Appendix 5 – Long Term Fauna Monitoring Program

Baseline Monitoring of Rehabilitation Programs

Alcoa's Bauxite Mining Areas

Prepared for: Alcoa of Australia Ltd

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REPORT CONTENTS

LIST OF CHARTS

LIST OF PLATES

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Alcoa of Australia Ltd (Alcoa) operates bauxites mines in the Huntly and Willowdale areas east of Pinjarra in the Western Australian Jarrah Forest. Alcoa is progressively rehabilitating mined areas once the local resources have been exhausted. The primary objective of Alcoa's bauxite mine rehabilitation program is to return a self-sustaining Jarrah Forest ecosystem after mining. This includes re-establishing populations of all faunal groups and species in densities and distributions required for maintaining forest biodiversity and ecosystem function.

Alcoa has established 12 long-term monitoring sites for vertebrate fauna. Three of the sites are in unmined habitat, and three of the sites are in areas rehabilitated 5, 10 and 15 years ago. It is proposed that the vertebrate fauna at these sites would be periodically monitored (e.g. every 5 years) to enable judgements to be made about the extent to which rehabilitated areas were progressing on a trajectory towards the recreation of functional ecosystems, as determined by the terrestrial vertebrate fauna assemblage, like that in the unmined areas. Outcomes from these monitoring surveys would inform planning for future rehabilitation programs and where appropriate taking corrective action in existing rehabilitated areas.

Terrestrial Ecosystems has undertaken the baseline survey, which will be the first of the long-term monitoring surveys. These survey data indicated that the three unmined sites selected as analogue climax communities for the rehabilitation areas are not similar, and there are appreciable differences among the fauna assemblages within aged classes of rehabilitation. Based on the available data, there are two alternative conclusions that can be reached about succession of rehabilitated areas along a trajectory to an analogue climax community:

- differences among the unmined areas makes it difficult to determine what is the target climax community, and it is possible there are other alternative Jarrah Forest communities that have not been sampled that would better represent climax communities that will eventuate in rehabilitated areas; or
- rehabilitation programs are not of sufficient quality to enable the mammal, reptile and amphibian assemblages in unmined area to recolonise rehabilitated areas within a 15-year period sufficiently to clearly indicate they are on a trajectory toward establishing analogue climax communities.

The preliminary data collected in this survey would suggest that conservation significant species are in the unmined areas, but not the rehabilitated areas. If further investigation indicates that this was the case, then a focus on the long-term preservation of conservation significant species, and in particular their use of rehabilitation areas should be a priority.

No foxes were recorded during the camera trapping program and only a single feral cat was recorded, however, the area surveyed was very limited when viewed in the context of the extent of Jarrah Forest managed by Alcoa. Feral pigs were abundant in a localised area and are known to cause environmental damage. It is suggested that Alcoa implement a program to manage feral pest species likely to be impact on ecosystems, and in particular conservation significant species.

It is suggested that this monitoring program is reviewed before the survey is repeated, with particular attention to:

- the fauna target(s) as represented by the rehabilitation trajectory and intended climax community(ies);
- survey design (i.e. location of analogue sites);
- use of camera traps to determine presence vs relative abundance or conservation significant fauna; and
- value-for-money of surveys, when compared with the alternative uses of these resources to achieve a similar objective(s) (e.g. the long-term preservation of conservation significant species, and in particular their use of rehabilitation areas).

1. INTRODUCTION

1.1 BACKGROUND

Alcoa of Australia Ltd (Alcoa) operates the Huntly and Willowdale bauxite mines east of Pinjarra in Western Australian on mineral lease ML1SA. The Huntly mine was established in 1972 and is located near Dwellingup and supplies bauxite ore to the Kwinana and Pinjarra refineries, as well as other clients. The Huntly mine currently includes locations at Myara, McCoy and Karnet. The Willowdale mine was established in 1984 and is located near Wagerup and supplies bauxite ore to the Wagerup refinery, as well as other clients. The Willowdale mine currently includes locations at Larego, Orion and Arundel.

The primary objective of Alcoa's bauxite mine rehabilitation program is to return a self-sustaining jarrah forest ecosystem after mining. This includes re-establishing populations of all faunal groups and species in densities and distributions required for maintaining forest biodiversity and ecosystem function. To ensure this objective is met, Alcoa established a long-term fauna monitoring program in 1991. This program characterises and monitors the key fauna of the areas in which Alcoa operates and assesses the impact of mining on these species.

1.2 SUCCESSION

Grant (2006) indicated that Alcoa's objective for its rehabilitation programs was to establish self-sustaining jarrah forest ecosystems. Grant (2006) went on to indicate that '*restored native ecosystems may be different in structure to the surrounding native ecosystems, but there should be confidence that they will change with time along with, or toward the structure and composition of the surrounding area*' and '*should be capable of withstanding disturbances such as fire or grazing*'. It has been presumed that this object is still applicable.

Primary succession is defined here as a process of change in the species structure of an ecological community over time from an assemblage that commences on barren or highly disturbed land to the climax community. This can be diagrammatically represented as shown in Plate 1.

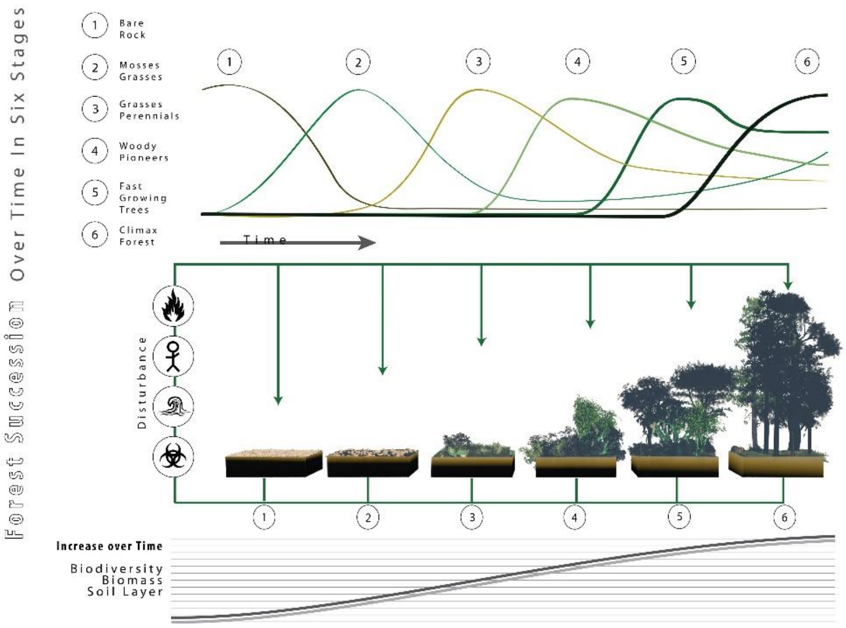

Plate 1. Conceptual diagram of primary succession

taken from https://commons.wikimedia.org/wiki/File:Forest_succession_depicted_over_time.png

During the very early stages, very few terrestrial vertebrate species will colonise the area due to a lack of suitable habitat and higher levels of predation because of a lack of cover and retreat sites. Once the vegetation, invertebrates and microbial activity move through the succession stages and additional habitat niches open up, then more species can colonise the rehabilitated areas. In some cases, the abundance of early colonisers (i.e. pioneers) will be reduced due to competition and changing habitat conditions. Rehabilitated areas will cycle through many iterations of this process and along the way, species abundance typically increases, and the various species reach population levels suitable for the habitat and resources available, until such time it becomes a climax community.

Vertebrate fauna are only a part of the primary succession process and their progress from pioneering species toward a climax community is interrelated with the vegetation, fungi, microbial and invertebrate community development. Within broad boundaries, the trajectory in rehabilitated areas should be apparent in monitoring data (Plate 2).

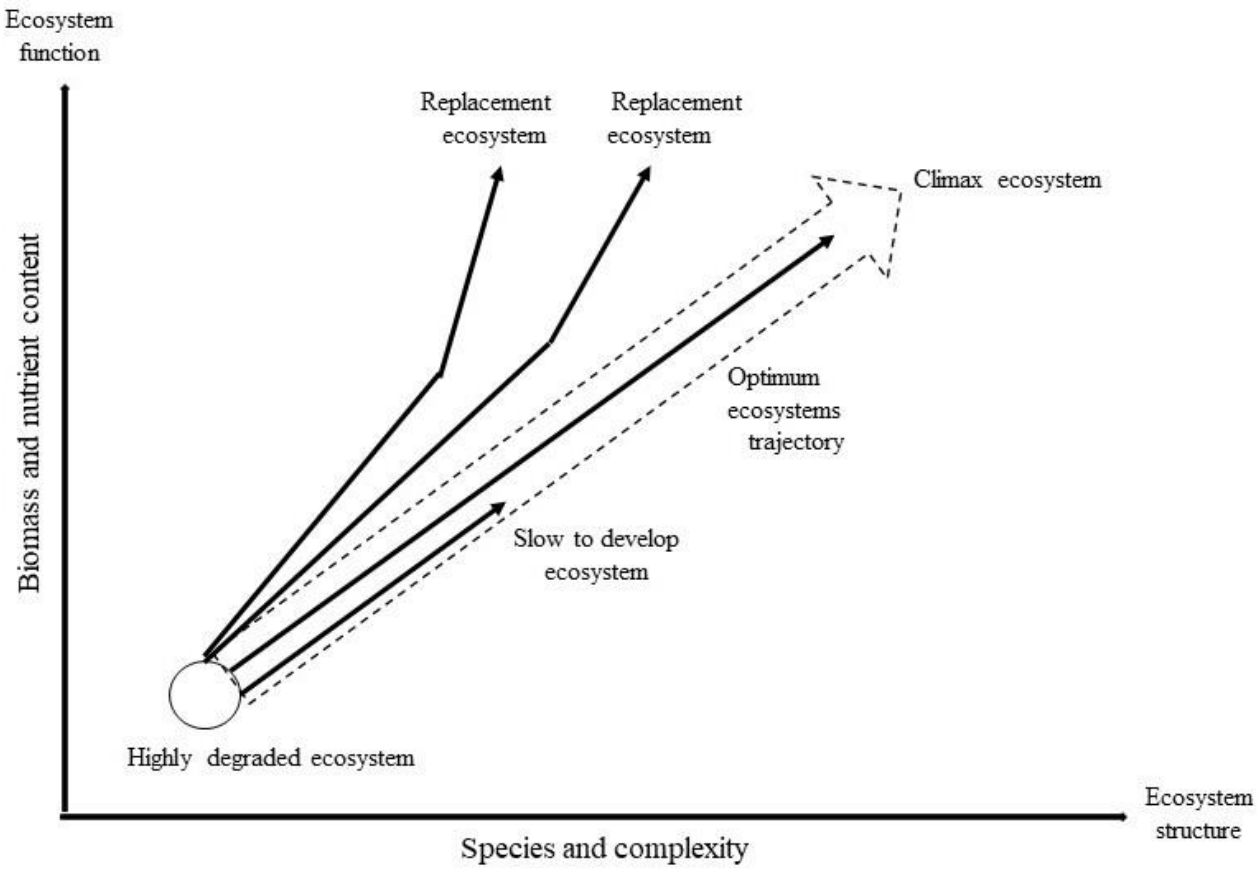

Plate 2. Primary succession trajectory(taken from: Bradshaw 1984)

Anderson et al. (2022) and Cross et al. (2019, 2021) argued that fauna have very often been forgotten in considering rehabilitation success with the focus on soils and vegetation. Anderson et al. (2022) went on to suggest a framework for incorporating fauna into the restoration process, and in doing so, identified the following five key criteria for effective faunal standards:

- appropriate reference ecosystem [analogue site(s)];
- faunal taxa to be considered;
- attributes of these taxa to be measured;
- acceptable level of similarity with reference conditions; and
- sampling methodology that is sufficiently robust to provide reliable comparative data.

1.3 OBJECTIVE

Alcoa's intention was to establish long-term monitoring sites for vertebrate fauna in unmined areas, and areas rehabilitated 5, 10 and 15-years ago. It was proposed that the vertebrate fauna at these sites would be periodically monitored to enable judgements to be made about the extent to which rehabilitated areas were progressing on a trajectory towards the recreation of functional ecosystems, like that in the unmined areas. Outcomes from these monitoring surveys would inform planning for future rehabilitated areas and where appropriate corrective action in existing rehabilitated areas.

Here we provide a description of the methods used to collect vertebrate fauna data, the results of the baseline monitoring program, discussion of the results and a commentary on the program and a suggested way forward.

2. METHODS

2.1 PIT-TRAPPING PROGRAM

Twelve sites in the Jarrah Forest (Figures 1 and 2) were established by Alcoa (Plates 16-39). This included three unmined analogue sites, three sites that were rehabilitated in 2007 (i.e. 15-years old), three sites that were rehabilitated in 2012 (i.e. 10-years old) and three sites that were rehabilitated in 2017 (i.e. 5-years old; Appendix A).

At each site there were four near parallel drift fences 30m long with approximately 25cm of flywire above the ground. Along each drift fence there were three 20L PVC buckets, three PVC 150mm diameter pipes that were 400mm deep and buried directly under the flywire drift fence. Three pair of funnels traps were deployed either side of the drift fence and three aluminium box traps were set approximately 10m to the side of the drift fence (Plate 3). Buckets used as pit-traps had holes and styrene sheets in the bottom to provide captured fauna protection from unfavourable environmental conditions. These traps targeted small mammals, reptiles and amphibians.

The location of trapping sites is shown in Figures 2-14 and the coordinates are provided in Appendix B. Traps were opened on 9 January and closed on 21 January 2023.

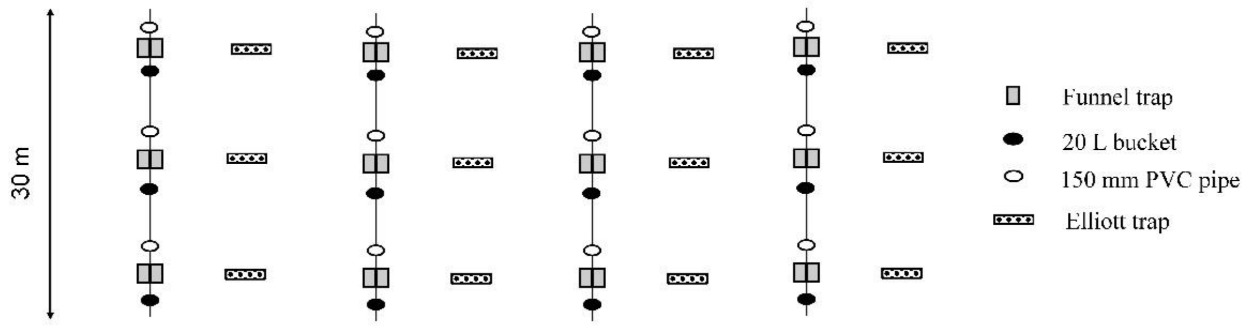

Plate 3. Trapping site layout

2.2 CAGE TRAPPING PROGRAM

Eighty cage traps (Plate 4) targeting Chuditch (*Dasyurus hallucatus*) were deployed adjacent to gravel tracks where Alcoa believed that there may have been Chuditch. Trapping sites were selected by Alcoa on the basis that one was inside the mine perimeter and comprised a variety of levels of disturbance (i.e. rehabilitation of various ages and remnant vegetation), and the other was outside the mine perimeter in unmined forest (Figures 18-21).

Cages were baited with raw chicken necks which were replaced every three days or as required. Traps were opened on 8 January and closed on 20 January 2023 at locations were Chuditch had previously been reported. Camera traps targeted the medium and large mammals, but any fauna recorded were reported.

Plate 4. Baited cage trap

2.3 CAMERA TRAPS

Twenty-four camera traps (Reconyx HC600) were deployed in the denser vegetation targeting Quokka (*Setonix brachyurus*) and Quenda (*Isoodon fusciventer*; Figures 15-17). Each camera trap had a non-reward lure (Plate 5) placed ~3-4m in front of the camera trap (Plate 6) in the detection zone. Lures were a mixture of peanut butter, rolled oats and sardines topped up with mullie oil. Traps were deployed on 8 January and retrieved on 20 January 2023.

Plate 5. Non-reward lure **Plate 6. Mounted camera trap**

2.4 INVERTEBRATE SAMPLING

Each trapping site was searched for invertebrates for one hour by two people for the following taxonomic groups: isopods, diplopods, opiliones, scorpions, mygalomorph spiders and pseudoscorpions. Specimens were preserved in ethanol but not identified. In addition, specimens from these taxonomic groups caught in pit and funnel traps were also collected and preserved. All specimens were given to Alcoa for identification and analysis.

2.5 DATA ANALYSIS

The diversity for the trapped fauna assemblage can be measured in numerous ways (Hayek and Buzas 1997, Magurran 2004). The four most common attributes are species richness, evenness, a single diversity score and relative abundance. These metrics are interrelated and there are a diverse number of analytical tools available to quantify these metrics and similarity among the trapped assemblages for each site.

2.5.1 Principal component analysis

A principal component analysis (PCA) is used to reduce the complexity of large datasets by transforming a large dataset of variables into a smaller one that contains most of the information. PCAs were calculated (StatistiXL) for all survey site-based trapping data (i.e. excluding cage and camera trap data), to determine the extent to which vertebrate fauna assemblages were similar/different among sites. Eigenvalues >1 are typically used to determine the components that are useful, and for each component a percentage of its contribution to displaying the attributes of larger data set provides useful information about the importance of each component.

