

Tronox Management Pty Ltd

Cooljarloo West Titanium Minerals
Mine

Additional Surveys for Significant Flora

Method Statement

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ENVIRONMENTAL

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Cover photos (clockwise from top left): *Andersonia gracilis* (Threatened), *Babingtonia delicata* (P1), *Anigozanthos viridis* subsp. *terraspectans* (Threatened) and *Paracaleana dixonii* (Threatened). All photos by Woodman Environmental.

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EXECUTIVE SUMMARY

Tronox Management Pty Limited (Tronox) proposes to develop the Cooljarloo West Titanium Minerals Mine (the CLW Project). A draft Public Environmental Review (PER) document was submitted to the Environmental Protection Authority (EPA) in May 2015. Subsequent discussion culminated in the EPA chairman indicating that additional surveys for significant flora taxa were necessary prior to finalisation of the PER document.

A list of taxa considered to require further survey with regard to the CLW Project, and their suitable habitat (including Vegetation Types (VTs) mapped in the CLW Project Study Area, has been determined. Determination of this listing considered correspondence from the EPA concerning the requirement for targeted searching for Threatened and Priority 1 and 2 taxa in all suitable habitats, and taxa with known records within the Footprint and/or Development Envelope, or that are considered to have a moderate or higher probability of occurring within the Footprint and/or Development Envelope (as presented in Woodman Environmental 2015).

The following two-phase survey method is proposed with regard to further survey for significant flora taxa, as summarised below:

Phase 1 (CLW Project Footprint and Development Envelope)

- Full census (GPS coordinates and counts of individuals) of all known populations, and a search of all suitable habitat for significant flora taxa using a grid pattern with no greater than 50 m spacing between transects, with a full census of any encountered populations.

Phase 2 (CLW Project Assessment Area (outside Development Envelope))

- A sufficient number of known populations of significant flora taxa to be visited to record GPS coordinates and counts individuals, to ensure adequate contextual information is available to characterise the significance of the impacts associated with the project. If required, a sufficient area of suitable habitat for significant flora taxa will be searched for such taxa to record additional individuals.

1. INTRODUCTION

1.1 Project Background

Tronox Management Pty Limited (Tronox) operates the Tiwest Joint Venture, an integrated titanium minerals mining and processing project established in 1988. To date the project has been based on the titanium minerals deposits at the Cooljarloo Mine, on the Swan Coastal Plain in Western Australia, approximately 175 km north of Perth within the Shire of Dandaragan, and 30 km west of the town of Dandaragan.

Tronox proposes to develop the Cooljarloo West Titanium Minerals Mine (the CLW Project), which involves dredge mining of three mineral deposits located adjacent to the existing Cooljarloo Mine. The CLW Project will require the movement of the mining dredge and ore processing plant (concentrator) from the existing Cooljarloo Mine to the CLW Project area and back again via flotation across an open channel (transportation channel) approximately 6 km long and 100 m wide.

Referral of the CLW Project to the W.A. Environmental Protection Authority (EPA) (with reference to the W.A. *Environmental Protection Act 1986* (EP Act)) and the federal Department of the Environment (DotE) (with reference to the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) resulted in a Public Environmental Review (PER) level of assessment being set by the EPA (EPA 2013a). It was also determined to be a controlled action in accordance with the EPBC Act. As such, the PER will also satisfy the EPBC Act assessment requirements in accordance with the bilateral agreement between the relevant State and Federal Authorities. An Environmental Scoping Document (ESD) was provided by the EPA (EPA 2013a), which defined the requirements of the PER document to be prepared for the CLW Project, in accordance with both the EP Act and the EPBC Act.

A draft PER document was submitted to the EPA in May 2015 (Tronox 2015). Subsequent discussion culminated in the EPA chairman indicating that additional surveys for significant flora taxa were necessary prior to finalisation of the PER document, in line with requirements outlined in the ESD. To this end, Tronox commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to produce a method statement detailing the proposed approach to these surveys.

1.2 Objectives

The primary objective of this method statement is to:

- Describe an appropriate approach (in line with relevant standards and requirements) for surveys for formally listed significant flora taxa within areas relevant to the CLW Project. The surveys will provide quantitative data on the abundance and distribution of such taxa, and allow for potential impacts of the CLW Project to such taxa to be assessed in a local and regional context.

2. BACKGROUND

2.1 Definition of Relevant Proposal Areas

The following areas relevant to the CLW Project and this method statement have been defined by Tronox, and are shown on Figure 1:

Footprint

The Footprint represents the planned location and upper limit (in terms of area) of clearing and disturbance for the CLW Project. It includes all elements of the CLW Project and hence is the planned area of direct impact of the CLW Project.

Development Envelope

To allow for some flexibility in the exact final positioning of the Footprint, a Development Envelope has also been defined, which represents the absolute limit of the final position of the Footprint.

Study Area

The Study Area represents the limit of flora and vegetation studies conducted for the CLW Project, particularly mapping of Vegetation Types (VTs), and was designed so that appropriate local contextual data on the flora and vegetation in the footprint and development envelope could be collected, for the purposes of impact assessment.

Assessment Area

As a precautionary approach to assessing potential impacts of the CLW Project on flora and vegetation, the Study Area was further refined in the Draft PER document (Tronox 2015) to the Assessment Area; the Assessment Area considered an existing approval to clear native vegetation on Mining Tenement M268SA within the Study Area, with flora and vegetation within the tenement regarded as not protected from clearing as a result of existing mining approvals. The Assessment Area is therefore the Study Area excluding Mining Tenement M268SA (Figure 1).

