Appendix I

Coomberdale TEC Flora Assessment (Trudgen 2018)

COMPARISON OF

THE FLORA AND VEGETATION OF

THE PROPOSED NORTH KIAKA MINE AREA

TO OTHER PARTS OF THE COOMBERDALE

CHERT THREATENED ECOLOGICAL

COMMUNITY

Prepared for

SIMCOA OPERATIONS Pty Ltd

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1.0 INTRODUCTION

1.1 Purpose of this report

The purpose of this report is to document the vegetation and flora of an area north of Kiaka Road in the Moora area where Simcoa Operations Ltd. ("Simcoa") plan to develop the proposed North Kiaka Mine (see Map 1). An important part of this documentation is to compare the vegetation and flora of the proposed impact areas to the overall flora and vegetation values of the Coomberdale Chert Threatened Ecological Community (TEC), in which the proposed North Kiaka Mine is situated. Comparisons are also made to the part of the Coomberdale Chert Threatened Ecological Community north of Kiaka Road as that area has floristic differences to the part of the TEC south of Kiaka Road.

Simcoa currently operate a small chert mine about 15 km north of Moora, south of Kiaka Road and east of the Midlands Road in the Midlands district. The chert mined is part of a geological unit called the Noondine Chert (formerly the Coomberdale Chert). The earlier name is still used in the name of the threatened ecological community developed on the chert.

1.2 The Coomberdale Chert Threatened Ecological Community

The proposed North Kiaka Mine will be located in part of a threatened ecological community which has the full title "Heath dominated by one or more of *Regelia megacephala*, *Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region" (Dep. Parks & Wildlife 2013). For simplicity, this threatened ecological community (TEC) will be referred to in this report by the shortened name Coomberdale Chert Threatened Ecological Community (following Dep. Parks & Wildlife 2013), or when appropriate as the Coomberdale Chert TEC, or simply the TEC.

The Noondine Chert and detrital material derived from it is the geological substrate of the Coomberdale Chert TEC, a complex of vegetation types that has been "assessed as Endangered by the Threatened Ecological Communities Scientific Advisory Committee on 29 October 1999 and this rank was endorsed by the Minister for Environment on 6 November 2001." (Dep. Parks & Wildlife 2013). This complex of vegetation types has high conservation value for vegetation and flora because of the limited area of the vegetation comprising it, its distinct floristic composition, the occurrence of declared rare and priority flora species in the vegetation (some of which are restricted to it) and the occurrence of disjunct populations of other species. The Coomberdale Chert TEC was first identified as a distinct floristic unit (an area of vegetation defined on the basis of flora species composition) in a detailed study at a subregional level of the remnant vegetation in the Bindoon to Moora area (Griffin 1992).

It is important to understand that the Coomberdale Chert Threatened Ecological Community is not a *community* in the sense of the word as used in the definition of *plant community* the lower order unit in the formal schemes of vegetation description. Plant community in formal vegetation description has a quite narrow definition, whereas the use of community in the term *The Coomberdale Chert Threatened Ecological Community* is a very broad sense of the word not related to formal vegetation description schemes. Rather, it is a catchall name for all the vegetation on the outcrop of the Coomberdale Chert and on detrital slopes derived from it. The Coomberdale Chert Threatened Ecological Community has very varied vegetation and is better considered a vegetation complex (a grouping of plant communities on related substrate) from a vegetation description point of view, rather than a community. "Ecological community" is a term that is used to define such complexes of vegetation (or other types of biological "communities") that are considered to be of particular conservation value. That is, it is largely an administrative term, not a term with a defined scientific usage.

1.3 Previous surveys of the Coomberdale Chert Threatened Ecological Community and work needed for this report

Several earlier reports documenting the vegetation and flora of areas of the Coomberdale Chert Threatened Ecological Community (TEC) cover a group of properties from north of Kiaka Road south to Dalaroo East Road. These report have provided detailed vegetation mapping, a floristic analysis of the vegetation, the results of searches for declared rare and priority flora and a flora inventory (Trudgen *et al.* 2012, 2006, 2001, and Trudgen 1985). The information in reports prior to Trudgen *et al.* 2012 has been incorporated in that report.

The series of studies carried out on the area of the Coomberdale Chert TEC that has been previously surveyed for flora and vegetation mean that is one of the best know areas of its size in Western Australia for these biological values. However, the earlier surveys have not had the proposed North Kiaka mine areas as a focus. To ensure this area was adequately known for assessment of the proposed North Kiaka Mine, further survey work was carried out. As the vegetation had been mapped in some detail (Trudgen *et al.* 2012), the further work was largely detailed flora surveys on transects across the remnants of the TEC and a review of the knowledge of the flora of the Coomberdale TEC. This included reviewing the naming of specimens collected for the earlier surveys. Of some note is that since much of the earlier work was carried out, more detailed information on the distribution of flora species has become available, raising questions relating to the taxonomy of flora species.

Therefore, the current report will supplement Trudgen *et al.* (2012) by providing more detailed flora searches of the proposed impact area, an updated flora list, and a comparison of the vegetation values of the proposed impact areas to the other parts of the Coomberdale Chert threatened Ecological Community that have been surveyed.

1.4 Location of the proposed North Kiaka Mine and areas surveyed

The survey area consists of remnant vegetation on parts of parallel low chert ridges centred seventeen kilometres slightly east of north of the town of Moora, which is some one hundred and forty-five (145) kilometres due north of Perth. The remnants surveyed are on three ridges that trend from the north-north-west to the south-south-east. The southern end of the 1.4 kilometre long area surveyed is 500 metres north of Kiaka Road and 2.2 kilometres east of the Midlands Road (Map 1). The ridges are separated by narrow cleared strips and are part of a larger group of ridges north of Kiaka Road.

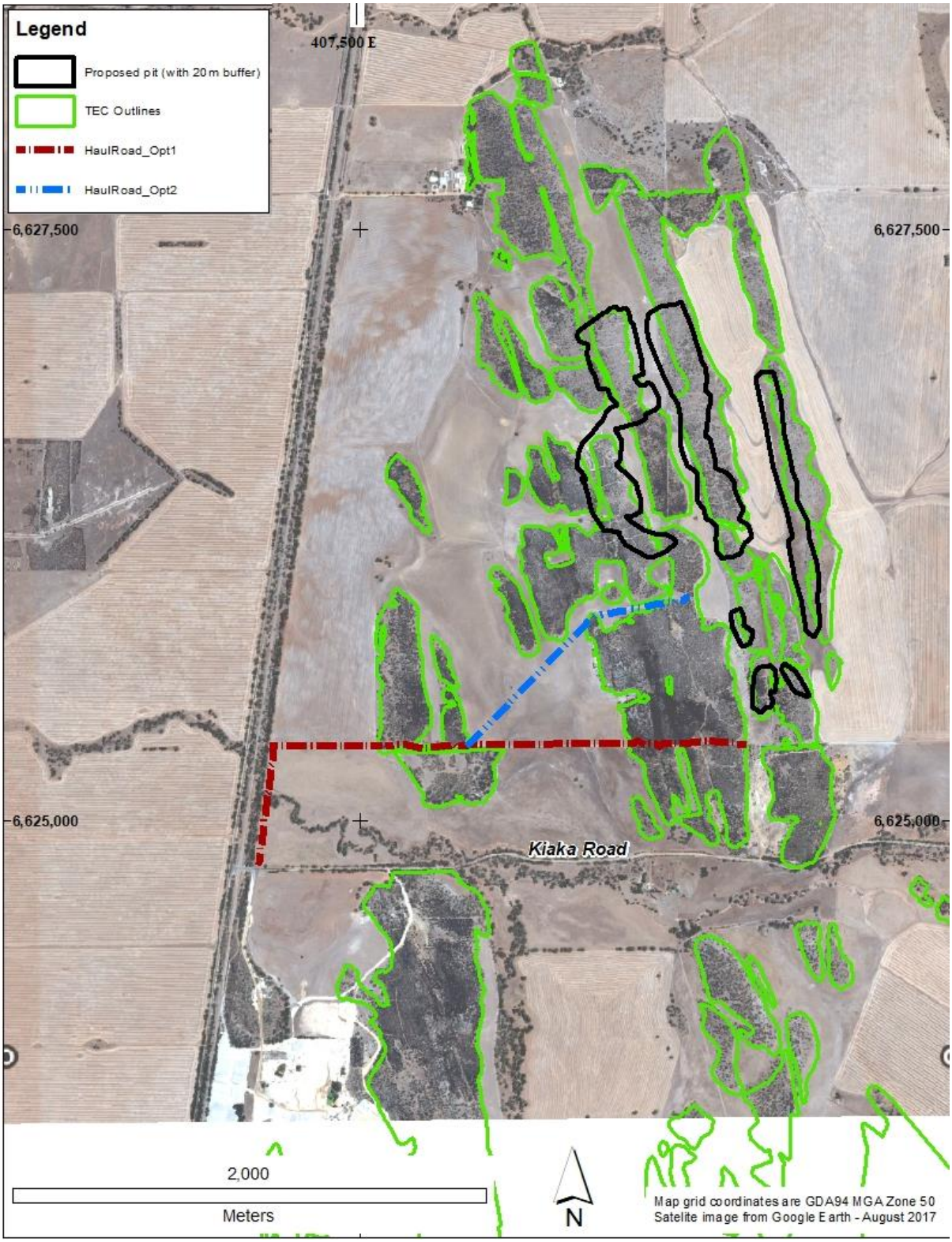
1.5 Definitions of terms used

A number of terms relating to flora and vegetation are used in this report; working definitions of these terms are given and discussed in Trudgen *et al.* (2012). Terms relating to flora include: declared rare flora, priority flora, [other] species of conservation significance (previously unknown species; species at the ends of their range; disjunct populations; known species that are uncommon or rare, but have not yet been declared or listed as priority species). Terms relating to vegetation defined and discussed include: vegetation; dominant species; stand, stratum (strata); plant community; vegetation association; vegetation formation; vegetation structure (and schemes describing its variation); quadrat or plot; floristic community type; habitat; ecological community; threatened ecological community; endangered ecological community. Terms relating to conservation defined and discussed are: conservation value; conservation status; reservation status.

1.6 Climate of the survey area region

The region including the survey area has a Mediterranean climate, with a cool wet winter and summer drought. The summers are warm to hot, with average maxima of approximately 30° Celsius and extremes of over 40° Celsius. The winters are cooler and milder with average maximum temperatures between 15° and 20° Celsius and minimums of around 5° Celsius.

The average annual rainfall is 463 mm, the majority of which falls from May to September. Figure 1 of Griffin (1992) shows rainfall and temperature graphs for the survey area and compares them with other regional centres.



Map 1: Location of the proposed North Kiaka Mine pits and haul road options

Notes: The green lines enclose areas of the Coomberdale Chert TEC. The black lines enclose the proposed mine pit outlines with (i.e. plus) a 20 metre buffer. The red and blue lines are two options for haul road access. Botanical surveys carried out in 2016 and 2017 were mainly carried out in the mine pit areas, adjoining areas, and along the haul road options.

1.7 Geology of the survey area

The underlying rocks of the survey area belong to the Middle Proterozoic Moora Group These sedimentary rocks are separated from the Darling Plateau by a series of poorly defined faults (Griffin, 1992). The Noondine (Coomberdale) Chert Formation, which outcrops frequently in the survey area, is part of the Moora Group. "It consists of bedded chert, chert breccia, orthoquartzite, silicified limestone and dolomite and contains significant siliceous siltstone and sandstone beds, and minor claystone." (Carter and Lipple 1982).

The largest and most extensive area of outcrops of the Noondine Chert is between Dalaroo and Coomberdale and includes Cairn Hill, a highpoint approximately fifteen kilometres north of Moora. This area has several faults present, perhaps most notably the Kiaka Fault, which runs NW-NE near Kiaka Road south of the survey area for this report.

1.8 Topography of the survey area

The survey area contains parts of a series of more or less parallel northerly-southerly trending ridges of chert, with swales between them. The ridges are formed from the higher, more resistant to erosion, parts of the Noondine Chert Formation. There is a larger valley just east of the survey area and more chert ridges to the west. The ridges vary in cross section, some having gentle slopes on both sides, or steeper slopes on one side. There were some steep rocky areas, but the slopes are mainly gentle to moderate, with a few being quite steep.

1.9 Soils of the survey area

The soils on the chert ridges vary in depth from skeletal on the blocky outcropping chert, to gravelly, loamy sands lower down the slopes (Griffin, 1992). The surface soil was often pale grey, silty, fine sand. The soils in the valleys between the ridges are deeper over clay and broken rock (A. Tonkin *per. com*. and personal observation).

1.10 Mapping summary of landscape, soils and remnant vegetation

Map 2 gives a regional scale visual summary of the topography, distribution of soils-landscape mapping units and the extent of remnant vegetation in an area containing the current survey area. There is a set of adjoining sheets in Trudgen *et al*. (2012) showing variation along the extent of the Coomberdale Chert.

Of particular interest is the existence of two soil-landscape mapping units in the region that both occur on the Noondine Chert. These are two landscape divisions of the Moora Group. The first is the Coorow Landscape (Chert subsystem) this has gentle topography with low stripping of the soils by erosion. It occurs to the north of the current survey area and does

include some chert outcrop (and has some smaller occurrences of the Coomberdale Chert TEC outside the areas mapped by Trudgen *et al* 2012). The second is the Coomberdale Landscape (Chert subsystem). This has gentle to moderate topography with moderate stripping of the soils by erosion. The survey area lies within areas of the Coomberdale Landscape (Chert subsystem). The surface in the Coomberdale Landscape (Chert subsystem) generally has outcropping chert on the higher parts and colluvium with chert gravel on the slopes. The Coomberdale Chert Threatened Ecological community mainly occurs on these ridges and the adjoining colluvium.

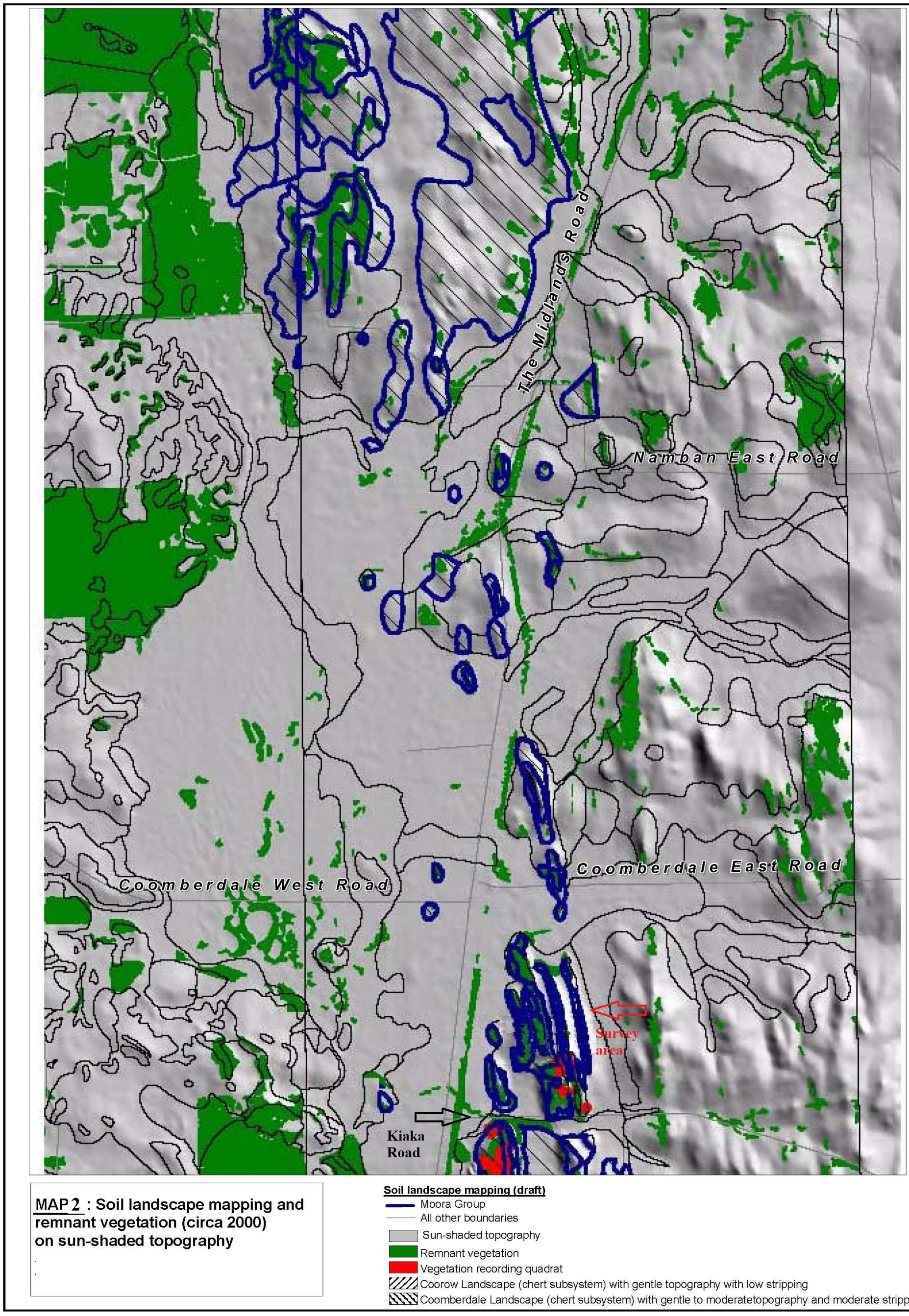
1.11 Some species common in the survey area

In order to understand the descriptions of the vegetation of the survey area provided in this report and the relationship of this vegetation to other vegetation it is necessary to have some familiarity with the species that form it. It is particularly important to have some familiarity with those species that are relatively important in the vegetation because they are major contributors to the vegetation, i.e., are the dominants, providing the structure of the vegetation.

Brief descriptions of a number of the species important in the structure of the vegetation of the Coomberdale Chert Threatened Ecological Community are given in section 5 of Trudgen *et al*. (2012). Note that the species referred to *Xanthorrhoea drummondii* and *Calytrix leschenaultii* in that report are now considered to represent undescribed species restricted to the Coomberdale Chert TEC and some small nearby areas (see below).

1.12 Vegetation description methodologies

The description of vegetation and the analysis of it for conservation purposes is not particularly complex. However, there are some confusing aspects for those who are not familiar with it. There are two basic approaches used. The first approach is the description and mapping of units based on the structure, dominance by different species and flora composition of stands. In this system individual stands of vegetation are grouped into a hierarchy of levels (stand, plant community, vegetation association, vegetation formation; and intermediate levels between them). The second approach is the definition of units based on the similarity of the species composition of stands using computer based programs to carry out the mathematics, the level of grouping being arbitrary.



Map 2: Regional scale soil landscape mapping and remnant vegetation (circa 2000) on sun-shaded topography of an area including the survey area. Note: Kiaka Road and the location of the survey area are in the centre of the bottom part of the map.

Some confusion comes in because the level above stand in the first approach is called plant community and has a tight definition, while the units of the second approach are called floristic community type, but can range in level from below plant community to above vegetation formation as there is no formalised set of units of different levels. The use of the word "community" in both systems, with quite different meanings, causing confusion. The issues touched on in this sub-section are dealt with in more detail in Trudgen *et al.* (2012) section 6.

1.13 Appropriate use for conservation value assessment of different vegetation description units

The range of different vegetation units (different types and different levels) that are useful in describing different aspects of the vegetation of an area have different uses in assessment of the values of such an area for conservation vale. For example a broad level of mapping (vegetation association or higher) can put an area in context using structure and dominance, while a more detailed level (sub-association or plant community) can be used to compare the values of two areas that are mapped as the same unit at a higher level for these values. On the other hand, floristic site data analysed to give "floristic community types" of different levels can provide more detailed information on the differing species composition of the floristic community types defined. These issues are discussed in more detail in Trudgen *et al.* (2012) section 7.

Good analyses will integrate the different strengths of the different approaches to describing the different attributes of vegetation to provide an overall assessment. However, actual use of the units for both systems for conservation assessment can be difficult, as there is usually no mapping of plant communities or vegetation association for a suitably sized area around a project area or no database of sites to compare new site data too. However, in the current case, we have both vegetation mapping of a suitable sized area and a database of sites outside the proposed impact areas for comparison of floristics that has been used in a floristic analysis (in Trudgen *et al*. 2012).

1.14 Botanical context for the project area and definition of the Coomberdale Threatened Ecological Community

To make an assessment of any area for the conservation vale of the native vegetation found in it, it is necessary to set an appropriate, scientifically justifiable boundary or boundaries. These will vary from project to project and for different levels of an assessment. The current project survey area lies in the South West Botanical Province of Beard (1980), one of the three botanical provinces defined by Beard for Western Australia. Within this province, it is located in the Avon Botanical District, close to the border of the Darling Botanical District.

At a more detailed level, Griffin (1992) surveyed an area from Bindoon to north of Moora, his study area samples parts of several of Beard's botanical districts, including the part of the Avon Botanical District the project area lies in. Griffin used floristic and cover data to define "floristic regions" for his study area and within these what he called "vegetation types". Further discussion of the relevance of this study to the current project area is given in Trudgen *et al.* (2012) section 8. Griffin placed the chert hills of the Noondine (Coomberdale) Chert in his Coomberdale Floristic Region, which extends from Moora to Jingemia Hill in the Watheroo National Park northwest of Watheroo.

The largest and most extensive area of outcrops of this chert, and hence the largest representation of the vegetation of the Coomberdale Floristic Region occurs between Dalaroo and Coomberdale. This is in the area of the landscape type (see Map 2, above) described for the Coomberdale Chert that has higher topography and more stripping (erosion); the Coomberdale Landscape (chert subsystem). Three of Griffin's (1992, see pp. 134, 135, 136) "vegetation types" (numbers 23, 25 and 26) are important in the vegetation of the survey area of Trudgen *et al.* (2012) that covers much of this landscape type. Hamilton-Brown (2000) has discussed the vegetation on the chert hills of the Coomberdale Floristic Region, recasting Griffin's three "vegetation types" as three "sub-units" of the Coomberdale Chert Threatened Ecological Community. The appropriate biological context for vegetation and flora of the Simcoa Operations Ltd. proposal is therefore the Coomberdale Chert Threatened Ecological Community.

The definition of the Coomberdale Chert Threatened Ecological Community has been updated in Department of Parks and Wildlife (2013), an interim recovery plan for the TEC. The plan also provides the location of occurrences of the TEC and some discussion of management and ecological issues.

