				~ 0.25%.			
Allocasuarina huegeliana	12%?	4%	4 m	1 plant.	1%	-	1 overhanging and 1 dead.
Arctotheca calendula	-	+	7 cm	1 plant.	+	5-10 cm	10 plants.
Austrostipa elegantissima	-	+	15 cm	1 juvenile plant (on S side of quadrat).	-	-	Not seen.
Austrostipa trichophylla	+	-	-	Not recorded.	-	-	Not seen.
*Avena barbata	+	+	10-35 cm	20 plants.	< 1%	10-35 cm	Ca. 100 plants.
*Briza maxima	+	1%	10-20 cm	200-300 plants.	< 1%	15-55 cm	150-200 plants.
*Bromus rubens	+	-	-	Not recorded.	-	-	Not seen.
Brunonia australis	-	-	-	-	+	12 cm	2 plants.
Cheilanthes adiantoides	-	+	5 cm	1 plant.	+	5 cm	4 plants.
Cheilanthes austrotenuifolia	-	-	-	-	+	5 cm	4 plants.
*Conyza bonariensis	< 1%	+	10-20 cm	< 20 plants.	-	-	Not seen.
Dryandra sessilis	-	-	-	-	+	5 cm	1 seedling.
Gilberta tenuifolia	-	-	-	-	+	5-9 cm	12 plants.
Hibbertia subvaginata	1%	3%	20-50 cm	17 plants (including 2 seedlings).	</= 5%	20-130 cm	11 plants (4 were seedlings).
*Hypochaeris glabra	+	≤ 1%	2-3 cm	Mostly dead and very small.	< 5%	2-3 cm	> 1,000 plants.
Kennedia prostrata	+	≤ 1%	10 cm	5 plants, including 2 seedlings.	4%	10-20 cm	2 large (to 3 m across) & 11 small plants.
Microtis sp.	+	+	15 cm	3 plants (near SE corner).	+	15 cm	2 plants.
Millotia tenuifolia var. tenuifolia	+	-	-	Not recorded.	-	-	Not seen.
Monoculus monstrosus	-	+	10-15 cm	< 10 plants.	-	-	Not seen.
*Pentameris airoides	3%	2-3%	5-12 cm	> 1,000-2,000 plants.	< 1%	10-15 cm	< 300 plants.
*Petrorhagia dubia	+	+	10-30 cm	> 50 plants	-	-	Not seen.
Podolepis lessonii	-	+	6-12 cm	4 plants.	+	12 cm	1 plant.
Rhodanthe laevis	-	+	6 cm	1 plant.	+	9 cm	1 plant.
Senecio diaschides	≥ 2%	+	10-20 cm	2 plants.	-	-	Not seen.
*Silene gallica var. gallica	+	-	-	Not recorded.	-	-	Not seen.
*Sonchus oleraceus	-	-	-	-	+	15 cm	1 plant.
Thysanotus manglesii	-	-	-	-	+	60 cm	4 plants
*Ursinia anthemoides	1-2%	< 5%	10-20	> 500-1,000	<	10-40	> 2,000 plants.

			cm	plants.	10%	cm	
*Vulpia myuros	1-2%	2%	8-15 cm	> 300-400 plants.	+	10-25 cm	< 150 plants
Wahlenbergia capensis	+	+	5 cm	1 plant.	-	-	Not seen.
Wahlenbergia preissii	+	-	-	Not recorded.	-	-	Not seen.
Waitzia nitida	-	+	5-10 cm	6 plants.	-	-	Not seen.

Quadrat Area 41 in 2013

Quadrat Area 41 in 2016

Quadrat Area 41 in 2019 (from SE corner)

Quadrat Area 41 in 2019 (from east side)

Quadrat Area 41 in 2022 (from SE corner)

Quadrat Area 41 in 2022 (from east side)

Site: Area 37
Described by: Malcolm Trudgen **Date:** 18/10/2019. **Type:** Quadrat
Location: South-west waste dump. **Geocode:** Zone 50 6623082 S, 407315 E [WGS84]
Habitat: South facing moderate to steep slope.
Soil: Mixed chert gravel to boulders, some fines.
Rock Type: Mixed chert gravel to boulders, mine waste.
Vegetation: Allocasuarina huegeliana low open woodland over Regelia megacephala (Grevillea biternata)shrubland over Hibbertia subvaginata low shrubland over Pentameris airoides, Briza maxima, Vulpia myuros, Ursinia anthemoides, Hypochaeris glabra open annual grassland/herbland
Notes: Species gained since 2010: Blennospora drummondii; Desmocladus asper; Acacia congesta subsp. congesta; Trifolium arvense var. arvense; Monoculus monstrosus; Dichopogon capillipes; Trachymene pilosa; Gilberta tenuifolia; Erodium botrys. Species lost since 2010: Arctotheca calendula; Avena barbata; Cynodon dactylon; Goodenia berardiana; Polypogon monspeliensis; Ptilotus polystachyus var. polystachyus; Solanum nigrum; Urospermum picroides; Waitzia nitida; Genus sp. (? Senecio diaschides).

