

MEMO

QUOYA ZONALIS
DATA CONSOLIDATION

PREPARED FOR: FORTESCUE METALS GROUP
IRON BRIDGE





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Project ID: 2215-3		<i>Quoya zonalis</i> Data Consolidation	
Prepared for:		Fortescue Metals Group Iron Bridge	
Date of issue:		19/06/2023	
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1. INTRODUCTION

Fortescue Metals Group Iron Bridge (FMG IB), a subsidiary of Fortescue Metals Group Limited (Fortescue), is developing the North Star Magnetite Project, located within the Pilbara region of Western Australia, approximately 110 km south of Port Hedland. The project was approved in 2015 under Part IV of the *Environmental Protection Act 1986* (WA) with issue of Ministerial Statement (MS) 993. One of the factors identified during assessment was direct and indirect impact to Threatened Flora species *Quoya zonalis* with related conditions 6, 7, 8 and 9 issued within MS 993. FMG IB is seeking to amend the approved project through an extension of the Mine Development Envelope (MDE) to enable the development of new mine pits; an extension of the waste rock dump, and ancillary infrastructure, referred to as the North Star Extension (NSE).

FMG IB engaged Spectrum Ecology & Spatial (Spectrum) to review all flora records of *Quoya zonalis* in their databases, those held by the Department of Biodiversity Conservation and Attractions (DBCA) within the Threatened and Priority Flora (TPFL) and Western Australian Herbarium (WAH) databases, and any in-publication reports to produce an updated consolidated census of *Quoya zonalis* locations and populations. The updated census will assist in maintaining ongoing compliance with MS 993 obligations and provide updated information that can be used as part of regulatory assessment of the NSE. Anticipated outcomes of the consolidation are:

- An accurate number of *Quoya zonalis* individuals/plants recorded across available flora surveys and databases, removing duplicate records;
- An accurate number of populations and their boundaries;
- An accurate number of remaining *Quoya zonalis* individuals and populations considering:
 - those that have been, and predicted to be, removed by clearing in associated with the approved North Star Magnetite project;
 - and those additional predicted for removal in association with the proposed North Star Magnetite Project Extension (NSE); and
- A Kernel Density Analysis (KDA) to visualise the density of *Quoya zonalis* individuals over the extent of occurrence.

1.1. FMG IB *Quoya zonalis* Surveys

Eleven field surveys commissioned by FMG IB have been utilised to determine the total number of *Quoya zonalis* individuals and populations. The first baseline surveys were conducted in 2011 to support Ministerial approval (MS 993) for the North Star Magnetite Project. Subsequent surveys were conducted between 2015 and 2020 in regional areas and potential development envelopes to support conditions of MS 993 and new expansion and exploration approvals. Regional surveys were required under MS 993 condition 7-4(iii) to identify a count of the total number of individuals, and MS 993 condition 6-2(i) to demonstrate that the mine and associated infrastructure within the MDE will be located to avoid or minimise the direct loss of the plant species. Additionally, targeted surveys conducted since 2021 have been undertaken to ensure compliance with conditions 2(a) and 2(c) of Threatened Flora Licence (TFL) 12B-2021 and 12B-2022. The TFL conditions require that records of the location and quantity of individuals taken are kept.

2. METHODS

2.1. *Quoya zonalis* Data Consolidation & Revision

2.1.1. Data Sources

Three data sources were accessed when consolidating the available *Quoya zonalis* data (Table 2.1). One data source, Spectrum Ecology (2023), has not been incorporated into the Fortescue database as the report is pre-publication at the time of this assessment. The Fortescue database contained *Quoya zonalis* records collected during 12 field assessments undertaken between 2012 and 2021 (Table 2.2). The TPFL/WAH databases contained records/specimens submitted to the DBCA.

Table 2.1: *Quoya zonalis* Data Sources

Data Source	Custodian	Details
TPFL/WAH Database	The Department of Biodiversity Conservation and Attractions (DBCA)	Date: 2022 Fortescue Tenements
Fortescue database	Fortescue	Date: 8/12/2022
Spectrum Ecology (2023) Shooting Star Targeted <i>Quoya zonalis</i> Survey	Spectrum Ecology	Unpublished Report – Preliminary Data, Survey Conducted in November 2022.