1.15 Rarity in relation to vegetation

Any assessment of the rarity of an area of vegetation depends on the level of description used, the boundary the assessment is related to and a decision regarding what constitutes rarity in the sense of either a relative measure (for example an attribute such as the remaining percentage of the original extent), or an absolute measure (e.g. having an original extent that was small enough to be inherently rare, or being reduced to an area that is inherently rare). These issues are discussed further in Trudgen *et al.* (2012).

While it may seem unnecessary to discuss rarity in relation to a threatened ecological community such as the Coomberdale Chert TEC, it needs to be remembered that this is a composite unit that contains a number of vegetation associations (and within these plant communities) that have varying areas and numbers of occurrences and hence varying rarity.

2.0 METHODS AND LIMITATIONS OF THE VEGETATION AND FLORA SURVEYS

2.1 Methods of the earlier flora surveys

The documentation of the flora of the proposed North Kiaka Mine area and its comparison to the parts of the Coomberdale Chert Threatened Ecological Community that have been surveyed is based on a series of surveys (Trudgen 1985, Trudgen *et al.* 2001, 2006, 2012) and additional rare flora surveys of the proposed impact areas in 2016 and 2017 (see 2.2 below). The earlier work provides detailed knowledge of the flora of the parts of the Coomberdale Chert TEC surveyed and was based on:

- Collection of flora specimens during the initial recording and re-visiting of floristic survey/vegetation survey quadrats;
- Collection of flora specimens during recording of releves for vegetation mapping;
- Opportunistic collections of flora specimens made between the quadrats and releves, especially of species not previously recorded;
- Collection of flora specimens during a systematic survey of the distribution of declared rare and priority flora over much of the area of the Coomberdale Chert TEC that has been surveyed for vegetation (see maps in Trudgen *et al.* 2012).

During the work for the earlier reports, three thousand seven hundred and fifteen (3,715) flora collections were made for the identification of species occurring in the quadrats, about another one thousand five hundred (1,500) collections were made during the vegetation mapping, on route between quadrats and releves and during the rare flora search. A further two hundred and sixty-six (266) collections were made while surveying Arthur and Rhonda Tonkin's property. This gives a total of about five thousand four hundred and sixty (5,460) collections made for the whole area covered Trudgen *et al.* (2012). The resulting flora list also incorporates records from the original survey of the mine site (Trudgen 1985) and data from Griffin (1992) from his sites located within the Trudgen *et al.* (2012) area.

The collection, drying and identification of specimens for the 2016 field work is as given in Trudgen *et al.* (2012). All specimens (except those donated to the Western Australian Herbarium as voucher specimens) collected for the earlier surveys were reviewed together to ensure consistency of naming. The naming of specimens that had been vouchered was reviewed by checking current naming on electronic data bases. The methods for earlier flora searches are also given in Trudgen *et al.* (2012).

As the flora of the Coomberdale Chert TEC is very well known, a search of Government databases for declared rare flora and priority flora records for the area would have been

pointless. Maps of the distribution of the declared rare flora and priority flora species for the whole area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* 2012 are given in that report.

2.2 Aims and methods for the 2016 and 2017 flora searches

The aim of the 2016 and 2017 flora searches was to increase the detail of knowledge for flora of the proposed impact areas of the North Kiaka Mine. This meant not only declared rare and priority flora, but all flora, so that a comprehensive flora list could be given for these areas. To do this, searches were carried out on lines across the vegetation remnants at about 30 m intervals. The exception to this was the most eastern ridge which is very degraded. This was searched from south to north using a long transect. Whenever flora of possible interest was encountered specimens were collected if necessary (declared rare flora were not collected as the two species present in the TEC could be sight recognised) and areas around the point of interest were searched and numbers of plants of the species of interest were counted. Other flora species were also collected and some areas south of Kiaka Road were also searched for comparative data. The latter searches were partly to look for populations of the *Banksia sphaerocarpa* form found in the proposed North Kiaka Mine area. The seventy-three transects walked in the proposed mine pit areas are marked on Map 34 in Appendix 7 and those for the haul road options on Map 28. A subset of the transects in the proposed pit areas was walked twice.

2.3 Assessing the status of flora species found in the Coomberdale Chert TEC

The knowledge of the taxonomy (naming), distribution and population status of flora species in the South West Botanical District of Western Australia is restricted by the state of knowledge of each of these three aspects of the flora of the region. Many groups are not well known taxonomically, herbarium collections are relatively small for the size of the area and most herbarium specimens do not have information on population size at the locality the specimen was collected from. Herbarium collections are also largely built up haphazardly (for instance many collections are from roadsides) and do not sample the flora evenly across the landscape.

These issues mean that assessing the status of flora species can be difficult if they are not already either declared rare flora (which must be adequately investigated before declaration), or priority flora that has a presumed level of rarity or threat. What can be done is to consider how many collections are known, where they from, and other information such as geological preference. The main source of information on distribution is the site "The Australasian Virtual Herbarium" (http://avh.chah.org.au/) which brings together records (collections) for a species

from all the major Australian herbaria (this data has some limitations, specimens of Western Australian species lodged in eastern states herbaria have a level of mis-determination higher than those in the Western Australian Herbarium, which still have a significant level of mis-determination). For this report species records from a data base of vegetation recording sites maintained by the author was used to supplement information from The Australasian Virtual Herbarium.

In the current case, many species found in the Coomberdale Chert Threatened Ecological community are disjunct by various distances from the nearest populations referred to the species. Depending on the details of each case, conclusions have been drawn to infer whether or not the disjunction is significant.

2.4 Methods of the vegetation survey and floristic analysis

The vegetation survey and mapping and the floristic analysis used in this report are from Trudgen *et al.* (2012). The methods for vegetation description, vegetation mapping, vegetation condition description and mapping, quadrat selection, quadrat recording, data basing of the results and floristic analysis are given in that report.

2.5 Limitations of the flora survey

The limitations of the flora surveys of the areas of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012) are given in that report. The main limitation for flowering plants, ferns and gymnosperms was that it was not possible to revisit all the survey sub-areas several times. For the current survey of the proposed North Kiaka Mine area, this limitation was not significant. First searches of transects in the proposed North Kiaka Mine area (and some adjoining areas, but not the eastern ridge on the J. Tonkin property) were searched on 30/6/2016, 1/7/2016, 6/7/2016, 7/7/2016, 13/7/2016, 7/7/2016, 1/8/2016, 1/8/2016 and 2/8/2016. Revisits of each second transect in the proposed mine area (except the eastern ridge) were made on 14/9/2016, 15/9/2016, 21/9/2016 and 22/9/2016. The eastern ridge on the J. Tonkin property was added to the proposed mine area after the visits above were made, this area was searched on the 17/7/2017 and 18/7/2017. For additional information on species distribution in the Coomberdale Chert TEC searches were made of some areas south of Kiaka Road on 18/8/2016, 19/8/2016 (on the "Eastern Ridge of Trudgen *et al.* 2012). Searches were made on Simcoa Block Two south of Kiaka Road to look for other populations of the *Banksia sphaerocarpa* form found in the Coomberdale Chert TEC on 10/11/2017 and 11/11/2017. On the 11/11/2017 and 12/11/2017 searches for rare flora were made on the two haul road options for the proposed North Kiaka Mine. On the 13/12/2017 the *Banksia sphaerocarpa* population

on Phil Gardiner's property (east of Cairn Hill Reserve) was surveyed to document the population size and condition.

A limitation of the flora survey is that it is restricted to flowering plant species and other vascular flora groups (pines, cycads, and ferns). Fungi, mosses, liverworts, lichens and algae are generally not surveyed for environmental impact assessment and associated surveys in Western Australia, as surveying each of these groups is a specialist task, the level of information available to assess them against is poor and they comprise only a small part of the vegetation biomass.

While the survey has been as thorough as possible given the time constraints, it is possible that some species of conservation significance (Priority species, Declared Rare Flora, previously unknown species etc.) occur in the survey area but have been missed; however any such omissions are likely to be very small populations as the intensity of search would have found any flora taxon present in more than very small numbers. Given the above limitations, it is likely that the data from various surveys incorporated in this report has more than 95% of the flora of the proposed North Kiaka Mine survey area.

One fairly minor limitation is that an area added to one of the proposed pits (see Appendix 7) after the flora searches had been done has not been searched for this report. However, it was searched during the field work for earlier reports (Trudgen *et al.* 2012, etc.) and no declared rare or priority flora was found there. The part of the ridge concerned is quite degraded.

2.6 Vouchering of flora specimens

One hundred and ninety-eight (198) flora specimens have been vouchered from the precursor studies to this report (Trudgen *et al.* 2001, 2006, 2012); a list of the specimens vouchered is given in Appendix 2. The specimens vouchered include six collections of the undescribed *Bossiaea* restricted to a part of the Coomberdale Chert Threatened Ecological Community and which had not been collected prior to the earlier surveys. Other material vouchered included specimens of restricted species, as well as twenty-one Asteraceae specimens, twelve Cyperaceae specimens, twenty-four Fabaceae specimens, twenty-six Myrtaceae specimens and eleven Poaceae specimens. Appropriate specimens from the surveys carried out for the proposed North Kiaka Mine will be vouchered.

2.7 Limitations of the vegetation mapping and classification

The vegetation of the survey area consists of a large number of small stands of a significant diversity of vegetation types, many of which were not discernible on the aerial photography

available for the project. This has meant that there are limits to the accuracy of the individual polygons, although such limitations are within those usually accepted for vegetation mapping.

Many of the stands have the same dominants in varying amounts, or variations of combinations of them, and similar permutations in the understorey layers. However, at the same time they are significantly different in terms of vegetation classification. These aspects of the vegetation have made the description of the vegetation fairly complicated, with the only way to express this diversity being a large number of units. While this reflects the diversity present, it makes "reading" the map more difficult due to its complexity.

In some places the stands were too small to map or were very variable, such areas have been mapped as mosaics.

2.8 Limitation of the vegetation condition mapping

The condition of the vegetation was not mapped in the field as a separate task by Trudgen *et al.* (2012). They used the information collected at the quadrats and releves to define vegetation condition at those points and then combine this information with aerial photograph interpretation to produce a map of vegetation condition. Therefore, the vegetation condition map is limited by the amount of information available to them. However, the number of points where condition was recorded was quite large and so the map should be of sufficient accuracy for environmental impact assessment or reserve planning uses.

2.9 Limitations of the floristic analyses

The floristic analysis used is from Trudgen *et al.* (2012) and the limitations for that analysis are detailed there. However, while any floristic analysis is limited to some degree by the number of sites used and other factors such as variations in vegetation condition, the analysis had sufficient sites chosen to be in areas of better condition to be appropriate for the purposes of that report and this report.

3.0 FLORA OF THE PROPOSED NORTH KIAKA MINE AREA AS PART OF THE COOMBERDALE CHERT TEC FLORA

3.1 Flora recorded in the proposed North Kiaka Mine area

One hundred and two (102) species of native flowering plants, one native pine (*Actinostrobus arenarius*) and five species of native ferns (three *Cheilanthes* species, *Pleurosorus rutifolius* and *Ophioglossum lusitanicum*) have been recorded for the proposed North Kiaka Mine survey area (Table 1). This is a significant subset of the three hundred and fifteen (315) native flowering plants (three with two subspecies or varieties) recorded for the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) and the one hundred and ninety-two (192) native flowering plant species recorded north of Kiaka Road within that area. Fifty-three (53) introduced species of flowering plants (weed species) have also been recorded in the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012), with thirty-one of these recorded in the proposed North Kiaka Mine area.

In contrast, four of the fern species recorded from the Coomberdale Chert Threatened Ecological Community are found in all three areas, while the fifth (*Ophioglossum lusitanicum*) has only been found in the TEC at one location in the proposed North Kiaka Mine area. The *Actinostrobus* is rare in the Coomberdale Chert TEC, only being recorded by Trudgen *et al.* (2012) at one place that that is now in the proposed North Kiaka Mine area. During the current survey, this small population (of six small trees) was extant, and one dead tree was seen nearby. The species is more commonly found on yellow sand than on chert and is common on that habitat west of the Midlands Road. This species was recorded in the TEC south of Kiaka Road by Griffin (1992), but was not recorded there by Trudgen *et al* (2012).

Table 1: Number of species in higher groups recorded for the proposed North Kiaka Mine area, TEC area surveyed by Trudgen *et al.* (2012) and north of Kiaka Road

Group of plants	Number of flora species recorded for TEC survey area of Trudgen *et al.* 2012	Number of flora species recorded north of Kiaka Road by Trudgen *et al*. 2012	Number of species recorded for North Kiaka mine area
Ferns	5	5	5
Pines	1	1	1
Native monocotyledons	90	58	37
Native dicotyledons	225	134	65
Total native Angiosperm species	315	192	102
Total native species	321	198	108
Weed species	53	46	36

As is usual in south-western Western Australia, there are fewer monocotyledons than dicotyledons in the proposed North Kiaka Mine area with thirty seven (37) and sixty five (65) native species recorded from these groups respectively. The ratio is similar for the numbers of species in these two groups recorded for the area north of Kiaka Road (58, 134) and the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012) where ninety (90) monocotyledons and two hundred and twenty-five dicotyledons have been recorded.

Table 2: Number of native species in in some families recorded for the proposed North Kiaka Mine area, TEC area surveyed by Trudgen *et al.* (2012) and north of Kiaka Road

Plant family	Number of species recorded for TEC survey area of Trudgen *et al.* 2012	Number of species recorded north of Kiaka Road by Trudgen *et al*. 2012	Number of species recorded for North Kiaka mine area
Pteridaceae	3	3	3
Ophioglossaceae	1	1	1
Aspleniaceae	1	1	1
Poaceae	20	10	7
Cyperaceae	11	4	2
Orchidaceae	24	16	10
Anthericaceae	14	10	5
Proteaceae	14	7	4
Amaranthaceae	7	4	2
Mimosaceae	15 (1 with 2 subspecies)	8	4
Papilionaceae	13	5	3
Myrtaceae	33 (1 with 2 forms)	12	10
Apiaceae	9	8	3
Goodeniaceae	11	2	1
Stylidiaceae	8	6	3
Asteraceae	35	23	20

While small in absolute terms, the five small ferns recorded in the proposed North Kiaka Mine area (which is all those recorded for the Coomberdale Chert TEC) is unusually high for the small area of the proposed mine area as ferns are a small part of the flora of the south-west of Western Australia. It reflects the fact that the harsh substrate there, thin soil over rock, suits species that have a cryptophyte life form (perennial rootstock of some form) and annual above ground parts. This habitat also inhibits smaller shrubs, lowering competition for the small cryptophytes and annuals. As with the small ferns, the same factors suit annual Asteraceae (Daisy family) and Orchids. There are twenty native Asteraceae species recorded in the proposed mine area, twenty-two in the area north of Kiaka Road, and thirty-four in the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012). Only one perennial native Asteraceae has been recorded in the TEC (an *Olearia*), which was not recorded in the proposed

North Kiaka Mine area. Ten Orchids have been recorded in the proposed North Kiaka Mine area, sixteen in the area north of Kiaka Road and twenty-four in the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012). With nine species recorded for the TEC, *Pterostylis* is the Orchidaceae genus with the most species recorded there, of these five have been recorded north of Kiaka Road and two in the proposed North Kiaka Mine area.

Except for the bias towards cryptophyte species and annual Asteraceae noted above, the proportion of different families of angiosperms (see Table 2) in the flora of the proposed North Kiaka Mine area and the TEC generally is broadly similar to other areas in the south-west of Western Australia. However, there is also a relative paucity of smaller shrubs, reducing the numbers of some families such as Proteaceae, Mimosaceae and Papilionaceae that might otherwise be expected. It is noticeable in this respect that most of the thirty-three (one with two forms) Myrtaceae (*Eucalyptus* and *Melaleuca* family) that are recorded for the Coomberdale Chert TEC are large shrubs or trees, with only seven being small shrubs (and even some of these get to over a metre tall). Ten species from the Myrtaceae have been recorded in the proposed North Kiaka Mine area of twelve recorded north of Kiaka Road.

The family Anthericaceae (part of the lilies group of monocotyledons) with fourteen species recorded for the TEC, ten for the area north of Kiaka Road and five for the proposed North Kiaka Mine area is another family that has been suited by the harsh substrate of the Coomberdale Chert TEC, with six cryptophyte species and the remainder mostly herbs that can die back significantly and recover from the rootstocks or tubers.

A list of the native and introduced flora recorded in the proposed North Kiaka Mine area, the area north of Kiaka Road and the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) is given in Appendix 4. To maintain consistency with earlier reports documenting the flora of the TEC some changes in family boundaries (e.g. including Mimosaceae in Papilionaceae) that have been proposed in recent years have not been used in this report. Changes in naming of native flora in the Coomberdale Chert Threatened Ecological Community since Trudgen *et al.* (2012) are given in Appendix 1.

3.2 Declared Rare Flora (DRF) species recorded in the Coomberdale Chert TEC

Five flowering plant species that have been gazetted as Declared Rare Flora under the Wildlife Act have been recorded from the Coomberdale Chert Threatened Ecological Community. They are *Acacia aristulata, Daviesia dielsii Synaphea quartzitica, Eucalyptus pruiniramis* and *Goodenia arthrotricha.* Table 3 summarises their occurrence in the Trudgen *et al.* (2012)

survey area, the area north of Kiaka Road in that survey area and in the proposed North Kiaka Mine area. Only the first two of these five species has been recorded in the proposed North Kiaka Mine area and north of Kiaka Road. Details of the occurrences of the declared rare flora species in the Coomberdale Chert TEC (numbers of groups of individuals, numbers of individuals, AMG references of populations) reported by Trudgen *et al.* (2012) are given in the tables in Appendix 4 of their report. For the area north of Kiaka Road and the proposed North Kiaka Mine area, details are provided below, including records added from 2016 and 2017.

Table 3: Number of occurrences of declared rare flora species recorded in the Coomberdale Chert Threatened Ecological Community

Notes: These are the number of locations where the species listed were found, not the numbers of plants. The data is from Trudgen *et al.* (2012) and the surveys for the current report. See Map 5 for more detail of the distribution of *Acacia aristulata* in the TEC.

Taxon	Number of occurrences for TEC survey area of Trudgen *et al.* 2012	Number of occurrences north of Kiaka Road by Trudgen *et al.* 2012	Number of occurrences s for North Kiaka Mine impact area
Acacia aristulata	220	63	32[#]
Daviesia dielsii	135	27	3
Eucalyptus pruiniramis	3	0	0
Goodenia arthrotricha	11	0	0
Synaphea quartzitica	1	0	0

[#] The occurrences in the proposed North Kiaka Mine area of *Acacia aristulata* include 2 clusters of significant numbers of plants.

The fewer species and lesser number of records of Declared Rare Flora (and Priority Flora) north of Kiaka Road are apparently due to a combination of factors other than just the size of the respective areas. Firstly, there seems to be some difference in flora distribution north of Kiaka Road compared to south of it (see floristic analysis section below). The differences seem to be a combination of natural differences and a reflection of different grazing history. However, for some species the apparent absence may partly reflect fire history (that is they may be present as seeds, requiring fire or other disturbance to appear). Secondly, the very northern part of A. & R Tonkin's property has woodland of *Allocasuarina huegelii*, which has fewer shrub species and herbs in the understorey than other vegetation types in the Coomberdale Chert Threatened Ecological Community. Thirdly, the area adjacent to the north side of Kiaka Road has areas of *Acacia acuminata* (“Jam”) woodland that also has fewer shrub species. Fourthly, parts of the area north of Kiaka Road (e.g. the easternmost ridge on J. Tonkin's property) are quite degraded.

3.3 Declared Rare Flora (DRF) species recorded in the North Kiaka Mine survey area

The two declared rare flora species recorded from the proposed North Kiaka Mine area are *Acacia aristulata* and *Daviesia dielsii* (see below for descriptions). While *Acacia aristulata* has a very restricted distribution (Map 3), within the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) it has been recorded at two hundred and twenty (220) locations, significantly more locations than the other declared rare species known for the TEC. However, this is still a plant with a very restricted distribution and a very small population. Although at a few of the locations where it has been recorded in the TEC more than twenty plants were recorded at most there was one plant or a few plants. *Daviesia dielsii* was the second most frequently recorded declared rare flora species by Trudgen *et al.* (2012) of the five declared rare species found in the Coomberdale Chert TEC, being recorded by them at one hundred and thirty-five (135) locations. This species has a wider geographic distribution than *Acacia aristulata* (Map 3), but is still geographically restricted, occurs in a region with high clearing and is quite uncommon.

Restricted distribution of *Acacia aristulata*. (Map from the DEC site "Florabase").

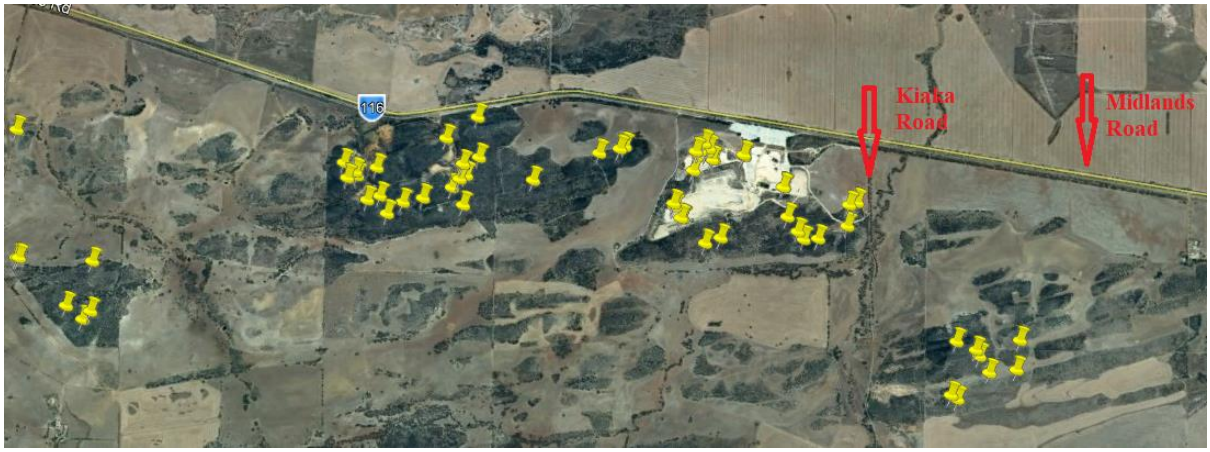
Restricted distribution of *Daviesia dielsii* (Map from the DEC site "Florabase").