It should be expected that if succession processes were advancing along an expected trajectory, then, survey sites should be grouped in the PCAs based according to the period of rehabilitation (i.e. unmined, 15-years, 10-years and 5-years) using the most significant principal components (i.e. PCAs 1 and 2).

2.5.2 Similarity

If having established that there were differences among the trapped fauna assemblages at each site, and if rehabilitation and succession were advancing along an expected trajectory, then the extent to which the trapped fauna assemblages were similar is of interest. Ideally, the three unmined analogue sites should be more similar to each other than to the rehabilitation sites, and rehabilitation site similarity should be greatest among rehabilitation aged class sites.

The Morisita-Horn similarity index was used to compare similarity among combinations of trapped fauna assemblages at each site. The quantitative Morisita-Horn similarity index was selected because it is not strongly influenced by either species richness or sample size (Wolda 1981) and it was recommended by Magurran (2004). Readers should, however, be aware that it is heavily influenced by the abundance of the most abundant species. The Morisita-Horn similarity index was calculated using Species, Diversity and Richness software (Pisces Conservation Ltd 2010).

2.5.3 Species richness and relative abundance

The actual number of species caught at each trapping site is one measure of species richness and is directly related to the trapping effort and number of individuals caught. Had the trapping effort been extended and more individuals caught, then it is likely the number of species caught at each site would increase (Colwell and Coddington 1994, Magurran 2004). Species richness and abundance was calculated using Species, Diversity and Richness software IV (Pisces Conservation Ltd 2010).

It should be expected that the unmined sites would have the highest number of species and species abundance, and as rehabilitation sites progress along an expected succession trajectory, then species richness would increase, however, abundance for many species will rise and fall based on the available habitat and competition among species.

2.5.4 Evenness

Smith and Wilson (1996), supported by Magurran (2004), reported their measure of evenness (Evar) to be the most satisfactory overall. Species, Diversity and Richness software IV software (Pisces Conservation Ltd 2010) was used to calculate the Smith and Wilson method of determining evenness. It is unknown how evenness is related to fauna assemblages in rehabilitated sites.

2.5.5 Diversity

Fisher's alpha (also known as Log series diversity) was used to measure diversity because of its good discriminating ability and low sensitivity to sample size (Kempton and Taylor 1974, Magurran 1988, Hayek and Buzas 1997). Other more commonly used diversity indices were also calculated.

Log series diversity, Shannon-Wiener and Simpson's indices were calculated using Species, Diversity and Richness IV software (Pisces Conservation Ltd 2010).

3. RESULTS

All vertebrate fauna caught in pit, funnel and aluminium box traps are shown in Table 1.

Table 1. Trapping data results

		Survey site status	Unmined	Unmined	Unmined	15-year rehabilitation	15-year rehabilitation	15-year rehabilitation	10-year rehabilitation	10-year rehabilitation	10-year rehabilitation	5-year rehabilitation	5-year rehabilitation	5-year rehabilitation	Total
Taxa	**Family**	**Species** / **Survey sites**	**1**	**2**	**3**	**7**	**8**	**12**	**4**	**5**	**6**	**9**	**10**	**11**	
Amphibian	Limnodynastidae	*Heleioporus eyrei*			2										2
		Heleioporus inornatus	1												1
	Myobatrachidae	*Crinia georgiana*		2					1			1			4
Mammal	Burramyidae	*Cercartetus concinnus*	3	2	1	23	13	8	3		12			1	66
	Dasyuridae	*Antechinus flavipes*		1	14	5	1	4	11	7	2	2	2		49
		Sminthopsis gilberti			1	2	1	2	5		1	2	1	2	17
	Muridae	*Mus musculus*								1	1	6		5	13
Reptile	Agamidae	*Pogona minor*				3	1			2	2			1	9
	Carphodactylidae	*Underwoodisaurus milii*	2	2						2		1	3	3	13
	Diplodactylidae	*Diplodactylus lateroides*		1		1	1				1	2	6	1	13
		Diplodactylus polyophthalmus				1			1					1	3
	Elapidae	*Suta gouldii*				1					1				2
		Suta nigriceps	1							3					4
	Gekkonidae	*Christinus marmoratus*												1	1
	Pygopodidae	*Lialis burtonis*									1				1
	Scincidae	*Acritoscincus trilineatus*		7	2	9	6	9	1	12	9		1	3	59
		Cryptoblepharus buchananii	3	7	2							1			13
		Egernia napoleonis	13	5	1					1					20
		Hemiergis initialis	2	4			2	2		5					15
		Lerista distinguenda	11	15	11	3	4			3	6	1			54
		Lerista elegans		1		1				3					5
		Menetia greyii	3		1	4	4		2	1	3	1	6	7	32
		Morethia obscura	14	13	2	7	7	4	4	6	9	9	1	4	80
		Tiliqua rugosa					1								1
	Typhlopidae	*Anilios australis*		5			1			1	1				8
		Total	53	65	37	60	42	29	28	47	49	26	20	29	485

Of interest, a single *Morelia imbricata* was recorded on one of the tracks while undertaking the survey (Plate 7).

Plate 7. Carpet python

Vertebrate fauna caught in cage traps are shown in Table 2.

Table 2. Fauna caught in a cage traps

Taxa	Family	Species	Trap numbers																			
			12C	13C	1C	28C	41C	42C	44C	45C	47C	50C	57C	59C	61C	63C	68C	6C	74C	76C	78C	Total
Mammal	Dasyuridae	*Dasyurus geoffroii*					1	1	1	1					1	1			1	3	2	12
	Peramelidae	*Isoodon fusciventer*											1				1					2
	Tachyglossidae	*Tachyglossus aculeatus*			1																	1
Reptile	Scincidae	*Tiliqua rugosa*										1	1									2
	Varanidae	*Varanus gouldii*		1		1		1	1	1	1			1		1						8
		Varanus rosenbergi	1	1		1						1						3				7
		Total	1	2	1	2	1	2	2	2	1	2	2	1	1	2	1	3	1	3	2	32

Vertebrate fauna caught by trap type are shown in Table 3.

Table 3. Vertebrate fauna recorded by trap type

Taxa	Family	Species	Aluminium box trap	Bucket	Funnel	Pipe	Cage trap - Large	Total
Amphibian	Limnodynastidae	*Heleioporus eyrei*		2				2
		Heleioporus inornatus		1				1
	Myobatrachidae	*Crinia georgiana*		3		1		4
Mammal	Burramyidae	*Cercartetus concinnus*		28		38		66
	Dasyuridae	*Antechinus flavipes*	21	4	5	19		49
		Dasyurus geoffroii					12	12
		Sminthopsis gilberti		8		9		17
	Muridae	*Mus musculus*	7		1	5		13
	Peramelidae	*Isoodon fusciventer*					2	2
	Tachyglossidae	*Tachyglossus aculeatus*					1	1
Reptile	Agamidae	*Pogona minor*		5	1	3		9
	Carphodactylidae	*Underwoodisaurus milii*		2	5	6		13
	Diplodactylidae	*Diplodactylus lateroides*		6	4	3		13
		Diplodactylus polyophthalmus		1	1	1		3
	Elapidae	*Suta gouldii*			2			2
		Suta nigriceps		1	3			4
	Gekkonidae	*Christinus marmoratus*				1		1
	Pygopodidae	*Lialis burtonis*			1			1
	Scincidae	*Acritoscincus trilineatus*		20	28	11		59
		Cryptoblepharus buchananii		1	1	11		13
		Egernia napoleonis	1	3	13	3		20
		Hemiergis initialis		9	2	4		15
		Lerista distinguenda		22	3	29		54
		Lerista elegans		5				5
		Menetia greyii		15		17		32
		Morethia obscura		21	38	21		80
		Tiliqua rugosa			1		2	3
	Typhlopidae	*Anilios australis*		2	2	4		8
	Varanidae	*Varanus gouldii*					8	8
		Varanus rosenbergi					7	7
		Total	29	159	111	186	32	517

Vertebrate fauna recorded by camera traps are shown in Table 4.

Table 4. Camera trap results

			Camera trap numbers																							
Taxa	Family	Species	CM1	CM2	CM3	CM4	CM5	CM6	CM7	CM8	CM9	CM10	CM11	CM12	CM13	CM14	CM15	CM16	CM17	CM18	CM19	CM20	CM21	CM22	CM23	CM24
Bird	Artamidae	*Strepera versicolor*	1													1	1									
	Casuariidae	*Dromaius novaehollandiae*		1																						
	Columbidae	*Phaps elegans*	2			1									1											
Mammal	Dasyuridae	*Antechinus flavipes*											1		1											
		Dasyurus geoffroii															1	1								
	Felidae	*Felis catus*													1											
	Macropodidae	*Macropus fuliginosus*	1		1	2		1		1			1		3	1	3	2		2	2	1		1	1	1
		Notamacropus irma											1	1	2											
		Setonix brachyurus									1	1	1	2	1											
	Muridae	*Mus musculus*	1																							
		Rattus rattus	1		1					1						1						1				
	Peramelidae	*Isoodon fusciventer*										1							1	1				1		1
	Suidae	*Sus scrofa*	1	1	2		4	3	1	2																
	Tachyglossidae	*Tachyglossus aculeatus*	1			1																				
Reptiles	Varanidae	*Varanus rosenbergi*	1																							

3.1 SIMILARITY AMONG SURVEY SITES

Survey site similarity (or difference) was determined using two metrics; PCA and Morisita-Horn similarity index.

For the PCA analysis, the PCAs 1 and PCAs 2, and PCAs 1 and PCAs 3 are plotted, and the eigenvalues and percent variance accounted by these PCAs are shown in Table 5.

Table 5. Percent variance and eigenvalues for the PCA

Value	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11
Eigenvalue	5.94	4.18	3.22	2.80	2.24	1.83	1.51	1.23	1.09	0.56	0.42
% of Variance	23.76	16.73	12.86	11.21	8.96	7.33	6.03	4.91	4.35	2.22	1.66
Cum. %	23.76	40.48	53.34	64.56	73.51	80.84	86.86	91.77	96.12	98.34	100.00

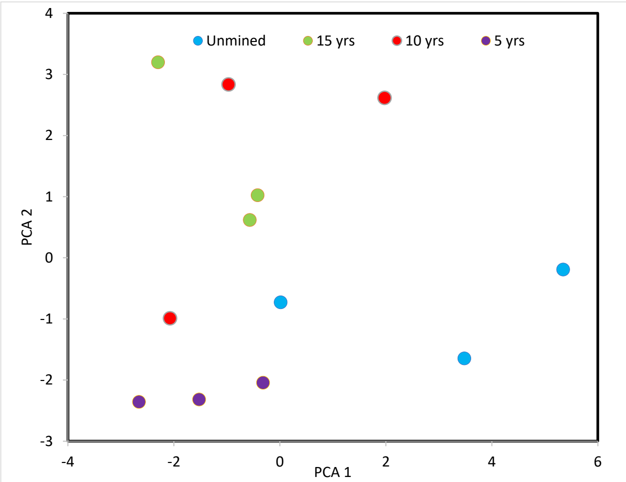

Chart 1. PCAs 1 and 2

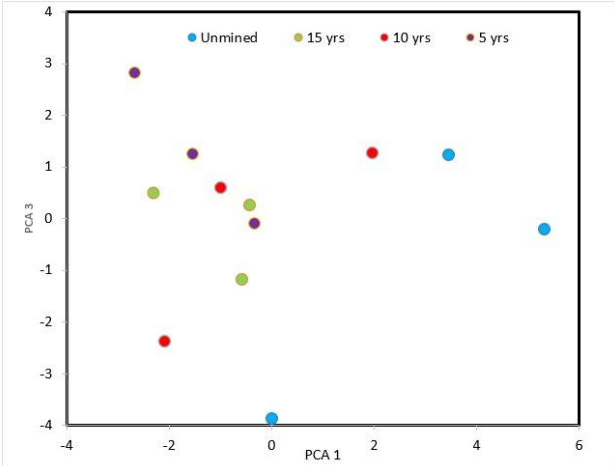

Chart 2. PCAs 1 and 3

The Morisita-Horn index provides an indication of the similarity of the fauna assemblage among sites (Table 6).

Table 6. Morisita-Horn index for 12 sites

	Sites	2	3	7	8	12	4	5	6	9	10	11
Sites		Unmined	Unmined	15	15	15	10	10	10	5	5	5
1	Unmined	**0.814**	0.410	0.344	0.500	0.269	0.232	0.378	0.540	0.547	0.177	0.344
2	Unmined		0.523	0.383	0.565	0.427	0.236	0.613	0.659	0.521	0.147	0.317
3	Unmined			0.330	0.317	0.368	0.710	0.513	0.404	0.290	0.226	0.116
7	15-years				**0.947**	**0.864**	0.500	0.439	**0.904**	0.276	0.229	0.388
8	15-years					**0.830**	0.418	0.506	**0.960**	0.392	0.282	0.487
12	15-years						0.568	0.707	**0.844**	0.304	0.180	0.364
4	10-years							0.486	0.438	0.459	0.352	0.316
5	10-years								0.619	0.396	0.265	0.432
6	10-years									0.466	0.258	0.512
9	5-years										0.331	0.645
10	5-years											0.634

*Cells in bold have a similarity greater than 0.75

3.2 SPECIES ABUNDANCE AND DIVERSITY

Species richness, Shannon Wiener index, Simpsons D index, Fishers' Alpha index and Smith and Wilsons B index are provided for each survey site and for all sites combined in Table 7.

Table 7. Diversity and abundance index scores

	Site #	Species richness	Shannon Wiener	Simpsons' D	Fishers' Alpha	Smith and Wilson B
Unmined	1	10	1.91	5.86	3.64	0.54
Unmined	2	13	2.22	8.19	4.89	0.56
Unmined	3	10	1.75	4.44	4.50	0.55
15-years	7	12	1.98	5.32	4.51	0.52
15-years	8	12	2.07	6.78	5.61	0.56
15-years	12	6	1.63	5.21	2.30	0.79
10-years	4	8	1.74	5.04	3.74	0.62
10-year	5	13	2.26	8.79	5.95	0.64
10-year	6	13	2.13	7.44	5.78	0.54
5-years	9	10	1.92	6.02	5.95	0.67
5-years	10	7	1.69	5.59	3.83	0.67
5-years	11	11	2.15	9.23	6.46	0.70
All		25	2.62	10.72	5.59	0.30

4. DISCUSSION

4.1 PIT, FUNNEL AND ALUMINIUM BOX TRAPS

It was anticipated that there would be similarity among the unmined sites in the vertebrate fauna assemblage and this would be reflected in a clustering of these sites in the graph of PCA 1 and PVA 2 (Chart 1) or PCA 1 and PCA 3 (Chart 2), which is not the case. The similarity index score for unmined sites 1 and 2 is relatively high (i.e. 0.81) but for sites 1 and 3 (i.e. 0.41), and 2 and 3 (0.52) there are differences. The most obvious differences were abundance of *Antechinus flavipes* (Plate 8), lower number of *Morethia obscura*, and less species and less individuals at unmined site 3 when compared with unmined sites 1 and 2.

Cryptoblepharus buchananii, *Egernia napoleonis* and *Lerista distinguenda* are species likely to be present and characterise climax assemblages, and should become evident as the rehabilitation programs progress. In this situation, their abundance appears uneven in the analogue sites and only *Lerista distinguenda* displays the anticipated pattern. If all unmined sites had a similar vertebrate fauna assemblage, then these data could collectively be used as the succession trajectory climax community, but given the differences, it begs the question if other unmined sites in the northern Jarrah forest were surveyed, then how different would they be to the existing three unmined survey sites. The vertebrate data in Appendix C (excluding volant species) indicates that there are numerous other species (particularly skinks) that have been recorded in the broader Jarrah Forest that were not caught in the three unmined survey sites.

Rehabilitation sites that are 5-years old provide a good grouping on PCA 2 when compared with the other groups, but had a similar dispersed grouping on PCA 1, and the similarly index suggests sites 9 and 11, and 10 and 11 are more closely aligned than sites 9 and 10. Pioneering colonising species are the *Mus musculus*, *Menetia greyii* and *Morethia obscura* and species richness of 7-11 is less than for older rehabilitated sites.

Rehabilitation sites that are 10-years old show an increase in species richness for two sites (i.e.13, 13 and 8), with sites well spread on PCA 1, but two sites are reasonably similar of PCAs 2 and 3 (Charts 1 and 2). The Morisita-Horn similarity index scores were low, reflecting the information provided by the PCAs. Small mammals are starting to colonise the 10-year rehabilitation sites, with an abundance of *Cercartetus concinnus* (Plate 9) at one site, which almost certainly reflects the abundance of suitable flowering plants. *Pogona minor* is a recognised early colonising reptile (Thompson and Thompson 2003, Thompson and Thompson 2007a) and *Acritoscincus trilineatus, Morethia obscura* and *Lerista distinguenda* were relatively abundant at two of the sites and widespread throughout the Jarrah Forest. As widely foraging species they have a greater propensity to colonise new areas than species with defined home ranges and high site fidelity.

Plate 8. Mardo

Plate 9. Western pygmy possum

Two of the rehabilitation sites that are 15-years old had a species richness of 12 and the other site had 6 recorded species, and this is reflected in the diversity scores. Two of these 15-year old sites grouped on PCA 1 and PCA 2 (Chart 1). A different two 15-years old rehabilitation sites also grouped closely on PCA 3 and also with two unmined sites (Chart 2).

These data might suggest it was more than one or two species contributing to the difference between unmined and 15-year old rehabilitation sites in the vertebrate fauna assemblage. *Cercartetus concinnus* were abundant at two sites and *Acritoscincus trilineatus* and *Morethia obscura* were abundant at all three sites. In the Goldfields we have observed substantial seasonal variability in the catch rate of *Cercartetus concinnus*, but the reason is not clear (Thompson 2004).