2.2 Survey Approach Standards and Requirements

The survey approach detailed in this method statement conforms to the standards and requirements of the following:

- The ESD for the CLW Project (EPA 2013a);
- Correspondence from the EPA, and outcomes of subsequent consultation (EPA 2013b, c; 2015);
- EPA Guidance Statement No. 51 (EPA 2004);
- *Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* – a technical report of the EPA and the Department of Parks and Wildlife (DPaW) (EPA & DPaW 2015); and
- Survey guidelines detailed in the DotE Species Profile and Threats (SPRAT) database (DotE 2016).

With reference to EPA Guidance Statement No. 51, the requirements of a Level 2 survey will be adhered to, however only with regard to survey requirements for significant flora taxa.

With reference to the *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment*, the requirements of a Targeted Survey will be adhered to, with specific regard to significant flora taxa.

With reference to survey guidelines detailed in the DotE SPRAT database, survey guidelines are not listed for all taxa contained in the database (DotE 2016), and therefore can only be adhered to if available.

2.3 Current Status of the CLW Project Concerning Significant Flora

A list of flora and vegetation studies conducted in the Study Area and surrounds is provided in Appendix A. This includes several surveys of exploration drill lines, a baseline flora and vegetation survey of the Study Area (Woodman Environmental 2014), and several surveys targeting particular significant flora taxa.

From these, a total of 4 Threatened flora taxa (as listed under both the W.A. *Wildlife Conservation Act* 1950 (WC Act) and the EPBC Act) were reported as occurring in the Study Area, with 63 DPaW-classified Priority flora taxa also reported as occurring in the Study Area. Additionally, a further 3 potential DPaW-classified Priority flora taxa were reported as occurring in the Study Area.

Following review of the draft PER document by the EPA, Woodman Environmental were commissioned by Tronox to undertake a risk assessment to identify the potential for significant impact to significant flora taxa as a result of the CLW Project, using existing data collected for Tronox or available from public sources (Woodman Environmental 2015a). The key findings of this risk assessment are presented below:

- A total of 20 formally listed significant flora taxa were reported as occurring within the Footprint;
- An additional 6 formally listed significant flora taxa occur outside the Footprint but within the Development Envelope, including the Threatened (as listed under both the WC Act and the EPBC Act) flora taxon *Paracaleana dixonii*, and 5 DPaW-classified Priority flora taxa;
- An additional 9 DPaW-classified Priority flora taxa are considered to have a High to Moderate likelihood of occurring in the Footprint and Development Envelope but had not been recorded in either. This includes the Priority 1 taxon *Babingtonia delicata*. Likelihood of occurrence rankings considered whether suitable habitat for a particular taxon occurred within the Footprint/Development Envelope, the strength of association of the taxon to a particular habitat (based on known records), and whether locations were known from close proximity to the Footprint/Development Envelope.
- An assessment of potential impacts on listed significant flora taxa as a result of the CLW Project determined that the risk of a significant impact in a regional context was High for a number of taxa, including *Anigozanthos viridis* subsp. *terraspectans*, *Macarthuria keigheryi* and *Paracaleana dixonii* (all Threatened), with a Moderate risk assigned to numerous other taxa. This risk ranking considered the potential level of local impact

(i.e. within the Study Area) to the taxon, and the significance of the local populations to the regional conservation of the taxon.

It should also be noted that subsequent to the submission of the draft PER to the EPA, and the completion of the above risk assessment (Woodman Environmental 2015a), several DPaW-classified Priority flora taxa have changed categories, as outlined below (as per Western Australian Herbarium 1998-):

- *Calectasia palustris* has been downgraded to Priority 2 from Priority 1;
- *Chordifex reseminans* has been downgraded to Priority 2 from Priority 1;
- *Frankenia glomerata* has been downgraded to Priority 4 from Priority 3.
- *Isopogon panduratus* subsp. *palustris* has been downgraded to Priority 3 from Priority 2
- *Schoenus pennisetis* has been downgraded to Priority 3 from Priority 1;
- *Stylidium hymenocraspedum* has been downgraded to Priority 3 from Priority 2; and
- *Schoenus griffinianus* has been downgraded to Priority 4 from Priority 3.

Following additional investigation of *Diuris ?eburnea* (P1) by Woodman Environmental in 2015, this taxon is now known as *Diuris* aff. *laxiflora*. Material and photographs of this taxon were forwarded to orchid specialist Andrew Brown (DPaW Species and Communities branch), who determined that it is an undescribed member of the *Diuris laxiflora* complex that has been sighted at several other locations between Perth and Eneabba, however is poorly known (A. Brown pers. comm. 2015). This taxon is clearly distinct from typical *D. laxiflora*, differing in floral coloration and in having a much later flowering time (late October-November). Material has now been forwarded to the W.A. Herbarium with a request to assign a formal phrase name and conservation category (if appropriate) to the taxon. This taxon was found to occur in specific habitat in Wongonderrah Nature Reserve, within a sedge-dominated Paperbark swamp with surface water present in late Spring. No such habitat is known to occur in the Development Envelope. It is therefore considered that the findings in Woodman Environmental (2015a) for *Diuris ?eburnea* are still appropriate following this taxonomic change – this taxon has a Low likelihood of being present within the Development Envelope. It is therefore not considered further in this method statement.