Map 3: Restricted distributions of *Acacia aristulata* and *Daviesia dielsii*

Acacia aristulata

Acacia aristulata is an erect or spreading small shrub to one metre tall, although it is usually smaller. It has distinctive phyllodes ("leaves"), which have a single mucron (spine) at the apex. It seems likely that *Acacia aristulata* is a pyrosere/gap phase species as it was observed to have germinated in 2016 in a quadrat east of the current mine where there had been death of *Allocasuarina campestris* due to the dry period from 2013 to 2016 opening up a gap. It was also observed to be absent from a quadrat (JT011) north of Kiaka Road when that quadrat was revisited in July 2017, suggesting a limited life span (or possibly death due to the dry period up to 2016). It appears to be most common in vegetation dominated by *Kunzea praestans*, but is also often found with *Regelia megacephala* and was observed to be often grazed (Trudgen *et al.* 2012).

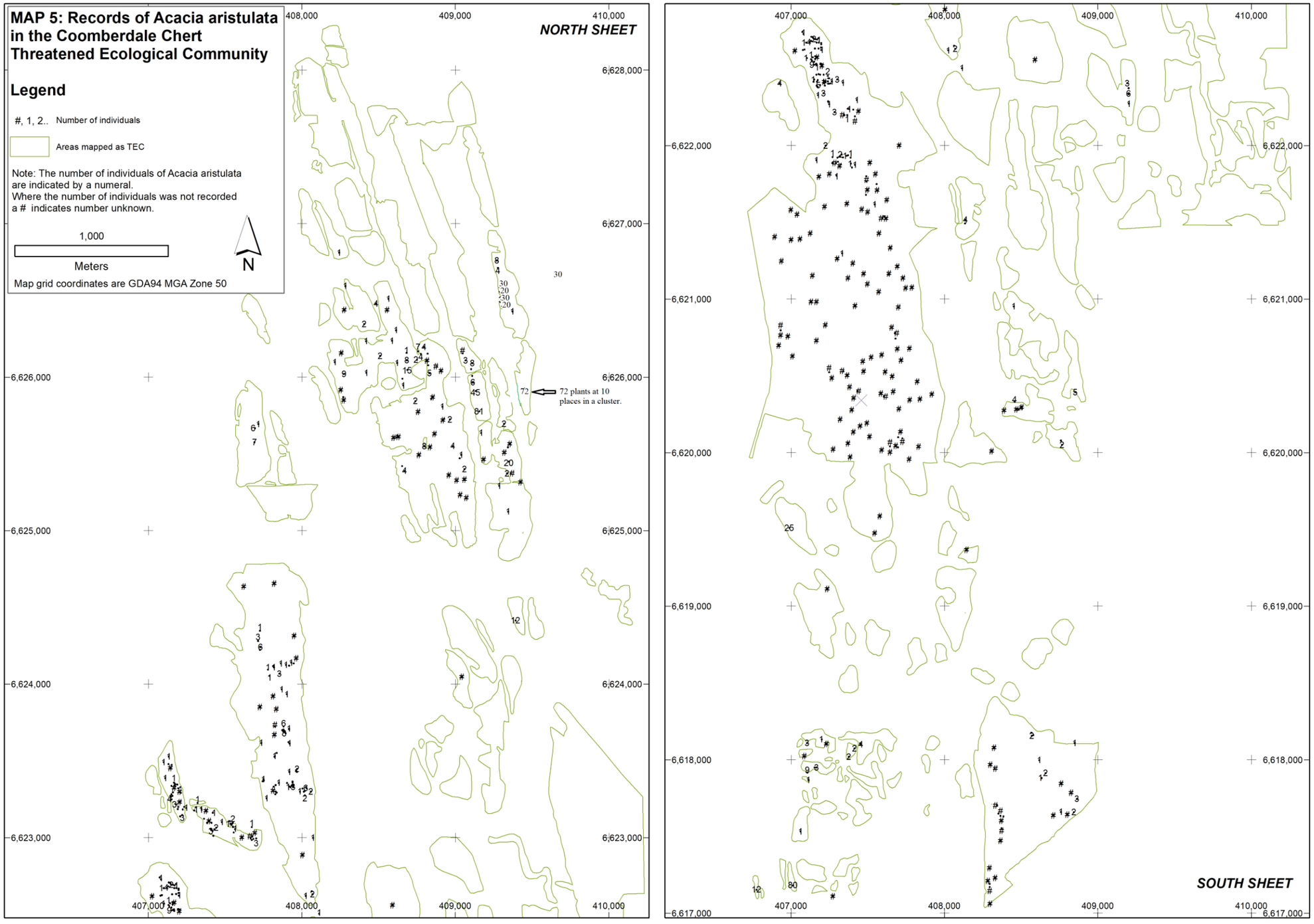
Trudgen *et al.* (2012, Appendix 4) had records for two hundred and six (206) locations in their study area where *Acacia aristulata* was recorded (the number of individuals at each site is given in their Appendix 4). Data from the current survey has increased that to two hundred and twenty locations (220), see maps 5 and 31. Thirty-two of these locations fall within the impact areas of the proposed North Kiaka Mine area, while some of the older locations south of Kiaka Road have been lost due to mining activity. Locations north of Kiaka Road includes those on the easternmost ridge on the J. Tonkin property where a population of one hundred and eighty-five (185) plants was recorded in 2017, many more plants than were recorded there in 2006. No such increase was seen in other parts of the proposed mine area during searches in 2016.



Map 4: Records of *Acacia aristulata* from the quadrat and vegetation mapping releve records of Trudgen *et al*. (2012) for areas of the Coomberdale Chert TEC they surveyed
Note. This shows the general distribution of this species in the Coomberdale Chert TEC. See Map 5 for more detail and with the 2017 records added.

Daviesia dielsii

Daviesia dielsii is a many-branched shrub to one and a half metres tall. Like *Acacia aristulata*, this shrub has a distinctive leaf with a spine at the tip. It was most commonly found at the ecotone between *Kunzea* and *Allocasuarina campestris* communities by Trudgen *et al.* (2012). It is usually not as common as *Acacia aristulata*, although it was more common in Cairn Hill North than that *Acacia*. It was less common in the areas searched south of Cairn Hill Reserve, than in the reserve or the central parts of their survey area. The general distribution of Daviesia dielsii in the Coomberdale Chert Threatened Ecological Community survey area of Trudgen *et al.* (2012) is shown in Map 6 based on vegetation site data. More detailed distribution of the species north of Kiaka Road based on vegetation site data and rare flora search data is shown in Map 7 and Map 30. Outlying records of this species on The Australasian Virtual Herbarium are in eastern states herbaria and are probably mis-determined.



Map 5: Records of *Acacia aristulata* in the Coomberdale Chert Threatened Ecological Community

Note. The numbers are the number of plants at a location, where known. A hash "#" indicates presence, but number of plants at the point not known.

Map 6: Records of *Daviesia dielsii* from the quadrat and vegetation mapping releve records of Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC they surveyed.

Note. Compare to Map 7, which has additional data from the rare flora searches carried out for the different surveys.

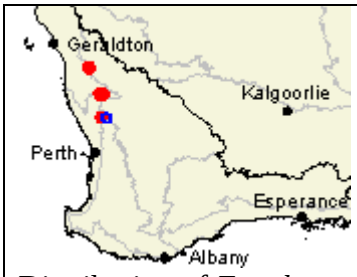
Map 7: All records of *Daviesia dielsii* north of Kiaka Road

Notes. The blue markers are records from rare flora searches in 2006, with the number of individuals. The yellow markers are from vegetation site data. An "x" means number of plants not known.

3.4 Other Declared Rare Flora species possibly in the proposed North Kiaka Mine area

Of the three declared rare flora species recorded for the Coomberdale Chert Threatened Ecological Community but not recorded in the North Kiaka Mine area (or north of Kiaka Road), two are very unlikely to occur there. If *Eucalyptus pruiniramis* occurred there it would have been recorded, as it is a mallee eucalypt species and would be very obvious. On the other hand, *Synaphea quartzitica* is a small shrub, but is quite distinctive, and if present in any numbers would have either been recorded by Trudgen *et al.* (2012), or by the survey work for

this report. Both of these species have geographically restricted distributions as well as being very uncommon (Map 8)



Distribution of *Eucalyptus pruiniramis*. (Map from the site "Florabase").

Distribution of *Synaphea quartzitica*. (Map from the site "Florabase").

Distribution of *Goodenia arthrotricha*. (Map from the site "Florabase").

Map 8: Restricted distributions of *Eucalyptus pruiniramis*, *Synaphea quartzitica* and *Goodenia arthrotricha*

While it has not been recorded north of Kiaka Road, there is a significant possibility that *Goodenia arthrotricha* occurs there. This is because of two factors, firstly it has been recorded just south of Kiaka Road and secondly it appears to be a pyrosere/gap phase species. This means that when the vegetation it occurs in is both long unburnt and not affected by drought or other factors, that it is suppressed, occurring as seed in the upper layer of the soil, but not as growing plants. When this suppression is relaxed (by fire or death of overstorey plants by other causes), the plant can "appear" where it has not been observed for a long time. During field work in the Coomberdale Chert TEC in 2016, this phenomenon was observed when a vegetation quadrat on the Eastern Ridge (south of Kiaka Road) recorded in 2002 was re-recorded in 2016. The dry years prior to 2016 had cause death of *Allocasuarina campestris*, opening the vegetation. In the gap in the (previously very dense) overstorey a number of *Goodenia arthrotricha* had germinated and established (Trudgen 2017a) as well as some seedlings of *Acacia aristulata*. Similar vegetation is present in the proposed North Kiaka Mine area and *Goodenia arthrotricha* is possibly present there as seed.

Goodenia arthrotricha is an erect herb to 40 cm tall; it has blue flowers with a white throat. . This species was possibly confused in the field with *Scaevola phlebopetala* at times during the Trudgen *et al* (2012) survey and may be more common in the Coomberdale Chert TEC than the records for that survey indicate. It was not observed during field work in the proposed North Kiaka Mine area in 2016 and 2017.

3.5 Priority flora species recorded in the Coomberdale Chert TEC

Nine flowering plant species that are currently listed as priority flora have been recorded from the Coomberdale Chert Threatened Ecological Community area surveyed by Trudgen *et al.* (2012). They are listed in Table 4, which also summarises their occurrence in the Trudgen *et al.* survey area, the area north of Kiaka Road in that survey area, and in the proposed North Kiaka Mine area. Only two of these nine species, *Regelia megacephala* and *Diuris recurva* have been recorded in the proposed North Kiaka Mine area.

In a similar fashion to the occurrence of declared rare flora, fewer priority flora species are known from north of Kiaka Road than south of it. The same reasons (see section 3.2) are likely to be involved. Grazing history is likely to be quite significant in this, but other factors such as subtle differences in habitat are also likely to be important. The floristic analyses carried out in Trudgen *et al*. (2012) indicate that there real floristic differences between different parts of their survey area and this may be a factor in the low number of priority flora species north of Kiaka Road (see floristics section below).

Details of the occurrences of the priority flora species in the Coomberdale Chert TEC (numbers of groups of individuals, numbers of individuals, AMG references of populations) are given in the tables in Appendix 4 of Trudgen *et al.* (2012).

3.6 Priority flora species recorded in the North Kiaka Mine survey area

Only two current priority flora species have been recorded from the North Kiaka Mine area. One is *Regelia megacephala* and the other is *Diuris recurva*. Unlike the other priority flora found in the Coomberdale Chert Threatened Ecological Community, *Regelia megacephala* is a large shrub that dominates areas of tall shrubland. So rather than being found scattered as single plants or small groups of plants it is found in moderately large patches where it is locally abundant. In contrast, the *Diuris* is found as scattered individuals or small clusters of a few plants.

Diuris recurva **(Priority 4 species)**

Diuris recurva was referred to *Diuris* aff. *recurva* in Trudgen *et al.* (2012), however the name *Diuris recurva* is now applied to material from the Moora area as well as material from the Geraldton area where the type specimen was collected. Map 9A shows that the name is in fact applied to specimens from three well separated areas, as well as to three outlying collections. It is likely from this distribution that *Diuris recurva* has subordinate taxa (subspecies or varieties). If this is the case, then they would deserve higher priority status than priority four.

Table 4: Priority flora species recorded in the Coomberdale Chert Threatened Ecological Community area surveyed by Trudgen *et al*. (2012)

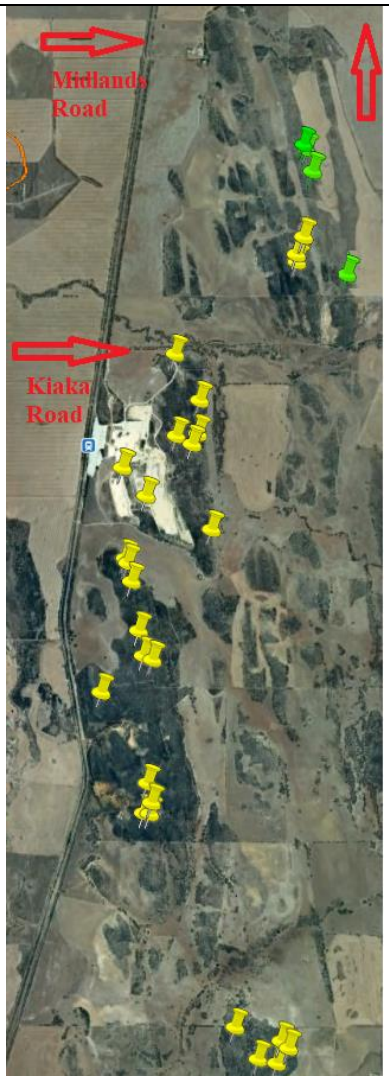
Notes: As the data is mostly from occurrence at vegetation recording sites (with some from 2016 & 2017 field work), the numbers are locations the species has been recorded at not counts of individuals. *Hemigenia conferta* was recorded by Trudgen *et al*. (2012) in Cairn Hill Reserve and a roadside locality, in 2017 it was also recorded in Simcoa Block 2 (east of the current mine). Some of the stands of *Regelia megacephala* would be quite small. For definitions of the priority flora levels see Appendix 5.

Taxon and priority flora level	**Records for the TEC survey area of Trudgen *et al.***	**Records for the TEC survey area of Trudgen *et al.* north of Kiaka Road by**	**Records for North Kiaka Mine area**
P3 *Austrostipa* sp. Cairn Hill	1	0	0
P3 *Babingtonia cherticola*	77	0	0
P4 *Diuris recurva*	31	7	3
P1 *Eremaea* sp. Cairn Hill	1	0	0
P2 *Grevillea amplexans* subsp. *semivestita*	2	0	0
P3 *Guichenotia tuberculata*	1	0	0
P4 *Hemigenia conferta*	2	0	0
P3 *Melaleuca sclerophylla*	3	0	0
P4 *Regelia megacephala*	71 stands	8 stands	1 stand
P2 *Stylidium glabrifolium*	3	0	0
P2 *Tricoryne* sp. Wongan Hills (B.H. Smith 794)	7	0	0

Map 9B shows the distribution of *Diuris recurva* in the area of the Coomberdale Chert Threatened Ecological Community survey area of Trudgen *et al.* (2012). This species occurs sporadically in the Coomberdale Chert TEC. Map 9A shows that the distribution of this species has disjunctions that suggest it may have subspecies or varieties. *Diuris recurva* was recorded at four localities north of Kiaka Road during the rare flora searches carried out during 2016 additional to those recorded in earlier surveys. Of these three localities are in the proposed North Kiaka Mine area. Fourteen individuals of this species were recorded in the proposed North Kiaka Mine area, suggesting that the population there is not large. There were two plants at the location north of Kiaka Road outside the proposed mine area where the species was observed in 2016.

Map 9A: Distribution of *Diuris recurva* showing disjunct populations

Notes: Image from The Australasian Virtual Herbarium 3/2018.



Map 9B: Distribution of *Diuris recurva* in the Coomberdale Chert TEC from Trudgen *et al.* (2012) vegetation site data (yellow pins) and 2016 field work (green pins).

Regelia megacephala **(Priority 4 species)**

Regelia megacephala is one of the defining species of some of the vegetation types of the Coomberdale Chert Threatened Ecological Community and is known to be restricted in distribution to the Coomberdale Chert. Where it does occur, it is often the dominant in the vegetation, although sometimes there is a taller (but more open) stratum over it. There are seventy-seven records for *Regelia megacephala* in the quadrat and releve data of Trudgen *et al.* (2012), although a small proportion of the stands they were recorded in have since been lost to mining. The proper assessment of this species is that it is very geographically restricted, locally common in vegetation it occurs in within its area of distribution, but not common in an absolute sense. The distribution of this Priority 4 species in the Trudgen *et al.* (2012) survey area is

shown on Map 10 from vegetation site data. At many of these sites the *Regelia* is the dominant in a vegetation stand, although some of these stands are quite small.

Map 10: *Regelia megacephala* records in the vegetation site data of Trudgen *et al.* (2012)
Note: As *Regelia megacephala* is often dominant or sub-dominant where it occurs the pins mostly represent the occurrence of stands of this species (see Map 27 for stands *Regelia megacephala* north of Kiaka Road).

3.7 Priority flora possibly in the North Kiaka Mine survey area but not recorded there

The shrub priority species listed in Table 3, except *Regelia megacephala*, can reasonably confidently be excluded from occurring in the proposed North Kiaka Mine area. None of them have been recorded north of Kiaka Road and this area has had significant searches for conservation flora for both Trudgen *et al.* (2012) and for the proposed mine area for the current report. The remaining three priority species are smaller and/or are available for collection less of the year. Therefore there is a small possibility that the grass *Austrostipa* sp. Cairn Hill, the lily *Tricoryne* sp. Wongan Hills and the trigger-plant *Stylidium glabrifolium* are in the proposed North Kiaka Mine area. However, if they were to be present the populations would be very small to have escaped notice given the intensity of botanical work carried out in that area.

Austrostipa sp. Cairn Hill (Priority 3)

Austrostipa sp. Cairn Hill is a small grass with erect flowering stems. It has been recorded three times in the Coomberdale Chert Threatened Ecological Community, but is not restricted to it. The three records are one in Cairn Hill Nature Reserve and two in rehabilitation areas. The range of the species extends from near Geraldton to east of Perth, but there are only elven (11) records on The Australasian Virtual Herbarium, indicating it is not a common species.

Tricoryne sp. Wongan Hills (B.H. Smith 794) (Priority 2)

Tricoryne sp. Wongan Hills is a rhizomatous perennial herb to 20 cm high. This Priority 2 species was recorded at three quadrats and three releves south of Kiaka Road in the Trudgen *et al.* (2012) survey area, and appears to be uncommon there. However, as it was not known to be in the survey area prior to one of the earlier reports in this series (Trudgen *et al.* 2006), it was

not searched for during the systematic rare flora surveys carried out at that time. In Trudgen *et al*. (2012) this taxon was referred to as *Tricoryne arenicola* MS (the name available at that time). It was not recorded during searches of the proposed North Kiaka Mine impact areas carried out in 2016 and 2017.

Stylidium glabrifolium **(Priority 2 species)**

Stylidium glabrifolium is a small herb and is a Priority 2 species. In the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) it was only recorded from three quadrats. Two were located on the Eastern Ridge, and the other in the remnant of native vegetation at the south end of the existing main mine (the Eastern Ore Body – note that some of this area has been mined since the collection was made). This species has not been recorded north of Kiaka Road.

3.8 Other flora of conservation interest in the Coomberdale Chert TEC with presence and absence for the proposed North Kiaka Mine area

For various reasons, some species (see Table 5 below) not on declared rare flora or priority flora lists may be of particular conservation interest (that is have interest beyond the value any species has intrinsically). Newly discovered or very poorly known species that have not been listed because insufficient was known about them are some examples. Also, a population of a species that is not declared rare or priority flora and is not particularly uncommon may be of interest because it is outlying from the main population. Such populations may represent taxa that have not been recognised as different due to lack of study, may indicate the potential of the species to expand its range, or may indicate that a species is contracting in range (leaving some small populations in more favourable habitat).

Several such species have been recorded in the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) and were commented on by them. Some others have become known since 2012 through further taxonomic work. Table 5 lists the species that are still relevant and gives information on their distribution in the area of the Coomberdale Chert TEC surveyed by Trudgen *et al*. (2012). Comments are made below on each species; the species that occur in the proposed North Kiaka Mine area are indicated in the right hand column of Table 5.

Changes in identification of specimens and concepts of species have meant that some species discussed in earlier reports are no longer of significance for the TEC area surveyed by Trudgen *et al* (2012) and are not discussed in detail.

Table 5: Other flora of conservation interest recorded from the Coomberdale Chert Threatened Ecological Community with distribution and number of occurrences at vegetation recording sites.

Notes: The numbers in the table are occurrences at vegetation recording sites in the data of Trudgen et al. (2012) and some other data. They indicate relative abundances and are not population counts. Light green highlighting indicates presence of a species in the Proposed North Kiaka Mine area. Where numbers of occurrences from quadrat & releve data would be misleading a comment is made as well. For Kunzea praestans, the number of "occurrences" represents stands of vegetation with the species often important in the structure.