4.2 TRAP TYPES

Aluminium box traps mostly caught *Antechinus flavipes* and *Mus musculus*, and buckets, pipes and funnel traps caught most reptiles. Because buckets, pipes and funnel traps also caught *Antechinus flavipes* and *Mus musculus,* the aluminium box traps inflated the number of these two species caught in the trapping programs in the 12 survey sites compared with other species that did not enter these traps. As shown by Thompson and Thompson (2007b) bucket and pipe pit-traps are far superior at catching small mammals compared with funnel traps, and overall, pipe pit-traps recorded more individuals than bucket pit-traps followed by funnel traps (Table 3). Because various trap types catch a different suite of vertebrate fauna, each trap type introduces a bias into the dataset when analysed using diversity, similarity and PCA methods.

4.3 CAGE TRAPS

Cage traps were deployed to target terrestrial vertebrate fauna unlikely to be caught in pit, funnel and aluminium box traps, and were placed at locations where Chuditch had previously been recorded. The use of chicken necks as bait, restricted the range of animals likely to be caught to mostly carnivores, but it was noted that two Quenda were caught, but they are often caught using sardines. Twelve Chuditch were caught in baited cage traps (i.e. #41, 42, 44, 45, 61, 63, 74, 76 and 78). Cage traps 44, 61, 63, 74, 76 and 78 were all in unmined areas, and traps 41 and 42 were in areas rehabilitated in 2004 (i.e. 18 years old). Although cage traps were not deployed across all rehabilitation areas, these data might suggest that Chuditch are mostly confined to unmined and old rehabilitation areas. Placing cage traps in a wider range of aged rehabilitation areas would provide a better indication of their use of rehabilitated areas. The use of selective trapping sites indicated that Chuditch were present in the mined Jarrah Forest, but no indication of their relative abundance nor preferred habitats, which would be useful data if conservation programs for this species were to be planned and implemented.

4.4 CAMERA TRAPS

Camera traps target the larger vertebrate species and those unlikely to be caught in other types of traps. The Western Grey Kangaroo is clearly abundant in the areas that camera traps were deployed, and because of their large home ranges, they are likely to be widespread in the Jarrah Forest. Only two Chuditch (Plate 10) were recorded compared to 12 in cage traps, but this difference is probably largely due to where camera and cage traps were deployed. Quenda (Plate 13) were recorded in two of the three camera trapping locations. The Western Brush Wallaby (Plate 12) was recorded in one of the camera trapping areas (i.e. camera #11, 12 and 13). Quokkas (Plate 11) were recorded in one of the three camera trapping areas (i.e. #9, 10, 11, 12, 13).

Of concern was the abundance of pigs recorded by camera traps (#1, 2, 3, 5, 6, 7, 8) and these were all in the same location. One pig had an ear tag (Plate 15) suggesting that pig-hunters were using this pig in some type of competition to capture a 'marked' pig.

Plate 10. Chuditch

Plate 11. Quokkas

Plate 12. Western Brush Wallaby

Plate 13. Quenda

4.5 CONSERVATION SIGNIFICANT SPECIES

Two conservation significant species (*Setonix brachyurus* and *Dasyurus geoffroii*) and two priority species (*Notamacropus irma* and *Isoodon fusciventer*) were recorded in the survey. The Quokka and Western Brush Wallaby were in the same area, and one of the Quenda records was in this area, but most were in another area. Given that both *Setonix brachyurus* and *Dasyurus geoffroii* are listed as vulnerable under Commonwealth and State conservation legislation, where resources are available these species should be given a higher priority for protection and long-term conservation than the more abundant species that are widespread in the Jarrah Forest.

4.6 PEST AND PREDATOR SPECIES

A single feral cat (Plate 14) was recorded, and of concern it was in the area where Quokkas were recorded. No foxes were recorded, but a small number of Black Rats were recorded on camera traps but not in cage traps, possibly because of the bait used in these traps, and House Mice were caught in aluminium box, pipe and funnel traps. Pigs (Plate 15) are progressively becoming widespread in the Jarrah Forest and are considered a pest species because of the environmental damage they do particularly around creeks and in the denser vegetation. Pigs can also do significant damage to water courses and introduce disease into drinking water catchments. There is an obvious need to reduce or eliminate pigs from the Alcoa managed Jarrah Forest.

Plate 14. Feral cat

Plate 15. Pig with ear tag

5. SUMMARY AND CONCLUSIONS

The survey data indicated that the three unmined sites selected as analogue climax communities for the rehabilitation areas are not similar, and there are appreciable differences among the fauna assemblages within aged classes of rehabilitation.

5.1 SUCCESSION AND ON TARGET TO A CLIMAX FAUNA COMMUNITY

Based on the available data, there are two alternative conclusions that can be reached about succession of rehabilitated areas along a trajectory to a climax community:

- differences among the unmined areas makes it difficult to determine what is the target climax community, and it is possible there are other alternative Jarrah Forest communities that have not been sampled that would better represent climax communities that will eventuate in rehabilitated areas; or
- rehabilitation programs are not of sufficient quality to enable the mammal, reptile and amphibian assemblages in unmined area to recolonise rehabilitated areas within a 15-year period sufficient to clearly indicate they are on a trajectory toward establishing analogue climax communities.

If there is no one target climax community valid for all rehabilitation areas because the vertebrate fauna assemblage in the Alcoa mined Jarrah forest is variable, then the current survey methodology is unlikely to provide evidence that the fauna assemblages in the rehabilitated areas are within the expected trajectory to reach the analogue climax community. This issue can be partially addressed by redesigning the survey protocol and placing 'unmined' analogue survey sites in the unmined areas immediately adjacent to the rehabilitation areas. Given that the vertebrate fauna are most likely to colonise rehabilitation sites from the adjacent areas, this approach would provide the maximum opportunity for the vertebrate fauna assemblages in rehabilitated areas to be within expected trajectories toward climax communities. Variation from the expected trajectory would then most probably be a consequence of an inappropriate habitat (e.g. soils, vegetation and microbial activity, etc) in the rehabilitated areas instead of high variability in the analogue undisturbed site. Investigating and adjusting habitats in existing and future rehabilitation areas would be an obvious future task.

5.2 CONSERVATION SIGNIFICANT SPECIES

The presence of conservation significant species within the Jarrah forests that are being mined by Alcoa warrants attention. When mining in the area is completed there will remain many unmined areas, and with time many of the mined areas, irrespective of how they were rehabilitated will be progressing toward self-sustaining functional ecosystems, albeit possibly different to that which existed before mining. The scant data collected in this survey would suggest that conservation significant species are in higher densities in the unmined areas, compared to the rehabilitated areas. If further investigation confirms that this was the case, then a focus on the long-term preservation of conservation significant species, and in particular their use of rehabilitation areas should be a priority. This may mean developing a better understanding of the location and abundance of *Setonix brachyurus*, *Dasyurus geoffroii*, *Notamacropus irma* and *Isoodon fuscivente*r in the general mining area and putting in place appropriate targeted management and monitoring regimes for these species.

5.3 PEST SPECIES

It was pleasing not to record foxes during the camera trapping program and only a single feral cat, however, the area surveyed was very limited when viewed in the context of the extent of Jarrah Forest managed by Alcoa. Foxes and feral cats are significant predators on our native vertebrate fauna (Catling 1988, Woinarski et al. 2018, Murphy et al. 2019, Woolley et al. 2019, Woinarski et al. 2020, Woolley et al. 2020, Fleming et al. 2021, Woinarski et al. 2021) and are implicated in the decline or extinction of many of the critical weight range mammals, and in many circumstances are having a long-term greater impact on the vertebrate fauna assemblage than the mining operations. Therefore, resources allocated to feral cat and fox management may provide better long-term outcomes than spending huge resources on fine-turning rehabilitation programs to achieve analogue climax communities. A better understanding and appreciation of foxes and feral cats in the Alcoa mining areas is an obvious starting point for implementing management programs.

The localised abundance of feral pigs is of concern. Feral pigs are known to cause serious damage to ecosystems, biodiversity, fauna habitats, water sources and agricultural assets (National Feral Pig Action Plan Steering Group 2021), and in addition, they pose a biosecurity and disease risk to Australia. Alcoa is urged to develop and implement a feral pig management program within the Jarrah Forest under its stewardship.

5.4 REPEATING THIS SURVEY

To understand whether rehabilitated areas are moving along an established trajectory toward an analogue climax vertebrate fauna community, requires an understanding of what constitutes the climax vertebrate fauna community and the trajectory. Monitoring is then undertaken so that existing rehabilitated areas might be amended where that is feasible and planning for new areas is adjusted based on experience and monitoring results.

If Alcoa are not achieving the desired fauna outcomes, then it may have to revisit its rehabilitation programs which are probably tuned to its completion criteria that are largely based on the abundance of eucalypt stems in rehabilitated areas (Australian Government 2016) and may not be particularly focussed on recreating suitable fauna habitat.

It is suggested that this monitoring program is reviewed before the survey is repeated, with particular attention to:

- the fauna target(s) as represented by the rehabilitation trajectory and intended climax community(ies);
- survey design (e.g. location of analogue sites);
- use of camera traps to determine presence vs relative abundance or conservation significant fauna; and
- value-for-money of surveys, when compared with the alternative uses of these resources to achieve a similar objective(s) (e.g. the long-term preservation of conservation significant species, and in particular their use of rehabilitation areas).

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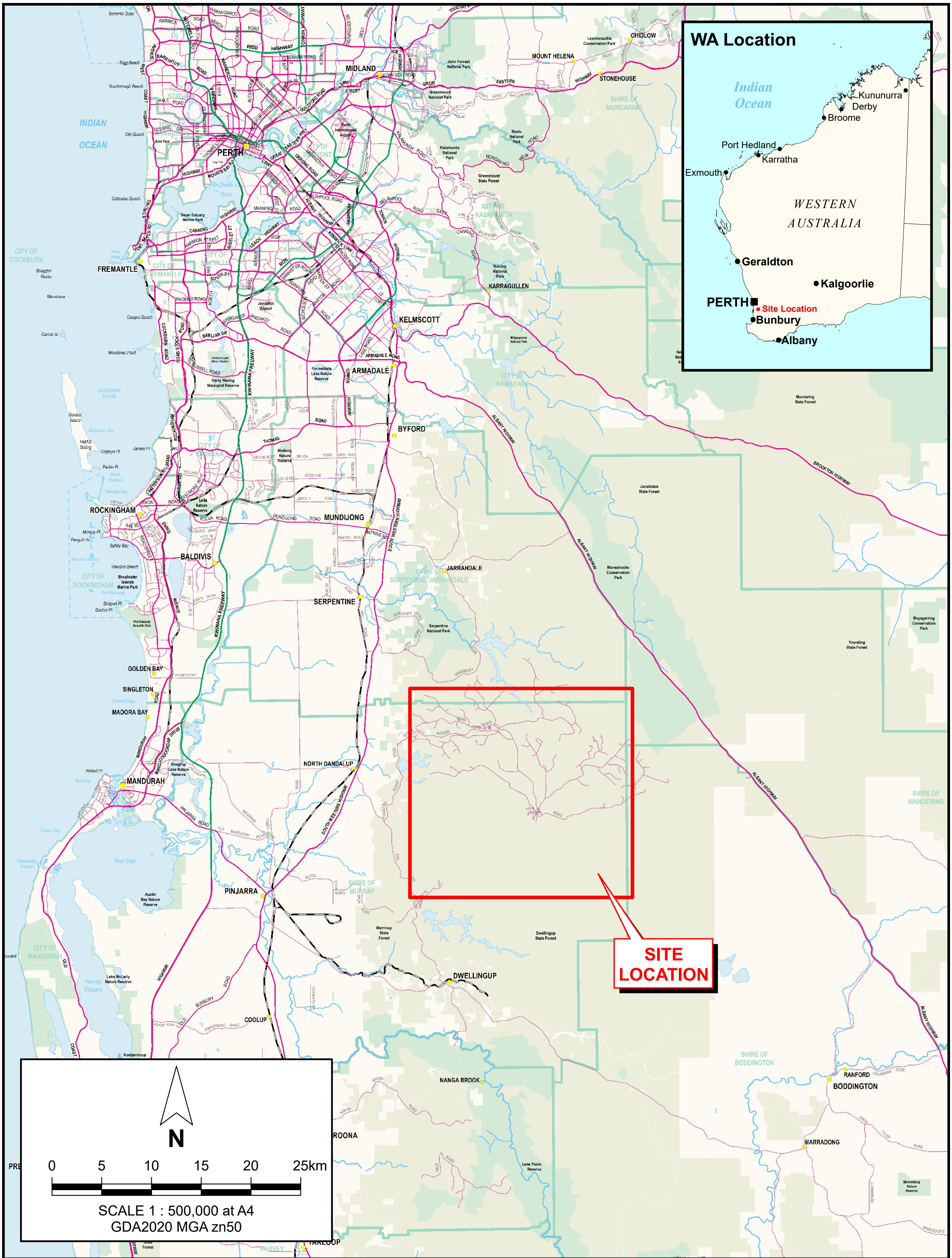
Figures

Baseline Monitoring of Rehabilitation Programs
Alcoa's Bauxite Mining Areas



TERRESTRIAL ECOSYSTEMS

Drawn: S. Thompson | Date: 30 May 2023

Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

REGIONAL LOCATION

Figure 1

Job: 2022-0087

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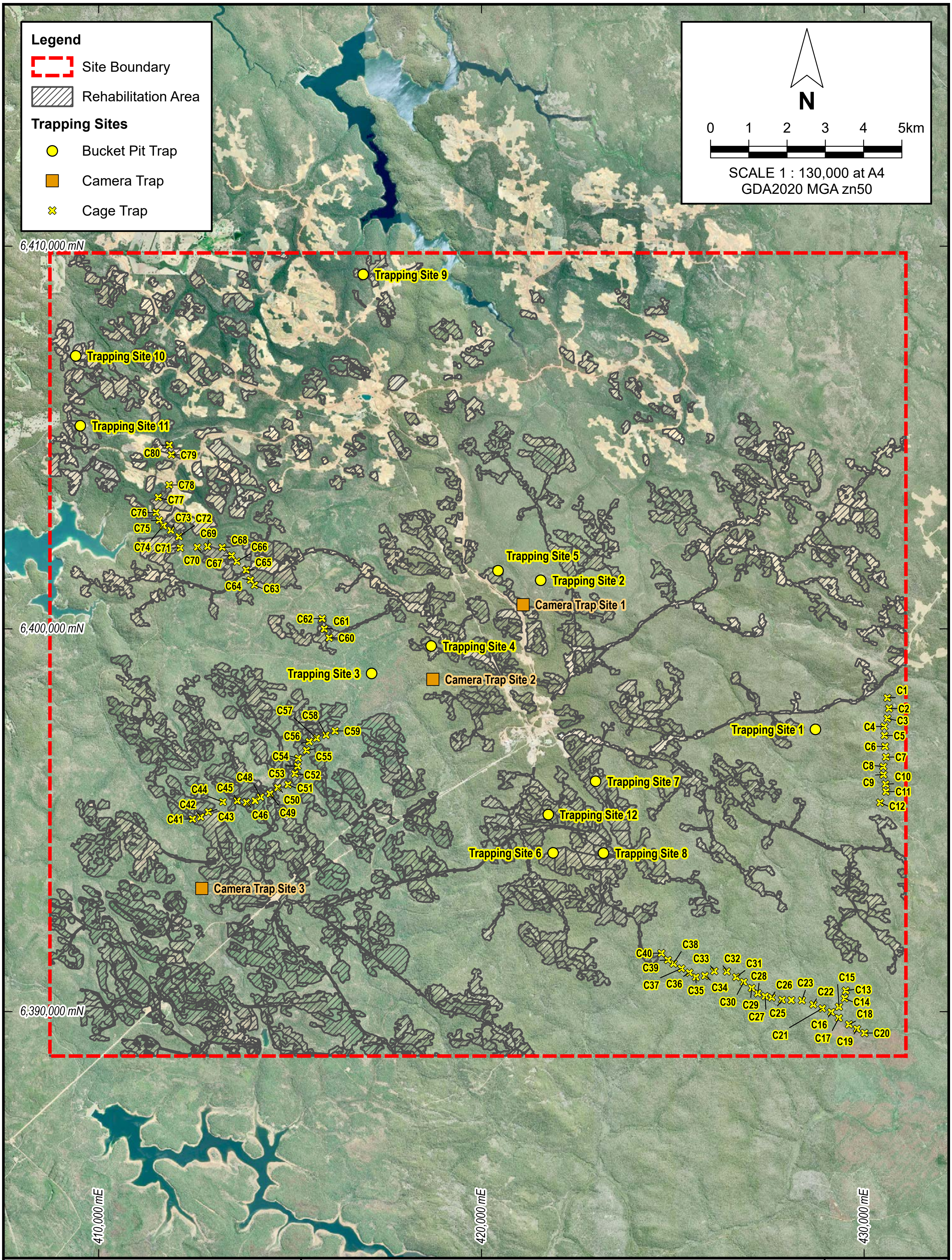