Tronox has recently been advised by the EPA that the Priority 1 taxon *Stylidium tinkeri* is known to occur just outside the Study Area on the Dandaragan Plateau, approximately 12 km north of the Development Envelope. It was indicated by the EPA that this taxon occurs in similar habitats to other significant taxa known from the Development Envelope, and therefore could warrant further survey. A review of the records of this taxon just outside the Study Area indicates that it occurs in a winter-wet area that likely possesses surface water well into spring; this assessment is based on the presence of co-occurring taxa including *Utricularia multifida*, a taxon that is generally found in areas that hold surface water (e.g. seepage areas). This location appears to be similar to the habitat where *Diuris* aff. *laxiflora* occurs in the Wongonderrah Nature Reserve; *Diuris* aff. *laxiflora* also co-occurs with *Utricularia multifida*, and occurs in close geographic proximity to the records of *Stylidium tinkeri* (approximately 3.5 km west). As described for *Diuris* aff. *laxiflora*, no such habitat is known to occur in the Development Envelope; it is therefore considered that *Stylidium tinkeri* has a Low likelihood of occurring in the Development Envelope; this taxon is therefore not considered further in this method statement.

Woodman Environmental has recently been advised by the EPA and DPaW (via orchid specialist Andrew Brown, DPaW Species and Communities branch) that a potentially undescribed taxon with affinities to *Thelymitra pulcherrima* (Priority 2) is known to occur within close proximity (approximately 2 km east) to the Study Area. This taxon is currently being treated as *Thelymitra pulcherrima* (Priority 2), however has smaller flowers and an earlier flowering period (late June – mid-August) than typical *Thelymitra pulcherrima*, and may be of higher conservation significance than the Priority 2 category allocated to *Thelymitra pulcherrima* (Andrew Brown *pers. comm.* 2015). The location near the Study Area occurs on the slopes of a low lateritic rise on the Dandaragan Plateau, in sandy-clay soils with laterite pebbles. It is considered that similar soil types occur within the Study Area and the Development Envelope, and while this taxon has not previously been identified in either area, it has not been directly targeted by historical surveys, and the majority of surveys undertaken in the Study Area have been undertaken outside its flowering period. It is therefore considered that this taxon has a Moderate likelihood of occurring in the Development Envelope.

3. SURVEY APPROACH

3.1 Determination of Formally Listed Significant Flora Taxa Requiring Further Survey

A list of taxa considered to require further survey with regard to the CLW Project is presented in Table 1.

In determining this listing, the following factors have been considered:

- Correspondence from the EPA (see Section 2.2) concerning the requirement for targeted searching for Threatened and Priority 1 and 2 taxa in all suitable habitats and detailed quantitative counts of individual plants;
- Taxa with known records within the Footprint and/or Development Envelope, or that are considered to have a moderate or higher probability of occurring within the Footprint and/or Development Envelope (as presented in Woodman Environmental 2015a), are considered to require further survey.

Consideration of the above factors has resulted in several Priority 1 and 2 taxa known from the wider Study Area being omitted from Table 1. All such taxa were determined to have a low probability of occurring in the Footprint and/or Development Envelope in the risk assessment conducted by Woodman Environmental (2015a). This determination was based on the taxa meeting one or more of the following criteria (as per Woodman Environmental 2015a):

- Not known from survey data within the Footprint or Development Envelope;
- Preferred habitat (strong or weak association) is not located within the Footprint or Development Envelope;
- No known suitable habitat in Footprint or Development Envelope; or
- Known locations not in close proximity to Footprint or Development Envelope.

The taxa omitted are listed in Table 2 below. It should be noted that while the taxa in Table 2 are not considered to require further survey, they will be surveyed for and recorded whilst conducting survey for those taxa listed in Table 1 (see Section 3.4).

No additional survey is proposed for taxa ranked as either Priority 3 or 4. As presented in Woodman Environmental (2015a), based on available local and regional data, it is considered that the risk of a significant impact from the CLW Project to any such taxa at a regional scale is unlikely to be high (Table 10). It is also considered that the collection of further data in the Footprint and Development Envelope will not serve to increase the ranking of the risk of a significant impact at a regional scale for any such taxa.

Based on the factors considered above, *Macarthuria keigheryi* (Threatened) is considered to require further survey with reference to the CLW Project, as it is known to occur within the Development Envelope and Footprint. However, as outlined in Woodman Environmental (2015a), *Macarthuria keigheryi* appears to respond favourably to fire, being noted as relatively common within and in the vicinity of the Development Envelope based on the results of surveys conducted soon (approximately 2 years) after a fire affected the area (Woodman Environmental 2014). Recent evidence (e.g. Woodman Environmental 2016 in prep.) suggests that at least the majority, and possibly all, of the individuals that have previously been recorded within and in the vicinity of the Development Envelope may have senesced. It is therefore possible that further survey for this taxon within and outside the Development Envelope will locate few or possibly no individuals, therefore survey results will misrepresent the distribution and abundance of this taxon within and adjacent to the Development Envelope. Such data will not be sufficient to assess potential impacts to this taxon in a local or regional context.

In light of this, it is therefore considered that survey for *Macarthuria keigheryi* will require an alternative approach than that proposed for the remaining taxa in Table 1. Potential further survey for this taxon is therefore discussed separately in Section 3.4 below.

Table 1: Formally Listed Significant Flora Taxa Requiring Further Survey

Taxon	Conservation Ranking
<i>Andersonia gracilis</i>	Threatened
<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	Threatened
<i>Macarthuria keigheryi</i>	Threatened
<i>Paracaleana dixonii</i>	Threatened
<i>Babingtonia delicata</i>	Priority 1
<i>Grevillea thelemanniana</i> subsp. Cooljarloo (B.J. Keighery 28 B)	Priority 1
<i>Calectasia palustris</i>	Priority 2
<i>Chordifex reseminans</i>	Priority 2
<i>Hypocalymma</i> sp. Cataby (G.J. Keighery 5151)	Priority 2
<i>Thelymitra pulcherrima</i> *	Priority 2

*Note: represents a potentially undescribed taxon that is currently being treated as *Thelymitra pulcherrima* (Priority 2).