Taxon	**Significance of taxon or TEC population of taxon**	**Number of occurrences for TEC survey area of Trudgen *et al.* 2012**	**Number of occurrences north of Kiaka Road by Trudgen *et al.* 2012**	**Number of occurrences for North Kiaka Mine impact area**
Agrostocrinum scabrum aff. ssp. *scabrum*	TEC population disjunct from ssp. *scabrum* and specimen atypical.	3	0	0
Austrostipa exilis (Previously P2 species)	Near range limit in Western Australia, widespread but not common.	3	1	0
Banksia sphaerocarpa var. aff. *caesia*	Range edge, atypical habit & habitat if var. *sphaerocarpa*. Range extension and atypical habitat for var. *caesia*. Needs further study.	3	1	2 (6 plants)
Bossiaea sp. Cairn Hill (M. Henson CH2-28)	Rare and very geographically restricted	39 (including 4 from data of E.A. Griffin)	0	0
Calothamnus aff. *quadrifidus* (Moora - Watheroo)	Moderately geographically restricted, edaphically restricted not very common.	56 (Including 1 from data of E.A. Griffin)	9	2
Calytrix sp. Coomberdale (M.E. Trudgen MET 21184)	Geographically restricted, common in some habitats in the TEC. Not recognised as distinct in earlier surveys of the TEC.	197 (Locally common)	34 (Locally common)	7 (Sample underestimates the large population in the North Kiaka Mine area.)
Cristonia stenophylla	TEC population outlying from main population by 60 km. Possibly locally extinct, or may be a pyrosere species.	3	3	1
Cyrtostylis huegelii	TEC population outlying by ca. 80 km from coastal part of population north of Perth.	3	0	0
Gastrolobium acutum (Previously P3 species)	Near northern limit, has disjunctions that may indicate unrecognised subspecies.	17	3	1

**Kunzea praestans* (Previously a P3 species)	More restricted than herbarium collections show (due to identification errors). May have unrecognised subspecies.	219	47	10 (Underestimates the large population in the North Kiaka Mine area.)
Leptospermum aff. *erubescens* (Moora Chert; B. Morgan 133).	Apparently very rare (2 known collections) and very restricted.	2	0	0
Pauridia aff. occidentalis var. occidentalis	Probably an undescribed species, but the genus needs revision and the material needs further study. Locally common in parts of the Coomberdale Chert TEC.	40	4	0 records in vegetation data (due to small size and distribution of sites) but common in some parts of proposed mine area.
Petrophile brevifolia (forma)	Possible new taxon. Not in impact area. Needs further study.	2	0	0
Pterostylis exserta	Known from less than ten locations.	3	1	1
Quoya (*Pityrodia*) *dilatata*	Has three centres of occurrence (may indicate subspecies), the southern one disjunct on current knowledge.	52	10	3 (Sporadic in the North Kiaka Mine area, data underestimates population)
Stenanthemum tridentatum (Previously a P3 species)	Has disjunctions, possibly has subspecies.		0	0
Trichocline sp.	Material sterile, if *Trichocline* (formerly *Amblysperma*) then undescribed.	1	0	0
Wurmbea drummondii (Previously a P4 species)	No longer a priority species, but not very common.	2	2	2
Xanthorrhoea sp. Coomberdale (M.E. Trudgen MET 25047)	Quite geographically restricted, only observed on the Coomberdale Chert south of Coomberdale and one location near Moora. Not recognised as distinct in earlier surveys of the TEC.	254 (Locally common)	36 (Locally common)	9 (Locally common; sample underestimates the population)

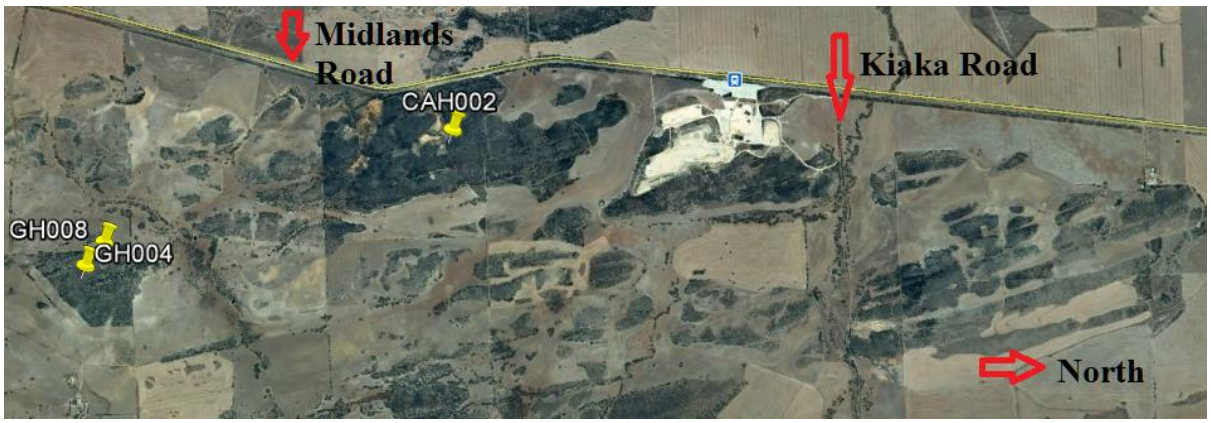
*****The proper application of the name *Kunzea praestans* is not clear (see page 46) and the species may have sub-specific variation.

For example, *Wurmbea drummondii*, *Stenanthemum tridentatum*, *Gastrolobium acutum* and *Austrostipa exilis* were priority species at the time of earlier reports but no longer are. However, the population in the Coomberdale Chert TEC of some species that have been removed from the priority list may still be significant. For example, while *Gastrolobium acutum* is no longer a priority species, the TEC populations have significance because of their location in the distribution of the species.

Agrostocrinum scabrum aff. ssp. *scabrum*

The collections referred to *Agrostocrinum scabrum* aff. ssp. *scabrum* from the Coomberdale Chert Threatened Ecological Community represent a small population that lies half way between the north end of the main occurrence and one outlying record from north of Three Springs (see Map 11). The disjunction is more than eighty kilometres from the Coomberdale Chert TEC records to the northernmost record in the main population. The size of the disjunction and the uncommon geology the Coomberdale Chert TEC is located on suggests the population is likely to represent at least a different variety. The material is also somewhat atypical, but better collections are needed to examine the status of the population. Even if the material does not represent a new variety, the population has significance as an outlier. The taxon was recorded (see Map 12) at three quadrats by Trudgen *et al.* (2012), but has not been recorded north of Kiaka Road.

Map 11: Distribution of *Agrostocrinum scabrum* aff. ssp. *scabrum* north of Perth
Note: Map from records on the site The Australasian Virtual Herbarium.



Map 12: Records of *Agrostocrinum scabrum* aff. ssp. *scabrum* in the Coomberdale Chert TEC
Note: From vegetation site data recorded by Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC they surveyed.

Austrostipa exilis **(Former priority species, near range limit)**

Austrostipa exilis was formerly a Priority 3 species, but has been removed from the priority flora list. It is now considered (The Australasian Virtual Herbarium 7/2017)) to be quite widespread in the southwest of Western Australia, although most records are south of Perth and the species is not very common. Apart from two coastal records, the three Coomberdale Chert Threatened Ecological Community records are near the norther limit of the species in Western Australia (there is a disjunct population in South Australia). One of the three records in the TEC is from north of Kiaka Road, but is not from the proposed North Kiaka Road Mine area.

Banksia sphaerocarpa **var. *aff. caesia*** **(Atypical , range extension, range end)**

A form of *Banksia sphaerocarpa* has been recorded at three localities in the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012), with two of the localities in the proposed North Kiaka Mine area. The material needs further study to determine its taxonomic identity within the species, but is closest to var. *caesia.* Due to the uncertainty naming the material, it is referred to here as *Banksia sphaerocarpa* var. aff. *caesia*. After var. *caesia*, the material is closest to var. *sphaerocarpa*.

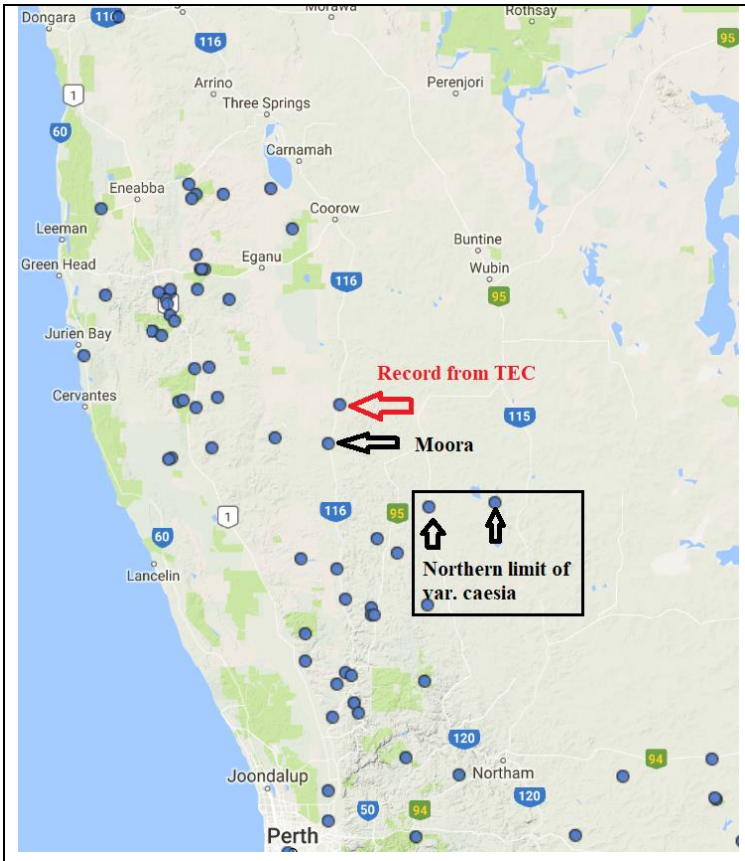
Banksia sphaerocarpa var. *sphaerocarpa* has a large distribution and is known to include several forms and there are some differences in the application of the name. The variety is still mapped as occurring to well north of Perth on Florabase (the Western Australian Herbarium species information portal), but is considered by A.S. George (2008) the authority on the genus, to occur "from the Darling Plateau east of Perth south to the Whicher Range and east to the Stirling Range and Cape Riche". The apparent conflict in application may simply be that specimens have not been redetermined, meaning the map is outdated. In the same publication, George (2008) considered that most of the collections north of Perth belonged to a new variety,

Banksia sphaerocarpa var. *pumilio,* which is usually a shrub less than one metre tall. A third variety, *Banksia sphaerocarpa* var. *caesia,* also occurs north of Perth, but the population there (three records) is disjunct from the main population and the nearest record to the occurrence in the Coomberdale Chert TEC is near Piawaning, fifty kilometres to the south-east.

The specimens from the Coomberdale Chert Threatened Ecological Community (see photographs and Map 13 below) key to a couplet with var. *sphaerocarpa* and var. *caesia,* so we can exclude var. *pumilio* (another two described varieties occur well south of Perth and can also be excluded).

Banksia sphaerocarpa var. *aff. caesia* has been recorded at three localities in the area of the Coomberdale Chert Threatened Ecological Community mapped by Trudgen *et al.* (2012). The three localities are shown on Map 14. George (1981) in his revision of the genus *Banksia* mentions an atypical specimen (Kenneally 5889) from 4 km east of Piawaning (see Map13A). George notes that this collection and others from the north and western part of the distribution of the variety have fruit more similar in size to var. *sphaerocarpa* than var. *caesia*. Map 13B shows all records on Australasia's Virtual Herbarium of *Banksia sphaerocarpa* var. *caesia,* with Kenneally 5889 arrowed and the Coomberdale Chert population added. The map shows that the Kenneally collection, two other collections and the Chert localities are disjunct from other localities of var. *caesia* by some 70 kilometres, with all other collections south of Great Eastern Highway. The disjunction and the difference in fruit size indicate that the north-western populations referred to *Banksia sphaerocarpa* var. *caesia* and the Coomberdale Chert population should be treated as a distinct taxon. Inspection of the Piawaning population (a few plants on a disturbed roadside) suggests that this form is the same as the population n the Coomberdale Chert.

While the status of *Banksia sphaerocarpa* var. aff. *caesia* undoubtedly needs further investigation, Nistelberger *et al.* (2015) investigating genetic diversity in part of the distribution of var. *caesia* found "a stark and unexpected division of the landscape into two genetic subregions". This was in an area of the varieties distribution with no disjunction, suggesting that the "variety" is somewhat more than it seems. Bearing in mind comments by George (2008) about other variation in *Banksia sphaerocarpa* it seems likely that the species as a whole needs a detailed revision. The Piawaning population grows on yellow sand, and the main chert population is on chert adjacent to an area of yellow sand.

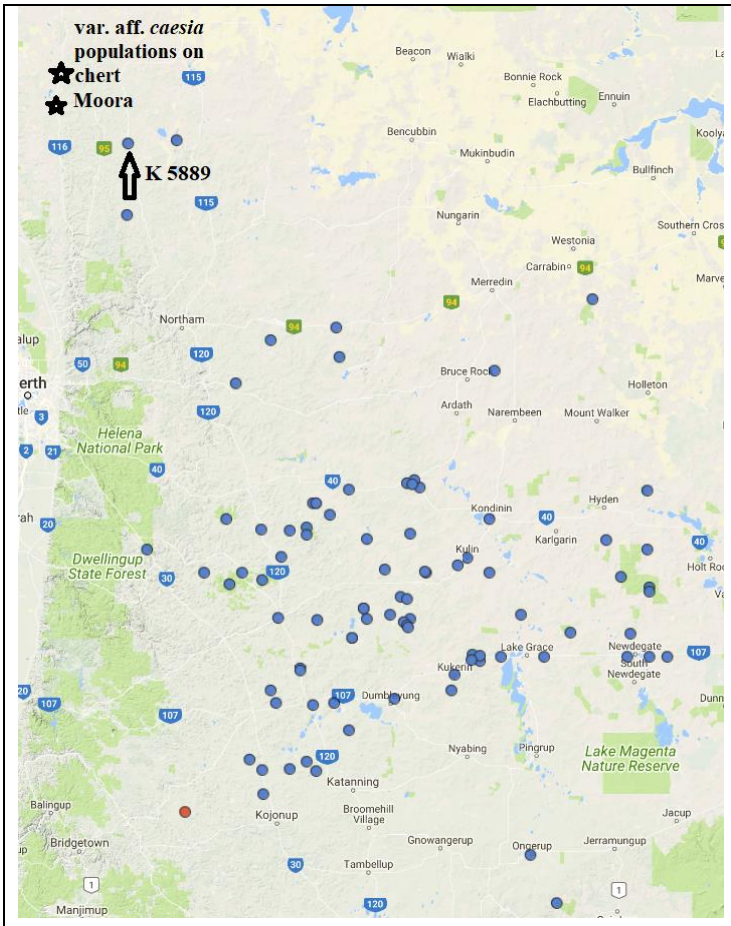


Map 13A: Records of all varieties of *Banksia sphaerocarpa* between Perth and Dongara.

Notes. The red arrow indicates the location of one of three occurrences of *Banksia sphaerocarpa* var. *aff. caesia* on the Coomberdale Chert (the others are nearby; see Map 14).

The black rectangle shows the three locations of the disjunct north-western occurrence of var. *caesia*, two of which are indicted by black arrows. The left hand arrow in the box indicates the locality of Kenneally 5889.

The map is from The Australasian Virtual Herbarium (accessed 8/2017).



Map 13B: All records of *Banksia sphaerocarpa* var. *caesia*

Notes. The black arrow indicates the location of Kenneally 5889. Also note the disjunction between the north-western locations and the locations between Northam and Bruce Rock. And, that the latter locations are disjunct from the main occurrence.

The map is from The Australasian Virtual Herbarium (accessed 3/2018).

Photographs 1 & 2: Two shrubs of *Banksia sphaerocarpa* var. *aff. caesia* showing variation in habit. The right hand individual may have been affected by grazing of the lower branches.

Map 14: Records of *Banksia sphaerocarpa* var. *aff. caesia* from quadrat and releve data of Trudgen *et al.* (2012) and from 2016 & 2017 field data.

The northern localities in the TEC are in the area of the proposed North Kiaka Mine. There are four plants of the *Banksia* at the northernmost locality and two at the nearby locality. These were the only localities found in the area of the proposed mine pits when they were searched in 2016. The southern locality is in a small remnant of native vegetation (one of a cluster in a paddock). It was visited in 2017 and the *Banksia* plants there counted, their condition noted and their locations recorded with a GPS unit. There are about 65 plants in the population, varying in size and condition. Smaller plants and the lower parts of larger plants were heavily grazed (probably by rabbits). The plants at this location were definitely lignotuberous and some plants were up to 1.9 metres tall.

***Bossiaea* sp. Cairn Hill (M. Henson CH2-28) (Rare, very restricted distribution)**

Bossiaea sp. Cairn Hill is a distinct, geographically restricted species related to *Bossiaea eriocarpa*. It is restricted to the Coomberdale Chert Threatened Ecological Community and is only known from the part of that TEC south of Kiaka Road (Map 15). In this area it is known from the Cairn Hill Reserve, Cairn Hill North, the Eastern Ridge, the Western Ridge, one record further east, and rehabilitation areas. This is a very restricted distribution, part of which (the Western Ridge) has been mined since the quadrats there were recorded. It is often grazed, and is spontaneously regenerating in some of the quadrats on the rehabilitation areas (Trudgen 2017b).

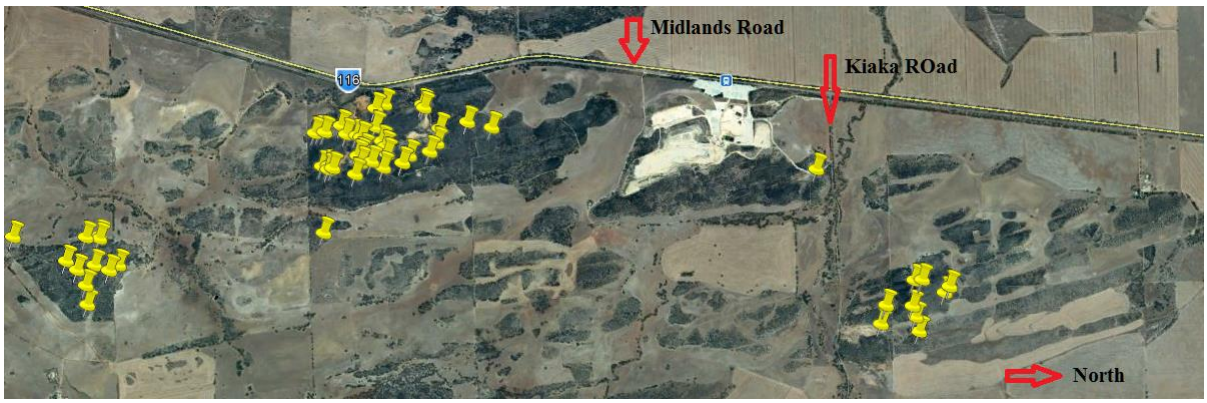
There is a possibility that this species (which would probably have very long-lived seeds) is suppressed in dense, long unburnt vegetation and may appear in other parts of the Coomberdale Chert TEC if they were burnt. As it has been observed to be grazed, this species may have been lost from more heavily grazed areas of the Coomberdale Chert Threatened Ecological Community due to its palatability. It is quite remarkable that this very rare species is neither declared rare flora nor priority flora (FloraBase accessed 15/7/2017).

Map 15: Records of *Bossiaea* sp. Cairn Hill from quadrat and releve data of Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC they surveyed and data of E.A. Griffin.

***Calothamnus* aff. *quadrifidus* (Moora - Watheroo)**

This taxon was separated out from other variants of *Calothamnus quadrifidus* at the Western Australian Herbarium during preparation of earlier reports for Simcoa Operations Ltd. It was recorded at fifty-five (55) sites during the surveys. Since this taxon was separated out in Herbarium material, material of it has been included in *Calothamnus quadrifidus* ssp. *angustifolius* by George and Gibson (2010). It has not been possible to examine this assignment in detail for this report, and it has been decided to leave the reference to the entity as in the earlier reports. This has been done as the author of this report has considerable

experience in the taxonomy of the Myrtaceae, examined the material in the Western Australian Herbarium and came to the conclusion specimens from the geographic area including the Coomberdale Chert were a distinct entity. This is not necessarily incompatible with the paper by George and Gibson, and this taxon and closely related ones need further taxonomic work to confirm their status.



Map 16: Records of *Calothamnus* aff. *quadrifidus* (Moora-Watheroo) from data of Trudgen *et al.* (2012) for the Coomberdale Chert TEC and data of E.A. Griffin.

Calothamnus aff. *quadrifidus* (Moora - Watheroo) is restricted to the Coomberdale Floristic Region of Griffin (1992) and it should be treated as a geographically restricted taxon. There are about fifteen specimens in the collections at the Western Australian Herbarium, but this may over-estimate the abundance of the taxon as it is a large species (generally two to four metres tall) and thus more likely to be collected than smaller ones. It is moderately common (Map 16) in parts of the survey area of Trudgen *et al.* (2012), but is absent in others.

Calytrix sp. Coomberdale (M.E. Trudgen MET 21184)

Calytrix sp. Coomberdale (M. Trudgen MET 21184) has previously been confused with *Calytrix leschenaultii*, a name that has been applied to a significant sized complex of species that occurs over much of the South West Botanical District of Western Australia. It is a small, purple flowered shrub belonging to the plant family Myrtaceae. It is quite common in the Coomberdale Chert Threatened Ecological Community (Map 17) and has been observed outside the areas of that community mapped by Trudgen *et al.* (2012), on soils with similar (silica rich) underlying rocks (just south of Moora), but does not seem to be common outside the TEC. It is more common in the proposed North Kiaka Mine area than the quadrat and releve mapping data indicate, this is partly due to the fact that much of the proposed mine area has vegetation in poorer condition and therefore fewer quadrats and releve sites were recorded in it.

Map 17: Records of *Calytrix* sp. Coomberdale from data of Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC surveyed by them.

Notes: This species is common in the proposed North Kiaka Mine area. The white areas on the image are the existing Simcoa mine, waste dumps and storage areas. For convenience north is to the right on the image.

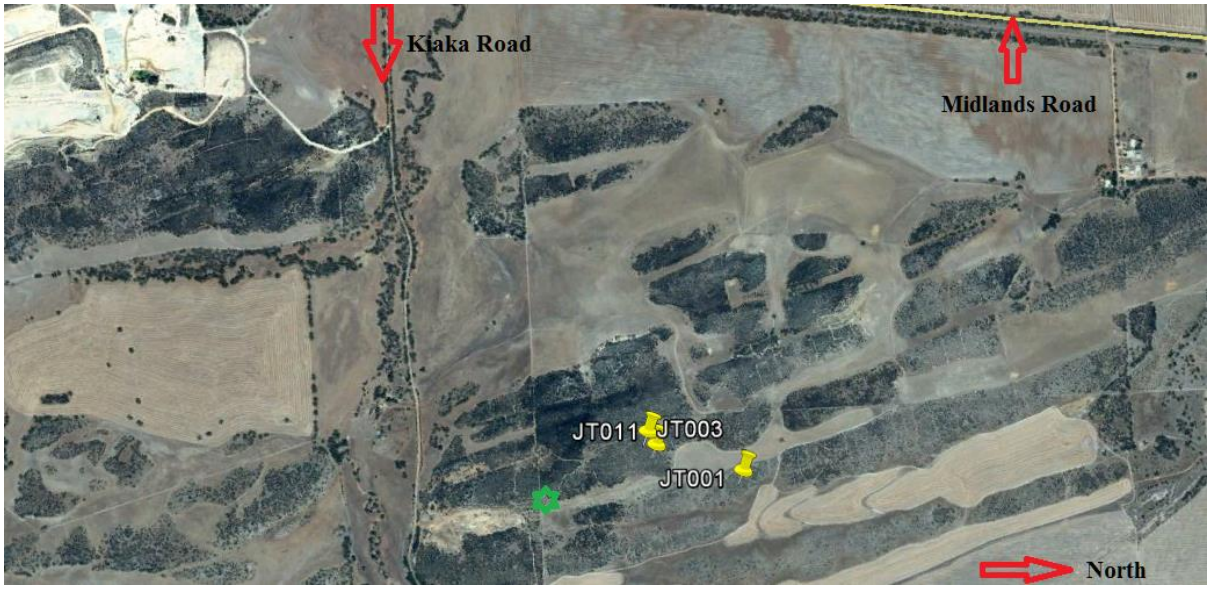
Photographs 3 & 4: Flowers and flowering plant of *Calytrix* sp. Coomberdale.