Species list	Cover 2016	Cover 2019	Height 2019	Notes 2019	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	+	-	-	Not recorded.	-	-	Not seen.
Acacia lasiocarpa var. sedifolia	≥ 1	-	-	Not recorded.	-	-	Not seen.
Allocasuarina campestris	-	+	90 cm	1 plant & 1 just out of east side.	+	70 cm	1 plant & 1 just out of east side.
Allocasuarina huegeliana	8-10%	≥ 10%	(0.25)1.2-6.5 m	16 plants including 3 juveniles (15-30 cm, on east side of quadrat).	15%	(1.9)3-7 m	14 plants, 5 smaller than others.
Austrostipa trichophylla	-	+	5-8 cm	2 plants.	-	-	Not seen.
Blennospora drummondii	-	+	2-3 cm	≥ 10 plants.	+	(1) 2-3 cm	> 100 plants.
Bossiaea moylei	1-2%	< 1%	20 cm	2 plants.	+	20 cm	1 plant.
*Brachypodium distachyon	+	+	7-10 cm	> 80 plants.	1-2%	7-25 cm	> 150 plants.
*Briza maxima	> 5%	1-2%	10-20 cm	> 400 plants.	1%	10-40 cm	100-200 plants.
Caladenia flava.	-	+	7 cm	1 plant.	-	-	Not seen.
Calytrix aff. leschenaultii (Moora)	+	< 1%	0.3-1m	1 adult plant and 2 young plants 15 cm tall.	< 1%	50-85 cm	3 plants (fruiting).
Cheilanthes adiantoides	-	+	7 cm	1plant.	-	-	Not seen. (Misdet?)
Cheilanthes austrotenuifolia	-	-	-	-	+	10 cm	6 plants.
Desmocladus asper	+	+	15 cm	2 plants.	+	20 cm	2 plants.
Dichopogon capillipes	+	+	7 cm	1 plant, height is for the leaves.	+	7 cm	6 plants.
*Ehrharta longiflora	2%	< 1%	10-15 cm	< 100 plants.	< 1%	10-75 cm	< 50 plants.

*Erodium botrys	< 1%	-	-	Not recorded.	-	-	Not seen.
Gilberta tenuifolia	+	-	-	Not recorded.	-	-	Not seen.
Goodenia berardiana	-	-	-	-	+	7 cm	1 plant.
Grevillea biternata	4%	-	-	Not recorded.	-	-	Not seen.
Hibbertia subvaginata	25% %	≤ 40%	0.2-1.4 m	128 plants.	</= 40%	40-160 cm	115 plants.
*Hypochaeris glabra	≥ 2%	< 1%	3-4 cm	< 100 plants.	-	-	Not seen (missed?).
Lasiopetalum sp.	+	-	-	Not recorded.	-	-	Not seen.
*Lysimachia arvensis	+	-	-	Not recorded.	+	5 cm	11 plants.
*Monoculus monstrosus	+	+	7-15 cm	≥ 10 plants.	+	7-15 cm	> 10 plants.
*Pentameris airoides	7%	< 1%	4-6 cm	< 100 plants.	2-3%	5-10 cm	> 200 plants.
Podotheca angustifolia	+	-	-	Not recorded.	+	10 cm	1 plant.
Pterostylis sp.	-	-	-	-	+	6 cm	1 plant.
Regelia megacephala	25%	≤ 20%	0.1-1.8 m	8 Adult & 4 seedlings to juvenile (0.1-1.1 m).	</= 10%	2.2-6 m	5 adult plants.
*Romulea rosea	+	+	20 cm	> 150 plants.	1%	10-20 cm	200-300 plants.
Rytidosperma acerosum	+	+	10 cm	2 plants.	+	8 cm	1 plant.
*Sonchus oleraceus	-	-	-	-	+	7 cm	1 plant.
Stylidium caricifolium	+	+	8 cm	4 plants (in flower).	-	-	Not seen.
Stylidium septentrionale	-	-	-	-	+	8 cm	2 plants.
Thysanotus manglesii	-	-	-	-	+	1 m	1 plant.
Trachymene cyanopetala	+	+	2-5 cm	≤ 100 plants.	+	2-5 cm	Ca. 100 plants
Trachymene ornata	+	+	2-4 cm	≤ 50 plants.	+	2-4(10) cm	Ca. 25 plants.
Trachymene pilosa	+	-	-	Not recorded.	-	-	Not seen.
*Trifolium arvense var. arvense	+	+	4 cm	2 plants.	-	-	Not seen.
*Trifolium hirtum	-	+	10 cm	1 plant.	-	-	Not seen.
*Ursinia anthemoides	3%	1-2%	7-15 cm	> 300 plants.	< 2%	7-35 cm	> 300 plants.
*Urospermum picroides	-	-	-	-	+	10 cm	2 plants.
*Vulpia myuros	4%	+	10-25 cm	> 100 plants.	+	10-25 cm	> 100 plants.
Wahlenbergia gracilenta	+	-	-	Not recorded.	-	-	Not seen.
Wahlenbergia preissii	-	+	12 cm	3 plants.	+	15 cm	4 plants


