



Weed Control 2023

Higginsville and surrounding areas



Prepared by
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Environmental solutions for

MINING

OIL & GAS

CONSTRUCTION

1.0 INTRODUCTION

Ecotec (WA) Pty Ltd (Ecotec) was engaged by Avoca Mining Pty Ltd, a subsidiary of Karora Resources Ltd, to undertake weed control at the company's Higginsville mine site and surrounding operations.

The intent of this work was to spray identified weeds with suitable herbicide while recording the main locations of infestation using a handheld GPS.

The work was undertaken on 19 and 20 September 2023.

2.0 METHOD

The previous weed mapping (2022) was used to target known weed locations. At the main Higginsville site, the target areas included the camp, exploration core yard, waste water treatment plant, the power station and surrounding laydown, and the north and east perimeter of the TSF. The areas were inspected on foot, weed locations recorded and herbicide applied. The Chalice site was also inspected, mapped and sprayed again this year.

Mapping was undertaken using a hand-held GPS unit. Each weed location was marked using codes for the species (Table 2.1) and weed density (Table 2.2).

Table 2.1: Weed species codes.

Code	Scientific name	Common name	Location
Aa	<i>Agave americana</i>	Century plant	Spargos
Af	<i>Asphodelus fistulosus</i>	Onion weed	Higginsville, Chalice
Cb	<i>Conyza bonariensis</i>	Flaxleaf fleabane	Higginsville
Cm	<i>Centaurea melitensis</i>	Maltese cockspur	Higginsville, Chalice
Hc	<i>Heliotropium curassavicum</i>	Smooth heliotrope	Higginsville
La	<i>Lysimachia arvensis</i>	Pimpernel	Higginsville
Mn	<i>Mesembryanthemum nodiflorum</i>	Slender iceplant	Higginsville
Os	<i>Opuntia stricta</i>	Prickly pear	Spargos
Rv	<i>Rumex vesicarius</i>	Ruby dock	Higginsville, Chalice
Sv	<i>Salvia verbenaca</i>	Wild sage	Higginsville
Si	<i>Sisymbrium irio</i>	London rocket	Higginsville
Sn	<i>Solanum nigrum</i>	Blackberry nightshade	Higginsville, Chalice
Sa	<i>Sonchus asper</i>	Prickly sowthistle	Higginsville, Chalice
So	<i>Sonchus oleraceus</i>	Common sowthistle	Higginsville

Table 2.2: Weed density scale.

Code	Number of individuals
1	<10
2	11-50
3	51-100
4	101-500
5	>500
6	>1000

At the Higginsville and Chalice sites, weeds were sprayed with herbicide using a vehicle mounted tank and spray wand, or a back pack sprayer where weeds were not accessible using the vehicle. The herbicide mix used has been found to be very effective against a broad range of weed species and comprised:

- Glyphosate (540 g/L) - a Group M non-selective herbicide
- Dicamba (340 g/L MCPA, 80 g/L DICAMBA) - a Group I broadleaf selective herbicide
- Simazine 900 (900g/kg Simazine) - a Group C pre-emergent herbicide for residual control of weed species
- Pulse Penetrant - a wetter/spreader/penetrant for improved penetration of herbicides.

3.0 RESULTS AND DISCUSSION

3.1 General observations

Weed abundance across the area was observed to be generally lower in 2023 than in previous years. The ongoing regular weed spraying program appears to have had a positive result, but below average rainfall over the last few years may also be a factor. Norseman, approximately 50 km south of Higginsville, has an average annual rainfall of 284.1 mm. The weather station at the Higginsville operations recorded 207.8 mm in 2022, and by August 2023 had recorded just 115 mm. Weed seeds typically have long dormancy periods (ruby dock seed is now believed to be viable after 20 years of dormancy), so an increase in weed abundance can be expected following future significant rainfall events.

Overall, the Higginsville Gold Operations are not badly infested with weed species. The weed species that are present across the operations are common throughout the Goldfields Region and are generally spread via wind, surface water movement and livestock. Ruby dock (*Rumex vesicarius*) is the only species considered to be problematic due to its invasive capability in disturbed areas. It is unlikely that ruby dock will be completely eradicated from the site due to the long dormancy of seed. Continued regular weed spraying should keep it under control.

Table 3.1 provides the quantities of herbicide used for the weed control work. Figure 3.1 and Figure 3.2 show the recorded weed locations where spraying was undertaken.

Table 3.1: Quantities of herbicide used.