In the Coomberdale Chert TEC, *Calytrix* sp. Coomberdale occurs in more open vegetation (that is not under dense *Allocasuarina campestris* or dense *Regelia megacephala*. It was observed to have regenerated fairly recently in one disturbed area that had low weed cover. It is common in disturbed areas with high weed cover, but in such places all the plants are older and may predate the weed invasion. It may mostly establish after fire and may have taken advantage of disturbance of the TEC to increase its population size. The population in the proposed North Kiaka Mine area is significantly larger than the quadrat and releve records on Map 17 indicate.

Given the geographical restriction of *Calytrix* sp. Coomberdale it is likely to warrant priority flora status, although it appears to be more resilient than *Xanthorrhoea* sp. Coomberdale to the pressures on the vegetation remnants of the Coomberdale Chert TEC.

Cristonia stenophylla **(Disjunct population)**

Three records of *Cristonia stenophylla* were made by Trudgen *et al.* (2012) during their survey, all on the J. Tonkin property north of Kiaka Road (Map 18). The material was identified in that report as *Cristonia biloba*. These are the only records from the Coomberdale Chert Threatened Ecological Community and are located 60 kilometres south-south-east of the main occurrence of the species. There is one record ninety kilometres further south-south-east, north of Bolgart. The TEC population has significance as an outlying record.



Map 18: Records of *Cristonia stenophylla* in the Coomberdale Chert TEC
Notes: Yellow pins records from data of Trudgen *et al.* (2012) green star from 2017 field survey. Two of the 2012 sites revisited and the *Cristonia* not found.

Two of the three quadrats *Cristonia stenophylla* was recorded at by Trudgen *et al.* (2012) were revisited in 2016 and again in 2017 and the species was not found on either occasion. It was also not found during any of the flora searches undertaken for the current report in 2016and 2017. However, one plant was observed in 2017 adjacent to the southern firebreak on the John Tonkin property. It seems likely that the species has become locally very rare due to a combination of climate change, grazing and other factors such as herbicide drift. However, it is possible that the species is still present as seed (which is likely to be long-lived) and might reappear after fire. One of the three quadrats the species was found in is in the proposed North

Kiaka Mine area, the other two are nearby. The locality found in 2017 is part of one possible route for a haul road.

Cyrtostylis huegelii **(Outlying population)**

Cyrtostylis huegelii is the only *Cyrtostylis* recorded north of Perth, where the species, apart from the Coomberdale Chert Threatened Ecological Community records, is only recorded west of the Brand Highway. The TEC population is therefore a significant outlying record of the species. *Cyrtostylis huegelii* was recorded three times by Trudgen *et al.* (2012), once in Cairn Hill Reserve and twice adjacent to the current Simcoa mine (one of these records was in an area now mined). It was not recorded during flora searches of the proposed North Kiaka Mine area in 2016 and 2017.

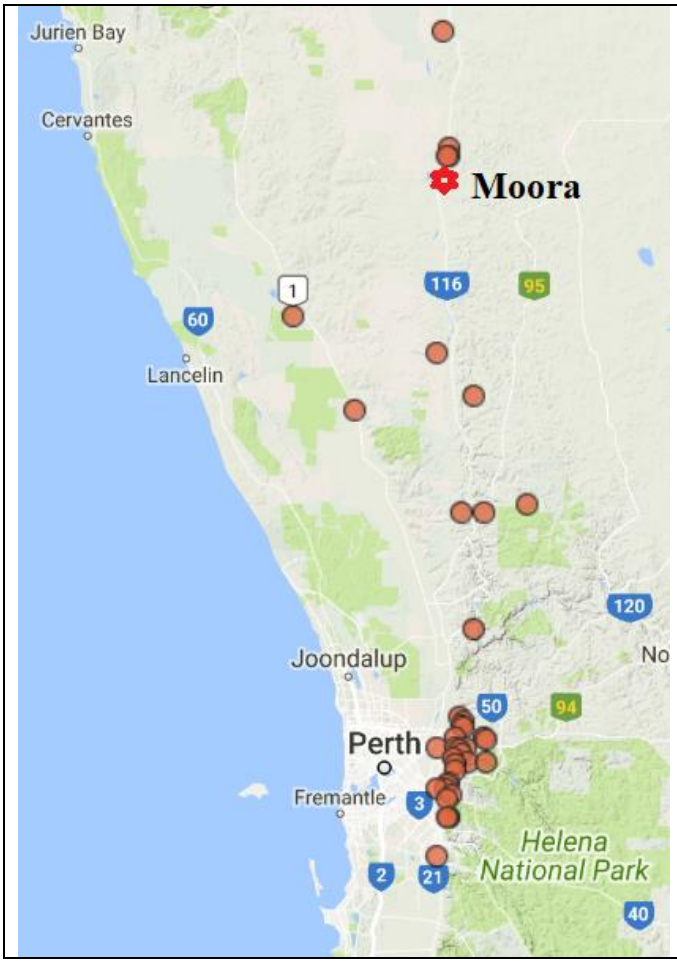
Gastrolobium acutum **(Disjunct population and near Northern limit)**

There are only five records of *Gastrolobium acutum* north of Mogumber in herbarium collections, of which three are from the Coomberdale Chert Threatened Ecological Community (Map 19). The population of *Gastrolobium acutum* in the Coomberdale Chert TEC is disjunct from the main population by ca. 53 kilometres. As Map 19 shows the main population extends southwards from that point to the east of Perth, but is fairly restricted. Twenty-four kilometres to the north of the Coomberdale Chert TEC population there is one record (noted as growing on yellow sand with chert outcrop) in Watheroo National Park.

While the population there is disjunct from the main population, *Gastrolobium acutum* is not uncommon in the Coomberdale Chert TEC with nineteen records (Map 20) at the quadrats and releves recorded for Trudgen *et al.* (2012). However, other observations indicate that *Gastrolobium acutum* is somewhat more common in the North Kiaka Mine area than the quadrat and releve records indicate. As Map 20 shows only three of these records were located north of Kiaka Road. Given the disjunction and the different geologies the two populations grow on, it is possible that the Coomberdale Chert TEC population is different at the variety or subspecies level from the main population. This issue needs further study. The Watheroo record is likely to be the same taxon as the TEC population as it is associated with chert geology.

Gastrolobium acutum was once a Priority Species, however it was removed from the Priority Flora list after more information became available about its distribution and population status. If the Coomberdale Chert population is confirmed as different, it would deserve priority status because of its geographically limited extent and number of threatening factors. It is an erect, or occasionally straggly shrub to one metre tall. It was recorded in fourteen of their eighty-nine

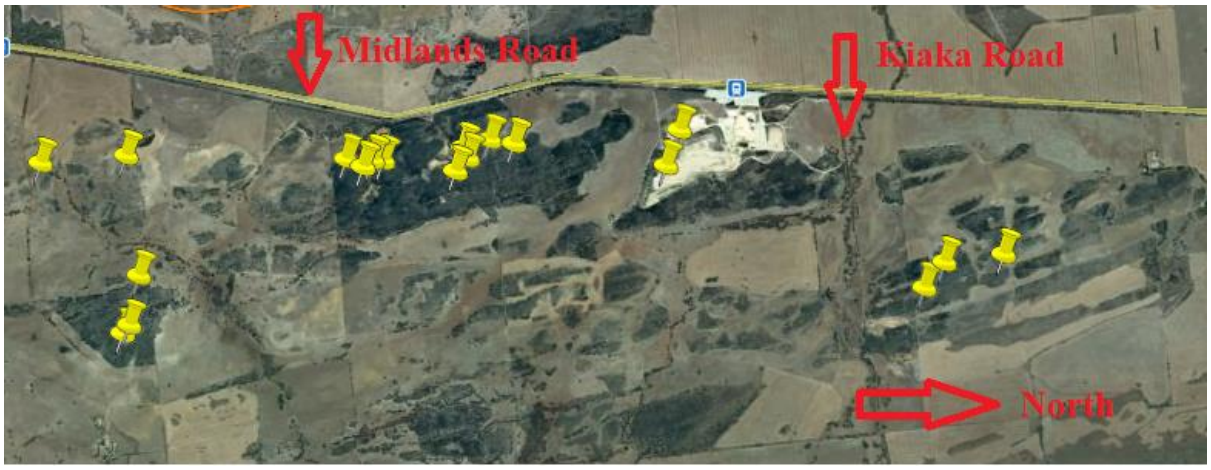
quadrats recorded in native vegetation and three vegetation recording releves by Trudgen *et al.* (2012). It was also observed as scattered individuals, or small groups of individuals, north of Kiaka Road.



Map 19: Distribution of *Gastrolobium acutum*

Notes. Map from The Australasian Virtual Herbarium, accessed 6/2017.

The Coomberdale Chert TEC records are the small cluster just north of Moora. Note the disjunction south from Moora



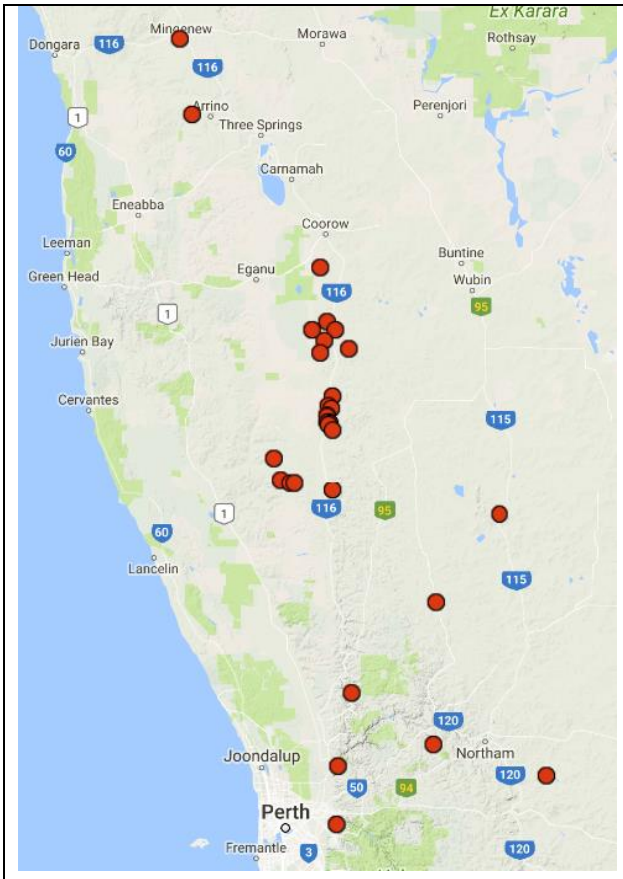
Map 20: Records of *Gastrolobium acutum* from quadrat and vegetation mapping releve data of Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC surveyed.

Notes: The white areas on the image are the existing Simcoa mine, waste dumps and storage areas.

[Records on The Australasian Virtual Herbarium for *Gastrolobium acutum* in the Kalbarri area are based on specimens held in eastern states herbaria which are likely to be wrongly named and these records are therefore not taken into account here.]

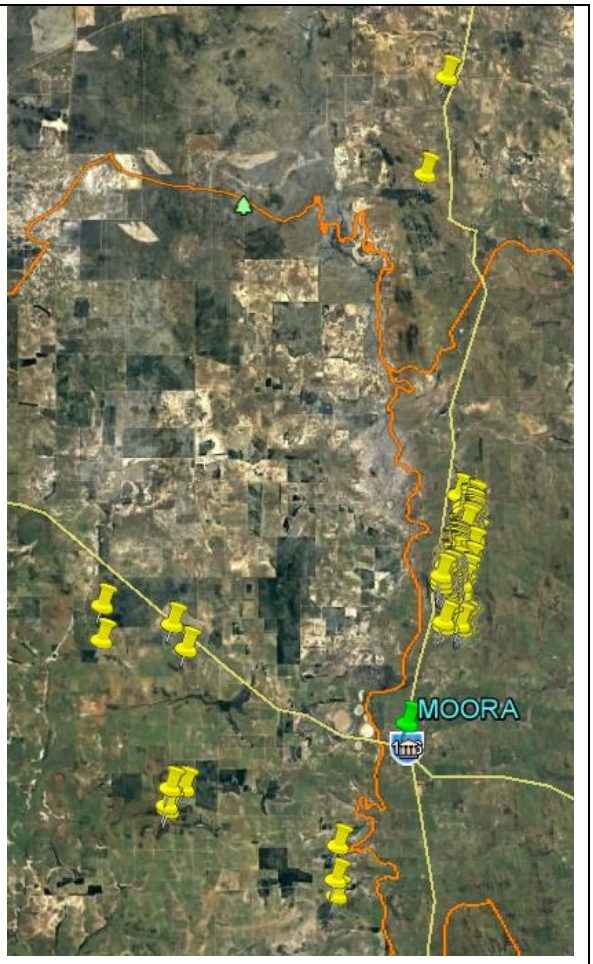
Kunzea praestans **(Has disjunctions, needs taxonomic review)**

The material from the Coomberdale Chert Threatened Ecological Community that has been identified as *Kunzea praestans* is a 1.5 to 2.5 metre tall shrub with pink flowers that in the TEC occurs mostly near the edges of chert outcrops on compacted gravelly soil (chert gravel colluvium) over chert. It was previously a Priority 3 species that was considered to have a fairly restricted distribution centred on the Coomberdale Chert, but was removed from the priority flora list on the basis of new collections from a broader range.



Map 21A: Distribution of *Kunzea praestans* based on herbarium records

Notes: Includes some mis-identified collections (see text). (Map from The Australasian Virtual Herbarium17/8/2017)



Map 21B: Records of *Kunzea praestans* in the Moora area from vegetation survey data. The large cluster of sites is the Coomberdale Chert TEC survey area

Records (Map 21A) on The Australasian Virtual Herbarium (AVH) show a wider distribution than the Moora area, but with significant disjunctions. Some of the specimens on AVH are certainly not the same taxon as on the Coomberdale Chert. For example the record from near

Arrino is from the margin of a wetland, the record from north of Wongan Hills is of a shrub to 30 cm with mauve flowers, one of the records near Dandaragan was recorded as having yellow flowers, the specimen from Mundaring was collected from adjacent to a river, the specimen from near Coorow was described as having mauve flowers, and two other collections were of shrubs under one metre tall.

The distribution of *Kunzea praestans* (or more correctly, the material placed under this name) from The Australasian Virtual Herbarium data (Map 21A) in the Moora area and the map from Moora area vegetation survey data of E.A. Griffin & M.E. Trudgen (Map 21B) have similar disjunctions and fairly restricted distributions. It therefore seems likely that the *Kunzea* on the chert is actually fairly restricted, but that further taxonomic work is needed to properly establish its limits as a species, whether or not it has subspecies, and from this its conservation status.

[Note: There are also single records in the AVH data from the Bunbury area and Albany, these are almost certainly either mis-idenifications or label errors. They have not been considered as *Kunzea praestans* in the discussion above.]

***Leptospermum* aff. *erubescens* (Moora Chert; B. Morgan 133). (Rare, very restricted)**
Two collections were known of this taxon prior to the field work for the current report. Both are from the Trudgen *et al.* (2012 etc.) survey area. One was collected during the rare flora survey of the Gardiner Hill bush area (on the property of P & J. Gardiner, at the same location as the *Banksia sphaerocarpa* form). The site was in a disturbed area on the edge of the vegetation remnant. The other (D.J.E. Whibley 4905) is from the gravel pit in Cairn Hill reserve. The two collections appear to represent a very uncommon undescribed taxon restricted to the Chert Hills at Moora (R. Davis pers. comm. 2006).

Until this taxon can be adequately surveyed, it should be treated as very rare. The earlier survey collection (Morgan 133) has been vouchered and is currently (erroneously) placed under *Leptospermum erubescens*. The taxon has not been recorded north of Kiaka Road (in fact, not north of Cairn Hill Reserve). The Morgan collection location on the Gardiner property was revisited in 2017 to survey the *Banksia* population, during the visit it was realised that there was a moderate sized population of the *Leptospermum* present as well. The population was not counted, but certainly has more than 50 individuals.

***Pauridia* aff. *occidentalis* var. *occidentalis* (Probably an undescribed species)**
The genus *Pauridia* (the Australian species were formerly in *Hypoxis*) consists of small

herbaceous species that have few easy to use characters to define species. At least in Western Australia, the genus is in need of revision. In an earlier report (Trudgen *et al.* 2012) one specimen (CH12-11A from Cairn Hill Reserve) was referred to the name *Hypoxis* aff. *glabella*. Re-examination of this specimen has shown that it is a very poor specimen (one small old plant) of the taxon that was referred to *Pauridia occidentalis* var. *occidentalis* in the earlier report. Further examination of the collections has indicated that the material referred to *Pauridia occidentalis* var. *occidentalis* in Trudgen *et al.* (2012) does not fit well any described taxon and is likely to be undescribed. Given the state of the taxonomy of *Pauridia*, this must be a preliminary assessment. The important issue here is that in the area of the Coomberdale Chert Threatened Ecological Community that was surveyed by Trudgen *et al.* (2012) the taxon mainly occurs out of the proposed North Kiaka Mine area (Map 22).

The important characters are that the specimens have a pair of opposite bracteoles rather than a single bracteole and a different fruit shape to the two closest species, *Pauridia occidentalis* and *Pauridia vaginata*.

Photograph 5: Flowering plants of *Pauridia* aff. *occidentalis* var. *occidentalis*

Map 22: Records of *Pauridia* aff. *occidentalis* var. *occidentalis* from the quadrat and vegetation mapping releve records of Trudgen *et al.* (2012)
Note. These records underestimate the number of occurrences north of Kiaka Road due to the distribution of quadrats and timing of releve recording.

***Petrophile brevifolia* (forma) (Needs taxonomic study)**

A collection (G316-4) referred to *Petrophile brevifolia* (forma) by Trudgen *et al.* (2012) is atypical for that species (B. Rye pers. comm. 2006), but flowering material and expert identification are necessary before the status of the collection can be fully assessed. This taxon has not been recorded north of Kiaka Road.

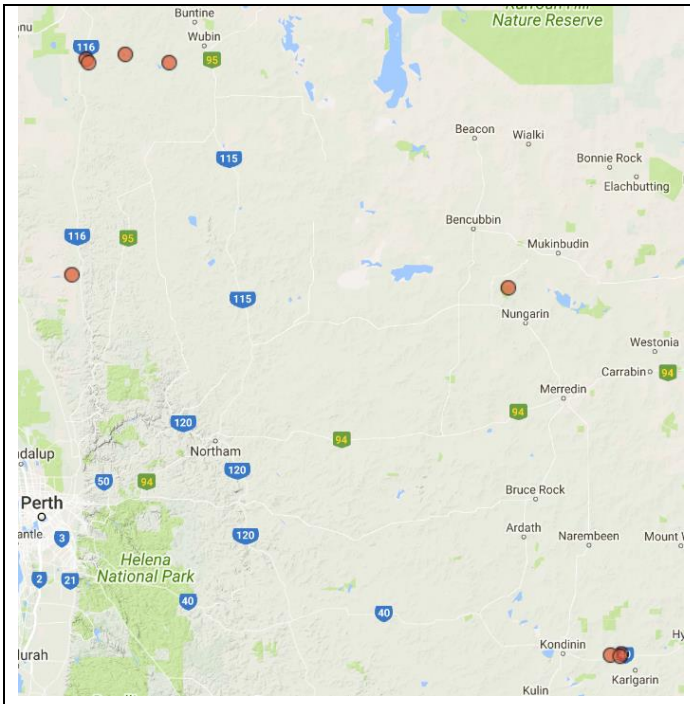
***Pterostylis exserta* (Known from few localities)**

There are three records for *Pterostylis exserta* in the vegetation site data of Trudgen *et al.* (2012), although two of them were original determined as *Pterostylis* aff. *rufa*. One of these records was from quadrat JT010 which is in the proposed North Kiaka Mine area. The species was refound there in 2017 and this was the only locality in the proposed North Kiaka Mine where it was recorded (Map 23B). *Pterostylis exserta* is a small Greenhood orchid that is known from nine localities apart from those in the Coomberdale Chert Threatened Ecological Community (Map 23A). It would seem to deserve priority flora status given it is known from few localities and most of its range has been cleared.

***Quoya* (formerly *Pityrodia) dilatata* (Disjunctions, possibly has subspecies)**

This species has a limited range from Three Springs to Wannamal, with most collections in a fairly narrow band. The distribution has three centres of distribution. The central one is in the Moora to Namban area and has a disjunction of forty-five kilometres to the southern population in the Mogumber area. The northern population is located south of Three Springs to the Coorow area. There are some scattered records between the northern and central populations and some other outlying records (of which some are much older with unlikely locations). The

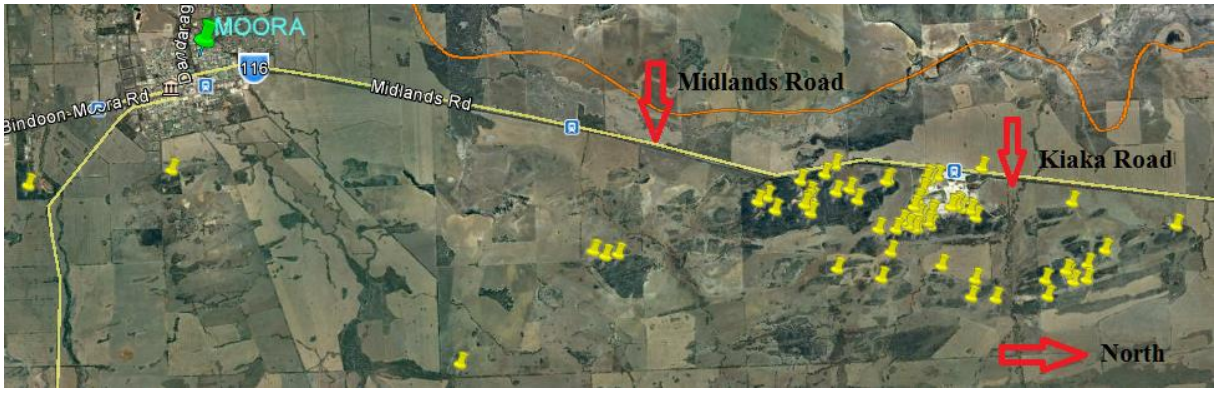
species needs investigation to see if there are sub-specific taxa. If there are, then this would mean that they could be of conservation concern.