Table 2: Priority 1 and 2 Taxa Considered to Not Require Further Survey

Taxon	Conservation Ranking	Notes
<i>Arnocrinum gracillimum</i>	Priority 2	Not known from within close proximity to Development Envelope; recorded approximately 7 km north of Development Envelope on Dandaragan Plateau in VT 17. All regional records are from the Dandaragan Plateau – this taxon is considered to be restricted to this landform. Considered unlikely to occur in the Development Envelope based on known habitat, proximity of known records, and absence of records in the Development Envelope.
<i>Lepyrodia curvescens</i>	Priority 2	Not known from within close proximity to Development Envelope; recorded approximately 9 km north of Development Envelope in VT 5. Considered unlikely to occur in the Development Envelope based on proximity of known records, and absence of records in the Development Envelope.
<i>Lyginia excelsa</i>	Priority 1	Not known from within close proximity to Development Envelope; recorded approximately 5 km north-west of Development Envelope in VT 1. Considered unlikely to occur in the Development Envelope based on proximity of known records, and absence of records in the Development Envelope.
<i>Onychosepalum microcarpum</i>	Priority 2	Known from within close proximity to Development Envelope in VTs 1 and 5 (approximately 1 km west), however considered highly likely to have been misidentified, as all known publicly available records are located on the Dandaragan Plateau – this taxon is considered to be restricted to this landform. Records are likely to represent the superficially similar <i>Onychosepalum nodatum</i> (P3). Considered very unlikely to occur in the Development Envelope based on known habitat and proximity of publicly available records.
<i>Stenanthemum sublineare</i>	Priority 2	Not known from within close proximity to Development Envelope; recorded approximately 5 km north-west of Development Envelope in VT 17. Considered unlikely to occur in the Development Envelope based on proximity of known records, and absence of records in the Development Envelope.
<i>Stylidium aceratum</i>	Priority 2	Known from within relatively close proximity to Development Envelope in VTs 2 and 6 (approximately 2 km north), however considered unlikely to occur in the Development Envelope, as has not been recorded in the Development Envelope despite numerous surveys in suitable habitat.
<i>Stylidium carnosum</i> ?subsp. Narrow leaves (J.A. Wege 490)	Priority 1	Known from a single record (1 plant) within relatively close proximity to Development Envelope in VT 17 (approximately 1 km east), however considered unlikely to occur in the Development Envelope, as has not been recorded in the Development Envelope despite numerous surveys in suitable habitat.

3.2 Identification of Suitable Habitat for Formally Listed Significant Flora Taxa Requiring Further Survey

Based on the relevant standards and requirements presented in Section 2.2, targeted searching for the significant taxa listed in Table 1 is required to be undertaken within all suitable habitat. Suitable habitat for the significant flora taxa listed in Table 1 was defined in Woodman Environmental (2015a) (as 'preferred habitat'). Such habitat for each significant flora taxon is presented in Table 2. However, it is considered that the suitable habitat for several taxa can be further refined, as detailed below:

- The single individual of *Paracaleana dixonii* (Threatened) known from the Study Area and the Development Envelope was located in an area mapped as VT 17, a widespread VT that is broadly described as dry *Banksia* woodland on deep grey sand. However, the precise location had soil and vegetation characteristics influenced by laterite, and as such is more likely to be representative of some areas mapped as VT 18, or potentially VT 7. This location occurs in an area where the vegetation exhibits marked fine-scale changes, grading from wet heaths through to dry *Banksia* woodlands, making mapping of VT polygons difficult. As such, the preferred habitat is considered to be areas of VTs that are influenced by laterite. Such areas can be determined through a review of soil information for sample sites in the Development Envelope (e.g. quadrats established by Woodman Environmental 2014)), and a review of aerial photography. This will be completed prior to further survey being conducted.
- *Babingtonia delicata* (P1) is not known from the Development Envelope, however is known from the wider Study Area, with records in VTs 1, 5 and 17. Although Woodman Environmental (2015a) presented the preferred habitat of this species as being VTs 5 and 17, it is considered that VT 17 is not preferred habitat for this taxon, as several surveys that have recorded this taxon report that it occurs in winter-wet areas such as clay pans and flats (Western Botanical 2014; Woodman Environmental 2015b). It is therefore considered that the preferred habitat for this species should be VTs 1 and 5, with VT 17 considered to be non-preferred habitat; records in this VT are likely to be the result of discrepancies in VT mapping polygon boundaries as outlined above.
- The single location of *Hypocalymma* sp. Cataby (G.J. Keighery 5151) (P2) in the Development Envelope was recorded in VT 17, within an area that is believed to be typical of this VT (i.e. dry *Banksia* woodland). Considering that the majority of other known records of this taxon are located on creek banks, breakaways and winter-wet depressions (DPaW 2016), the habitat at single location in the Development Envelope is considered atypical. It is therefore considered that the preferred habitat for this taxon cannot be determined until the known location is visited to confirm the presence of this taxon and an assessment of its habitat is made.

As mentioned in Section 3.1, the potentially undescribed taxon with affinities to *Thelymitra pulcherrima* is known to occur within close proximity to the Study Area in sandy-clay soils influenced by laterite. It is therefore considered that suitable habitat for this taxon is areas of VTs that are influenced by laterite; as outlined above, such areas can be determined through a review of soil information for sample sites in the Development Envelope and a review of aerial photography.