Table 2.2: Fortescue Database Reports

Author & Year	Title	Document Control Number
Atlas Iron Ore, 2014	Data Provided by Atlas Iron Ore	NS-EN-0011
ecologia Environment, 2012a	North Star Vegetation and Flora Assessment	NS-AS-EN-0001
ecologia Environment, 2012b	<i>Pityrodia</i> sp. Marble Bar Targeted Flora Survey	NS-RP-EN-0006
ecologia Environment, 2015a	North Star Slurry and Infrastructure Corridors Conservation Significant Flora and Vegetation Assessment	662MIC0023-5530-AS-EN-0001
ecologia Environment, 2015b	<i>Pityrodia</i> sp. Marble Bar Regional Survey 2015	662MIC0023-5530-SV-EN-0001
ecologia Environment, 2016	North Star Water Corridor Targeted Flora and Vegetation Survey	662MIC0023-5530-SV-EN-0002
Ecoscope, 2016	North Star Conservation Significant Fauna Monitoring	100-RP-EN-9625
Ecoscope, 2018	Glacier Valley Extension Flora and Vegetation Survey, North Star Project	NS-SV-EN-0001
Ecoscope, 2020	North Star Extension Flora and Vegetation Survey	662NS-0000-SY-EN-0002
Spectrum Ecology, 2020	Targeted Flora and Vegetation Survey, Iron Bridge	NS-0000-RP-EN-0001
Spectrum Ecology, 2021a	<i>Quoya zonalis</i> Targeted Flora Survey, Iron Bridge	IB-RP-EN-0003
Spectrum Ecology, 2021b	Shooting Star & South Star <i>Quoya zonalis</i> Targeted Flora Survey, Iron Bridge	IB-0000-RP-EN-0001

2.1.2. Definitions

The following terms are defined as:

- Individual: A single plant of *Quoya zonalis*; and
- Record: A specific location where the number of *Quoya zonalis* plants were counted.

2.1.3. Number of *Quoya zonalis* Individuals

The following changes were made to the TPFL/WAH and Fortescue databases prior to assessing duplicate records:

- All individuals/plants were assumed to be mature individuals given that this was inconsistently recorded between surveys and the amount of time that has passed since many of these surveys were undertaken; and
- Text, such as "plants" or "p" was removed from abundance field and assumed to be a count of individuals/plants; and
- Records that had no abundance data were assigned a single individual.

The following changes were made to the Fortescue database prior to assessing duplicate records:

- The abundance of records collected via quadrat sampling types was often entered as a percentage. The percentage of all these records was recorded as "< 1" or "<1 %". All *Quoya zonalis* recorded in quadrats were converted to a single individual; and
- Twenty-three records had a negative abundance value as they were updating previous records at the same location. These were ignored in the data and removed, it was assumed the highest number of individuals at a location/record persist over time.

Assessing and removing duplicate records from the three data sources was undertaken in accordance with the below:

- Records that were re-monitored within a quadrat during different phases of a detailed survey were removed;
- Records collected at quadrats or that no abundance attached were removed if the location was traversed and opportunistically sampled during a separate targeted flora survey;
- Records with the same coordinates were assessed to determine if they were duplicate records. Records that had no differences in any data field were assumed to be duplicate values and were removed;
- To investigate potentially duplicated records of *Quoya zonalis* found in different surveys all records were buffered with a radius of 5 m. All records separated by > 10 m were typically not investigated further as they were assumed to be separate records. This size was selected as *Quoya zonalis* individuals are typically recorded as frequently as possible in field assessments. All buffers that overlapped, separated by < 10 m, were investigated further:
 - Overlapping records from the same survey were retained as they were assumed to have a consistent recording method;
 - Records from the TPFL/WAH Database were removed if they overlapped with a record from the Fortescue database. The TPFL/WAH Database records represent vouchered specimens or TPFL forms submitted to the DBCA and may have already been recorded within the Fortescue database;
 - Buffers that overlapped with surveys conducted by Spectrum Ecology in 2020 and 2021 were ignored. The Spectrum Ecology surveys only recorded additional *Quoya zonalis* individuals that were not counted by the previous record at that location;
 - When buffers that overlapped from different surveys:
 - The record with the highest number of individuals was retained;
 - If the same number of individuals were recorded, the data from the survey with the most accurate count estimation method was retained; or

- If the number of individuals and the survey count estimation accuracy was the same, the most detailed (most information) record(s) were retained.