Herbicide	Quantity used
Glyphosate	5 litres
Dicamba	0.5 litre
Simazine	2.5 kg
Pulse	0.5 litre

Figure 3.1, Figure 3.2 and Figure 3.3 provide the location of weed species recorded during the 2023 program. The symbols are sized to provide a representation of the relative abundance of the dominant weed species encountered at each location. The spatial data can be provided if required.

It is recommended that inspection and spraying is continued as a minimum at annual intervals to ensure ruby dock in particular is kept under control. While Maltese cockspur, onion weed and the sowthistles are unlikely to ever be eradicated from the site, regular and continued treatment will reduce their abundance.

3.2 Higginsville and surrounds

Twelve introduced weed species were identified around the main Higginsville site during the 2023 spraying program (refer to Table 2.1).

The abundance of ruby dock has noticeably reduced around the TSF, indicating success of the prior control efforts but possibly also reflecting low rainfall, noting the discussion in Section 3.1. Repeated and consistent spraying is required to maintain control of ruby dock and prevent it dominating rehabilitated areas.

Asphodelus fistulosus (onion weed) was prevalent in several locations on the eastern side of the TSF. The species flowers opportunistically, so can set seed at any time of the year. As with many weed species, seeds are abundant and can remain dormant for many years. It can become prolific in disturbed areas but does not compete well with other flora, so is not an invasive species. Repeated spraying will be required to control onion weed in the areas where it is currently prevalent.

Two varieties of sow thistle (*Sonchus asper* and *S. oleraceus*) and Maltese cockspur were found across the site. These species are predominately spread by wind and are common throughout Western Australia. Maltese cockspur is very difficult to eradicate once established as it is drought tolerant and a prolific seeder. It is also partially resistant to some herbicides, often continuing to set seed after having been sprayed. It is listed by some sources as an invasive species, but in WA tends to be restricted to low lying disturbed areas such as roadside drains. Good results have been achieved using a woody weeds herbicide such as Tordon or Grazon in the mix, but repeated treatment of heavily infested areas is required.

All weed species recorded in 2023 have previously been recorded at Higginsville with the exception of *Heliotropium curassavicum* (smooth heliotrope) which was recorded for the first time in low numbers on the southern side of the TSF. It is likely *H. curassavicum* has been present around the site for some time but not previously observed or is now experiencing favorable conditions. It is not known to be a particularly invasive species.

Weed prevalence around the camp was much reduced from previous years with just Maltese cockspur and two varieties of sow thistle found in low abundance.

A small patch of ruby dock had returned from a previous seed bank at the exploration core yard. The plants were very localised and should be easily controlled. There were other scattered common weeds at the core yard, mainly around the sheds.

Salvia verbenaca (wild sage) was again found to the south of the TSF in an area of rehabilitation but in much reduced abundance. It is not an invasive species and generally remains fairly localised.

Carrichtera annua (Ward's weed) is found across the site. It is very common in disturbed areas throughout the Goldfields Region and is extremely difficult to eradicate. While it can be locally abundant, Ward's weed is short lived and does not outcompete native species. Ecotec does not consider it worthwhile targeting this species unless it is with other weeds of greater concern.

The recorded weed locations are shown on Figure 3.1.

3.3 Chalice

Five weed species were identified at the Chalice site (refer to Table 2.1).

An area of ruby dock was identified on the upper surface of the waste dump that had not previously been recorded. This area was not inspected in 2021 due to inaccessibility nor in 2022 due to lack of time. Ruby dock has been present in this area for some time as there was a significant seed mat in places. The pre-emergent herbicide Simazine was

included in the mix and has demonstrated good results in reducing the number of germinants from large seed deposits such as this. Repeated treatment of this area will be required.

Ruby dock was also prevalent in the pit. Accessible areas were sprayed however mature plants are located on the berms and further down the main pit ramp which is no longer accessible. Repeated control will be required but may be better achieved using the Ecotec ATV which is equipped with a boom spray and hose reel and is much more versatile than a standard vehicle.

Maltese cockspur was abundant in localised areas, mainly along the access and haul roads. These species are locally prolific in disturbed areas, typically in areas where surface water collects such as road verges, topsoil stockpiles and depressions in rehabilitated areas, but they do not compete well with native species and are generally not invasive. These two weed species were most common around the village, the exploration core yard and the power station. *Sonchus asper* (prickly sowthistle) was recorded in a few locations across the project area. The recorded locations are shown on Figure 3.2.