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TERRESTRIAL ECOSYSTEMS		Alcoa of Australia Ltd BASELINE MONITORING OF REHABILITATION PROGRAMS IN ALCOA'S BAUXITE MINING AREAS	Figure 2
		PROJECT AREA	
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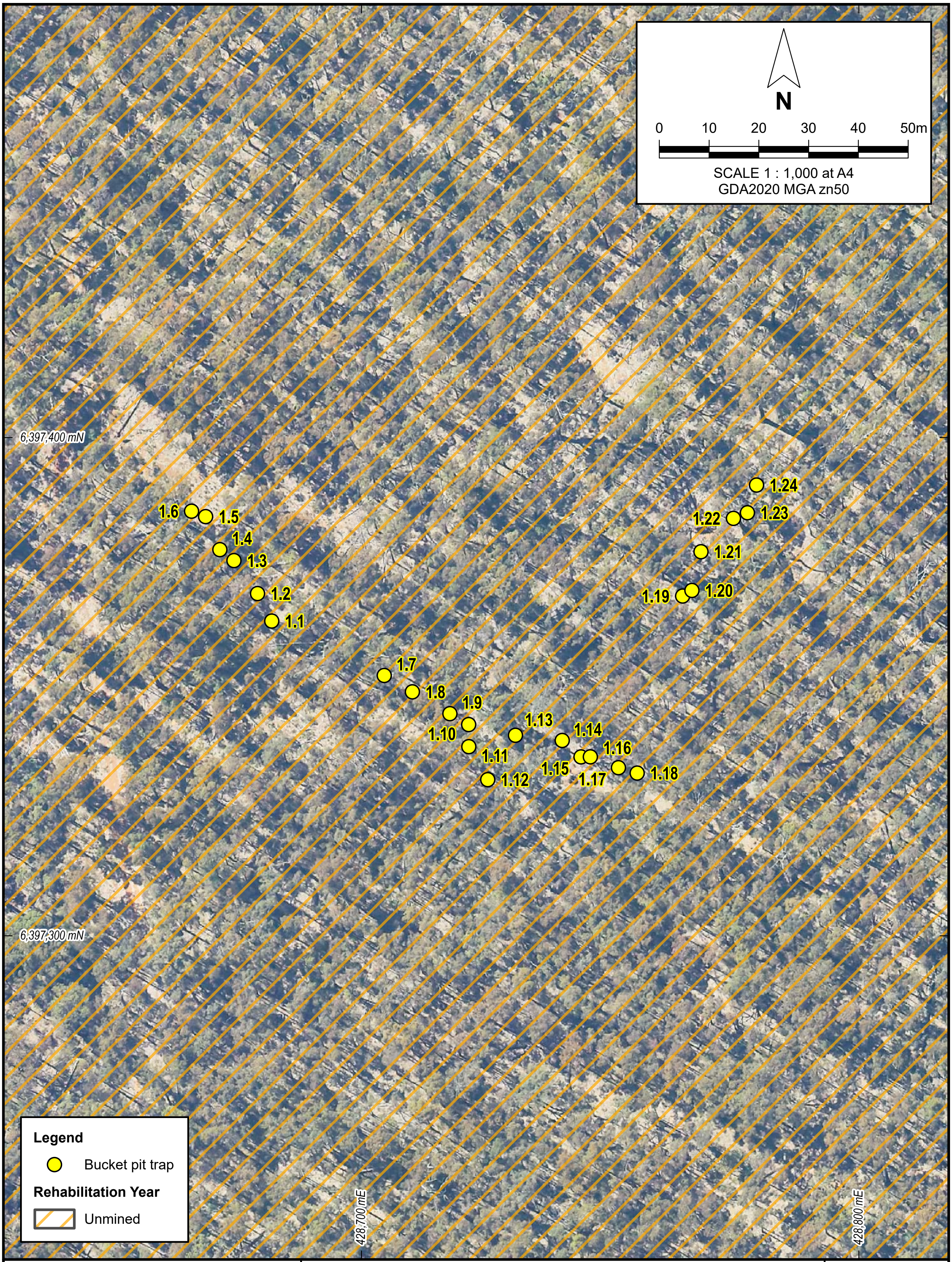

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TERRESTRIAL ECOSYSTEMS

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BASELINE MONITORING OF REHABILITATION PROGRAMS IN ALCOA'S BAUXITE MINING AREAS

Figure 3

PIT TRAP LOCATIONS - TRAP SITE 1

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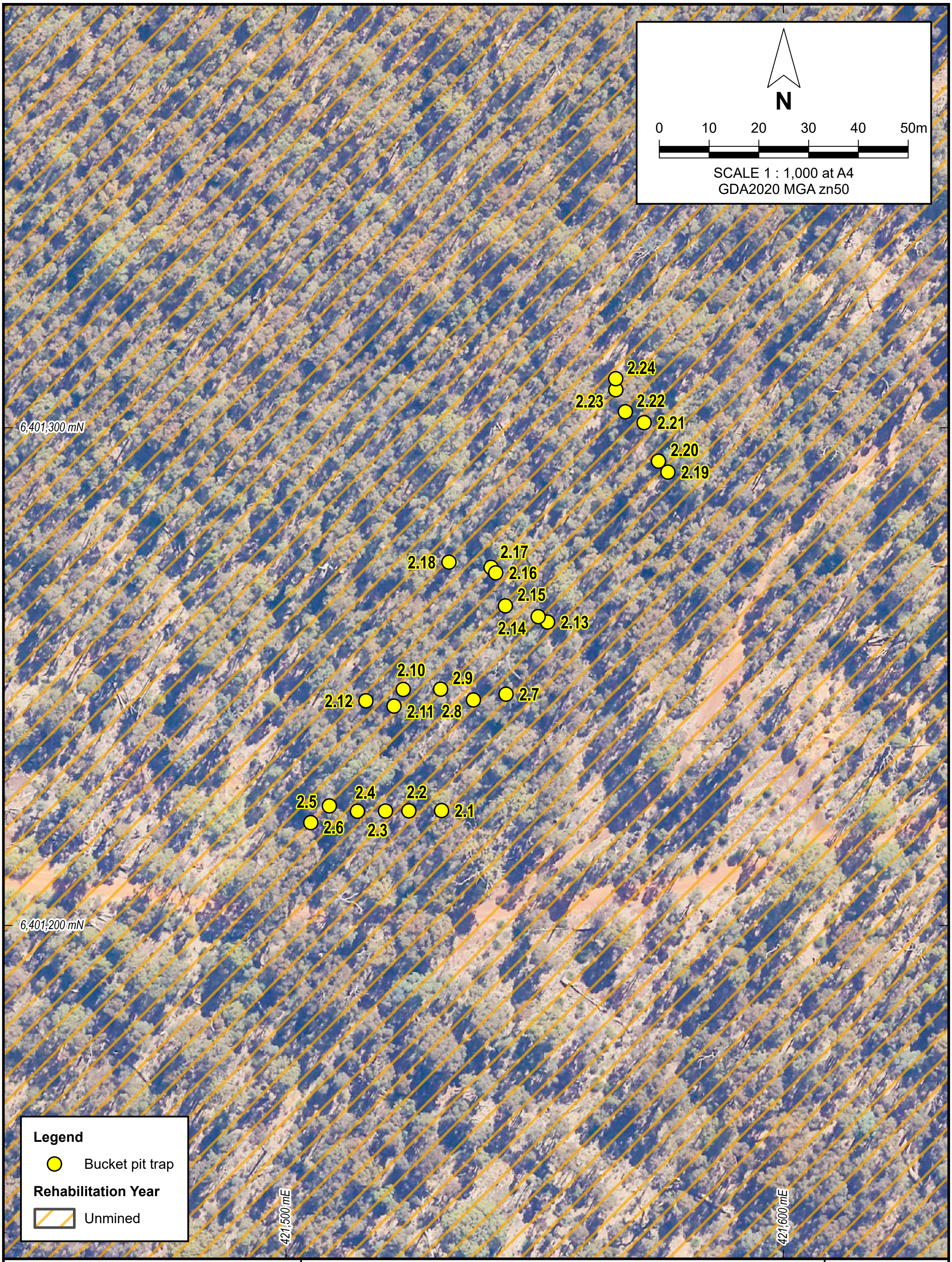

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Figure 4

PIT TRAP LOCATIONS - TRAP SITE 2

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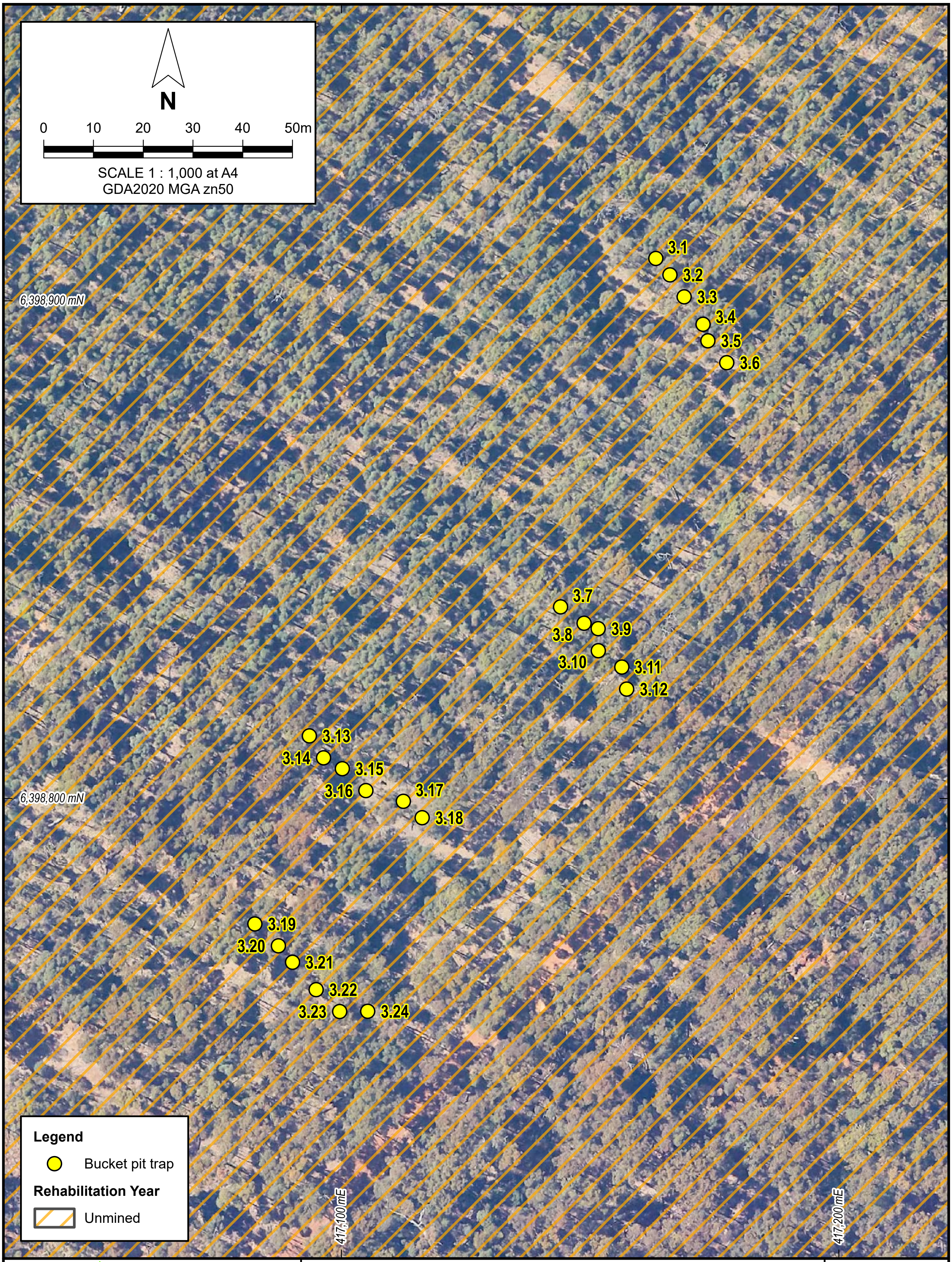

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Figure 5

PIT TRAP LOCATIONS - TRAP SITE 3

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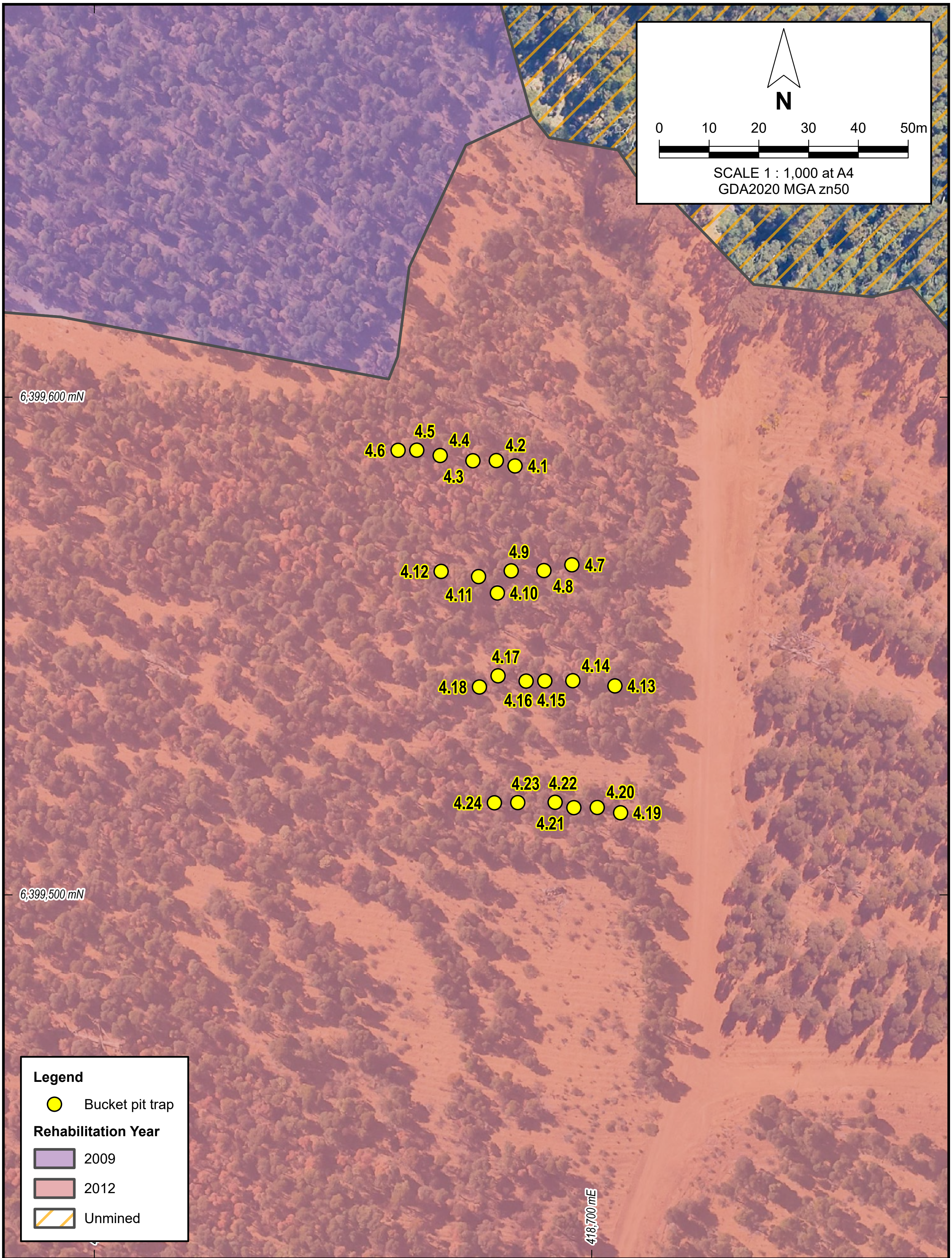

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IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 4

Figure 6

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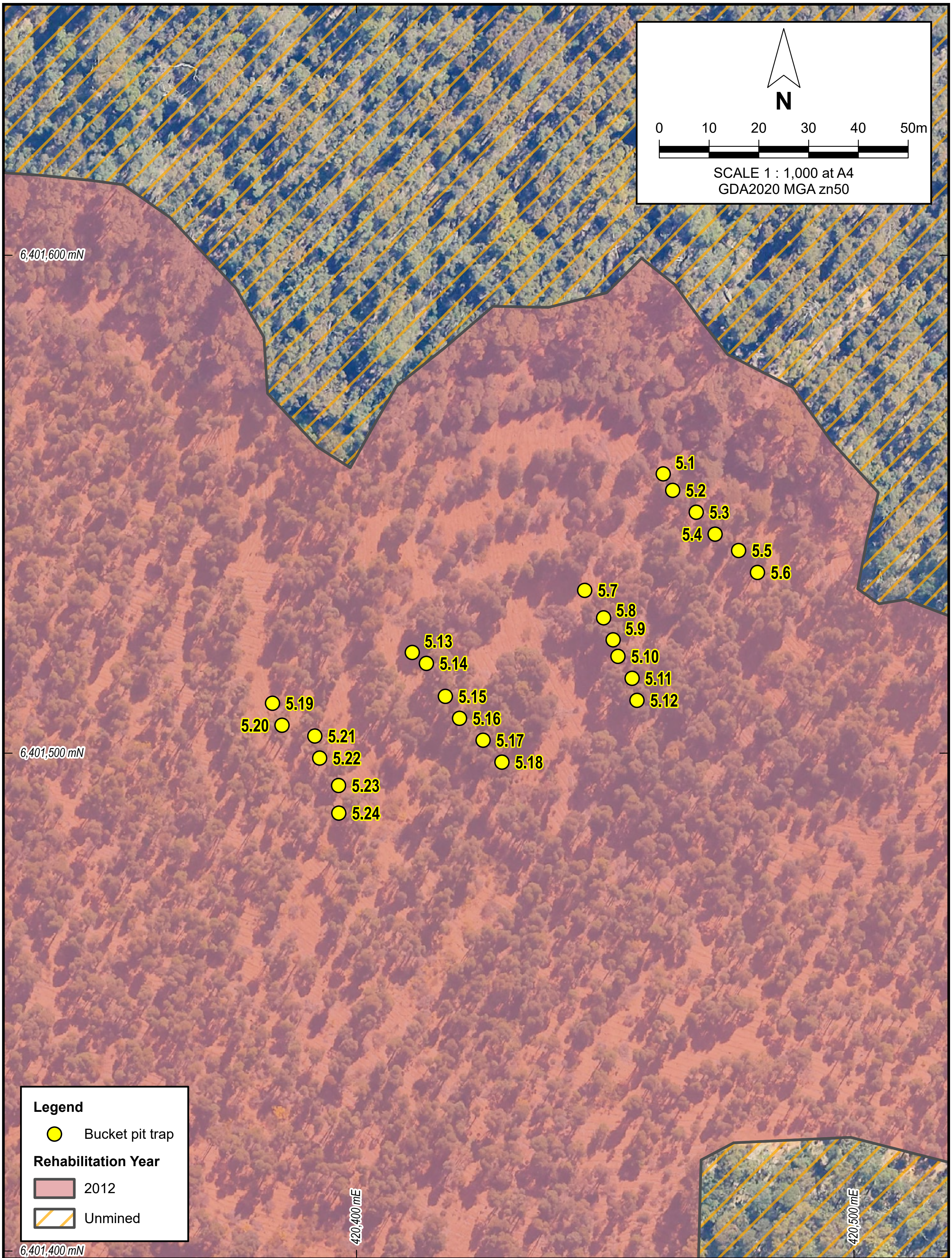