2.1.4. Cleared or Projected to be Cleared Classification

All records that intersected with a footprint within the Cleared Areas shapefile provided by Fortescue were assumed to be cleared unless notes associated with the record indicated otherwise (e.g. those individuals known to occur on road sides). Records projected to be cleared were those intersected areas expected to be cleared in accordance with S40 approvals granted for the North Star mine and pipeline under the *Biodiversity Conservation Act 2016* (WA), or those that fall within the proposed disturbance footprint of the NSE.

2.2. Kernel Density Analysis

A Kernel Density Analysis or Estimation (KDA) was performed on the consolidated *Quoya zonalis* data. The KDA was used to visualise the density of *Quoya zonalis* individuals which can be unclear when displaying mapping records alone. The KDA heatmap helps to easily identify “hotspots” and the clustering of *Quoya zonalis* individuals. The KDA was performed using a 100 m radius and *Quoya zonalis* abundance (number of individuals per record) as a weight. One record from the TPFL/WAH Database with an abundance of 361 was down sampled to 100 (the second largest record) as it was a large outlier and disproportionately impacted the results of the KDA. The KDA output was an estimation of counts per metre (1 m pixel size) and evaluated against the consolidated *Quoya zonalis* records. The KDA was undertaken in ArcGIS Pro v3.0.1 using the “Kernel Density” tool (Esri, 2022).

2.3. Population Assessment

The Threatened and Priority Flora Report Form – Field Manual defines a population as a groups of plants separated by > 500 m and defines subpopulations as “plants that occur on different land tenure parcels, or those that have considerable, recognisable separation between them (e.g. plants occur on either side of a river, or on close but distinct peaks or outcroppings) are considered to be separate subpopulations” (DBCWA, 2017). For the purpose of this document, populations were defined as plants separated by > 500 m to be consistent with previous population assessments as per the *Pityrodia sp. Marble Bar Regional Survey 2015* (662MIC0023-5530-SV-EN-0001) and *Quoya zonalis Infrastructure Plan* (662-NS-5530-PL-EN-0001) both required by MS 993. Subpopulations were not assessed.

3. RESULTS & DISCUSSION

3.1. *Quoya zonalis* Individuals

A total of 23,710 *Quoya zonalis* individuals from 5,563 records were identified from the three sources prior to the review (Table 3.1).

Table 3.1: Raw Number of *Quoya zonalis* Records & Individuals in Data Sources

Data Source	Records	Individuals
Fortescue database	5,443	16,728
Spectrum Ecology (2023)	28	49
TPFL/WAH databases – DBCA	92	6,934
Total	5,563	23,711

A total of 17,040 *Quoya zonalis* individuals from 5,346 records remained after the data was consolidated and duplicate records were removed (Table 3.2; Map 3.1). Twenty and 18 of the TPFL/WAH databases and Spectrum Ecology (2023) records were not included in the Fortescue database, respectively (Table 3.2). The unique records from the TPFL/WAH Databases and Spectrum Ecology (2023) sources accounted for 614 and 39 individuals, respectively (Table 3.2). A total of 82 records and 6,330 individuals from the TPFL/WAH databases and Spectrum Ecology (2023) survey were removed as they were existed within the Fortescue database.

There were three causes of data duplication within the Fortescue database:

- Quadrat resurveys, three individuals from three records were removed from the database;
- Data duplication errors, 13 individuals from 13 records were removed from the database; and
- Separate opportunistic collections from different surveys at the same location, 370 individuals from 95 records were removed from the database.