3.4 Spargos

A DMIRS inspection of the Spargos mine site prior to the 2023 weed control work raised the presence of *Agave americana* (century plant) and *Opuntia stricta* (prickly pear) as a concern. The Spargos site was briefly inspected on completion of spraying work at Higginsville and Chalice.

Both species are found within a localised area of historic occupation by prospectors and small scale mining operators (Photograph 3.1 and Photograph 3.2). There was only one or two of each species observable from the Spargos access road. There may be more present within the historic disturbance, but none was located within the current operational area. The known locations are shown on Figure 3.3.

Both species are very slow growing in the Goldfields and do not spread quickly. It is assumed both species can be spread by seed, but this does not appear to be the most common method of spread. Both species are capable of growing from pieces of plant (vegetative reproduction) that are spread by earthmoving machinery and this is the most commonly observed method of reproduction of these plants. For this reason complete removal of the plants is required from the area prior to stripping of topsoil. The prolonged moist soil conditions required for vegetative reproduction rarely occur in this region so spread is slow and easily controllable. Both are readily controlled using glyphosate and a woody weeds herbicide such as Tordon or Grazon.

It is recommended that all traces of these plants are completely removed prior to commencement of clearing. Deep burial will prevent future growth.

Neither of these species are considered to pose a significant risk to rehabilitation at the site.



Photograph 3.1: Prickly pear located in an area of historic occupation near the Spargos mine site.



Photograph 3.2: Century plant located in an area of historic occupation near the Spargos mine site.