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IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 5

Figure 7

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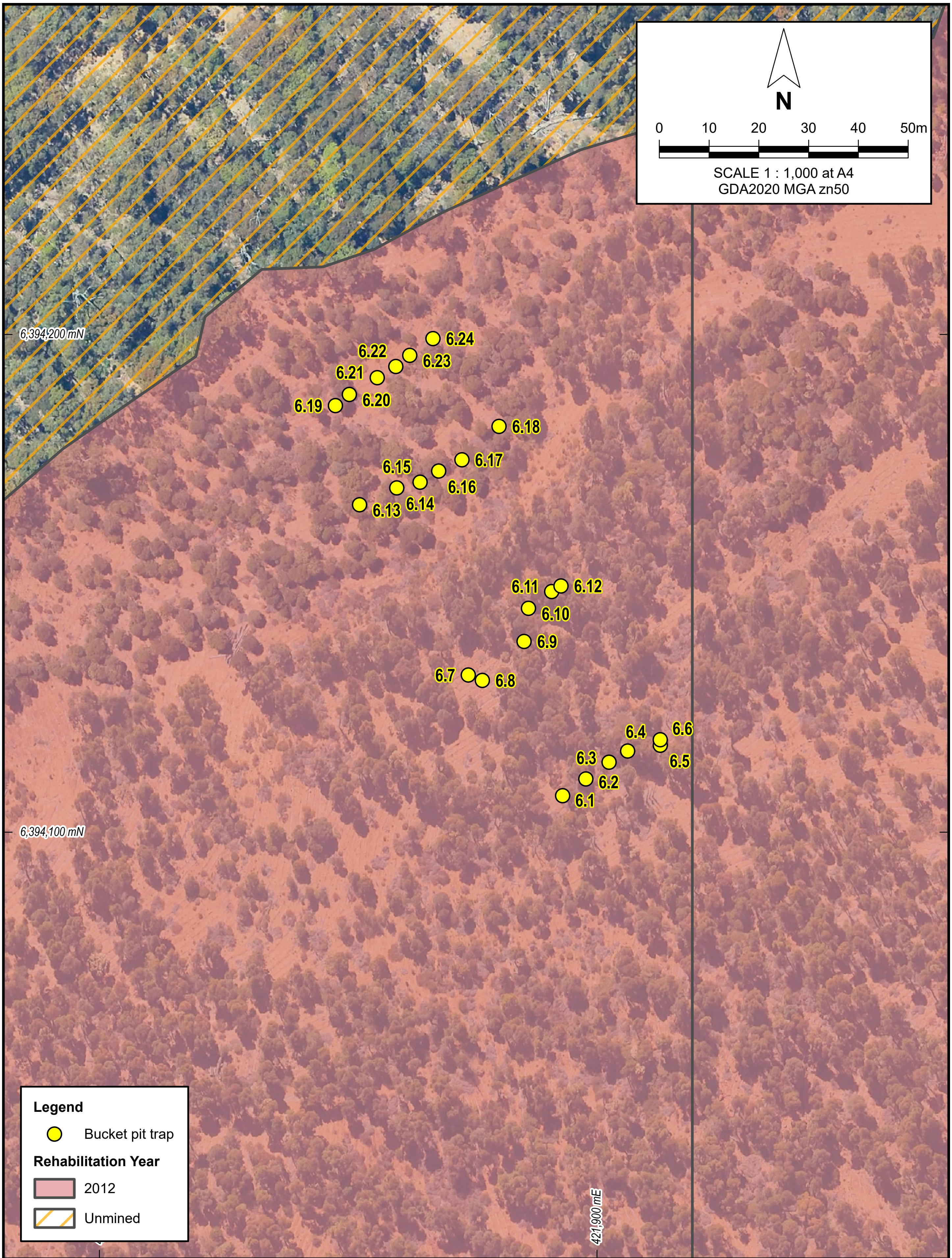

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IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 6

Figure 8

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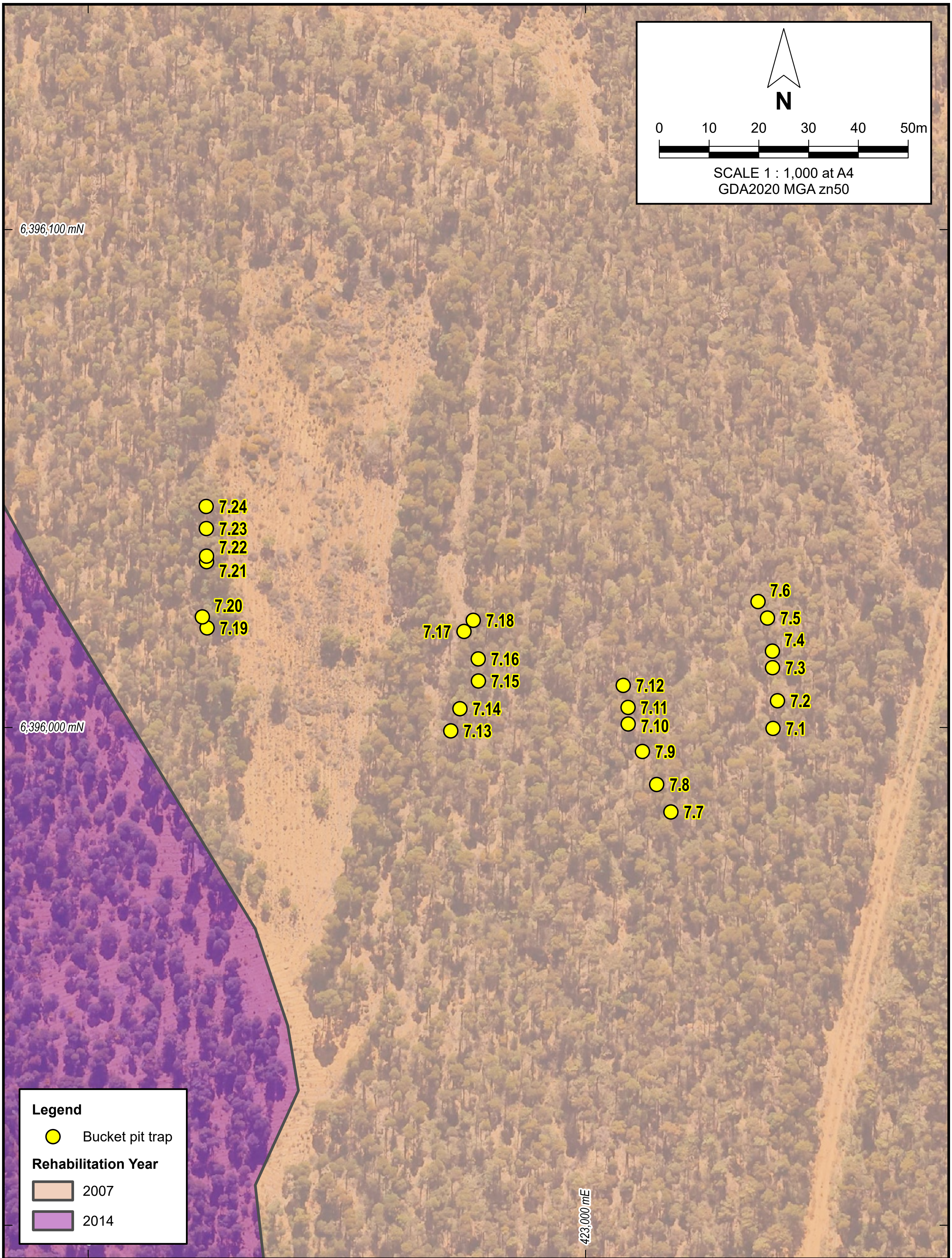

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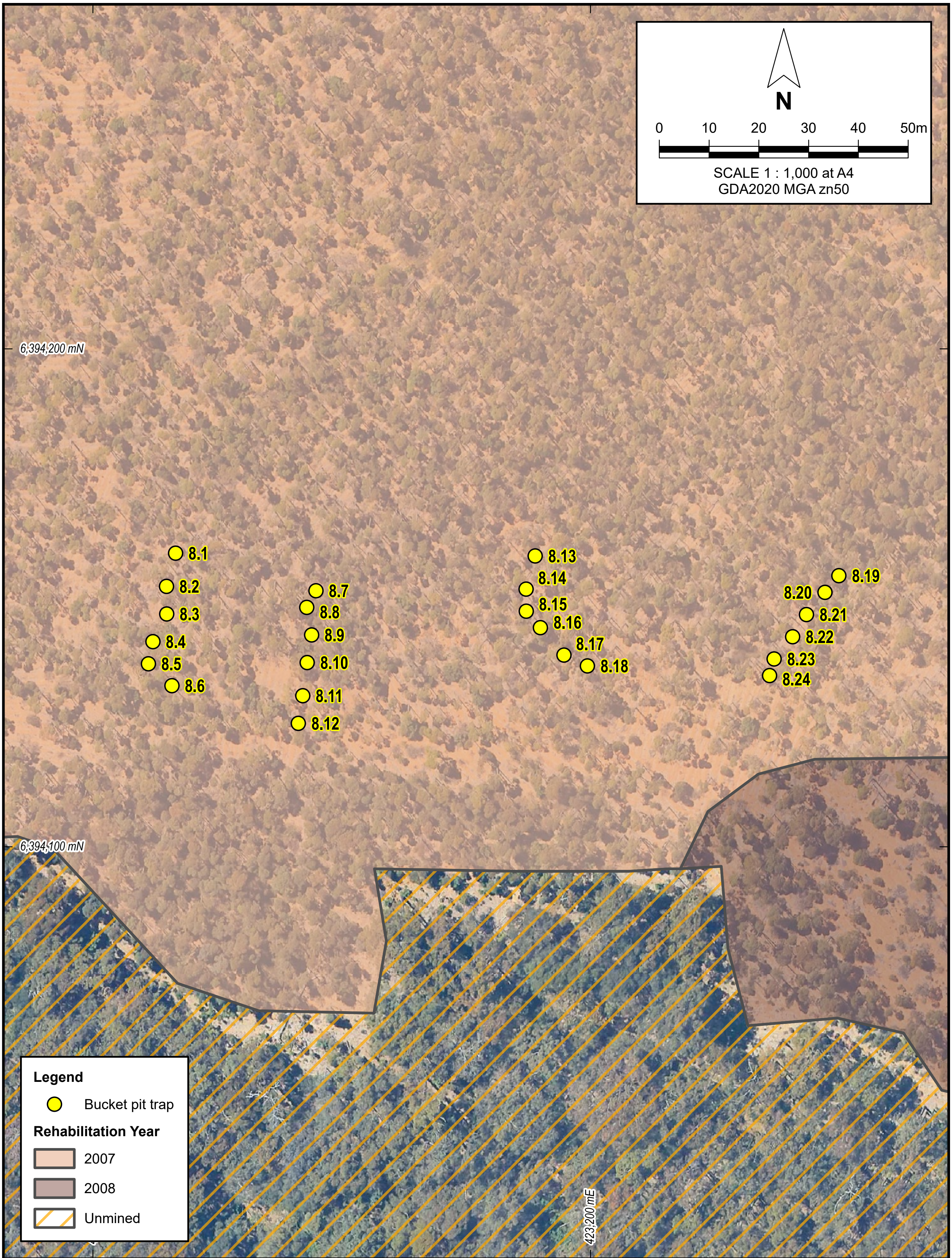
IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 7

Figure 9

Job: 2022-0087



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TERRESTRIAL ECOSYSTEMS

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Figure 10

PIT TRAP LOCATIONS - TRAP SITE 8

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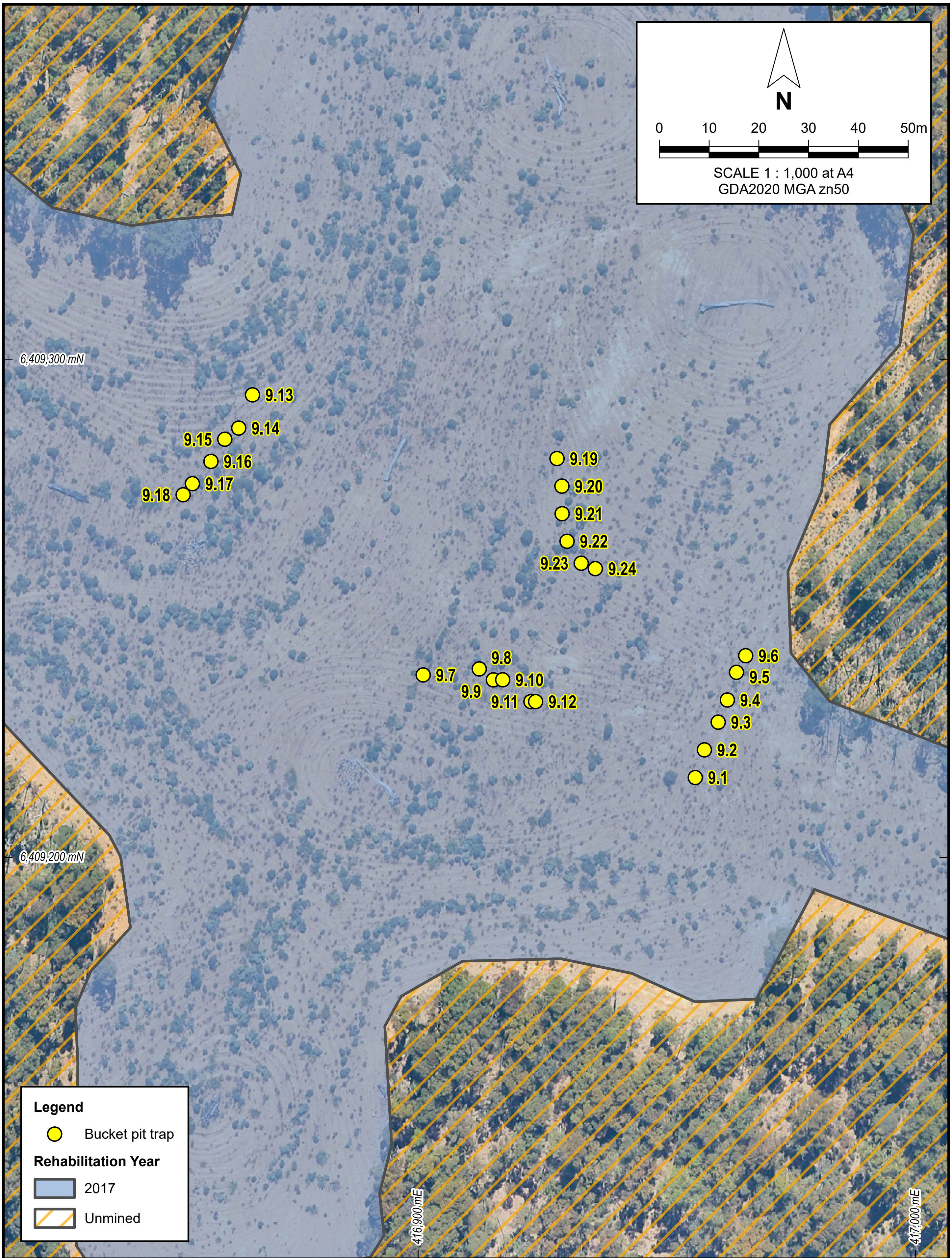