Table 2: Suitable Habitat for Formally Listed Significant Flora Taxa Requiring Further Survey

Taxon	Conservation Ranking	Suitable Habitat
<i>Andersonia gracilis</i>	Threatened	VTs 1, 2, 5
<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	Threatened	VT 1
<i>Macarthuria keigheryi</i>	Threatened	VTs 17, 18
<i>Paracaleana dixonii</i>	Threatened	Areas influenced by laterite
<i>Babingtonia delicata</i>	Priority 1	VTs 1, 5
<i>Grevillea thelemanniana</i> subsp. Cooljarloo (B.J. Keighery 28 B)	Priority 1	VTs 1, 2
<i>Calectasia palustris</i>	Priority 2	VTs 2, 7
<i>Chordifex reseminans</i>	Priority 2	VTs 1, 5
<i>Hypocalymma</i> sp. Cataby (G.J. Keighery 5151)	Priority 2	Unknown (potentially VT 17) – investigation of known location required
<i>Thelymitra pulcherrima</i> *	Priority 2	Areas influenced by laterite

*Note: represents a potentially undescribed taxon that is currently being treated as *Thelymitra pulcherrima* (Priority 2).

3.3 Survey Timing for Formally Listed Significant Flora Taxa

The timing of surveys will correspond with the most appropriate time for confident identification of the taxa. The ideal survey timings for the target taxa are listed in Table 3. From this it is considered that surveys for all taxa except *Paracaleana dixonii* and *Thelymitra pulcherrima* should commence in mid-September 2016 and preferentially conclude by the end of October 2016.

This timing corresponds with the known flowering periods of all remaining taxa except *Babingtonia delicata*, *Chordifex reseminans* and *Hypocalymma* sp. Cataby (G.J. Keighery 5151) (Western Australian Herbarium 1998-). *Babingtonia delicata*, while being superficially similar to *Babingtonia urbana*, a species also known from the Study Area, is a relatively large plant that can be identified confidently in the absence of flowers. This is also the case for *Chordifex reseminans*, with material required for identification generally persisting on the plants of this species for the majority of the year (although potentially not through the dry summer and autumn months). *Hypocalymma* sp. Cataby (G.J. Keighery 5151) is known to flower in August, however it is expected that it would continue to flower into the proposed survey period.

Table 3: Ideal survey timing for target flora taxa

Taxon	Conservation Ranking	Ideal Survey Timing
<i>Andersonia gracilis</i>	Threatened	September to October
<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	Threatened	September to October
<i>Macarthuria keigheryi</i>	Threatened	September to October
<i>Paracaleana dixonii</i>	Threatened	Mid October to mid December
<i>Babingtonia delicata</i>	Priority 1	November to February
<i>Grevillea thelemanniana</i> subsp. Cooljarloo (B.J. Keighery 28 B)	Priority 1	September to October
<i>Calectasia palustris</i>	Priority 2	September to October
<i>Chordifex reseminans</i>	Priority 2	June to December
<i>Hypocalymma</i> sp. Cataby (G.J. Keighery 5151)	Priority 2	August to October
<i>Thelymitra pulcherrima</i> *	Priority 2	June to mid-August

*Note: represents a potentially undescribed taxon that is currently being treated as *Thelymitra pulcherrima* (Priority 2).

Paracaleana dixonii can only be identified during its flowering period, which is considered to be mid-October to mid-December (Western Australian Herbarium 1998-). All surveys for this taxon will therefore be undertaken within this period.

The potentially undescribed taxon with affinities to *Thelymitra pulcherrima* can also only be identified during its flowering period, which is considered to be late June to mid-August (Andrew Brown *pers. comm.* 2015). All surveys for this taxon will therefore be undertaken within this period.

Although not desirable, it is also considered acceptable for survey for all taxa except *Thelymitra pulcherrima* to be undertaken during November if required. This may be outside the flowering period for *Hypocalymma* sp. Cataby (G.J. Keighery 5151), and is towards the end of the known flowering periods of *Andersonia gracilis* and *Anigozanthos viridis* subsp. *terraspectans*, however these species would still retain material that would enable positive identification, and would still remain relatively visible to searchers, although less so than when in full flower.

3.4 Survey Method for Formally Listed Significant Flora Taxa

A two-phase survey method is proposed with regard to further survey for significant flora taxa. The first phase involves targeted searches for significant flora taxa (as listed in Table 1) within all suitable habitat (as listed in Table 2) within the Footprint and Development Envelope, to gather quantitative data on the abundance and distribution of such taxa. This will facilitate an accurate assessment of impacts of the CLW Project to such taxa in terms of number of individuals to be impacted.

The second phase involves collecting quantitative data on the abundance and distribution of significant flora taxa (as listed in Table 1) in the wider Assessment Area, to allow for potential impacts to such taxa from the CLW Project to be appropriately assessed in a local and regional context. The objective of this phase is to ensure adequate contextual information is available to characterise the significance of the impacts associated with the CLW Project.

The scope of Phase 2 will be determined following review of quantitative data collected in Phase 1 (survey within the Footprint and Development Envelope). Where this review indicates proportional impact on any target taxon is ranked above Low as per Woodman Environmental (2015a) Table 4b (i.e. the CLW Project will impact on more than 10% of known individuals within the assessment area), and it is determined that additional survey would provide greater confidence in the impact significance ranking, Phase 2 will proceed.

Phase 1 (Footprint and Development Envelope)

The following method is proposed for all significant flora taxa listed in Table 1, except *Macarthuria keigheryi* (as per Section 3.1).