Map 23A: Distribution of *Pterostylis exserta*.

Note. The small number of records and how they are spread through a largely cleared part of the wheat belt.

Map 23B: Location of the records for *Pterostylis exserta* in the proposed North Kiaka Mine area



Map 24: Records of *Quoya dilatata* from the quadrat and vegetation mapping releve records of Trudgen *et al.* (2012) and two records (near Moora) from data of E.A. Griffin.

Quoya dilatata is fairly common (Map 24) in the Coomberdale Chert TEC area surveyed by Trudgen *et al.* (2012) and a number of other locations were recorded in the proposed North Kiaka Mine area in 2016 and 2017.

[A supposed record of *Quoya dilatata* from the Nerren-Nerren area is almost certainly mi-identified and some of the other outlying records on The Australasian Virtual Herbarium may be also.]

Stenanthemum tridentatum **(Near northern limit of species, disjunction.)**

Stenanthemum tridentatum is a very small shrub that was formerly a Priority 3 species, but has been removed from the Priority Flora List. In the Trudgen *et al.* (2012) survey area it was only recorded from the Gardiner's Hill survey sub-area (at one quadrat and five releves). This species has a moderate sized distribution with the survey area close to the north-west limit of the species range, which is at Gunyidi. The records from the Coomberdale Chert Threatened Ecological Community, one to the east (near Miling) and one to the north near Gunyidi are disjunct from the main population by about 60 kilometres. The species has not been recorded north of Kiaka Road in the Coomberdale Chert Threatened Ecological Community area.

Trichocline **sp. (Uncertain determination, if** ***Trichocline*** **new taxon)**

A sterile specimen from site GH7-57 on the Gardiner property (Trudgen *et al*. 2012) is possibly a *Trichocline* (an alternative of *Ptilotus* has been excluded (Trudgen *et al*. 2012)). However, it does not match *Trichocline spathulata* the only *Trichocline* species currently accepted for Western Australia. The site needs to be re-visited to collect flowering material, to enable proper identification. The species has not been recorded north of Kiaka Road.

Wurmbea drummondii

Wurmbea drummondii is a very small herb (ca. 5 cm tall with one or two leaves and usually one or two small flowers) that occurs in seasonally damp areas with thin soil over rock. It was only recorded at two places on John Tonkin's property during the Trudgen *et al.* (2012) survey, both outside the impact area of the proposed North Kiaka Mine. While it is present north of Kiaka Road, it is very uncommon there. *Wurmbea drummondii* was a Priority 4 species, but has been removed from the Priority Flora list. It was also observed once (one plant) during rare flora searches carried out in 2016 for the proposed North Kiaka Mine, again outside the proposed mine area. This species has a moderate distribution that has a small disjunction (from New Norcia and Wyening) between possible northern and southern occurrences (possibly varieties?)..

***Xanthorrhoea* sp. Coomberdale (M.E. Trudgen MET 25047)**

Xanthorrhoea sp. Coomberdale has previously been confused with *Xanthorrhoea drummondii*, a name that has been applied to a complex of species that occurs from the Kalbarri area southwards to north of Albany. It is a grass tree to just over two metres tall with greyish-green leaves that is usually single headed, but can have several heads (see Photographs 6 & 7).

Photograph 6: *Xanthorrhoea* sp. Coomberdale on slopes adjacent to remnant vegetation.
Notes: Individuals vary from single headed (most plants) to multiple headed.

Photograph 7: *Xanthorrhoea* sp. Coomberdale in remnant vegetation.
Notes: Comparison to the photograph to the left shows significant variation in stipe and inflorescence length.

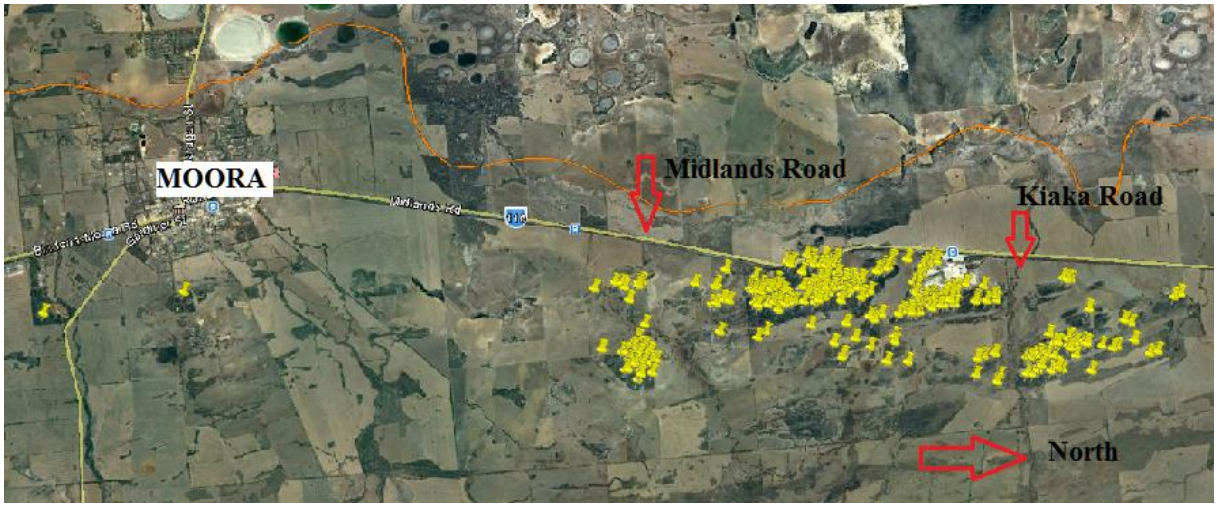
On current knowledge *Xanthorrhoea* sp. Coomberdale is restricted to an area from just south of Moora to the area north of Kiaka Road (see Map 25a), but south of Coomberdale. Almost all of the records are from the Coomberdale (Noondine) Chert, with the majority of them from the study area of Trudgen *et al.* (2012). The other records are on chert east and south-south-east of Moora, except for one from 3 kilometres south-south-east of Moora near the Moora wheat bins. The latter record is on a different substrate (although there could be chert at depth) that is still silica rich.

Map 25B puts the population of *Xanthorrhoea* sp. Coomberdale in a regional context. The two parts of the map show (left hand side) herbarium records that indicate the population is disjunct. The right hand side confirms this disjunction using vegetation site data records. Although, the disjunction is shown to be less than herbarium records show.

Photograph 8: *Xanthorrhoea* sp. Coomberdale with stumps of dead individuals.

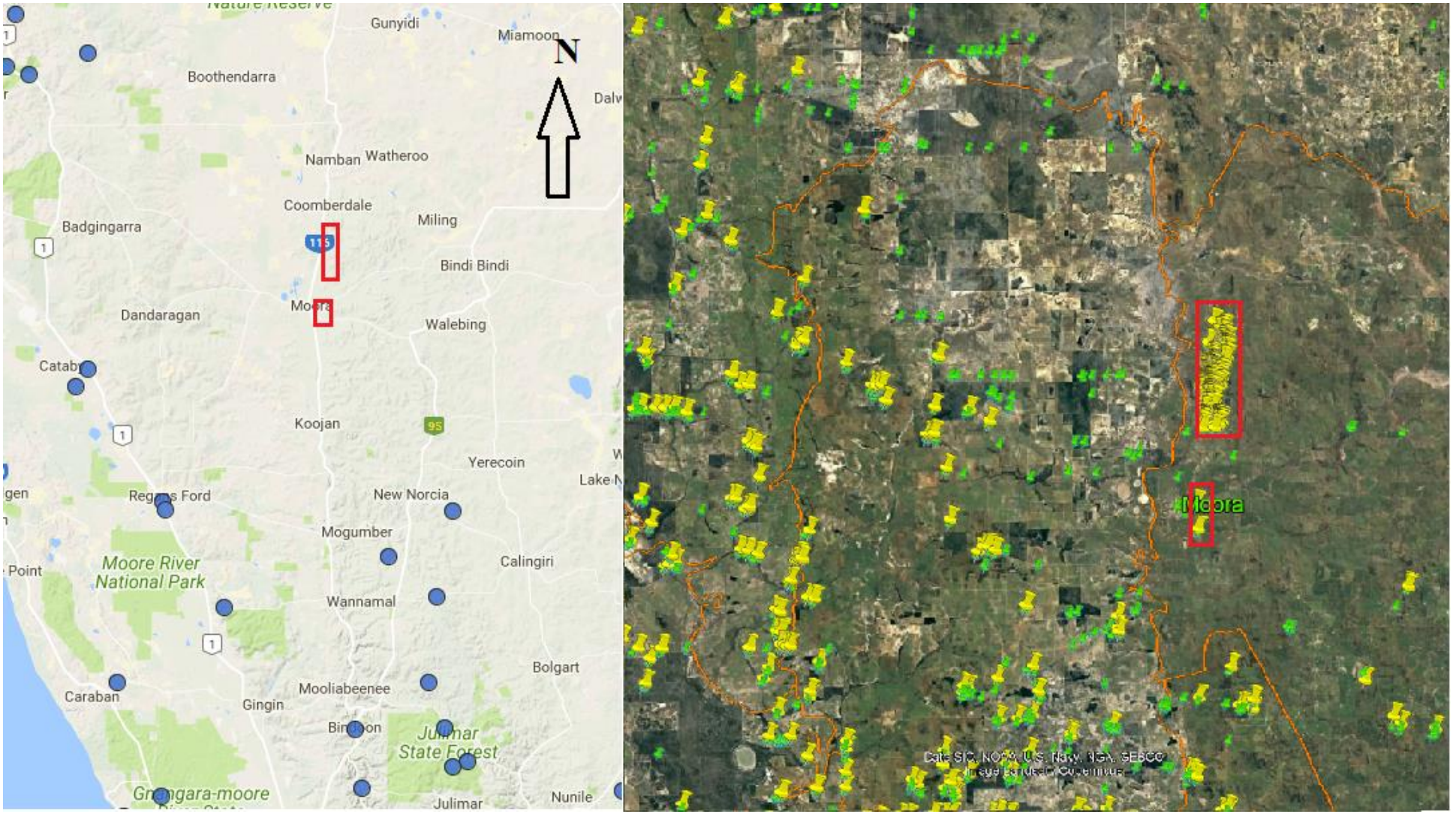
Notes: Within fifteen metres of the live plant of *Xanthorrhoea* sp. Coomberdale in the photograph there was one other live plant and the remains of ten (10) dead plants (two stumps arrowed). Such situations were not uncommon and a significant part of the population of *Xanthorrhoea* sp. Coomberdale has died in a relatively short time (< 10-20 years). Young plants were rarely seen during the flora searches for the proposed North Kiaka Mine or other work in the Coomberdale Chert TEC in 2016 and 2017.

Given the geographical restriction of *Xanthorrhoea* sp. Moora and the threatening factors affecting it (particularly climate change, but also factors preventing recruitment of new individual such as grazing and weed invasions), this species is likely to warrant priority flora status.



Map 25A: Records of *Xanthorrhoea* sp. Coomberdale from quadrat and vegetation mapping releve sites of Trudgen *et al.* (2012) for areas of the Coomberdale Chert TEC surveyed and from data collected by E.A. Griffin (the two southern records).

Notes: *Xanthorrhoea* sp. Coomberdale is more common in the areas mapped by Trudgen *et al.* (2012) than the quadrat and releve records indicate. The white areas on the image to the left of the Kiaka Road arrow are the existing Simcoa mine, waste dumps and storage areas. Image from Google Earth



Map 25B: Distribution of the genus *Xanthorrhoea* in the region around Moora showing the population of *Xanthorrhoea* sp. Coomberdale is disjunct

Notes: The left hand image shows all *Xanthorrhoea* records on The Australasian Virtual Herbarium (accessed 20/3/2018) in the region around Moora as blue dots, with *X.* sp. Coomberdale in the red rectangles. The right hand image shows records of *Xanthorrhoea* in vegetation data (mainly E.A. Griffins & M.E. Trudgen's data) as yellow pins. The RH image shows more accurately that the *Xanthorrhoea* sp. Coomberdale population (red rectangles) is disjunct from other *Xanthorrhoea* populations. The green pins indicate vegetation sites without *Xanthorrhoea*.

Xanthorrhoea sp. Coomberdale is common in the Coomberdale Chert TEC and is the only *Xanthorrhoea* recorded in the TEC. In the TEC it occurs in a range of habitat and vegetation types. The population has suffered a significant proportion of deaths of adult plants of the species in recent years. This may partly be due to declining rainfall and particularly the series of dry years between 2013 and 2016. There is almost no regeneration of this species occurring, with weed invasion likely to be a contributing factor, at least where weeds have higher cover.

To confirm that *Xanthorrhoea* sp. Moora is restricted to the Coomberdale Chert Threatened Ecological Community, searches were made along the Midlands Road and side roads from it from south of Moora to well north of Moora. Near Gillingarra (south of Moora) there is a similar entity that has different leaf cross section, slightly different fruit and grows on a different soil type.

3.9 New flora records for the Coomberdale Chert TEC

Although the Coomberdale Chert survey of Trudgen *et al.* (2012) has been extensively surveyed for flora, some new records of flora species were found during the 2016 survey work. The new records are: *Ophioglossum lusitanicum*, *Isoetopsis graminifolia*, *Hyalosperma demissum*, *Diuris brumalis*, *Diuris tinkeri*; *Podolepis capillaris* and *Salsola australis*.

The first of the new records (*Ophioglossum lusitanicum*) is a very small fern species; it was only seen at one locality and is a widespread sporadically distributed species. The second and third of the new records are very small daisy (Asteraceae) species. *Isoetopsis graminifolia* is only a few centimetres tall and *Hyalosperma demissum* is only one to two centimetres tall. They were found twice and once respectively in the proposed North Kiaka Mine area. Both are widespread species. Both the *Diuris* species are small ground dwelling orchids. *Diuris tinkeri* has a modest range from north of Perth to north of Geraldton, the two locations in the Coomberdale Chert Threatened Ecological Community (both in the proposed North Kiaka Mine area) are a modest eastwards range extension for the species. *Diuris brumalis* has a modest range from the Mandurah area to the Eneabba area. The location in the Coomberdale Chert Threatened Ecological Community is on the eastern edge of the range of the species and the species was recorded at one locality in the proposed North Kiaka Mine area. *Podolepis capillaris* is a very open herbaceous daisy to about 25 cm tall. It was recorded at one locality in the proposed North Kiaka Mine area and is very widespread in Australia south of the tropics. Salsola australis was seen in the remnant vegetation of the Coomberdale Chert TEC, but was more common in the surrounding paddocks and the species is probably a weed in the TEC.

4.0 VEGETATION OF THE PROPOSED NORTH KIAKA MINE AREA AND HAUL ROADS

4.1 Introduction

The native vegetation of the proposed North Kiaka Mine and haul roads areas consists of parts of remnants of the Coomberdale Chert Threatened Ecological Community separated by narrow cleared areas. Most of the remaining vegetation of the Coomberdale Chert TEC was mapped and described by Trudgen *et al.* (2012), incorporating work from earlier surveys. Their mapping and description of their units will be used, but not all of it will be reproduced as it is available in their report. To provide the appropriate context for the proposed North Kiaka Mine, their northern map sheet will be reproduced. This sheet starts a short distance south of Kiaka Road and covers the area north of Kiaka Road, including the area of the proposed North Kiaka Mine area and haul roads and extends to the north boundary of the area mapped.

The descriptions from Trudgen *et al.* (2012) of the vegetation types in the proposed North Kiaka Mine area will be reproduced. Descriptions of the other vegetation types found in the Coomberdale Chert Threatened Ecological Community can be found in their report if needed.

The description and classification of vegetation of the proposed North Kiaka Mine area in this section uses "traditional" techniques based on the vegetation structure and dominant species of different stands of vegetation. More details of the methods used and the extensive data set (99 quadrats and 407 releves) their mapping is based on are given in Trudgen *et al.* (2012). Their analysis of the floristic composition of the same vegetation is discussed in Section 60 below.

Trudgen *et al.* (2012) classified the vegetation of their survey area into three levels that go from low order to fairly high order of synthesis. Their lowest order units are mostly defined near the *plant community* level (see their Table 1 and section 6.2.1), the sites in such units having very similar structure, dominance and floristics. They grouped their plant communities into one hundred and four *vegetation associations* if they had similar structure and dominant species and then grouped these into thirty-one *vegetation alliances* as a third level of classification. On their vegetation map they showed plant communities and vegetation associations with a combined code (see Table 6 for the key to the letters in the codes) and vegetation alliances as colours so the map has three levels of information. The alliances vary in the number of associations they contain, with some having only one association. See Trudgen *et al.* (2012) for more detail of the rank and variation of their units and their Appendix 7, for a complete classification of the vegetation of the area of the Coomberdale Chert Threatened Ecological Community that they surveyed.

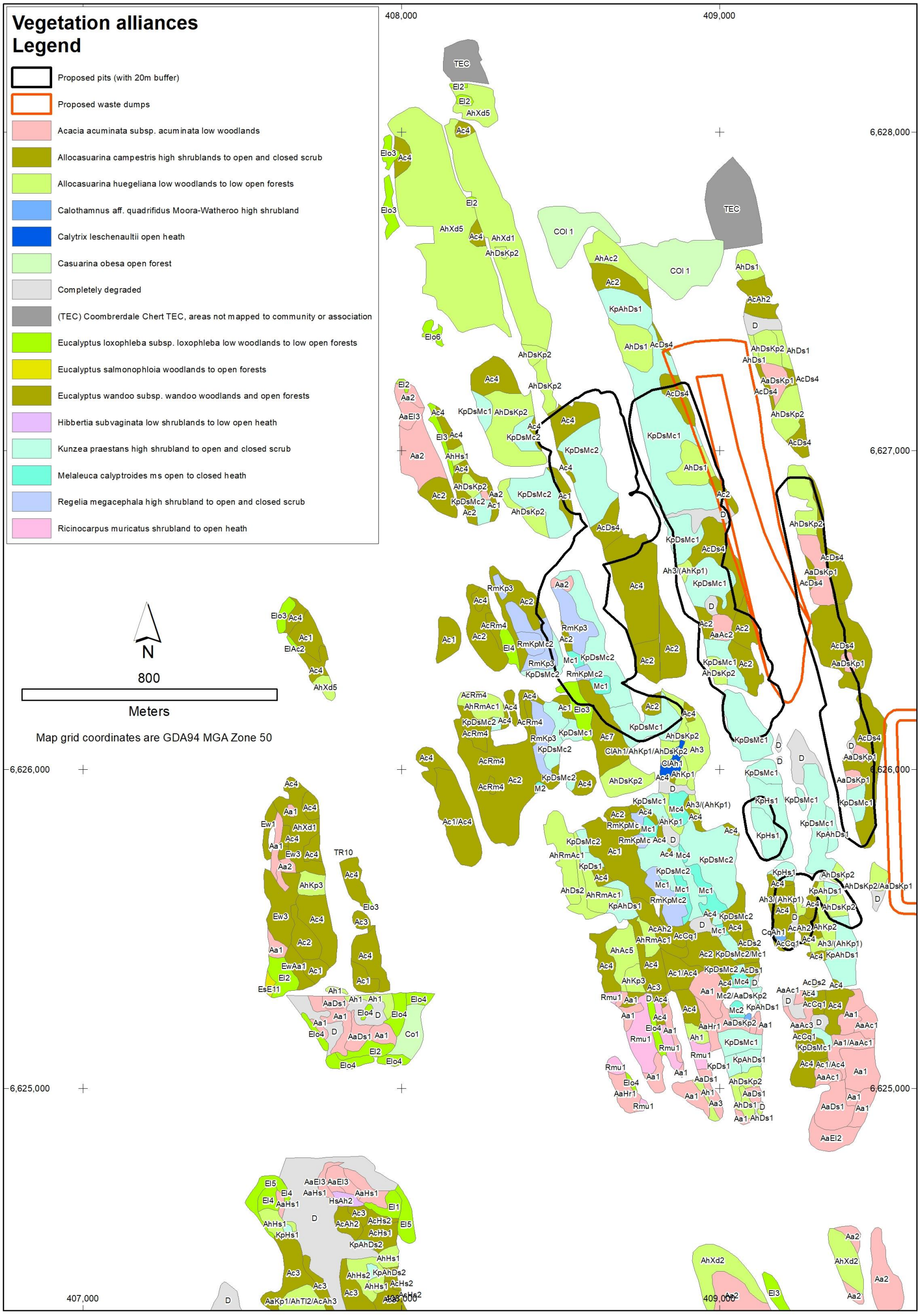
Table 6: Abbreviations used for the species in the vegetation association/plant community codes.

Note: The abbreviations are used on the vegetation map and in tables.

Code for species	**Species**	**Code for species**	**Species**
Aa	Acacia acuminata subsp. acuminata	Ep	Eucalyptus pruiniramis
Ac	Allocasuarina campestris	Es	Eucalyptus salmonophloia
Ah	Allocasuarina huegeliana	Ew	Eucalyptus wandoo subsp. wandoo
Ahu	Allocasuarina humilis	Ha	Hypocalymma angustifolium
Am	Allocasuarina microstachya	Hr	Hakea recurva subsp. recurva
As	Acacia scirpifolia	Hs	Hibbertia subvaginata
B	*Babingtonia cherticola* [Previously: *Baeckea* sp. Moora (R. Bone 1993/1)]	Id	Isopogon divergens
Bp	Banksia prionotes	Kp	Kunzea praestans
Cd	Calytrix depressa	Lp	Lepidosperma pubisquameum
Cl	Calytrix sp. Coomberdale	Mc	Melaleuca calyptroides
Cq	Calothamnus aff. quadrifidus (Moora-Watheroo)	Mco	Melaleuca concreta
Co	Casuarina obesa	Mcor	Melaleuca coronicarpa
Df	Dryandra fraseri	Mr	Melaleuca radula
Di	Dodonaea inaequifolia	Ms	Melaleuca sclerophylla
Dp	Dodonaea pinifolia	Pd	Quoya (Pityrodia) dilatata
Ds	Dryandra sessilis var. flabellifolia	Rv	Ricinocarpus velutinus
Ec	Eucalyptus camaldulensis	Rm	Regelia megacephala
Ee	Eucalyptus eudesmioides	Rmu	Ricinocarpus muricatus
Eh	Eucalyptus horistes	Td	Trymalium daphnifolium
El, Elo	Eucalyptus loxophleba subsp. loxophleba	Tl	Trymalium ledifolium subsp. rosmarinifolium
Eo	Eucalyptus obtusiflora	Xd	Xanthorrhoea sp. Coomberdale

The vegetation alliances found in the proposed North Kiaka Mine area and the vegetation associations that they group together are listed and described in section 4.2 below. For the sake of brevity, the plant communities recorded are not included but are available under their respective vegetation alliances and vegetation associations in Appendix 7 of Trudgen *et al.* (2012), which is a complete classification of the vegetation.