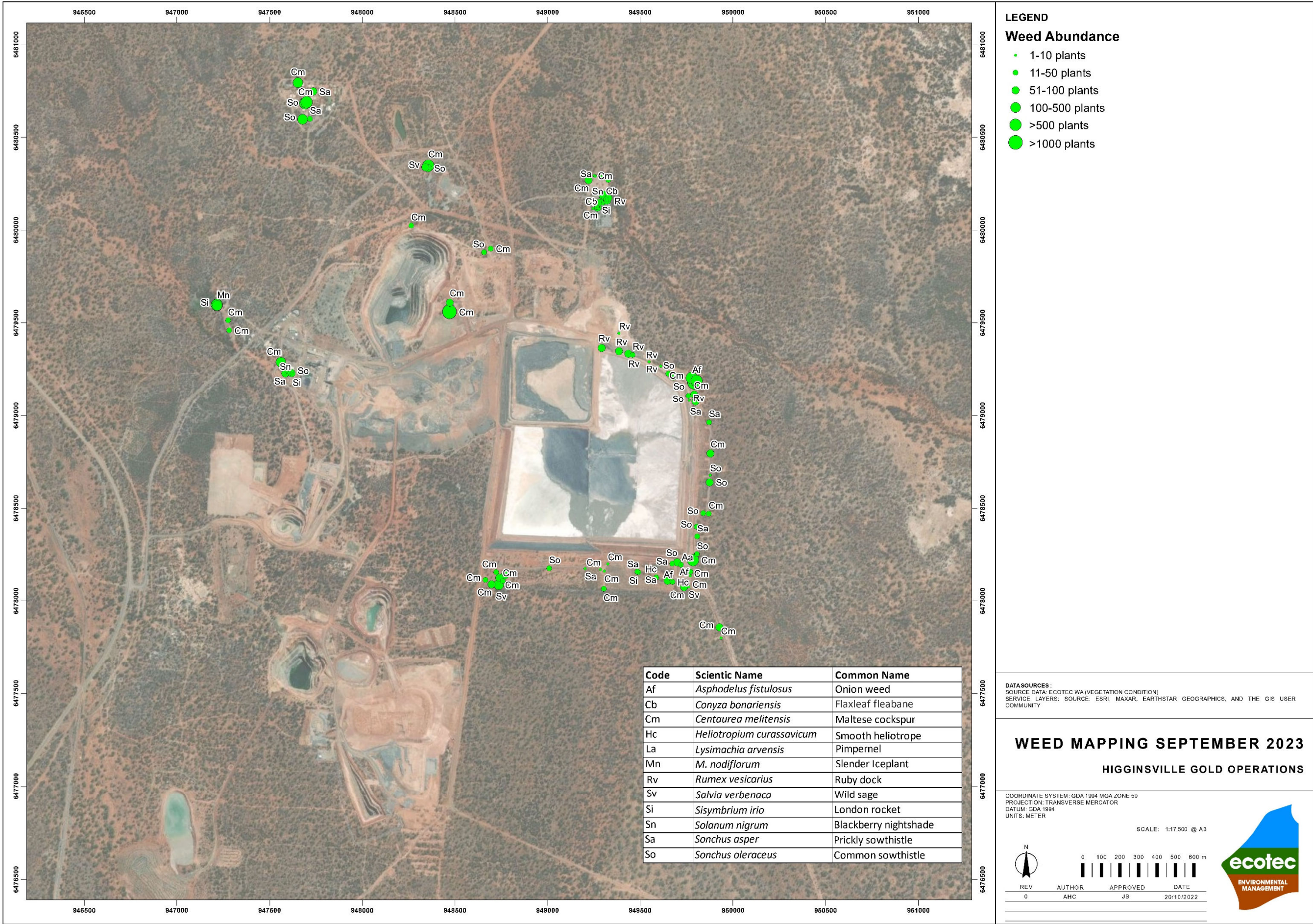


Figure 3.1: Weed locations September 2023 – main Higginsville operations.

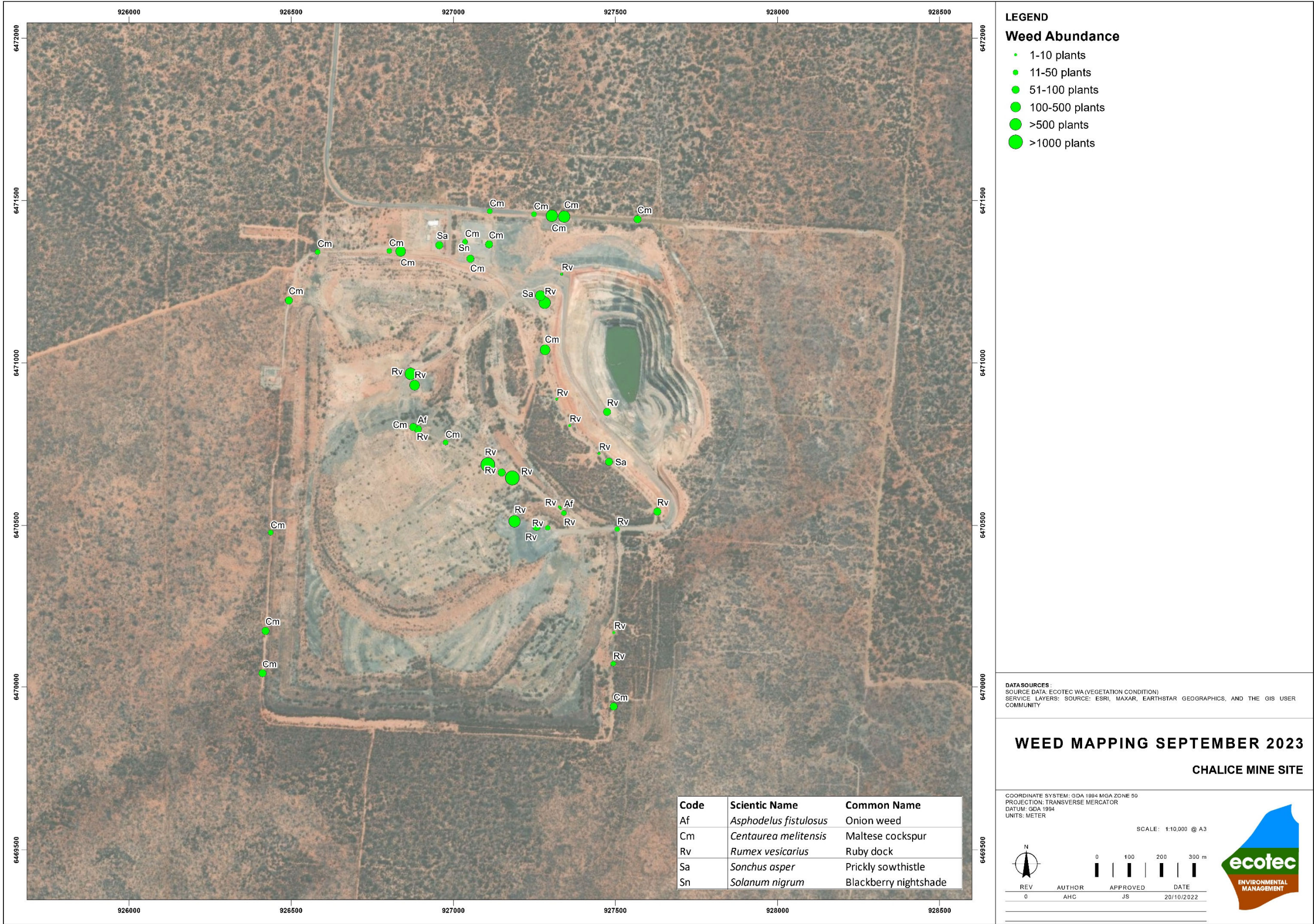


Figure 3.2: Weed locations September 2023 – Chalice mine site.