- All known locations of significant flora taxa will be visited, and a full census of the population will be conducted, with a thorough search of all surrounding discrete suitable habitat conducted, and all individuals counted and their locations (either individual plants or clumps of plants) recorded using a GPS.
- All suitable habitat for significant flora taxa (as presented in Table 2) will be searched for such taxa via foot transects, using a grid pattern with no greater than 50 m spacing between transects. The grid pattern will take into account previously surveyed transects (e.g. drill lines), with previously surveyed transects not repeated (i.e. the new transects will be infill transects). Any populations encountered will be subject to a full census as outlined above (i.e. the entire population will be subject to the census, including individuals located between transects).

Although a spacing of 50 m may imply some uncertainty that all populations of significant flora taxa will be found, this spacing has been found in the past by Woodman Environmental to be efficient at identifying the presence of populations of significant flora taxa, including such taxa that are small in stature (e.g. *Paracaleana dixonii*). This spacing has previously been approved and utilised for targeted significant flora surveys to support impact assessments for other proposals in the general vicinity of the CLW Project (e.g. Iluka Resources' IPL North proposal (Woodman Environmental 2012)).

For *Macarthuria keigheryi*, it is proposed that a selection of locations (corresponding to the larger of the known populations in the Development Envelope) are visited, to compare previously recorded individual numbers to individual numbers currently present. This is to test the hypothesis presented in Section 3.1 that the majority or all individuals have senesced since they were originally recorded. If this is found to be the case, no further survey will be conducted. If the numbers of individuals are similar to those originally recorded, it is proposed that further survey for this species in the Development Envelope will be conducted as for other significant flora taxa.

It should also be noted although only the taxa listed in Table 1 are considered to require further survey, and hence determine the suitable habitat to be surveyed, all significant flora taxa will be recorded while conducting the surveys for the taxa listed in Table 1. This includes the Priority 1 and 2 taxa listed in Table 2.

Phase 2 (Assessment Area outside Development Envelope)

As outlined above, Phase 2 will collect quantitative data on the abundance and distribution of significant flora taxa in the wider Assessment Area however will only proceed if the level of impact requirement outlined above cannot be met by existing quantitative data and it is considered that additional survey will improve the impact assessment findings. The following method is proposed for all significant flora taxa listed in Table 1, except *Macarthuria keigheryi* (as per Section 3.1).

- A sufficient number of known populations of significant flora taxa will be visited to record individuals, such that the level of impact requirement outlined above can be met. Populations will be subject to the census method outlined for Phase 1. Priority will be given to known populations within secure conservation tenure (i.e. Nature Reserve) in the Assessment Area.
- If required, a sufficient area of suitable habitat for significant flora taxa (as presented in Table 2) will be searched for such taxa via foot transects to locate and census populations of significant flora taxa, such that the level of impact requirement outlined above can be met. The foot transects and census method will be the same as for Phase 1.

For *Macarthuria keigheryi*, further survey in the wider Assessment Area will only proceed if either of the following scenarios occurs:

- Phase 1 survey determines that numbers of individuals currently present within populations located in the Development Envelope are similar to those originally recorded (see Phase 1). In this case, further survey in the Assessment Area will proceed as outlined above for other significant flora taxa.
- A fire affects suitable habitat in the Assessment Area outside the Development Envelope during the summer or autumn of 2016. In this case, irrespective of the results of Phase 1 survey for this taxon, suitable habitat will be searched to identify additional populations of the taxon, with quantitative data collected to be utilised in assessing the potential impacts of the CLW Project to this taxon. Possible fire locations can be obtained from sources such as the Commonwealth Government's Sentinel database (Geoscience Australia 2016). In this case, further survey in the Assessment Area will proceed as outlined above for other significant flora taxa, to an extent that is considered reasonable with respect to the size of the fire-affected area.

3.5 Survey Results and Documentation

Final documentation to be produced following the completion of all surveys will include the final methods and results of the surveys, as well as a revised assessment of impacts on all conservation significant flora taxa. Additionally, the documentation will include a

consolidated review of relevant previous surveys and assessments, which will be sufficient to:

- Justify conclusions relating to the likelihood of each significant flora taxon occurring within the Development Envelope;
- Demonstrate sufficiently strong associations between significant flora taxa and VTs to justify the identification of suitable habitat for significant flora taxa as mapped areas of VTs;
- Justify the omission of previously surveyed drill lines in the survey approach; and
- Justify any decisions to conduct survey outside the flowering season of any of the taxa listed in Table 1 should this occur.
- Validate or revise vegetation community type boundaries within the development Envelope and Study area (as relevant) based on survey findings