Quadrat Area 37 in 2016 (From NW corner)


Quadrat Area 37 in 2019 (From NW corner)


Quadrat Area 37 in 2019 (From SW corner)


Quadrat Area 37 in 2022 (From SW corner)


Quadrat Area 37 in 2022 (From West side)


Quadrat Area 37 in 2022 (From NW corner)

Site: NEW01
Described by: Malcolm Trudgen **Date:** 13/10/2022. **Type:** Quadrat (10 x 10 m).
Location: New North Waste Dump. **Geocodes** [WGS84]**:** Zone 50: NW corner 407245E 6624146 S; NE corner 407255 E 6624147; SE corner 407257 E 6624136 S; SW corner 407257 E 6624136 S.
Habitat: West facing lower (to mid) slope of a large mine waste dump.
Soil: Pale brown, hard setting, silty to gravelly soil between rocks and boulders of chert.
Rock Type: Mixed chert gravel to boulders, mine waste.
Vegetation: *Allocasuarina huegeliana*, *Regelia megacephala* high open shrubland over *Acacia congesta* subsp. *congesta* (*Allocasuarina campestris*) shrubland over *Hibbertia subvaginata*

scattered low shrubs with **Lupinus cosentinii* annual herbland over **Ehrharta longiflora*, **Avena barbata* (**Brachypodium distachyon*) annual grassland over **Hypochaeris glabra* (**Erodium botrys*) low annual herbland

Notes: The quadrat site was selected to have the main perennial species in the rehabilitation present. Much of the surrounding area had fewer *Acacia* and *Allocasuarina* plants. Some adjoining areas (especially on the lowest slopes) had very high cover of **Lupinus cosentinii* (Lupin) which is overwhelming other species.

Species list	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	15-18%	1.5-1.7 m	5 plants (3 in corners of quadrat).
Acacia aristulata	< 1%	40 cm	2 plants
Allocasuarina campestris	3%	(.5)1.6-1.8 m	5 plants, 1 on north edge.
Allocasuarina huegeliana	3%	4 m	1 plant
*Arctotheca calendula	1-2%	10-30 cm	> 100 plants.
Aristida contorta	+	30 cm	10-15 plants.
Austrostipa variabilis	2%	20-35 cm	> 55 plants
*Avena barbata	+15%	60-110 cm	> 2,500 plants.
*Brachypodium distachyon	< 5%	20-50 cm	-
Crassula colorata var. colorata	+	5-7 cm	< 10 plants.
*Ehrharta longiflora	20-25%%	60-120 cm	> 3,000 plants.
*Erodium botrys	3%	50 cm	> 300 plants.
Hibbertia subvaginata	1-2%	40-70 cm	5 plants.
*Hypochaeris glabra	15-20%	2-7 cm (leaves)	> 2,500 Inflorescences to 50 cm.
*Lolium rigidum	+	45 cm-	1 plant.
*Lupinus cosentinii	</= 25%	(30)50-140 cm	700-900 plants.
Maireana brevifolia	1%	60 cm	1 plant.
*Monoculus monstrosus	1-2%	(20)50-90 cm	50-100 plants.
*Orobanche minor	+%	10-20 cm	2 stems.
Ptilotus polystachyus	1%	(10)30-90 cm	< 40 plants.
*Raphanus raphanistrum	1%	70-135 cm	8 plants.
Regelia megacephala	4-5%	(1)1.5-2.5 m	6 plants.
*Sonchus oleraceus	+	10-40 cm	6 plants.
*Trifolium arvense var. arvense	+	15 cm	< 10 plants.
*Trifolium hirtum	+	15 cm	12 plants.
*Ursinia anthemoides	< 1%	15-30 cm	> 100 plants?
*Vulpia myuros	< 1%	40 cm	> 100 plants?