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TERRESTRIAL ECOSYSTEMS

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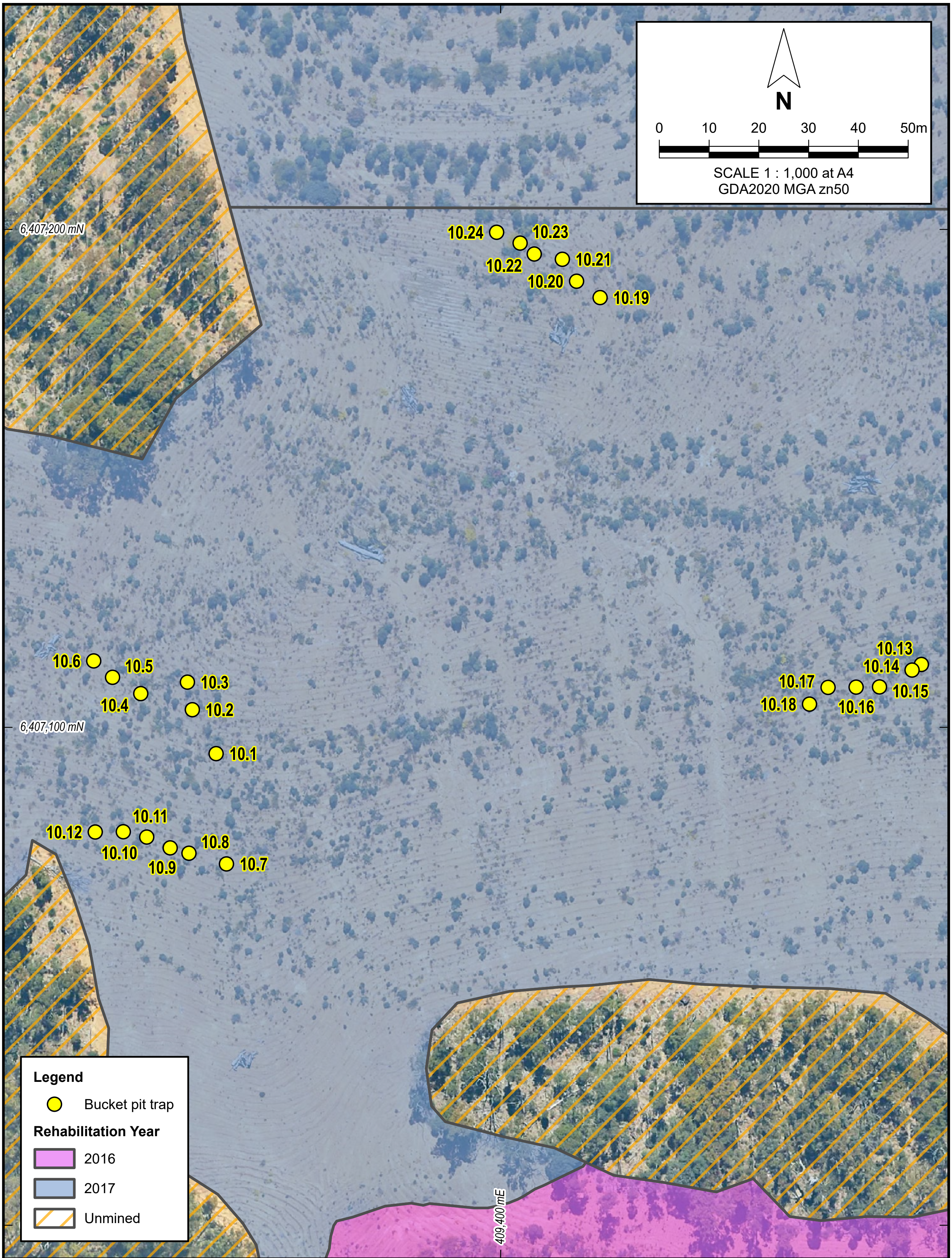
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 9

Figure 11

Job: 2022-0087



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TERRESTRIAL ECOSYSTEMS

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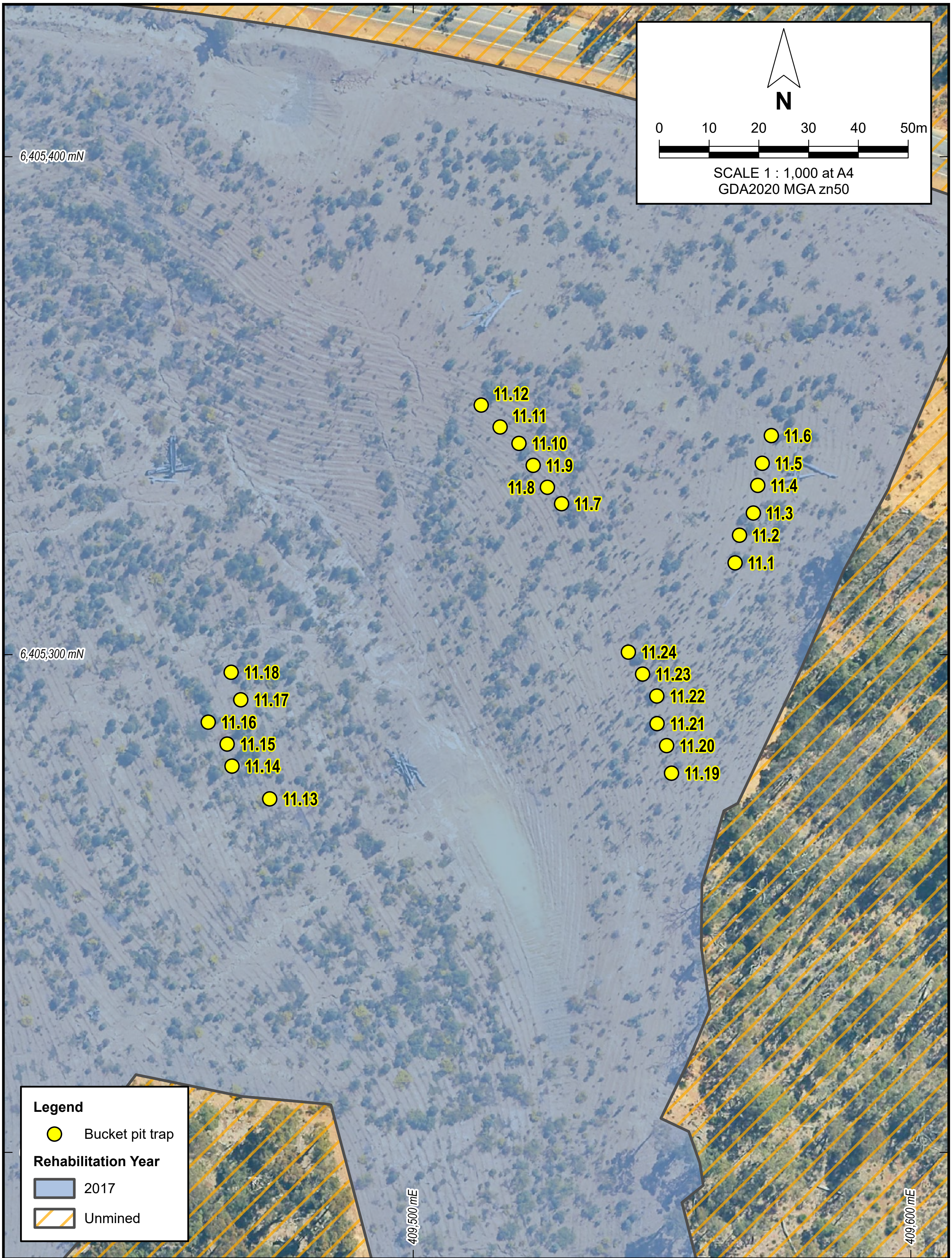
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

Figure 12

PIT TRAP LOCATIONS - TRAP SITE 10

Drawn: S. Thompson | Date: 30 May 2023 | Job: 2022-0087



PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0087.mxd

TERRESTRIAL ECOSYSTEMS

Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

Figure 13

PIT TRAP LOCATIONS - TRAP SITE 11

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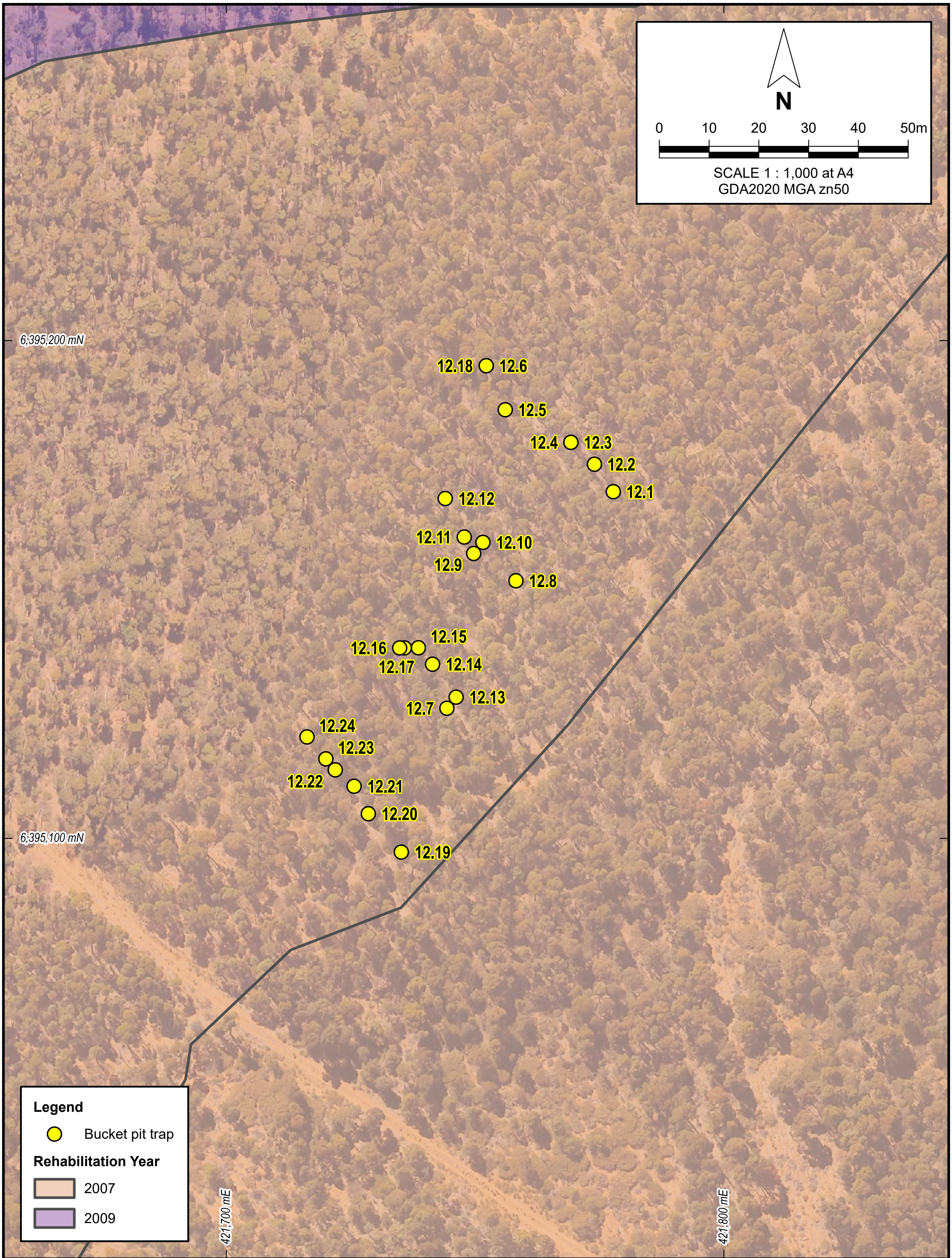

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TERRESTRIAL ECOSYSTEMS

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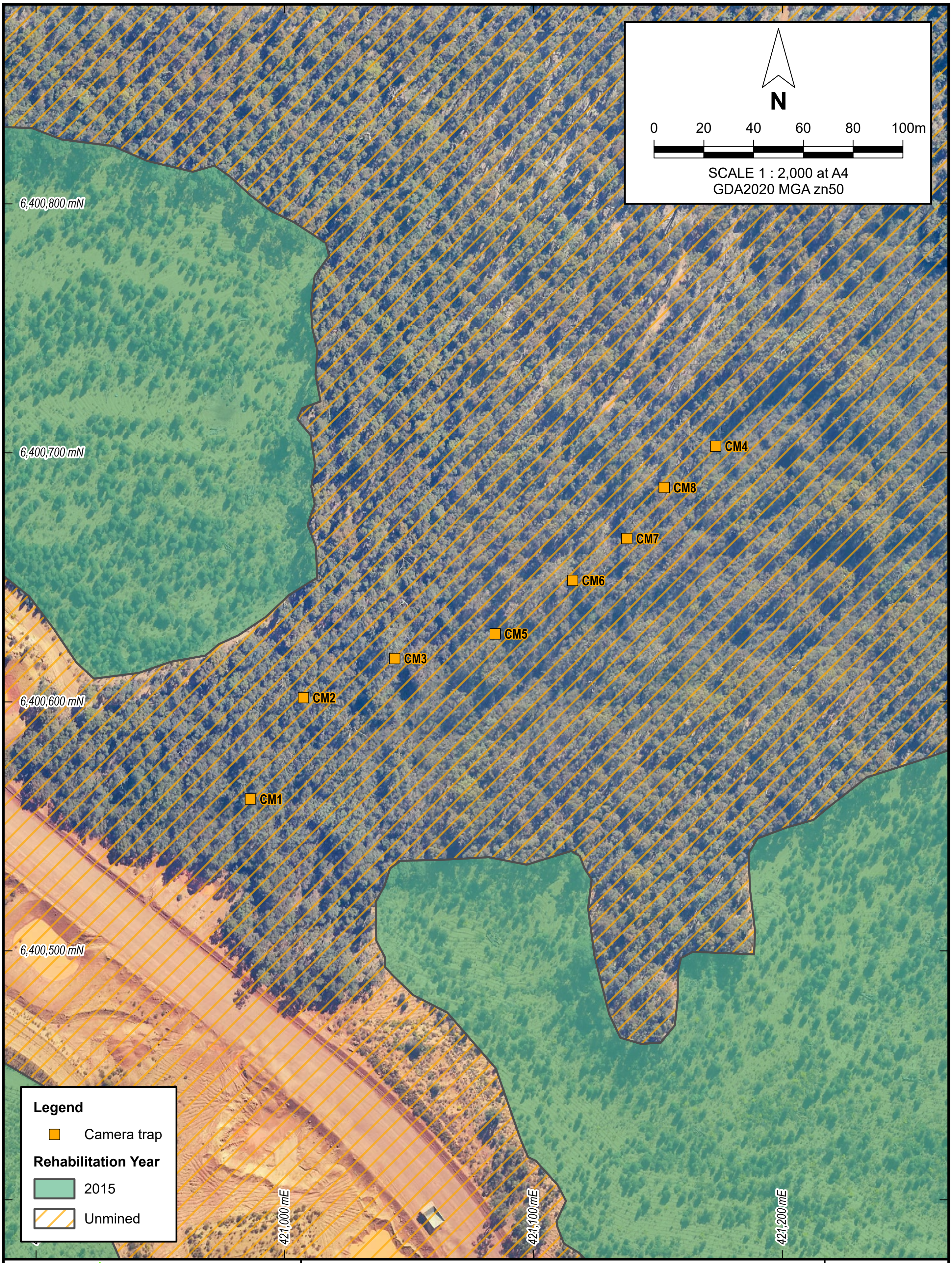
IN ALCOA'S BAUXITE MINING AREAS

PIT TRAP LOCATIONS - TRAP SITE 12

Figure 14

Job: 2022-0087



Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

Figure 15

TERRESTRIAL ECOSYSTEMS

CAMERA TRAP LOCATION - SITE 1

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TERRESTRIAL ECOSYSTEMS

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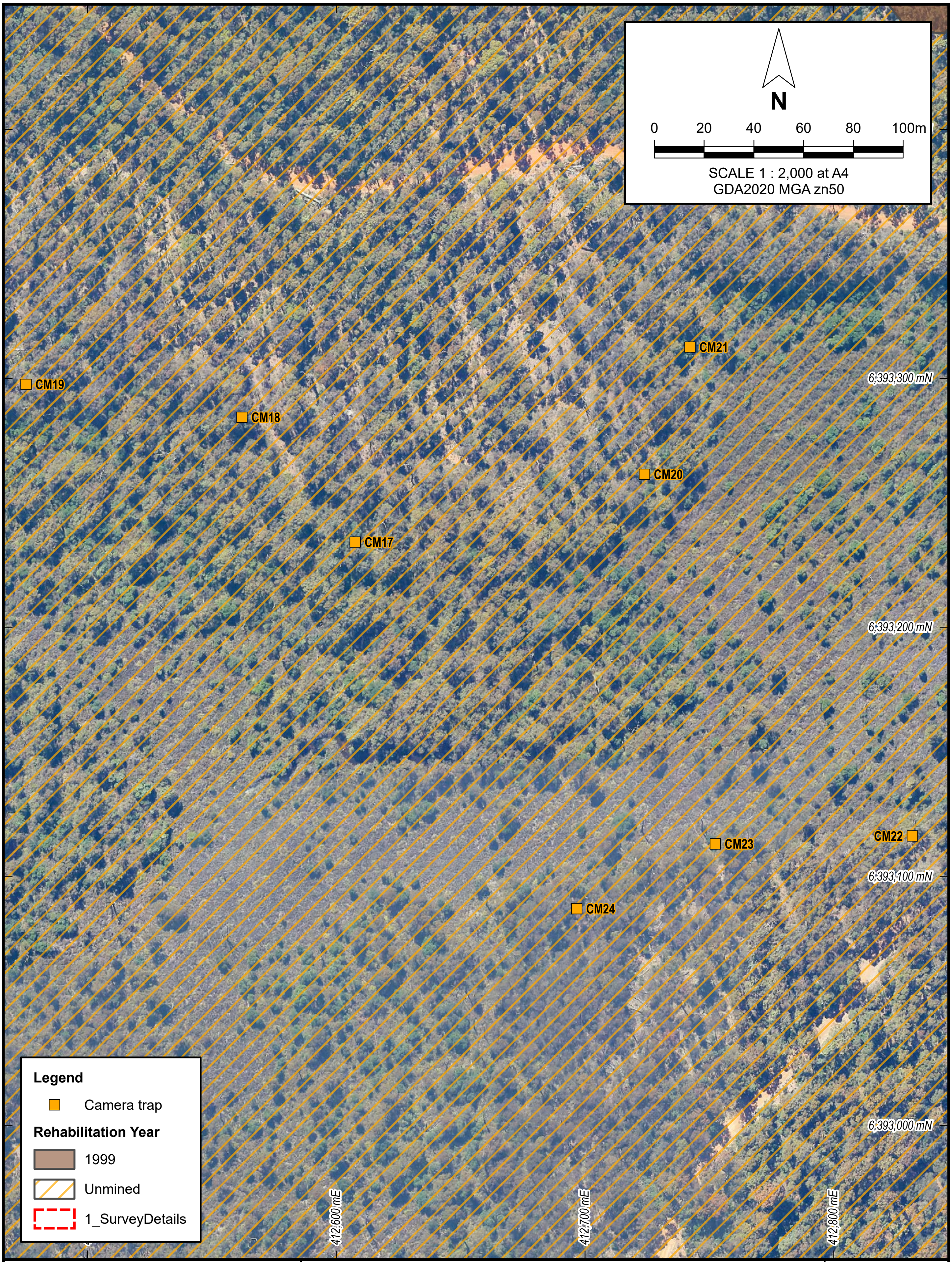
IN ALCOA'S BAUXITE MINING AREAS