Table 3.2: Consolidated Number of *Quoya zonalis* Records & Individuals in Data Sources

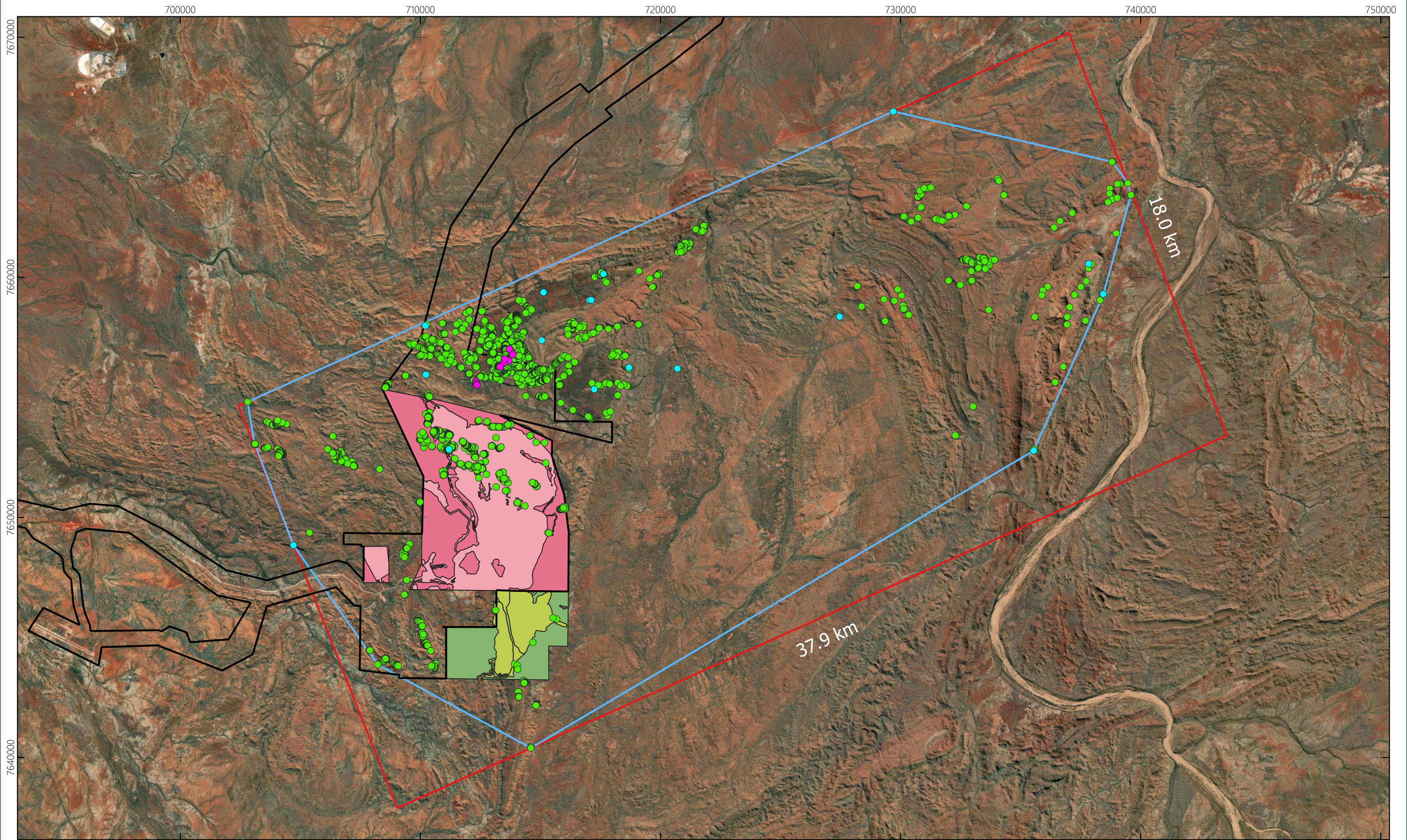
Data Source	Records	Individuals
Fortescue database	5,308	16,387
Spectrum Ecology (2023)	18	39
TPFL/WAH databases – DBCA	20	614
Total	5,346	17,040

3.2. Kernel Density Analysis

A KDA was performed to display a “heatmap” of *Quoya zonalis* abundance and is presented in Map 3.2.