On the vegetation map (see Map 26), the individual polygons show the distribution of one stand of a plant community. The code within a polygon shows the vegetation association the vegetation in the polygon has been placed in using letters from the names of the dominant species. If more than one plant community has been described for the vegetation association, then it is indicated by a number at the end of the code. Vegetation alliance, the higher level of the classification grouping the vegetation associations, is indicated by the colours on the map.



Map 26: Vegetation alliances, vegetation associations and plant communities of the Coomberdale Chert TEC area north of Kiaka Road

Notes: This area includes both the proposed North Kiaka Mine and two haul road options to service the mine. The vegetation alliances are shown by colours and the vegetation associations and plant communities shown by codes (see text section 4 for codes).

4.2 The vegetation of the proposed North Kiaka Mine area

The vegetation of the proposed North Kiaka Mine area is a subset of eight vegetation alliances (Table 7 and Table 11) of the thirty-three vegetation alliances described for the Coomberdale Chert Threatened Ecological Community by Trudgen *et al.* (2012). Within the area of those eight alliances in the North Kiaka mine area there are areas of nineteen vegetation associations and twenty-three plant communities.

Table 7: The vegetation alliances represented in the proposed North Kiaka Mine area
Note: The numbering of the alliances in the text and Table 11 has been left as in Trudgen *et al.* (2012) to facilitate referral to that report. The vegetation associations and plant communities present are listed in Table 8.

Vegetation alliances in the proposed North Kiaka Mine area	**Number of polygons of the alliance in the North Kiaka Mine area**	**Number of vegetation associations for the alliance in mine area**	**Number of plant communities in mine area**
Kunzea praestans high shrubland to open and closed scrub	16	3	4
Allocasuarina campestris high shrublands to open and closed scrub	27	4	7
Allocasuarina huegeliana low woodlands to low open forests	10	4	4
Calothamnus aff. *quadrifidus* Moora-Watheroo high shrubland	1	1	1
Acacia acuminata subsp. *acuminata* low woodlands	5	3	3
Eucalyptus loxophleba subsp. *loxophleba* low woodlands to low open forests	1	1	1
Melaleuca calyptroides open to closed heath	2	1	1
Regelia megacephala high shrubland to open and closed scrub	3	2	2

The vegetation alliances, vegetation associations and plant communities recorded in the proposed North Kiaka Mine area are briefly described below. The vegetation associations are each given a unique code based on abbreviations of the names of the dominant species. A capital letter indicates the genus and a lower case letter indicates species. Where two or more species of the same genus occur in the same structural layer, the genus is indicated only once in

the code. Abbreviations for the species names used in the codes are given in Table 6 (see above).

The division of vegetation into such units is based mainly on the height and abundance of species, with emphasis on the tallest stratum. However, this can be misleading at times where the tallest stratum has low abundance and in such cases the most abundant stratum is sometimes used in the classification used here to group plant communities together where this makes more sense.

The vegetation alliances represented in the proposed North Kiaka Mine area are listed in Table 7, with the number of vegetation associations and plant communities in each for the proposed mine area. They are described below with the associations and plant communities found in them in the proposed mine area also described. Table 8 is an expanded version of this synopsis, with the vegetation associations and plant communities the vegetation alliances in the proposed mine area listed.

Vegetation Alliance 3: *Eucalyptus loxophleba* ssp. *loxophleba* low woodlands to low open forests

Eucalyptus loxophleba subsp. *loxophleba* was mainly recorded on lower slopes of ridges and the adjacent valley floor areas in the Coomberdale Chert Threatened Ecological Community. It was also occasionally found growing on the crest of the low ridges and along some sections of narrow linear features between some of the ridges (these are probably dolerite dykes). Only one of the four vegetation associations defined for this alliance occurs in the proposed North Kiaka Mine area.

Vegetation Association Elo: *Eucalyptus loxophleba* subsp. *loxophleba* low open to closed forest over scattered shrubs and very open herbland.

Six plant communities that differ in the shrub species present (or the lack of them) were defined for this vegetation association, but only one of these (plant community Elo.3) occurs in the proposed North Kiaka Mine area.

Plant community Elo.3: *Eucalyptus loxophleba* subsp. *loxophleba* low open forest over very open herbland.

This community has one occurrence in the proposed North Kiaka Mine area that is 0.29 hectares in area. Three sites were recorded in this community in Cairn Hill Reserve and other areas were assigned to it during the vegetation mapping. Unlike the other plant communities in vegetation association Elo, it usually did not have a shrub layer.

Table 8: Vegetation alliances and their contained vegetation associations and plant communities recorded in the proposed North Kiaka Mine area

Notes**:** The vegetation association and plant communities can share the same names, with the plant communities having the addition of a number to the codes, or for more variation from the vegetation association name by additional letters. Where there is more than one community in an association the association is not repeated in the table. The vegetation alliance code is also used for the first association described for it, others having additional letters.

Vegetation alliance [Alliance number of Trudgen *et al.* 2006, 2012]	**Vegetation Alliance code**	**Vegetation associations and plant communities of the alliances**
Acacia acuminata subsp. *acuminata* low woodlands [Alliance 11]	Aa	Association **Aa**: *Acacia acuminata* subsp. *acuminata* low open forest over scattered grasses sedges and very open herbland Community **Aa.2**: *Acacia acuminata* subsp. *acuminata* low open woodland over *Xanthorrhoea* sp. Coomberdale scattered tall shrubs over scattered sedges with *Gilberta tenuifolia*, *Podolepis lessonii*, *Waitzia nitida* open herbland and *Cheilanthes adiantoides* very open fernland
	Aa	Association **AaAc**: *Acacia acuminata* subsp. *acuminata* low woodland over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over very open herbland Community **AaAc.2**: *Acacia acuminata* subsp. *acuminata* low woodland to low open forest over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over scattered grasses with very open herbland and *Cheilanthes adiantoides* scattered ferns
	Aa	Association **AaDsKp**: *Acacia acuminata* subsp. *acuminata* low woodland over *Dryandra sessilis* var. *flabellifolia (Xanthorrhoea* sp. Coomberdale) scattered tall shrubs over *Kunzea praestans* scattered tall shrubs to high open shrubland over very open herbland Community **AaDsKp1**: *Acacia acuminata* subsp. *acuminata*, *Nuytsia floribunda* scattered low trees over *Dryandra sessilis* var. *flabellifolia* high open shrubland over *Xanthorrhoea* sp. Coomberdale, *Kunzea praestans* high open shrubland over Hibbertia subvaginata, Acacia restiacea scattered low shrubs
Allocasuarina campestris high shrublands to open or closed scrub [Alliance 13]	Ac	Association **Ac**: *Allocasuarina campestris* open to closed scrub over scattered sedges/grasses/herbs. Community **Ac.1**: *Allocasuarina campestris* open heath to closed heath over scattered sedges/grasses with *Borya sphaerocephala* scattered herbs and *Cheilanthes adiantoides* scattered ferns
	Ac	Community **Ac.2**: (*Acacia acuminata* subsp. *acuminata* (+ (3-5%)) scattered low trees to low open woodland over *Allocasuarina campestris* (90%) closed scrub over scattered grasses/sedges with *Cheilanthes adiantoides* scattered ferns and *Borya sphaerocephala* scattered herbs.
	Ac	Community **Ac.4**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland over *Allocasuarina campestris* closed scrub over *Neurachne alopecuroidea* scattered grasses with scattered herbs and *Cheilanthes adiantoides* scattered ferns.

	Ac	Community **Ac.7**: *Allocasuarina campestris* open to closed heath over *Melaleuca calyptroides* scattered shrubs over *Calytrix* sp. Coomberdale scattered low shrubs over *Stylidium septentrionale* very open herbland.
	Ac	Association **AcAh**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland to low open forest over *Allocasuarina campestris* high open shrubland to open to closed scrub. Community **AcAh.2**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland to low woodland over *Allocasuarina campestris* high shrubland to open and closed scrub over open sedgeland/grassland/herbland.
	AcCq	Association **AcCq**: *Allocasuarina campestris, Calothamnus quadrifidus* var. Moora-Watheroo open to closed scrub. **AcCq** Community **AcCq.1**: *Acacia acuminata* subsp. *acuminata* (*Allocasuarina huegeliana*) scattered low trees to low open woodland over *Allocasuarina campestris* (*Calothamnus* aff. *quadrifidus* Moora-Watheroo) open to closed scrub over scattered grasses/sedges/herbs.
	AcDs	Association **AcDs**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Allocasuarina campestris* open to closed scrub. Community : **AcDs.4**: (*Acacia acuminata* subsp. *acuminata*, *Allocasuarina huegeliana*) scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Allocasuarina campestris*, *Xanthorrhoea* sp. Coomberdale high open shrubland to high shrubland over scattered sedges/grasses with scattered ferns (and annual grassland/herbland).
Allocasuarina huegeliana low woodlands to low open forests [Alliance 9]	Ah	Association **Ah**: *Allocasuarina huegeliana* low woodland to low open forest over scattered shrubs Community **Ah.3/(AhKp1)**:[description of Ah.3] *Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata* low woodland to low open forest over *Allocasuarina campestris* [*Kunzea praestans*] scattered tall shrubs to high open shrubland over *Podolepis lessonii*, *Trachymene ornata* open annual herbland.
	AhDs	Association **AhDs**: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland. Community **AhDs.1**: Allocasuarina huegeliana, Acacia acuminata subsp. acuminata low open forest over Dryandra sessilis var. flabellifolia scattered tall shrubs over Xanthorrhoea sp. Coomberdale (Allocasuarina campestris) scattered tall shrubs.
	AhDsKp	Association **AhDsKp**: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high shrubland over *Kunzea praestans* scattered tall shrubs to high open shrubland. Community **AhDsKp.2**: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra*

		sessilis var. *flabellifolia* scattered tall shrubs to high shrubland over *Kunzea praestans* scattered tall shrubs to high open shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.
	AhKp	Association **AhKp**: *Allocasuarina huegeliana* low woodland to low open forest over *Kunzea praestans* scattered tall shrubs to high open shrubland. Community **AhKp.2**: Allocasuarina huegeliana (Acacia acuminata subsp. acuminata) low woodland to low open forest over Kunzea praestans, Xanthorrhoea sp. Coomberdale scattered tall shrubs to high open shrubland over (Hibbertia subvaginata, Calytrix sp. Coomberdale) open shrubland over scattered sedges/grasses/herbs/ferns.
Calothamnus aff. *quadrifidus* Moora-Watheroo high shrubland [Alliance 20/8]	CqAh	Association **CqAh**: *Allocasuarina huegeliana* scattered low trees over *Calothamnus* aff. *quadrifidus* Moora Watheroo (*Kunzea praestans*, *Allocasuarina campestris*) high open shrubland to high shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland. Community **CqAh.1**: Vegetation description is the same as for the association .
Eucalyptus loxophleba subsp. *loxophleba* low woodlands to low open forests [Alliance 3]	El	Association **El**: *Eucalyptus loxophleba* subsp. *loxophleba* low woodlands to low open forests Community **Elo.3**: *Eucalyptus loxophleba* subsp. *loxophleba* low open forest over very open herbland.
Kunzea praestans high shrubland to open and closed scrub [Alliance 16]	KpAhDs	Association **KpAhDs**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata)* scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high shrubland to open scrub over *Hibbertia subvaginata* low open shrubland Community **KpAhDs.1**: (*Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata*) scattered low trees over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high shrubland to open scrub over *Hibbertia subvaginata* (*Calytrix* sp. Coomberdale) (low) open shrubland over *Desmocladus asper*, *Neurachne alopecuroidea* very open sedgeland/grassland with *Cheilanthes adiantoides* very open fernland.
	KpDsMc	Association **KpDsMc**: *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Kunzea praestans* high shrubland to open scrub over *Melaleuca calyptroides* scattered shrubs to shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland. Community **KpDsMc.1**: Allocasuarina huegeliana (Acacia acuminata subsp. acuminata) scattered low trees to low open woodland over Dryandra sessilis var. flabellifolia scattered tall shrubs over Kunzea praestans (Allocasuarina campestris, Xanthorrhoea sp. Coomberdale) high open shrubland to open scrub over Melaleuca calyptroides scattered shrubs to open shrubland over (Hibbertia subvaginata), Calytrix leschenaultia low open shrubland over scattered sedges/grasses with Borya sphaerocephala very open

		herbland and annual grassland. Community **KpDsMc.2**: Dryandra sessilis var. flabellifolia scattered tall shrubs over Kunzea praestans (Xanthorrhoea sp. Coomberdale) high shrubland over Melaleuca calyptroides scattered shrubs to open shrubland over Hibbertia subvaginata (Calytrix sp. Coomberdale) low shrubland over Desmocladus asperus, Stylidium septentrionale scattered sedges and herbs.
	KpHs	Association **KpHs**: *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* (low) open shrubland to (low) open heath over scattered to very open sedgeland/grassland/herbland. Community **KpHs.1**: *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* open shrubland to open heath over very open herb/fernland.
Melaleuca calyptroides open to closed heath [Alliance 17]	Mc	Association **Mc**: *Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata, Calytrix* sp. Coomberdale scattered low shrubs to low open shrubland. Community **Mc.1**: *Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata, Calytrix* sp. Coomberdale low open shrubland over *Desmocladus asperus* scattered sedges/grasses with *Stylidium septentrionale, Borya sphaerocephala* scattered herbs.
Regelia megacephala high shrubland to open and closed scrub [Alliance 15]	RmKp	Association **RmKp**: *Regelia megacephala* high shrubland to open scrub over *Kunzea praestans* high open shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland Community **RmKp.3**: *Regelia megacephala, Kunzea praestans* open scrub over *Hibbertia subvaginata, Calytrix* sp. Coomberdale low scattered shrubs over **Avena barbata*, very open grassland with **Ursinia anthemoides* very open herbland.
	RmKpMc	Association **RmKpMc**: *Regelia megacephala open to closed scrub and Kunzea praestans* high open shrubland to open scrub over *Melaleuca calyptroides* open shrubland to shrubland over *Hibbertia subvaginata* low open shrubland. Community **RmKpMc.2**: (*Allocasuarina huegeliana* scattered low trees over) *Regelia megacephala* tall shrubland to open or closed scrub over *Kunzea praestans, Melaleuca calyptroides* open shrubland to shrubland over *Calytrix* sp. Coomberdale scattered low shrubs over *Borya sphaerocephala* low open herbland and scattered annual herbs.

Vegetation Alliance 9: *Allocasuarina huegeliana* low woodlands to low open forests

Allocasuarina huegeliana forms low woodlands and low open forests on ridge crests and slopes in the Coomberdale Chert Threatened Ecological Community. The variation uncounted has been grouped into thirteen vegetation associations, four of which are fond in the proposed North Kiaka Mine area.

Vegetation Association Ah: *Allocasuarina huegeliana* low woodland to low open forest over scattered shrubs.
Four plant communities were included in this vegetation association, differentiated by the composition of the tree layer and the shrub species present.

Plant community: **Ah.3/(AhKp1)**:[description for community Ah.3] *Allocasuarina huegeliana, Acacia acuminata* subsp. *acuminata* low woodland to low open forest over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over *Podolepis lessonii*, *Trachymene ornata* open annual herbland.
Two quadrats (JT2 and JT5) on the John Tonkin property were assigned classified as plant community Ah.3, but lie just outside the proposed North Kiaka Mine area. During vegetation mapping an area was interpreted as close to this unit but tending towards plant community AhKp.1 because of the presence of *Kunzea praestans*. The single stand mapped as this unit is 1.32 hectares in size.

Vegetation Association AhDs: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland.
Four plant communities were included in this vegetation association in the Coomberdale Chert TEC, differing in the associated species in the tree and shrub layers. One of these communities (AhDs.1) is present in the proposed North Kiaka Mine area.

Plant community: **AhDs.1:** *Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata* low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs over *Xanthorrhoea* sp. Coomberdale (*Allocasuarina campestris*) scattered tall shrubs.
Four sites (releves) scattered through the TEC were recorded in this plant community and there is one polygon of 1.32 hectares in the proposed mine area.

Vegetation Association AhDsKp: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high shrubland over *Kunzea praestans* scattered tall shrubs to high open shrubland.

This vegetation association was recorded from John Tonkin's, Ridgway's, Cairn Hill North, Cairn Hill and Gardiner's Hill in the TEC. Four plant communities were described for this vegetation association, differing in the composition of the tree and shrub strata. One was differentiated by having *Hibbertia subvaginata* scattered low shrubs to low open shrubland, while another plant community was a single stand at Gardiner's Hill where the *Dryandra sessilis* var. *flabellifolia* formed an open scrub under an *Allocasuarina huegeliana* low open forest. A third plant community was distinguished by having a *Babingtonia cherticola* low open shrubland to shrubland. One of these communities (AhDsKp.2) is present in the proposed North Kiaka mine area.

Plant community **AhDsKp.2**: *Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high shrubland over *Kunzea praestans* scattered tall shrubs to high open shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.
Seven sites were recorded in this vegetation type by Trudgen *et al.* (2012), with four of them from the John Tonkin property. Seven polygons of the community occur in the proposed North Kiaka Mine area, with a combined area of 1.99 hectares.

Vegetation Association AhKp: *Allocasuarina huegeliana* low woodland to low open forest over *Kunzea praestans* scattered tall shrubs to high open shrubland.

This vegetation association has three plant communities in the Coomberdale Chert TEC. One was differentiate by having a *Hibbertia subvaginata* scattered low shrubs to low open shrubland layer, while another (AhKp.2) has a *Xanthorrhoea* sp. Coomberdale high shrubland layer and a *Calytrix* sp. Coomberdale (*Hibbertia subvaginata*) low open shrubland layer. The third has an *Allocasuarina campestris* high open shrubland layer.

Plant community: **AhKp.2:** *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low woodland to low open forest over *Kunzea praestans*, *Xanthorrhoea* sp. Coomberdale scattered tall shrubs to high open shrubland over (*Hibbertia subvaginata*, *Calytrix* sp. Coomberdale) open shrubland over scattered sedges/grasses/herbs/ferns.
Nine sites (releves) were recorded in this plant community, which has one polygon 0.23 hectares in size in the proposed North Kiaka Mine area.

Vegetation Alliance 11: *Acacia acuminata* low woodlands to low open forests

Acacia acuminata subsp. *acuminata* formed stands of low woodlands to low open forests in mainly small areas along the lower slopes of ridges in the Coomberdale Chert Threatened Ecological Community. It commonly occurs with *Allocasuarina huegeliana* in that area.

Vegetation Association Aa: *Acacia acuminata* subsp. *acuminata* low open forest over scattered grasses sedges and very open herbland.
This vegetation association has three plant communities in the Coomberdale Chert Threatened Ecological Community. One was distinguished by having *Allocasuarina huegeliana* present in the tree layer and another by having a *Xanthorrhoea* sp. Coomberdale high open shrubland.

Plant community: **Aa.2:** *Acacia acuminata* subsp. *acuminata* low open woodland over *Xanthorrhoea* sp. Coomberdale scattered tall shrubs over scattered sedges/ with *Gilberta tenuifolia, Podolepis lessonii, Waitzia nitida* open herbland and *Cheilanthes adiantoides* very open fernland.
This plant community has one polygon 0.22 hectares in area in the proposed North Kiaka Mine area.

Vegetation Association AaAc: *Acacia acuminata* subsp. *acuminata* low woodland over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over very open herbland.
This vegetation association was has three plant communities described for the Coomberdale Chert Threatened Ecological Community. One differs in having *Allocasuarina huegeliana* present in the tree layer, while another was distinguished by having *Allocasuarina huegeliana* present in the tree layer and a *Xanthorrhoea* sp. Coomberdale high open shrubland layer.

Plant community: **AaAc.2:** *Acacia acuminata* subsp. *acuminata* (10-15 (30)%) low woodland to low open forest over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over scattered grasses with very open herbland and *Cheilanthes adiantoides* scattered ferns.
Four sites (releves) were recorded in this plant community, which has one polygon of 0.465 hectares area in the proposed North Kiaka Mine area.

Vegetation Association AaDsKp: *Acacia acuminata* subsp. *acuminata* low woodland over *Dryandra sessilis* var. *flabellifolia (Xanthorrhoea* sp. Coomberdale) scattered tall shrubs over *Kunzea praestans* scattered tall shrubs to high open shrubland over very open herbland.
Two plant communities were defined for this vegetation association by Trudgen *et al.* (2012) differing in the shrub layer species present. One (AaDsKp.1) had a *Hibbertia vaginata* scattered low shrub layer, while the other had a *Melaleuca calyptroides* open shrubland layer.

Plant community: **AaDsKp.1:** *Acacia acuminata* subsp. *acuminata*, *Nuytsia floribunda* scattered low trees over *Dryandra sessilis* var. *flabellifolia* high open shrubland over *Xanthorrhoea* sp. Coomberdale, Kunzea praestans high open shrubland over Hibbertia subvaginata, Acacia restiacea scattered low shrubs
One site (a releve) was recorded in this plant community, which has an area of 1.8 hectares in the proposed North Kiaka Mine area in three stands.

Vegetation Alliance 13: *Allocasuarina campestris* high shrublands to open and closed scrub

Allocasuarina campestris forms stands of high shrublands, open scrub or closed scrub, often in large stands, throughout the area of the Coomberdale Chert surveyed by Trudgen *et al.* (2012). Such stands were most common between the low chert ridges and on their lower slopes, but did occur further upslope. They occur where there is deeper soil over the underlying chert and the underlying rock is more fractured, allowing this species to dominate rather than *Regelia megacephala*.