CAMERA TRAP LOCATION - SITE 2

Figure 16

Job: 2022-0087



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TERRESTRIAL ECOSYSTEMS

Drawn: S. Thompson | Date: 30 May 2023

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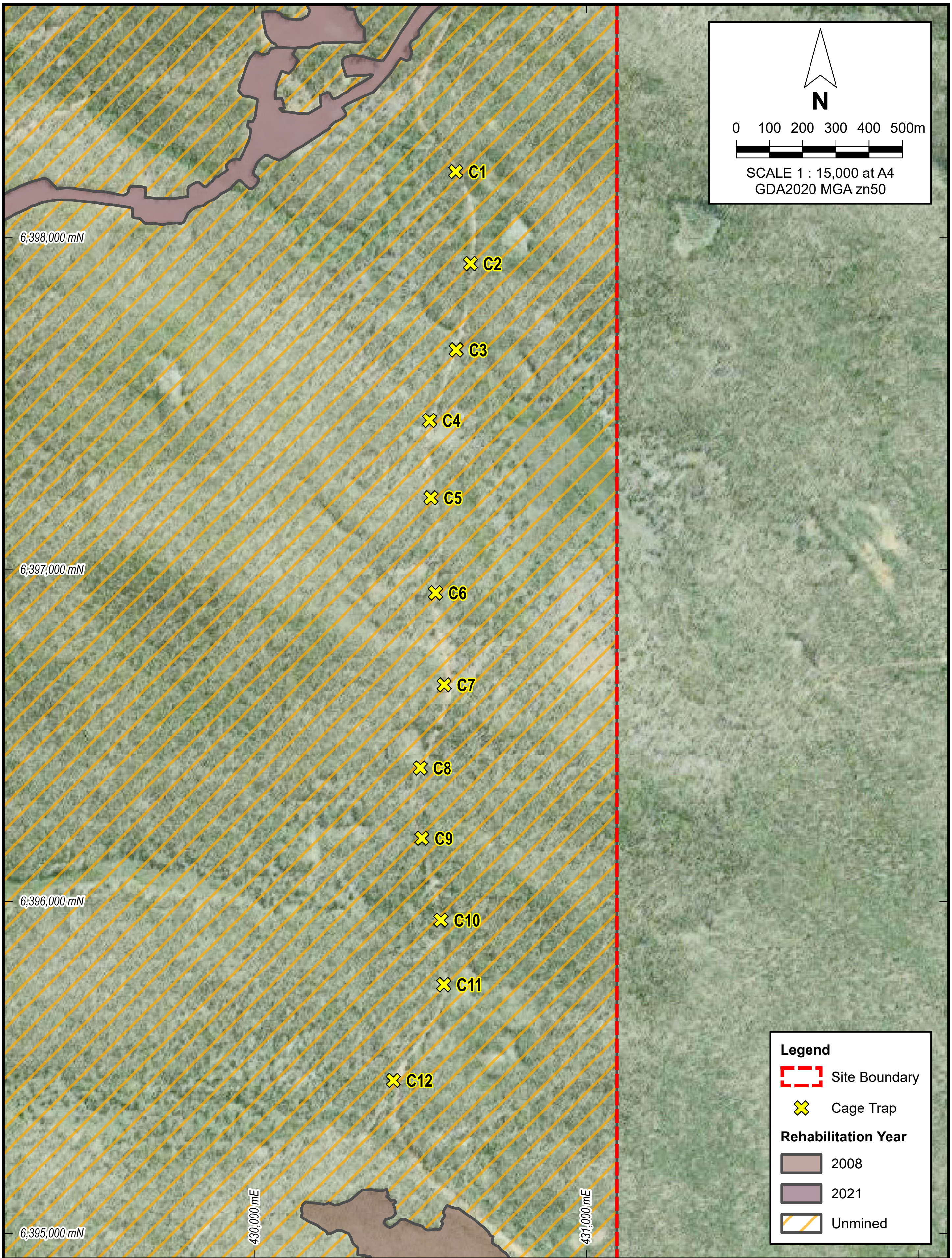
BASELINE MONITORING OF REHABILITATION PROGRAMS IN ALCOA'S BAUXITE MINING AREAS

CAMERA TRAP LOCATION - SITE 3

Figure 17

Job: 2022-0087



TERRESTRIAL ECOSYSTEMS

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IN ALCOA'S BAUXITE MINING AREAS

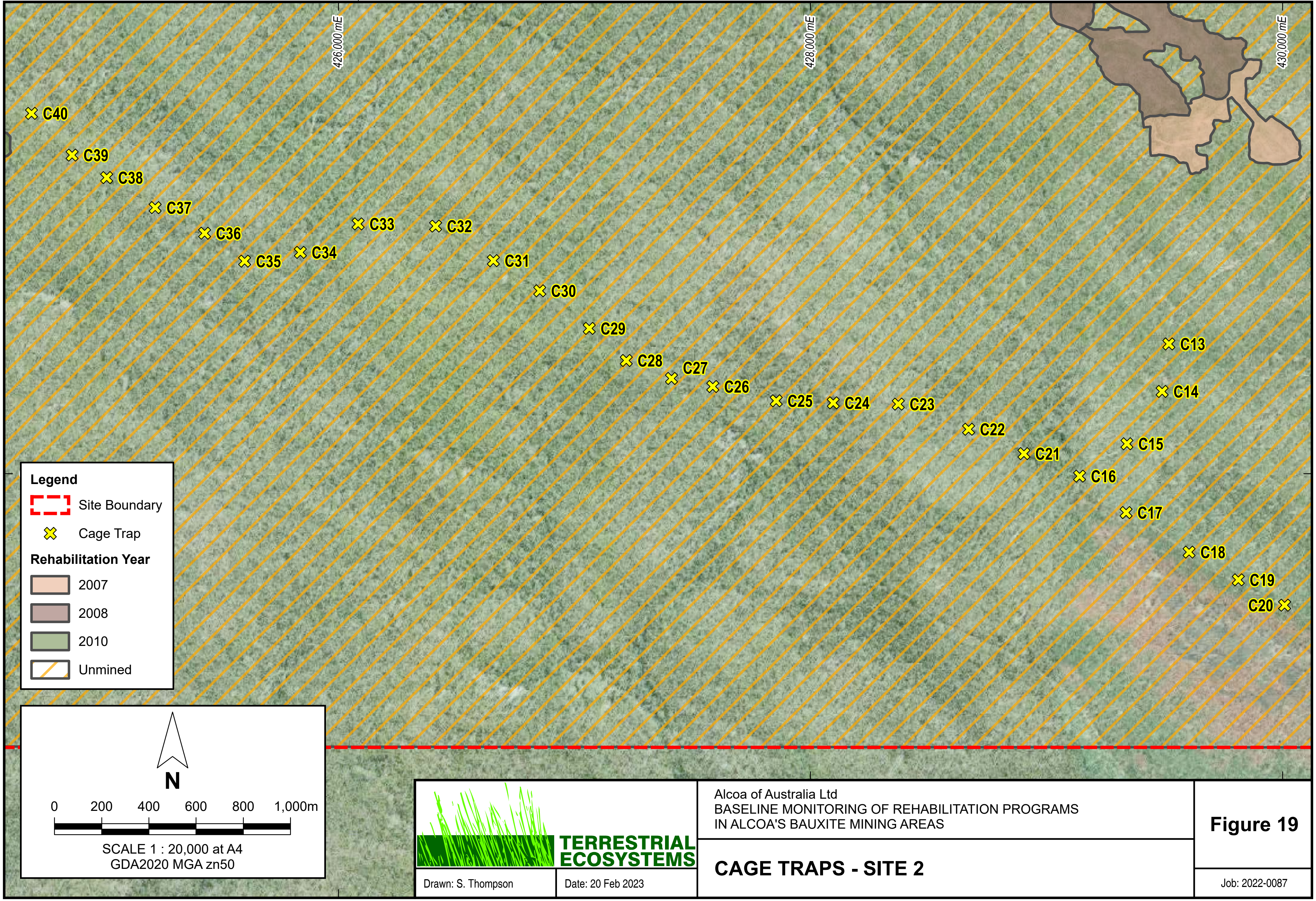
Figure 18

CAGE TRAPS - SITE 1

Drawn: S. Thompson | Date: 30 May 2023 | Job: 2022-0087

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0087.mxd

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0087-f19.aprx



TERRESTRIAL ECOSYSTEMS

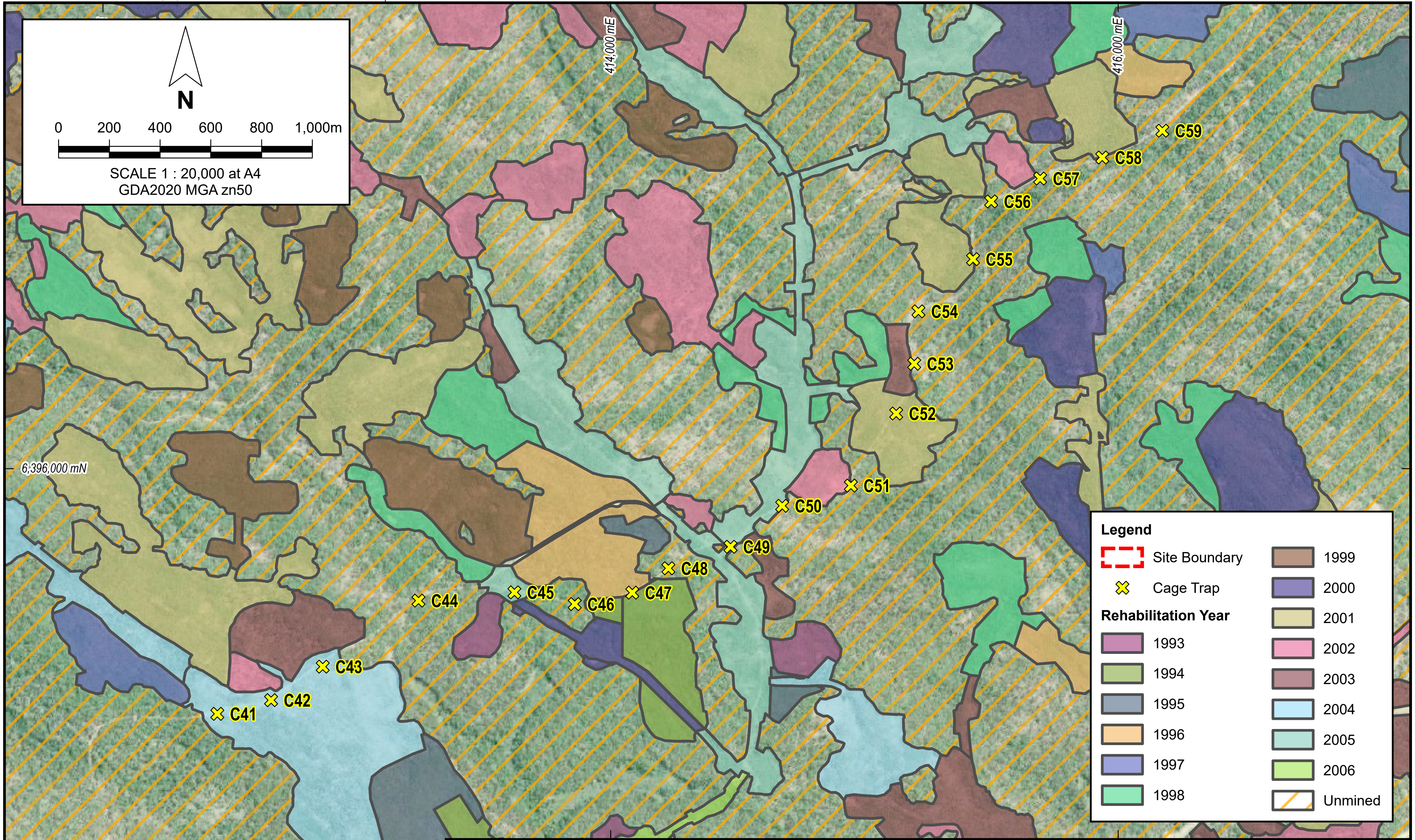
Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