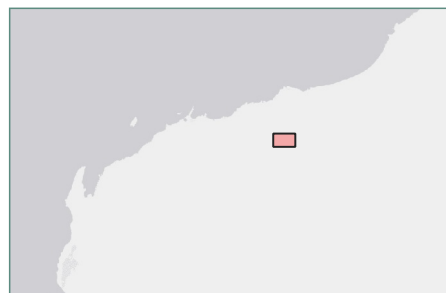
3.3. *Quoya zonalis* Populations

Unique records from the TPFL/WAH Database and Spectrum Ecology (2023) survey were incorporated with the Fortescue database to update an existing population assessment. Eighty-seven *Quoya zonalis* populations have been identified in the updated assessment (Map 3.3). Eight new populations were added due to the of TPFL/WAH Database records. One population (68) was merged with an existing population (77) as a record from the TPFL/WAH Database linked these previously separate populations. All Spectrum Ecology (2023) records fell in the centre of a large existing population (77), and none constituted a new population.



Legend

- | | | |
|------------------------------|------------------------------------|--|
| Quoya zonalis Records | Quoya zonalis Extent of Occurrence | IB Section 40 Approved |
| Spectrum Ecology (2023) | Minimum Bounding Box | IB Section 40 Approved Direct Disturbance Zone |
| TPFL/WAH Database | Impact Areas | North Star Expansion |
| Fortescue Database | IB Development Envelope | North Star Expansion Direct Disturbance |



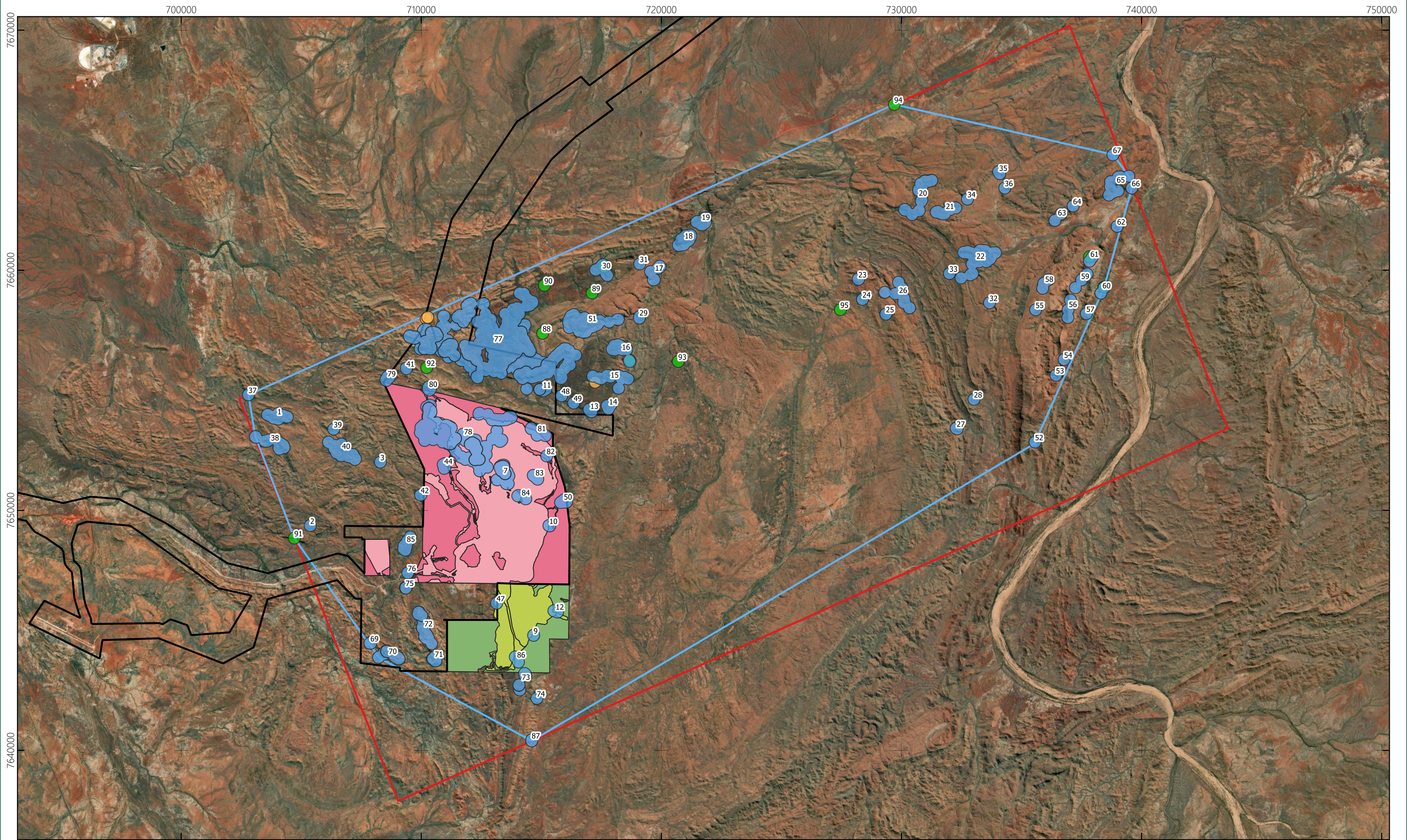
Scale 1:142,850 @ A3
 Coordinate System: GDA 1994 MGA Zone 50
 Projection: Universal Transverse Mercator
 Units: Metre