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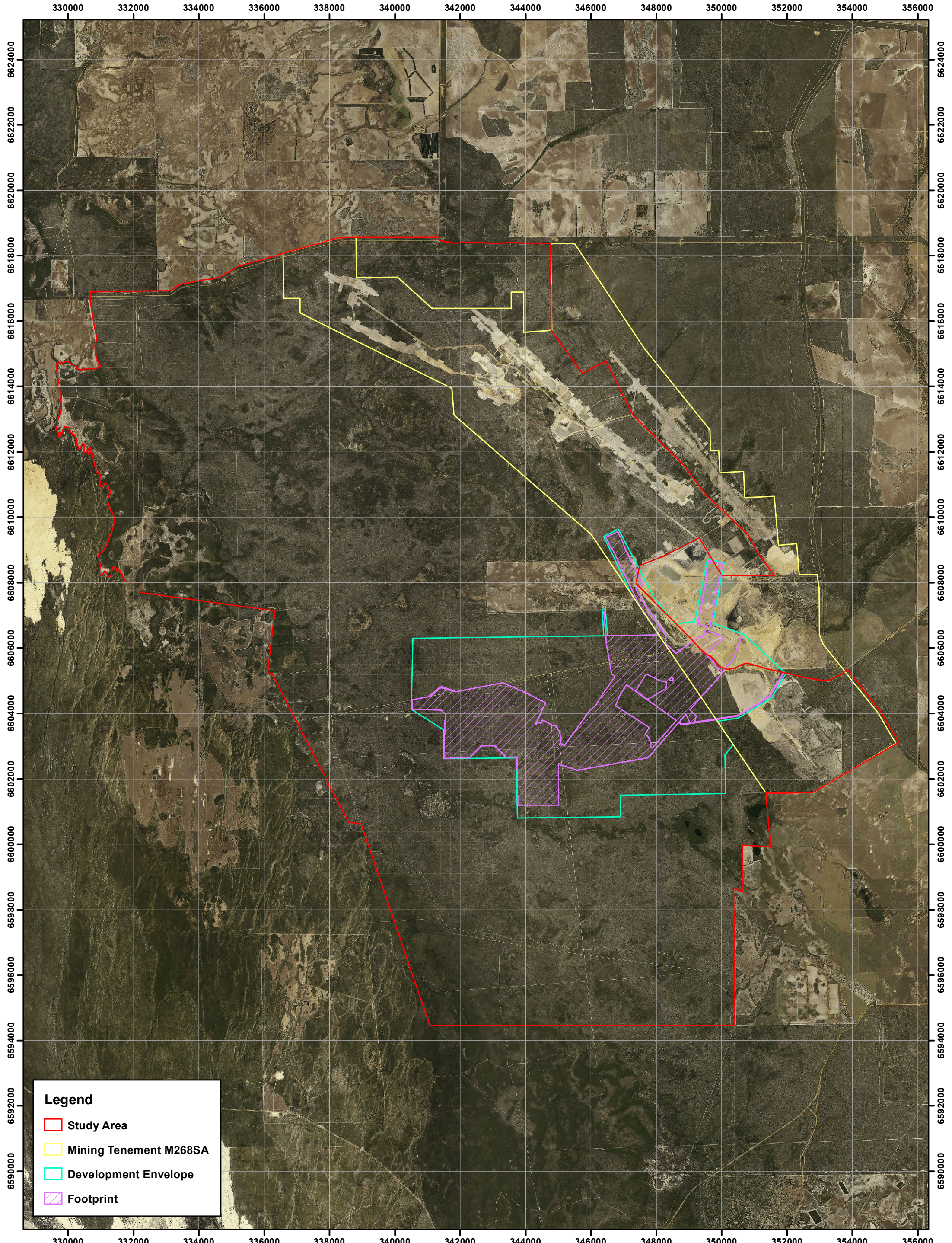
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Legend