Figure 19

CAGE TRAPS - SITE 2

Drawn: S. Thompson | Date: 20 Feb 2023 | Job: 2022-0087

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0087-f20.aprx



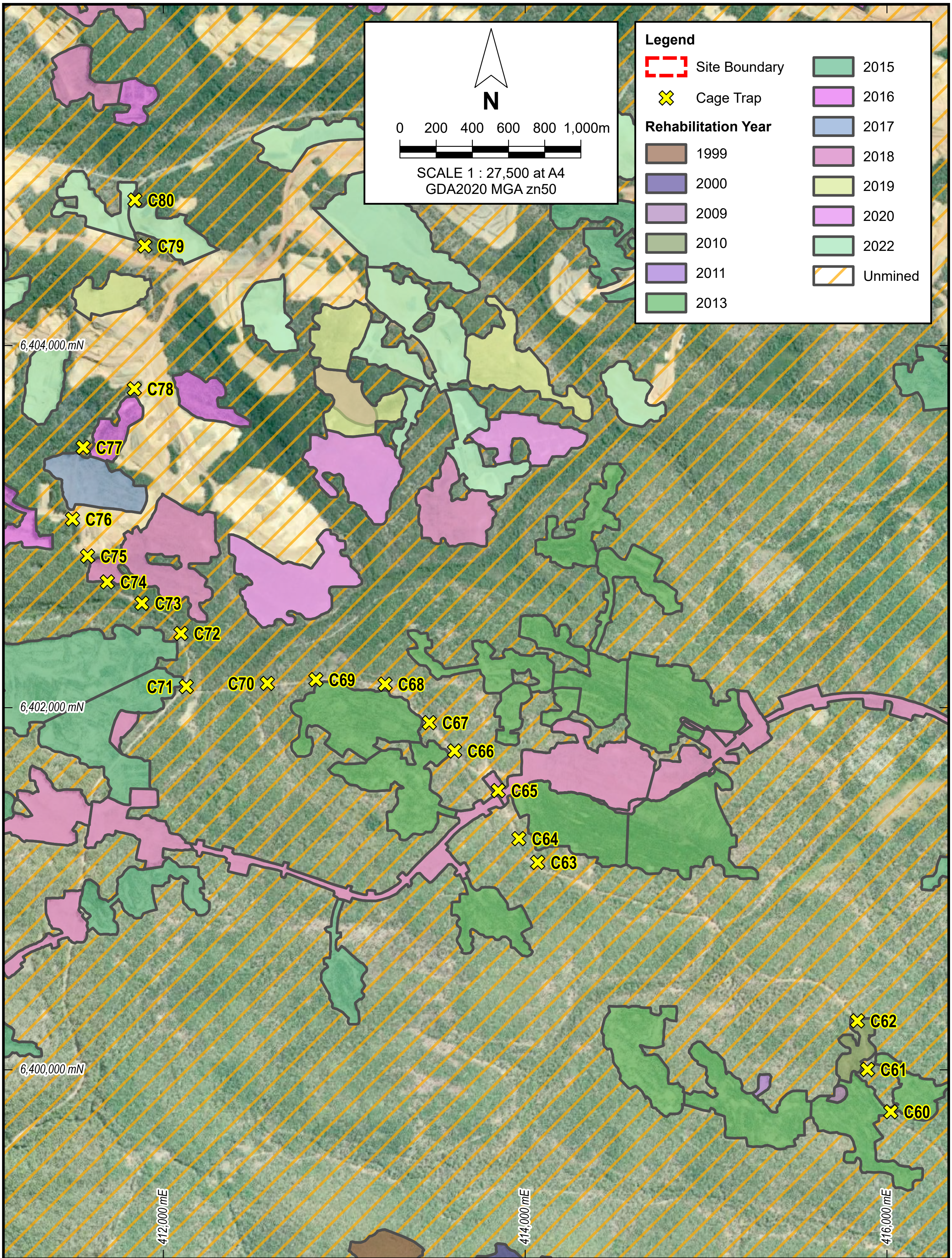
TERRESTRIAL ECOSYSTEMS

Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

Figure 20

CAGE TRAPS - SITE 3

Drawn: S. Thompson | Date: 30 Mar 2023 | Job: 2022-0087



PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0087.mxd

TERRESTRIAL ECOSYSTEMS

Drawn: S. Thompson | Date: 30 May 2023

Alcoa of Australia Ltd
BASELINE MONITORING OF REHABILITATION PROGRAMS
IN ALCOA'S BAUXITE MINING AREAS

CAGE TRAPS - SITE 4

Figure 21

Job: 2022-0087

Appendix A.
Images of trapping sites

Baseline Monitoring of Rehabilitation Programs
Alcoa's Bauxite Mining Areas

Plate 16. Site 1 unmined

Plate 17. Site 1 unmined

Plate 18. Site 2 unmined

Plate 19. Site 2 unmined

Plate 20. Site 3 unmined

Plate 21. Site 3 unmined

Plate 22. Site 4 10-year rehabilitation

Plate 23. Site 4 10-year rehabilitation

Plate 24. Site 5 10-year rehabilitation

Plate 25. Site 5 10-year rehabilitation

Plate 26. Site 6 10-year rehabilitation

Plate 27. Site 6 10-year rehabilitation

Plate 28. Site 7 15-year rehabilitation

Plate 29. Site 7 15-year rehabilitation

Plate 30. Site 8 15-year rehabilitation

Plate 31. Site8 15-year rehabilitation

Plate 32. Site 9 5-year rehabilitation

Plate 33. Site 9 5-year rehabilitation

Plate 34. Site 10 5-year rehabilitation

Plate 35. Site 10 5-year rehabilitation

Plate 36. Site 10 5-year rehabilitation

Plate 37. Site 10 5-year rehabilitation

Plate 38. Site 10 15-year rehabilitation

Plate 39. Site 10 15-year rehabilitation

Appendix B.
Trapping site coordinates

Baseline Monitoring of Rehabilitation Programs
Alcoa's Bauxite Mining Areas

Table 8. Trap site coordinates and opening and closing dates

Trap #	Easting	Northing	Date opened	Date closed
Pit and funnel traps				
1.A	428680	6397362	9/1/2023	21/1/2023
1.B	428703	6397351	9/1/2023	21/1/2023
1.C	428729	6397339	9/1/2023	21/1/2023
1.D	428763	6397366	9/1/2023	21/1/2023
2.A	421553	6401260	9/1/2023	21/1/2023
2.B	421576	6401290	9/1/2023	21/1/2023
2.C	421531	6401223	9/1/2023	21/1/2023
2.D	421544	6401247	9/1/2023	21/1/2023
3.A	417176	6398886	9/1/2023	21/1/2023
3.B	417156	6398820	9/1/2023	21/1/2023
3.C	417115	6398794	9/1/2023	21/1/2023
3.D	417104	6398755	9/1/2023	21/1/2023
4.A	418660	6399587	9/1/2023	21/1/2023
4.B	418668	6399563	9/1/2023	21/1/2023
4.C	418676	6399540	9/1/2023	21/1/2023
4.D	418679	6399517	9/1/2023	21/1/2023
5.A	420382	6401508	9/1/2023	21/1/2023
5.B	420410	6401518	9/1/2023	21/1/2023
5.C	420455	6401509	9/1/2023	21/1/2023
5.D	420479	6401534	9/1/2023	21/1/2023
6.A	421911	6394117	9/1/2023	21/1/2023
6.B	421891	6394147	9/1/2023	21/1/2023
6.C	421879	6394180	9/1/2023	21/1/2023
6.D	421866	6394197	9/1/2023	21/1/2023
7.A	422922	6396018	9/1/2023	21/1/2023
7.B	422976	6396020	9/1/2023	21/1/2023
7.C	423016	6395981	9/1/2023	21/1/2023
7.D	423033	6396023	9/1/2023	21/1/2023
8.A	423113	6394130	9/1/2023	21/1/2023
8.B	423140	6394123	9/1/2023	21/1/2023
8.C	423198	6394134	9/1/2023	21/1/2023

Trap #	Easting	Northing	Date opened	Date closed
8.D	423235	6394132	9/1/2023	21/1/2023
9.A	416954	6409214	9/1/2023	21/1/2023
9.B	416922	6409229	9/1/2023	21/1/2023
9.C	416934	6409256	9/1/2023	21/1/2023
9.D	416851	6409271	9/1/2023	21/1/2023
10.A	409342	6407093	9/1/2023	21/1/2023
10.B	409343	6407071	9/1/2023	21/1/2023
10.C	409483	6407111	9/1/2023	21/1/2023
10.D	409398	6407197	9/1/2023	21/1/2023
11.A	409470	6405269	9/1/2023	21/1/2023
11.B	409550	6405274	9/1/2023	21/1/2023
11.C	409528	6405328	9/1/2023	21/1/2023
11.D	409563	6405316	9/1/2023	21/1/2023
12.A	421738	6395132	9/1/2023	21/1/2023
12.B	421743	6395166	9/1/2023	21/1/2023
12.C	421751	6395192	9/1/2023	21/1/2023
12.D	421715	6395118	9/1/2023	21/1/2023
Camera traps				
CM1	420985	6400559	8/01/2023	20/01/2023
CM2	421006	6400600	8/01/2023	20/01/2023
CM3	421043	6400615	8/01/2023	20/01/2023
CM4	421151	6400684	8/01/2023	20/01/2023
CM5	421136	6400664	8/01/2023	20/01/2023
CM6	421114	6400647	8/01/2023	20/01/2023
CM7	421083	6400625	8/01/2023	20/01/2023
CM8	421172	6400701	8/01/2023	20/01/2023
CM9	418788	6398676	8/01/2023	20/01/2023
CM10	418811	6398679	8/01/2023	20/01/2023
CM11	418851	6398676	8/01/2023	20/01/2023
CM12	418880	6398696	8/01/2023	20/01/2023
CM13	418716	6398674	8/01/2023	20/01/2023
CM14	418674	6398691	8/01/2023	20/01/2023
CM15	418603	6398676	8/01/2023	20/01/2023

Trap #	Easting	Northing	Date opened	Date closed
CM16	418555	6398638	8/01/2023	20/01/2023
CM17	412606	6393232	8/01/2023	20/01/2023
CM18	412561	6393283	8/01/2023	20/01/2023
CM19	412474	6393296	8/01/2023	20/01/2023
CM20	412722	6393260	8/01/2023	20/01/2023
CM21	412741	6393311	8/01/2023	20/01/2023
CM22	412830	6393114	8/01/2023	20/01/2023
CM23	412751	6393111	8/01/2023	20/01/2023
CM24	412695	6393085	8/01/2023	20/01/2023
Cage traps				
C1	430604	6398198	8/01/2023	18/1/2023
C2	430648	6397921	8/01/2023	18/1/2023
C3	430605	6397661	8/01/2023	18/1/2023
C4	430525	6397448	8/01/2023	18/1/2023
C5	430529	6397215	8/01/2023	18/1/2023
C6	430543	6396929	8/01/2023	18/1/2023
C7	430569	6396652	8/01/2023	18/1/2023
C8	430497	6396401	8/01/2023	18/1/2023
C9	430502	6396189	8/01/2023	18/1/2023
C10	430559	6395942	8/01/2023	18/1/2023
C11	430568	6395748	8/01/2023	18/1/2023
C12	430416	6395460	8/01/2023	18/1/2023
C13	429517	6390549	8/01/2023	18/1/2023
C14	429488	6390347	8/01/2023	18/1/2023
C15	429339	6390125	8/01/2023	18/1/2023
C16	429138	6389988	8/01/2023	18/1/2023
C17	429336	6389833	8/01/2023	18/1/2023
C18	429602	6389666	8/01/2023	18/1/2023
C19	429811	6389548	8/01/2023	18/1/2023
C20	430007	6389440	8/01/2023	18/1/2023
C21	428903	6390083	8/01/2023	18/1/2023
C22	428668	6390187	8/01/2023	18/1/2023
C23	428371	6390293	8/01/2023	18/1/2023

Trap #	Easting	Northing	Date opened	Date closed
C24	428095	6390299	8/01/2023	18/1/2023
C25	427853	6390307	8/01/2023	18/1/2023
C26	427585	6390368	8/01/2023	18/1/2023
C27	427410	6390402	8/01/2023	18/1/2023
C28	427218	6390478	8/01/2023	18/1/2023
C29	427061	6390614	8/01/2023	18/1/2023
C30	426852	6390774	8/01/2023	18/1/2023
C31	426655	6390902	8/01/2023	18/1/2023
C32	426410	6391048	8/01/2023	18/1/2023
C33	426082	6391058	8/01/2023	18/1/2023
C34	425837	6390937	8/01/2023	18/1/2023
C35	425601	6390900	8/01/2023	18/1/2023
C36	425432	6391018	8/01/2023	18/1/2023
C37	425222	6391127	8/01/2023	18/1/2023
C38	425017	6391254	8/01/2023	18/1/2023
C39	424871	6391350	8/01/2023	18/1/2023
C40	424699	6391527	8/01/2023	18/1/2023
C41	412449	6395031	8/01/2023	18/1/2023
C42	412661	6395085	8/01/2023	18/1/2023
C43	412864	6395217	8/01/2023	18/1/2023
C44	413242	6395477	8/01/2023	18/1/2023
C45	413619	6395510	8/01/2023	18/1/2023
C46	413857	6395464	8/01/2023	18/1/2023
C47	414084	6395509	8/01/2023	18/1/2023
C48	414226	6395605	8/01/2023	18/1/2023
C49	414471	6395690	8/01/2023	18/1/2023
C50	414674	6395851	8/01/2023	18/1/2023
C51	414945	6395931	8/01/2023	18/1/2023
C52	415124	6396216	8/01/2023	18/1/2023
C53	415194	6396412	8/01/2023	18/1/2023
C54	415211	6396619	8/01/2023	18/1/2023
C55	415426	6396824	8/01/2023	18/1/2023
C56	415498	6397052	8/01/2023	18/1/2023

Trap #	Easting	Northing	Date opened	Date closed
C57	415691	6397143	8/01/2023	18/1/2023
C58	415935	6397226	8/01/2023	18/1/2023
C59	416172	6397331	8/01/2023	18/1/2023
C60	416020	6399766	8/01/2023	18/1/2023
C61	415891	6399999	8/01/2023	18/1/2023
C62	415835	6400268	8/01/2023	18/1/2023
C63	414068	6401144	8/01/2023	18/1/2023
C64	413964	6401275	8/01/2023	18/1/2023
C65	413850	6401540	8/01/2023	18/1/2023
C66	413609	6401759	8/01/2023	18/1/2023
C67	413469	6401915	8/01/2023	18/1/2023
C68	413224	6402128	8/01/2023	18/1/2023
C69	412842	6402153	8/01/2023	18/1/2023
C70	412574	6402132	8/01/2023	18/1/2023
C71	412126	6402114	8/01/2023	18/1/2023
C72	412096	6402408	8/01/2023	18/1/2023
C73	411880	6402575	8/01/2023	18/1/2023
C74	411689	6402693	8/01/2023	18/1/2023
C75	411580	6402835	8/01/2023	18/1/2023
C76	411496	6403039	8/01/2023	18/1/2023
C77	411555	6403436	8/01/2023	18/1/2023
C78	411838	6403759	8/01/2023	18/1/2023
C79	411896	6404549	8/01/2023	18/1/2023
C80	411841	6404802	8/01/2023	18/1/2023

Appendix C.
Vertebrate Fauna Recorded in Biological Surveys in the Region

Baseline Monitoring of Rehabilitation Programs
Alcoa's Bauxite Mining Areas

		Surveys	A	B		C							D		E		F
Family	**Species**	**Common name**		**South**	**North**	**Site 3**	**Site 6**	**Site 4**	**Site 7**	**Site 5**	**Site 9**	**Site 8**	**Plot 5**	**Plot 6**	**Unknown**	**Lease**	
Amphibians																	
Limnodynastidae	*Heleioporus barycragus*	Hooting Frog	X														
	Heleioporus eyrei	Moaning Frog	X	2													
	Heleioporus inornatus	Whooping Frog	X	2		1	1										
	Limnodynastes dorsalis	Western Banjo Frog	X					1									
	Neobatrachus pelobatoides	Humming Frog	X														
Myobatrachidae	*Crinia georgiana*	Quacking Frog	X	2	2	5	4	3	4	1			2				
	Crinia glauerti	Glauert's Frog	X		2	2									2		
	Crinia insignifera	Sin-bearing Froglet	X														
	Crinia pseudinsignifera	Bleating Froglet	X		2												
	Geocrinia leai	Lea's Frog	X		2		8			5					1		
	Pseudophryne guentheri	Gunther's Toadlet	X	2													
Pelodryadidae	*Litoria adelaidensis*	Slender Tree Frog	X	2	2										1		
	Litoria moorei	Motorbike Frog			2												
Reptiles																	
Agamidae	*Ctenophorus ornatus*	Ornate Crevice Dragon	X	2	2						1						
	Pogona minor	Western Bearded Dragon	X	2	2												
Carphodactylidae	*Underwoodisaurus milii*	Barking Gecko	X														
Diplodactylidae	*Diplodactylus lateroides*	Speckled Stone Gecko	X														
	Diplodactylus polyophthalmus	Spotted Sand Plain Gecko	X	2	2												
Diplodactylidae	*Oedura marmorata*	Marbled Velvet Gecko		2	2												
Elapidae	*Acanthophis antarcticus*	Southern Death Adder	X														
	Notechis scutatus	Tiger Snake	X	2	2										1		
	Suta gouldii	Gould's Snake	X	2	2												
	Suta nigriceps	Short-tailed Snake	X		2												
	Pseudonaja affinis	Dugite	X		2												
Gekkonidae	*Christinus marmoratus*	Marbled Gecko	X														
	Gehyra variegata	Variegated Gehyra	X														
Pygopodidae	*Aprasia parapulchella*	Pink-tailed Worm-lizard				1											
	Aprasia pulchella	Pretty Worm-lizard	X	2	2												
	Aprasia repens	Southwest Sandplain Worm Lizard	X														
	Lialis burtonis	Burton's Legless Lizard	X	2	2												
	Pygopus lepidopodus	Common Scaly-foot		2													
Pythonidae	*Morelia spilota*	Carpet Python	X														
Scincidae	*Acritoscincus trilineatus*	Western Three-lined Skink	X	2	2												
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink	X	2	2					1				6	1		
	Ctenotus delli	Dell's Ctenotus	X	2	2								6				
	Ctenotus impar	Odd-stripped Ctenotus		2													
	Ctenotus labillardieri	Common South-west Ctenotus	X	2	2			2	1						2		
	Egernia kingii	King's Skink	X	2	2		2										
	Egernia napoleonis	Southwestern Crevice Skink	X	2	2	1	1	3							2		
	Hemiergis initialis	South-western Earless Skink	X	2	2			4	2				6		1		
	Lerista distinguenda	South-western Orange-tailed Slider	X	2	2				2				2				
	Lerista elegans	West Coast Four-toed Lerista	X														
	Liopholis pulchra	South-western Rock-skink	X														
	Lissolepis luctuosa	Western Mourning Skink	X	2	2												
	Menetia greyii	Common Dwarf Skink	X	2	2										1		
	Morethia obscura	Shrubland Pale-flecked Morethia	X	2	2	2		3	5				4		1		
	Tiliqua rugosa	Bobtail	X	2	2		2					3					
Typhlopidae	*Anilios australis*	Austral Blind Snake	X	2													
Varanidae	*Varanus gouldii*	Gould's Goanna	X	2													
	Varanus rosenbergi	Heath Monitor					1										
Mammals																	
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna		2	2										4		
Suidae	*Sus scrofa*	Pig		2											2		
Canidae	*Vulpes vulpes*	Red Fox													1		
Dasyuridae	*Sminthopsis fulinginosa*	Grey-bellied Dunnart	X														
Molossidae	*Austronomus australis*	White-striped Freetail Bat		2	2												
	Mormopterus planiceps	Southern Free-tail Bat	X	2													
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	X	2													
	Chalinolobus morio	Chocolate Wattled Bat	X		2												
	Falsistrellus mackenziei	Western False Pipistrelle															2
	Nyctophilus geoffroyi	Lesser Long-eared Bat	X	2													

		Surveys	A	B		C							D		E		F
Family	**Species**	**Common name**		South	North	Site 3	Site 6	Site 4	Site 7	Site 5	Site 9	Site 8	Plot 5	Plot 6	Unknown	Lease	
	Nyctophilus holtorum	Holt's Long-eared Bat	X		2												
	Nyctophilus major	Greater Long-eared Bat	X														
	Vespadelus regulus	Southern Forest Bat	X	2	2												
Dasyuridae	*Antechinus flavipes*	Yellow-footed Antechinus	X	2	2				2				50	58			
	Dasyurus geoffroii	Chuditch	X														
	Sminthopsis gilberti	Gilbert's Dunnart	X	2													
Burramyidae	*Cercartetus concinnus*	Southwestern Pygmy Possum	X														
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo	X	2	2										6		
	Notamacropus irma	Western Brush Wallaby	X	2	2										1		2
	Setonix brachyurus	Quokka	X														
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum											4	6			
Tarsipedidae	*Tarsipes rostratus*	Honey Possum	X														
Leporidae	*Oryctolagus cuniculus*	Rabbit	X												2		
Peramelidae	*Isoodon fusciventer*	Quenda	X	2	2								6	2	4		2
Muridae	*Mus musculus*	House Mouse		2	2												
	Rattus rattus	Black Rat	X			1						1					

A Atlas of Living Australia

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