 Author: CS Date: 14-04-2023

Quoya zonalis Records

Quoya zonalis Data Consolidation

Prepared for FMG IB



Legend

- | | | |
|---------------------------|------------------------------------|--|
| Quoya zonalis Populations | Quoya zonalis Extent of Occurrence | IB Section 40 Approved |
| Existing | Minimum Bounding Box | IB Section 40 Approved Direct Disturbance Zone |
| Extension | Impact Areas | North Star Expansion |
| New | IB Development Envelope | North Star Expansion Direct Disturbance |

Scale 1:142,850 @ A3
 Coordinate System: GDA 1994 MGA Zone 50
 Projection: Universal Transverse Mercator
 Units: Metre

 Author: CS Date: 14-04-2023

Quoya zonalis Populations

Quoya zonalis Data Consolidation

Prepared for FMG IB

3.4. Updated Impact Assessment

A total of 1,678 *Quoya zonalis* individuals have or will be cleared leaving 15,362 individuals remaining taking into consideration the proposed disturbance footprint of the NSE (Map 3.4; Table 3.3). Land clearing up to September 2022 at Iron Bridge has directly removed 114 *Quoya zonalis* individuals from 28 records. A further 1,562 *Quoya zonalis* individuals from 502 records are projected to be cleared as part of the approved North Star project based on updated information. Two *Quoya zonalis* individuals from a single record are located within the North Star expansion direct disturbance area which is projected to be cleared subject to regulatory approval.

Eighty-three populations of *Quoya zonalis*, based on the updated assessment (Section 3.3), will remain after accounting for records cleared to date or projected to be cleared including the NSE. Four *Quoya zonalis* populations are likely to be completely removed as their associated occurrence records all fall within areas approved or projected for clearing (Populations 7, 47, 83 and 84; Table 3.4). Populations 77 and 78 have already been impacted in part by clearing to date, with population 81 projected for impact when records are partially removed. Remaining groups of *Quoya zonalis* records within populations 78 and 81 will be separated by > 500 m. Populations 78 and 81 may each need to be split into two separate populations after these records are impacted. The number of records, individuals, cleared individuals, and projected cleared individuals for each *Quoya zonalis* population is presented in Appendix A.

Table 3.3: Number of Impacted *Quoya zonalis* Records & Individuals

Impact	Records	Individuals
Approved Ironbridge Project (MS 993)		
Cleared	28	114
Projected to be Cleared	502	1,562
Unimpacted	417	1,371
Under Assessment (NSE)		
Cleared	0	0
Projected to be Cleared	1	2
Unimpacted	6	15
Cleared or Projected to be Cleared	531	1,678
Pre-Clearing	5,346	17,040
Remaining	4,815	15,362

Table 3.4: Number of Impacted *Quoya zonalis* Populations

Impact	Populations
Approved Ironbridge Project (MS 993)	
Projected to be Cleared	3
Impacted to date	2
Projected to be Impacted	1
Under Assessment (NSE)	
Projected to be Cleared	1
Cleared	4
Impacted	3
Pre-Clearing	87
Remaining (at least in part)	83