- Study Area
- Mining Tenement M268SA
- Development Envelope
- Footprint



This map should only be used in conjunction with WEC report Tronox16-03-01



**Cooljarloo West Titanium Minerals Mine
Relevant Areas**

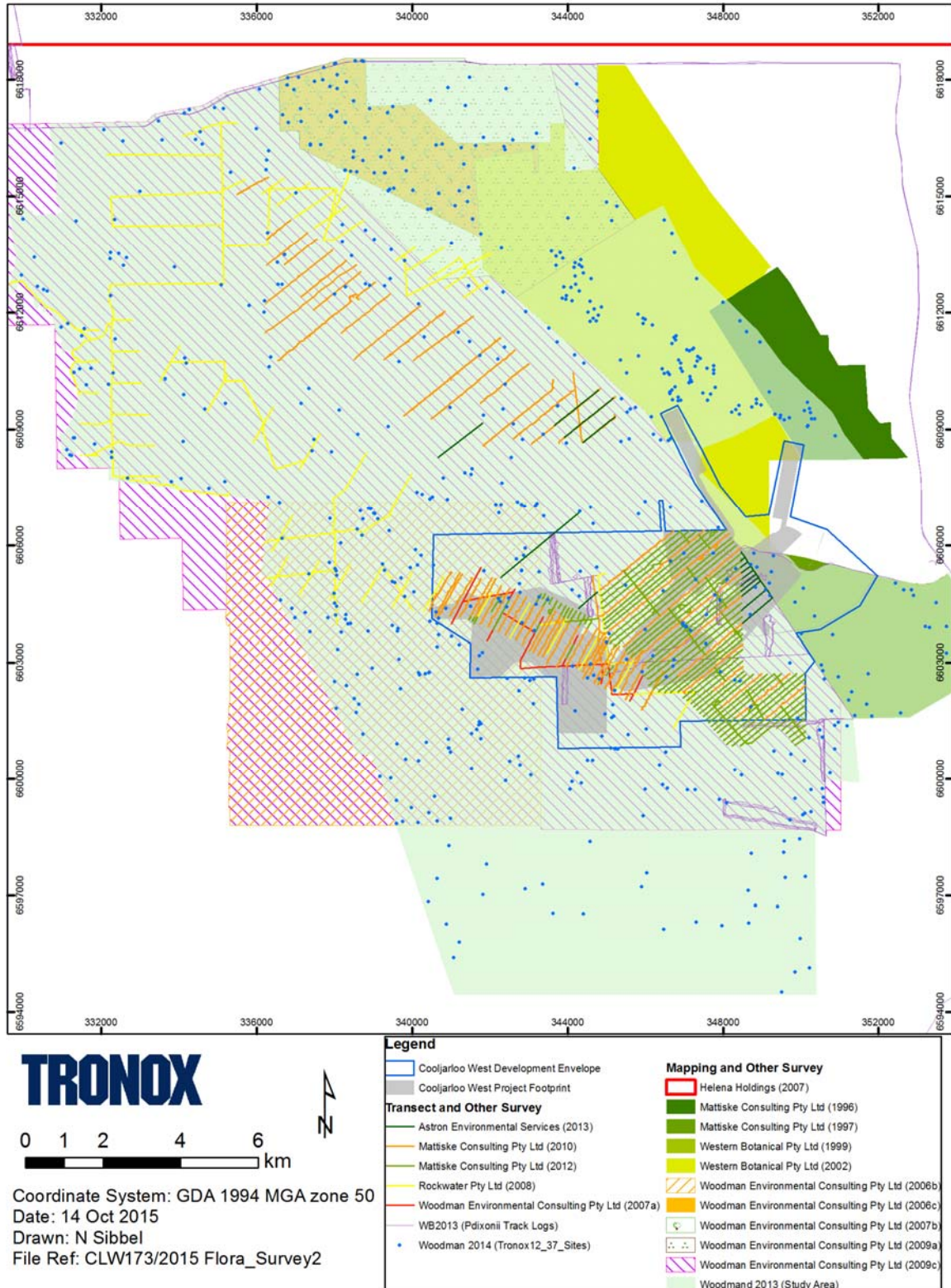
Revision: A - 17 February 2016

Author: David Coultas
WEC Ref: Tronox16-03-01
Filename: Tronox16-03-01-f01.mxd
Scale: 1:100,000 (A3) Grid: MGA Zone 50

Figure
1

Appendix A: Previous Flora and Vegetation Studies Conducted in the Study Area and Surrounds

Flora surveys conducted within the Study Area are listed in the table below and their extent represented in the preceding figure.



Survey (Report reference)	Timing of Survey	Location of Survey	Purpose	Type of Data Collected	Size of Survey Area (ha)
Mattiske Consulting Pty Ltd (Mattiske) (1996) (TIW007/203/96)	April 1996	North Mine	Community mapping & significant flora survey / review	Reference sites; no quadrats established	700
Mattiske (1997) (TIW014/37/97)	September 1997	27000 (South Mine)	Community mapping & significant flora survey / review	Reference sites; no quadrats established	1 000
Landcare Services (1999) (LSC 92)	August 1999	ML application 70/1010	Community mapping and significant flora survey / review	No reference sites, transects walked; Survey for significant flora taxa	100
<i>ecologia</i> (2000)	November 1999	Lancelin DTA Extension (includes majority of Study Area)	EIA mapping and significant flora survey / review	55 quadrats established	35 000
Landcare Services (2002b)	2001-2002	Regional – Greenhead to Lower Chittering, Moora to Watheroo	Significant flora regional survey / review	Targeted searching for significant flora species	NA
Western Botanical (2002)		North and western portion of the Cooljarloo Mine Lease	Community mapping	Unknown	4,500
Woodman Environmental (2006b) (Empire05-20)	September-November 2005; May 2006	Mullering (vicinity of Woolka Rd)	Community mapping and significant flora survey / review	131 detailed recording sites; Targeted survey for significant flora taxa undertaken	6 680
Woodman Environmental (2006c) (Tiwest05-37)	November 2005	Falcon	Community mapping and significant flora survey / review	Detailed site recordings	1 233
Woodman Environmental (2007a) (Tiwest06-23)	December 2006	Cooljarloo West	Significant flora survey / review	Survey of drill lines for significant flora taxa	NA
Woodman Environmental (2007b) (Tiwest06-23)	October - November 2006	Falcon (and adjacent UCL and Nature Reserves (regional plots)) M70/1162 & M70/1163	Community mapping and significant flora survey / review	27 quadrats established (in Falcon); 24 quadrats established (regional plots)	1 233
Rockwater Pty Ltd 2008	October-Dec 2007	Cooljarloo West	Significant flora survey / review	Survey of drill lines for significant flora	NA
Helena Holdings (2007) (Tiwest07-01)	October – December 2007	Wongonderrah Road to Regans Ford	Significant flora survey / review	Survey for populations of <i>Schoenus</i> species	Not detailed
Woodman Environmental 2009 (Tiwest 09-62-01)	September-October 2009	Cooljarloo West	Targeted significant flora survey / review	Survey of drill lines for significant flora	NA
Mattiske 2010(TJV1002)	September-December 2010	Cooljarloo West & North West	Significant flora survey / review	Survey of drill lines for significant flora	N/A
Astron Environmental Services (Astron) (2013a) (16502b-12-BSR-1Rev1_130205)	October – November 2013	Cooljarloo West, Cooljarloo North West, Cooljarloo South West	Significant flora survey / review	Survey of drill lines for significant flora taxa	NA

Survey (Report reference)	Timing of Survey	Location of Survey	Purpose	Type of Data Collected	Size of Survey Area (ha)
Astron (2013b) (16504-12-BSR-2Rev0_130507)	December 2012	Cooljarloo West	Significant flora survey / review	Survey of drill lines for significant flora taxa	NA
Astron (2013c) (16504-12-BSR-1Rev1A_130530)	December 2012	Cooljarloo North West	Significant flora survey / review	Survey of drill lines for significant flora taxa	NA
Woodman Environmental (2014) (Tronox12-37-01)	January 2014	Cooljarloo West	Vegetation mapping and significant flora review	Reference sites, 370 quadrats	34,400
Western Botanical (2014) (WBS819)	December 2013	Cooljarloo West & Broader Region	Targeted significant flora survey	Targeted local and regional survey for <i>Paracaleana dixonii</i>	NA
Western Botanical (2014a) (WBS820)	February 2014	Cooljarloo West and broader region	Targeted significant flora survey	Targeted local and regional survey for <i>Malleostemon</i> sp. Cooljarloo and <i>Baeckea</i> sp. Perth Region	NA