Quadrat NEW 01 (From SE corner)


Quadrat NEW 01 (From SW corner)


Quadrat NEW 01 (From east side)


Adjacent to Quadrat NEW 01


Adjacent to Quadrat NEW 01

Site: NEW02
Described by: Malcolm Trudgen **Date:** 13/10/2022. **Type:** Quadrat (10 x 10 m).
Location: New North Waste Dump. **Geocodes** [WGS84]**:** Zone 50: NW corner 407303E 6624152 S; NE corner 407312 E 6624149; SE corner 407306 E 6624138 S; SW corner 407296 E 6624145 S.
Habitat: South-west facing, mid to upper slope of a large mine waste dump.
Soil: Mine waste, mostly gravelly (chert) with very pale fines and a few boulders..
Rock Type: Chert, gravel to boulders.
Vegetation: *Allocasuarina huegeliana* high open shrubland over *Acacia congesta* subsp. *congesta* shrubland over *Hibbertia subvaginata* scattered low shrubs annual grassland over **Hypochaeris glabra* (**Ursinia anthemoides*) low annual herbland
Notes: The quadrat site was selected to have the main perennial species in the rehabilitation present.

*Raphanus raphanistrum and *Avena barbata were present just outside the quadrat, while Acacia stenoptera and *Lupinus cosentinii were nearby.

Species list	Cover 2022	Height 2022	Notes 2022
Acacia congesta subsp. congesta	15%	50-160 cm m	5 plants.
Acacia acuminata	< 1%	(0.6)2.3-3 m	3 plants.
Acacia aristulata	> 1%	35 cm	1 plant, 1.2 m across.
Allocasuarina huegeliana	4%	(0.6)4 m	3 plants; 2 x 4 m & 1 x 0.6 m.
*Arctotheca calendula	+	5-12 cm	5 plants.
Aristida contorta	+	15-20 cm	7 plants.
Austrostipa variabilis	< 1%	10-15 cm	34 plants
*Bromus rubens	+	20 cm	1 plant.
Crassula colorata var. colorata	+	5 cm	1 plant.
Crassula decumbens var. decumbens	+	5 cm	2 plants
*Conyza bonariensis	+	30 cm	4 plants.
Eucalyptus sp.	< 1%	2 m	1 plant.
Hibbertia subvaginata	< 1%	60 cm	2 plants.
*Hypochaeris glabra	< 10%	1 cm (leaves)	1,000- 2,000 plants.
*Monoculus monstrosus	1%	15-35 cm	> 40 plants.
*Pentameris airoides ssp. airoides	2%	10-20 cm	2 stems.
*Petrorhagia velutina	< 1%	7-12 cm	> 800 plants.
Ptilotus polystachyus	+	25 cm	2 plants.
*Silene gallica var. gallica	+	20 cm	4 plants.
*Silene sp.	< 1%	10-25 cm	> 30 plants
*Trifolium arvense var. arvense	</= 2%	5-12 cm	150-200 plants.
*Trifolium hirtum	+	5 cm	2 plants.
*Ursinia anthemoides	< 5%	10-20(50) cm	800-1,000 plants, dead at survey.
*Vulpia myuros	2%	10-30 cm	> 500 plants


Quadrat NEW 02 (From SE corner)


Quadrat NEW 02 (From east side)

Appendix 2: Vegetation structural table of Specht with modifications by Aplin and Trudgen

Life form and height of tallest stratum	Projective foliage cover of tallest stratum as %	Description
Trees over 30 metres	70 -100	High closed forest
	30 -70	High open forest
	10 - 30	High woodland
	2 -10	High open woodland
	under 2	Scattered tall trees
Trees 10 - 30 metres	70 -100	Closed forest
	30 -70	Open forest
	10 - 30	Woodland
	2 -10	Open woodland
	under 2	Scattered trees
Trees under 10 metres	70 -100	Low closed forest
	30 - 70	Low open forest
	10 - 30	Low woodland
	2 -10	Low open woodland
	under 2	Scattered low trees
Shrubs over 2 metres	70 - 100	Closed scrub
	30 - 70	Open scrub
	10 - 30	High shrubland
	2 -10	High open shrubland
	under 2	Scattered tall shrubs
Shrubs 1 - 2 metres	70 - 100	Closed heath
	30 - 70	Open heath
	10 - 30	Shrubland
	2 -10	Open shrubland
	under 2	Scattered shrubs
Shrubs under 1 metre	70 - 100	Low closed heath
	30 - 70	Low open heath
	10 - 30	Low shrubland
	2 -10	Low open shrubland
	under 2	Low scattered shrubs
Herbs/Sedges/Grasses	70 - 100	Closed herb, sedge, grassland
	30 - 70	Herb, sedge, grassland
	10 - 30	Open herb, sedge, grassland
	2 -10	Very open herb, sedge, g'land
	under 2	Scattered herbs sedges, grasses

Grasslands then divided into:
Tussock grasslands (perennial tussock species, e.g. Eragrostis species);
Hummock grasslands (Triodia and Plectrachne species that form hummocks)
Curly spinifex grassland (Plectrachne pungens, which does not form hummocks) (follows J.S. Beard).
Annual tussock grassland (e.g. annual Sorghum species).