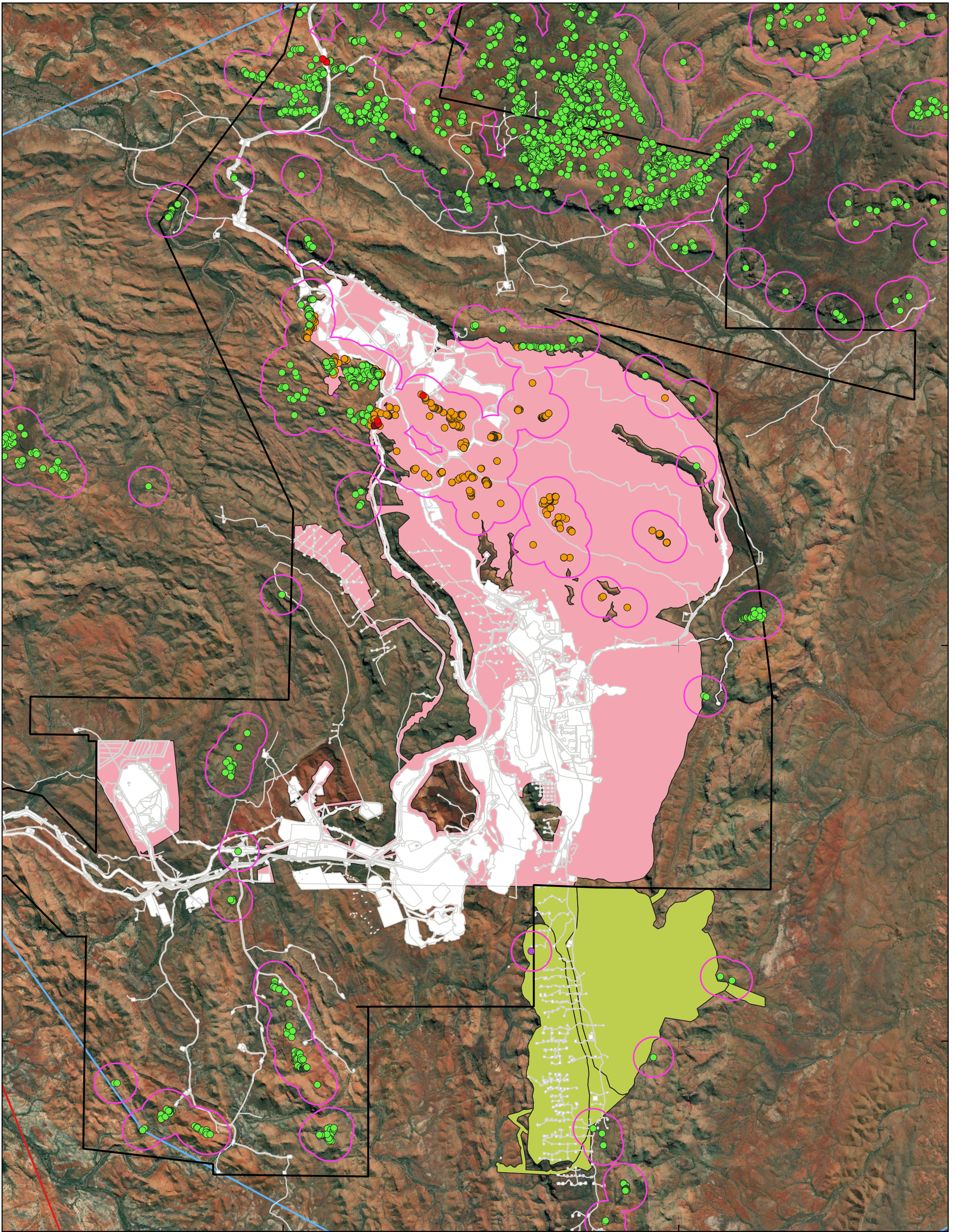
710000

715000

7655000

7650000

7645000



Legend

Quoya zonalis Records

- Cleared
- Approved to be Cleared
- Awaiting Approval to be Cleared
- Not Impacted

Impact Areas

- IB Development Envelope
- Cleared Areas
- IB Section 40 Approved Direct Disturbance Zone
- North Star Expansion Direct Disturbance

- Quoya zonalis Populations
- Minimum Bounding Box
- Quoya zonalis Extent of Occurance



0 0.5 1 1.5 km
 Scale 1:43,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
 Projection: Universal Transverse Mercator
 Units: Metre



Author: XX

Date: 14-04-2023

Impacted Quoya zonalis Records

Quoya zonalis Data Consolidation

Prepared for FMG IB

MAP

3.4

4. CONCLUSION

The data consolidation identified 17,040 *Quoya zonalis* total individuals from the three data sources. The population analysis indicated there are 87 populations of *Quoya zonalis*, incorporating unique records from the TPFL/WAH Database which identified seven new populations and merged two existing populations.