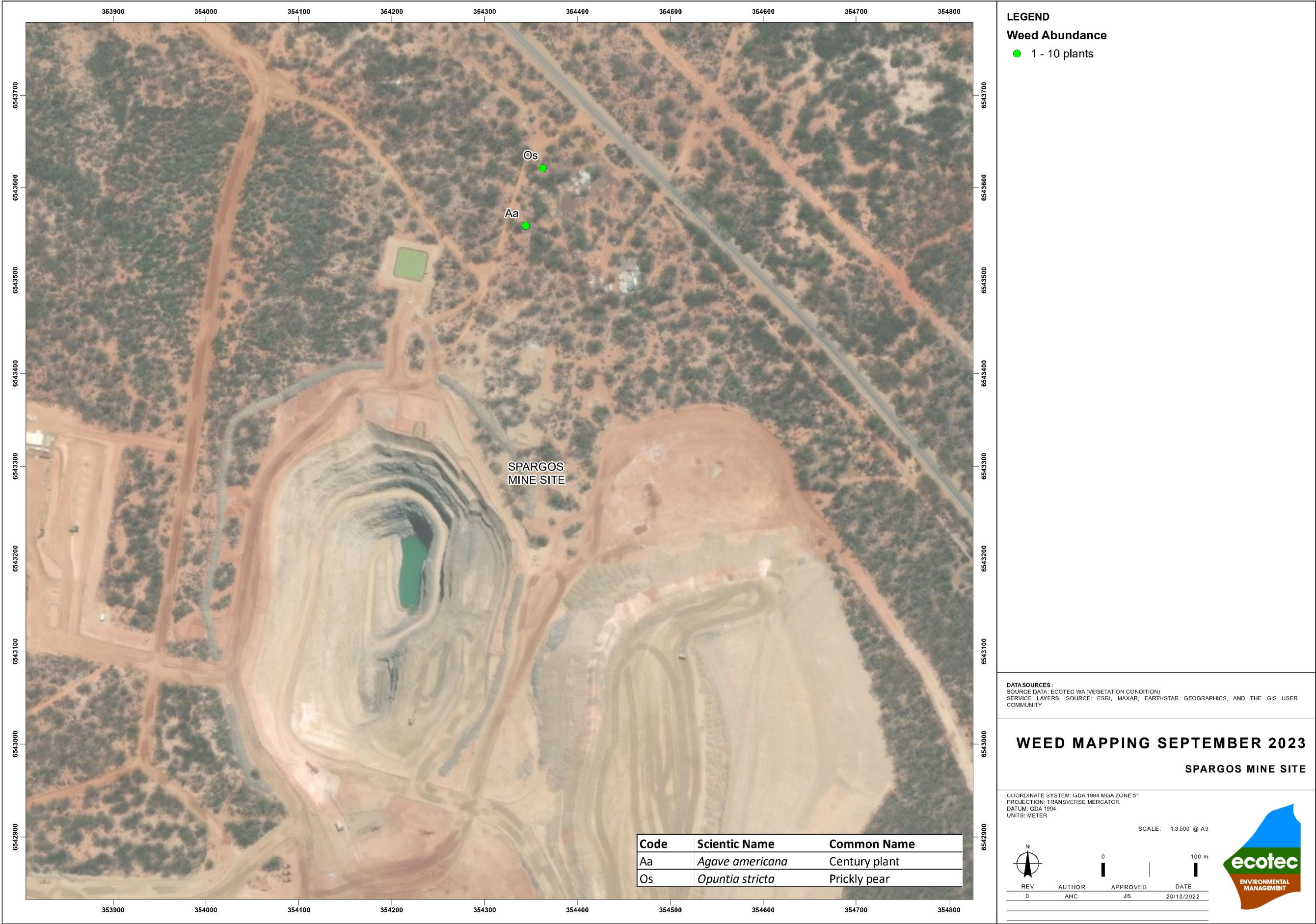


Figure 3.3: Weed locations September 2023 – Spargos mine site.