A total of 1,678 *Quoya zonalis* individuals have been cleared to date or occur in areas projected to be cleared as part of the approved North Star Magnetite project and proposed NSE. A total of 15,362 *Quoya zonalis* individuals will remain after clearing activities have been undertaken for both projects. Clearing for both projects is projected to completely remove four *Quoya zonalis* populations, with a further three impacted by partial removal of associated records. A total of 83 populations will remain after clearing activities within these areas have been undertaken.

5. REFERENCES

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Appendix A: Population Statistics



Population	Total Known Records	Total Known Individuals	Total Cleared Individuals	Number Of Individuals Projected to Be Removed by Approved Project	Number Of Individuals Projected to be Removed by NSE
1	53	115	-	-	-
2	1	1	-	-	-
3	1	1	-	-	-
7	68	127	-	127	-
9	1	2	-	-	-
10	2	12	-	-	-
11	15	77	-	-	-
12	2	2	-	-	-
13	7	27	-	-	-
14	3	9	-	-	-
15	17	70	-	-	-
16	40	171	-	-	-
17	13	47	-	-	-
18	70	143	-	-	-
19	17	72	-	-	-
20	19	112	-	-	-
21	12	91	-	-	-
22	232	723	-	-	-
23	2	47	-	-	-
24	1	2	-	-	-
25	1	4	-	-	-
26	10	39	-	-	-
27	2	8	-	-	-
28	1	1	-	-	-
29	3	3	-	-	-
30	25	193	-	-	-
31	1	6	-	-	-
32	1	6	-	-	-
33	1	19	-	-	-
34	1	30	-	-	-
35	2	38	-	-	-
36	1	1	-	-	-
37	1	1	-	-	-
38	175	400	-	-	-
39	3	9	-	-	-
40	86	411	-	-	-
41	2	6	-	-	-
42	2	12	-	-	-
44	10	36	-	-	-

Population	Total Known Records	Total Known Individuals	Total Cleared Individuals	Number Of Individuals Projected to Be Removed by Approved Project	Number Of Individuals Projected to be Removed by NSE
47	1	2	-	-	2
48	1	6	-	-	-
49	1	4	-	-	-
50	51	173	-	-	-
51	68	236	-	-	-
52	2	22	-	-	-
53	1	30	-	-	-
54	1	50	-	-	-
55	1	10	-	-	-
56	3	61	-	-	-
57	1	2	-	-	-
58	3	47	-	-	-
59	3	200	-	-	-
60	3	6	-	-	-
61	3	116	-	-	-
62	1	3	-	-	-
63	2	7	-	-	-
64	1	3	-	-	-
65	8	144	-	-	-
66	1	5	-	-	-
67	3	9	-	-	-
69	2	3	-	-	-
70	45	83	-	-	-
71	20	150	-	-	-
72	74	293	-	-	-
73	37	74	-	-	-
74	1	4	-	-	-
75	4	7	-	-	-
76	1	1	-	-	-
77	3071	8795	7	-	-
78	739	2615	107	1372	-
79	125	125	-	-	-
80	44	69	-	-	-
81	16	16	-	1	-
82	1	2	-	-	-
83	56	56	-	56	-
84	3	6	-	6	-
85	26	38	-	-	-
86	3	11	-	-	-

Population	Total Known Records	Total Known Individuals	Total Cleared Individuals	Number Of Individuals Projected to Be Removed by Approved Project	Number Of Individuals Projected to be Removed by NSE
87	5	22	-	-	-
88	1	361	-	-	-
89	2	43	-	-	-
90	2	8	-	-	-
91	1	8	-	-	-
92	1	26	-	-	-
93	1	1	-	-	-
94	1	3	-	-	-
95	1	10	-	-	-