Allocasuarina campestris stands often have no tree layer in the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012). However, stands with open tree overstoreys do occur there and varied in the species composition of low woodlands overstoreys and in the associated plant species. The variation in composition of the stands correlated partly with the different sub-areas of the TEC and partly with habitat.

Vegetation Association Ac: *Allocasuarina campestris* open to closed scrub over scattered sedges/grasses/herbs.
Eight plant communities have been defined in this vegetation association for the Coomberdale Chert Threatened Ecological Community. They differ mainly in the presence or absence and composition of an open tree layer (scattered low trees to low open woodland) and the species of low shrubs that form a very open to open lower shrub layer. One of the plant communities differed in having an *Acacia acuminata* subsp. *acuminata* scattered low trees to low open woodland strata. Another had a *Eucalyptus loxophleba* subsp. *loxophleba* (with a fewer *Acacia acuminata* subsp. *acuminata* and *Allocasuarina huegeliana*) scattered low trees to low open woodland layer. Another by having an *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered low trees to low open woodland layer. Different shrub and low shrub species that were present (scattered) in different plant communities were *Calytrix depressa*,

Dryandra fraseri, *Hibbertia subvaginata* and *Melaleuca calyptroides*. The four plant communities of the association present in the proposed North Kiaka Mine area are:

Plant community: **Ac1**: *Allocasuarina campestris* open heath to closed heath over scattered sedges/grasses with *Borya sphaerocephala* scattered herbs and *Cheilanthes adiantoides* scattered ferns.
Nine sites (releves) were recorded in this plant community from the John Tonkin property to the Gardiner property. There is one occurrence in the proposed mine area with an area of 0.37 hectares.

Plant community: **Ac.2:** (*Acacia acuminata* subsp. *acuminata* scattered low trees to low open woodland over *Allocasuarina campestris* closed scrub over scattered grasses/sedges with *Cheilanthes adiantoides* scattered ferns and *Borya sphaerocephala* scattered herbs.
This plant community differed from the others in the association by having an *Acacia acuminata* subsp. *acuminata* scattered low trees to low open woodland stratum over the *Allocasuarina*
Ten sites (releves) were recorded in this plant community from the John Tonkin property to the Gardiner property. There are eight occurrences in the proposed mine area with combined area of 2.78 hectares.

Plant community: **Ac.4:** *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland over *Allocasuarina campestris* closed scrub over *Neurachne alopecuroidea* scattered grasses with scattered herbs and *Cheilanthes adiantoides* scattered ferns.
This plant community differed by having an *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered low trees to low open woodland layer.
Two quadrats (one on the John Tonkin property and one on the Eastern Ridge) and twenty-one other sites (releves) were recorded in this plant community from the John Tonkin property to the Gardiner property. There are eight occurrences in the proposed mine area with combined area of 3.45 hectares.

Plant community: **Ac.7:** *Allocasuarina campestris* open to closed heath over *Melaleuca calyptroides* scattered shrubs over *Calytrix* sp. Coomberdale scattered low shrubs over *Stylidium septentrionale* very open herbland.
This plant community differed by having *Melaleuca calyptroides* associated scattered low shrubs. Two sites (releves) were recorded in this plant community which has one occurrence in the proposed mine area with area of 0.69 hectares.

Vegetation Association AcAh: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland to low open forest over *Allocasuarina campestris* high open shrubland to open to closed scrub.

Two plant communities have been defined for this vegetation association in the Coomberdale Chert Threatened Ecological Community, only one of which occurs in the proposed North Kiaka Mine area. They differed in the cover of the *Allocasuarina huegeliana* upper storey and the cover of the *Allocasuarina campestris* stratum.

Plant community **AcAh.2:** *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland to low woodland over *Allocasuarina campestris* high shrubland to open and closed scrub over open sedgeland/grassland/herbland.

Two quadrats and seven other sites (releves, three on the John Tonkin property) were recorded in this plant community. There is one occurrence in the proposed mine area with area of 0.21 hectares.

Vegetation Association AcCq: *Allocasuarina campestris, Calothamnus* aff. *quadrifidus* (Moora-Watheroo) open to closed scrub.

Three plant communities have been defined for this vegetation association in the Coomberdale Chert Threatened Ecological Community. One was differentiated by having a *Melaleuca calyptroides* scattered shrubs to open shrubland layer. Another by having a scattered *Astroloma serratifolium* and *Hakea lissocarpha* low shrub layer. Only one of the three plant communities occurs in the proposed North Kiaka Mine area.

Plant community **AcCq.1:** *Acacia acuminata* subsp. *acuminata* (*Allocasuarina huegeliana*) scattered low trees to low open woodland over *Allocasuarina campestris* (*Calothamnus* aff. *quadrifidus* Moora-Watheroo) open to closed scrub over scattered grasses/sedges/herbs.

One quadrat (on the John Tonkin property) and one other site (releve) were recorded in this plant community. There is one occurrence in the proposed mine area with area of 0.14 hectares.

Vegetation Association AcDs: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Allocasuarina campestris* open to closed scrub.

Four plant communities were defined for this vegetation association in the Coomberdale Chert Threatened Ecological Community. One was distinguished by the additional presence of *Kunzea praestans* in the open scrub layer. Another differs by having a high open shrubland layer of *Xanthorrhoea* sp. Coomberdale, while the third differed by having a high open shrubland of a mixture of *Melaleuca radula* and *Xanthorrhoea* sp. Coomberdale as well as the *Dryandra*. Only one of these plant communities occurs in the proposed North Kiaka Mine area.

Plant community: **AcDs4**: *Acacia acuminata* subsp. *acuminata*, *Allocasuarina huegeliana* scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Allocasuarina campestris*, *Xanthorrhoea* sp. Coomberdale high open shrubland to high shrubland over scattered sedges/grasses with scattered ferns (and annual grassland/herbland).
Four sites (releves) were recorded in stands of this plant community, which has seven occurrences in the proposed North Kiaka Mine area with a total are of just over seven hectares.

Vegetation Alliance 15: *Regelia megacephala* high shrubland to open and closed scrub

Regelia megacephala high shrubland to open and closed scrub occurs on the slopes, and less commonly the crests, of low ridges with chert exposed as outcrop or sub-outcrop in the Coomberdale Chert Threatened Ecological Community. In places *Regelia* stands occurred under low open woodlands. The associated tree and shrub species in *Regelia* stands varied in different sub-areas of the survey area of Trudgen *et al.* (2012). Eight different vegetation associations were defined for this vegetation alliance by Trudgen *et al.* (2012), but only two of these occur in the proposed North Kiaka Mine area.

Vegetation Association RmKp: *Regelia megacephala* high shrubland to open scrub over *Kunzea praestans* high open shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.

Three plant communities were defined for this vegetation association by Trudgen *et al.* (2012), but only one of these occurs in the proposed North Kiaka Mine area. One of the plant communities defined was a *Regelia megacephala* high shrubland over *Kunzea praestans* open scrub over very open herbland. The second plant community differed by having a lower cover of *Kunzea praestans* (high open shrubland to high shrubland) over *Hibbertia subvaginata* scattered shrubs. The third plant community had a *Regelia megacephala*, *Kunzea praestans* open scrub over *Hibbertia subvaginata* with *Ricinocarpus muricatus* as an associated species.

Plant community **RmKp3**: *Regelia megacephala, Kunzea praestans* open scrub over *Hibbertia subvaginata, Calytrix* sp. Coomberdale low scattered shrubs over **Avena barbata*, very open grassland with **Ursinia anthemoides* very open herbland.
One site (a releve) was recorded in this plant community, which has two occurrences in the proposed North Kiaka Mine area with a total area of 1.54 hectares.

Vegetation Association RmKpMc: *Regelia megacephala* open to closed scrub and *Kunzea praestans* high open shrubland to open scrub over *Melaleuca calyptroides* open shrubland to shrubland over *Hibbertia subvaginata* low open shrubland.

Three plant communities have been defined for this vegetation association in the Coomberdale Chert Threatened Ecological Community. One has a *Kunzea praestans* high shrubland to open scrub with a *Melaleuca calyptroides* open shrubland. Another has a lower *Kunzea praestans* cover (high open shrubland rather than scrub) and a higher cover of *Melaleuca calyptroides* (open shrubland to shrubland). The third differs by having *Allocasuarina campestris* in the scrub layer. Some vegetation with open tree layers has been included in this (otherwise scrub) vegetation association to keep stands otherwise similar in overall composition together.

Plant community: **RmKpMc2**: *Allocasuarina huegeliana* scattered low trees over *Regelia megacephala* tall shrubland to open and closed scrub over *Kunzea praestans, Melaleuca calyptroides* open shrubland to shrubland over *Calytrix* sp. Coomberdale scattered low shrubs over *Borya sphaerocephala* low open herbland and scattered annual herbs.
This plant community has a lower *Kunzea praestans* cover (high open shrubland) and a higher cover of *Melaleuca calyptroides* (open shrubland to shrubland) than other plant communities in the same vegetation association. Four quadrats were recorded in this plant community by Trudgen *et al.* (2012) one each from the John Tonkin property and the Eastern Ridge and two from the Gardiner property. There is one occurrence of 0.19 hectares in the proposed North Kiaka Mine area.

Vegetation Alliance 16: *Kunzea praestans* high shrubland to open and closed scrub
Kunzea praestans forms stands of high shrublands and open scrub on parts of the slopes and crests of the chert ridges underlying the Coomberdale Chert Threatened Ecological Community. It commonly grew over *Hibbertia subvaginata* which varied in cover from low open shrublands to open heaths in these stands.

Eight vegetation associations were defined for this vegetation alliance in the Coomberdale Chert Threatened Ecological Community by Trudgen *et al.* (2012), three of which occur in the proposed North Kiaka Mine area. In these eight associations *Kunzea praestans* occurs as the dominant tall shrub species or co-dominant with several other tall shrub species, including *Dryandra sessilis* and *Xanthorrhoea* sp. Coomberdale. Sometimes, one of the other shrubs forms a taller, but more open, second tall shrub layer. Where trees occur over the high shrubland or scrub layer, they are at low cover and the tall shrubs are the main feature of the vegetation.

Vegetation Association KpAhDs: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale*)* high shrubland to open scrub over *Hibbertia subvaginata* low open shrubland.

Three plant communities were described for this vegetation association by Trudgen *et al.* (2012) one of which occurs in the proposed North Kiaka Mine area. One of the three plant communities had a *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high shrubland over *Hibbertia subvaginata* low open shrubland, another differed by having a *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high open shrubland over *Hibbertia subvaginata* low heath. The third differed by not having *Hibbertia subvaginata* in the low shrub layer.

Plant community **KpAhDs1**: *Allocasuarina huegeliana, Acacia acuminata* subsp. *acuminata* scattered low trees over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high shrubland to open scrub over *Hibbertia subvaginata* (*Calytrix* sp. Coomberdale) (low) open shrubland over *Desmocladus asperus, Neurachne alopecuroidea* very open sedgeland/grassland with *Cheilanthes adiantoides* very open fernland.
Two stands of this plant community occur in the proposed North Kiaka Mine area, with a combined area of 0.32 hectares. Five sites (releves) were recorded in this plant community by Trudgen *et al.* (2012), including one on the John Tonkin property.

Vegetation Association KpDsMc: *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Kunzea praestans* high shrubland to open scrub over *Melaleuca calyptroides* scattered shrubs to shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.

Three plant communities were recorded in this vegetation association. One plant community differed by having a stratum of scattered low trees to low woodland of *Allocasuarina huegeliana* and smaller amounts of *Acacia acuminata* subsp. *acuminata.* Another differed by having a *Xanthorrhoea* sp. Coomberdale high open shrubland stratum. There was also variation in the cover of shrub (rather than tall shrub) species such as *Hibbertia subvaginata* and *Calytrix* sp. Coomberdale, with the former usually more abundant.

Plant community: **KpDsMc1**: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered low trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs over *Kunzea praestans* (*Allocasuarina campestris*, *Xanthorrhoea* sp. Coomberdale) high open shrubland to open scrub over *Melaleuca calyptroides* scattered shrubs to open shrubland over *Hibbertia subvaginata* (*Calytrix* sp. Coomberdale) low open shrubland over scattered sedges/grasses with *Borya sphaerocephala* very open herbland and annual grassland.
This plant community has seven stands in the proposed North Kiaka Mine area with a total area of 10.49 hectares. Trudgen *et al.*(2012) recorded one quadrat and four other sites (releves) in this plant community on the John Tonkin property and six other sites in other areas of the Coomberdale Chert Threatened Ecological Community including three on the Gardiner property.

Plant community: **KpDsMc.2:** *Dryandra sessilis* var. *sessilis* scattered tall shrubs over *Kunzea praestans*, (*Xanthorrhoea* sp. Coomberdale) high shrubland over *Melaleuca calyptroides* scattered shrubs to open shrubland over *Hibbertia subvaginata*, (*Calytrix* sp. Coomberdale) low shrubland over *Desmocladus asper*, *Stylidium septentrionale* scattered sedges and herbs.
This plant community has no tree layer, but has two open layers of tall shrubs over the *Melaleuca calyptroides* layer with the three common tall shrubs in the Coomberdale Chert Threatened Ecological Community present. There are four stands of this plant community in the proposed North Kiaka Mine area with a combined area of 6.04 hectares. Two quadrats were recorded in this plant community by Trudgen *et al.* (2012) both ion the John Tonkin property where a releve was also recorded with another recorded on the A & R. Tonkin property.

Vegetation Association KpHs: *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* (low) open shrubland to (low) open heaths over scattered to very open sedgeland/grassland/herbland.

Two plant communities have been defined for this vegetation association. One of these differed from the other, which occurs in the proposed North Kiaka Mine area by having *Allocasuarina campestris* in the open scrub stratum.

Plant community: **KpHs1**: *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* open shrubland to open heath over very open herb/fernland.
This plant community has an area of 1.37 hectares in the proposed North Kiaka Mine area, spread between three stands. Three quadrats were recorded in this plant community by Trudgen *et al.* (2012) two on the Eastern Ridge and one on the John Tonkin property. One releve was also recorded.

Vegetation Alliance 17: *Melaleuca calyptroides* open to closed heath

While this vegetation alliance is defined by having a dense to very dense shrub layer of *Melaleuca calyptroides*, the stands often have scattered shrubs to tall open shrublands of taller species such as *Dryandra sessilis* or *Kunzea praestans* over them and occasionally an open tree layer. Only one vegetation association was defined for this alliance. Most of the stands of this vegetation were recorded on the John Tonkin and Ridgway properties.

Vegetation Association Mc: *Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata, Calytrix sp.* Coomberdale scattered low shrubs to low open shrubland.

Four plant communities were defined for this vegetation association. One differed from the others by having a scattered *Dryandra sessilis* var. *flabellifolia* upper stratum. Another differed by having a scattered *Dryandra sessilis* var. *flabellifolia* upper stratum and a *Babingtonia cherticola* low open shrubland stratum. The fourth plant community differed by having a low tree layer (*Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered low trees).

Plant community: **Mc1**: *Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata, Calytrix* sp. Coomberdale low open shrubland over *Desmocladus asperus* scattered sedges/grasses with *Stylidium septentrionale*, *Borya sphaerocephala* scattered herbs.
This plant community has two stands in the proposed North Kiaka Mine area with a combined area of 0.49 hectares. Only two releves were recorded in this plant community by Trudgen *et al.* (2012), both on the John Tonkin property.

Vegetation Alliance 20/8: Calothamnus aff. quadrifidus (Moora-Watheroo) high shrubland

The dominant species of this vegetation alliance is a form of *Calothamnus quadrifidus* that occurs between Moora and Watheroo. It is a large shrub that is restricted to areas with Chert at or near the surface in the Coomberdale Chert Threatened Ecological Community and is probably restricted to sites with chert near the surface elsewhere. Two vegetation associations have been defined for the alliance, each with just one plant community.

Vegetation Association CqAh: *Allocasuarina huegeliana* scattered low trees over *Calothamnus* aff. *quadrifidus* (Moora-Watheroo) (*Kunzea praestans*, *Allocasuarina campestris*) high open shrubland to high shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.

Plant community: **CqAh1**: As it is the only community in the association, the vegetation description is the same as for the association. This community was recorded at two releves, one on the John Tonkin property and one on the Gardiner property. There is one stand of plant community CqAh1 in the proposed North Kiaka Mine area, with an area of 0.12 hectares.

4.3 Extent of vegetation alliances in the proposed North Kiaka Mine area compared to the Coomberdale Chert TEC

Some of the vegetation alliances defined for the Coomberdale Chert Threatened Ecological Community by Trudgen *et al.* (2012) have larger areas than others in the area those authors surveyed. The particular way this variation occurs largely reflects the fact that the areas of the Coomberdale Chert TEC remaining are those with chert at or near the surface so it was not practical to clear them for agriculture, this meant that communities on the lower slopes tend to have been cleared and communities on the upper slopes and crests have remained uncleared. There is also substrate variation (such as fragmentation of the chert, depth of topsoil) that affects the areas of individual vegetation alliances and their constituent vegetation associations and plant communities.

The remnants of the Coomberdale Chert TEC in the proposed North Kiaka Mine area reflect this clearing history and the alliances found there are mostly found in amounts (Table 9) reflecting the amount of the alliance in the areas surveyed by Trudgen *et al.* (2012). However, there is some variation, the most significant one of which is that the *Kunzea praestans* high shrubland to open and closed scrub vegetation alliance has 31.5% of its known area in the proposed mine area whereas the vegetation of the proposed mine area (41.86 hectares) is 5.74%

of the area of the Coomberdale Chert TEC mapped by Trudgen *et al.* (2012) which is 728.81 hectares.

Table 9: Areas of the eight vegetation alliances found in the proposed North Kiaka Mine area compared to known areas

Note: The vegetated areas in haul road option 2 are part of those in option 1, but are smaller.

Vegetation alliances in the proposed North Kiaka Mine area	**Area in haul road option 1 (ha)**	**Area in haul road option 2 (ha)**	**Area in proposed North Kiaka Mine (ha.)**	**Total in the area mapped by Trudgen *et al*. (ha)**
Kunzea praestans high shrubland to open and closed scrub	0	0	19.67	92.34
Allocasuarina campestris high shrublands to open and closed scrub	0.84	0.28	14.65	247.96
Allocasuarina huegeliana low woodlands to low open forests	0.23	0.26	3.88	128.71
Calothamnus aff. *quadrifidus* Moora-Watheroo high shrubland	0	0	0.12	0.89
Acacia acuminata subsp. acuminata low woodlands	0.23	0	2.47	97.94
Eucalyptus loxophleba subsp. *loxophleba* low woodlands to low open forests	0.18	0.18	0.29	114.13
Melaleuca calyptroides open to closed heath	0.14	0	0.49	3.37
Regelia megacephala high shrubland to open and closed scrub	0	0	1.73	50.73

Of interest also, is that the vegetation alliances dominated by *Calothamnus* aff. *quadrifidus* (Moora-Watheroo) and *Melaleuca calyptroides* both have limited extent with overall areas of 0.89 hectares and 3.37 hectares respectively in the areas mapped by Trudgen *et al.* (2012). The areas of these vegetation alliances in the proposed North Kiaka Mine area are 0.12 hectares (13.5%) and 0.49 hectares (14.5%) respectively. The areas of these two vegetation alliances in the proposed North Kiaka Mine area are roughly three times higher proportionally than their extent in the TEC overall. It should be noted however, that the two species these two

vegetation alliances are named for are present as the dominant (or co-dominant) of shrub layers in other vegetation types and as associated species in yet others. Some of these other vegetation types (plant communities in other vegetation alliances) may be *floristically* fairly similar to the stands in the two alliances.

In Trudgen *et al.* (2012 sections 12.3 and 12.4 there is further discussion of the distribution of the different alliances found in the Coomberdale Chert Threatened Ecological Community, several of which are not found in the proposed North Kiaka Mine area. The parts related to *Kunzea praestans*, and *Regelia megacephala* are reproduced below as they are particularly relevant to the North Kiaka Mine proposal environmental impact assessment. The *Regelia megacephala* vegetation is of particular importance, because the species is restricted to the Coomberdale Chert Threatened Ecological Community. On the current application of the name *Kunzea praestans*, this species is less restricted in area, but there is some doubt over the proper application of the name (see flora sections above) and the form in the Coomberdale Chert TEC may be restricted in distribution.

4.4 Vegetation associations dominated by *Kunzea praestans* in the Coomberdale Chert TEC

Kunzea praestans vegetation associations occurred in all the main bushland areas in the Trudgen *et al.* (2112) survey area, but were most extensive north of Kiaka Rd. While *Kunzea praestans* was often a fairly minor component of vegetation associations, it was also prominent in a significant number of associations, including:

- Vegetation Association EeKp: *Eucalyptus eudesmioides* low mallee woodland over *Kunzea praestans* scattered tall shrubs to high shrubland.

- Vegetation Association AaDsKp: *Acacia acuminata* subsp. *acuminata* low woodland over *Dryandra sessilis* var. *flabellifolia (Xanthorrhoea* sp. Coomberdale) scattered tall shrubs over *Kunzea praestans* scattered tall shrubs to high open shrubland over very open herbland.

- Vegetation Association Am: Allocasuarina huegeliana scattered low trees over *Allocasuarina microstachya*, *Kunzea praestans* open scrub over *Calytrix* sp. Coomberdale, *Calytrix depressa* scattered low shrubs over scattered sedges/grasses and open herbland.

- Vegetation Association RmB: *Regelia megacephala* (*Kunzea praestans*) open scrub over *Babingtonia cherticola* low open shrubland.

- Vegetation Association RmKp: *Regelia megacephala* high shrubland to open scrub over *Kunzea praestans* high open shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.

- Vegetation Association RmKpMc: *Regelia megacephala open to closed scrub and Kunzea praestans* high open shrubland to open scrub over *Melaleuca calyptroides* open shrubland to shrubland over *Hibbertia subvaginata* low open shrubland.

- Vegetation Association KpAh: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata)* low open woodland to low woodland over *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.

- Vegetation Association KpAhB: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata)* scattered trees to low open woodland over *Kunzea praestans* high shrubland to open scrub over shrubland including *Melaleuca calyptroides* and *Babingtonia cherticola* scattered shrubs to open shrubland.

- Vegetation Association KpAhDs: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata)* scattered trees to low open woodland over *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) high shrubland to open scrub over *Hibbertia subvaginata* low open shrubland.

- Vegetation Association KpAhMc: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata)* scattered trees to low open woodland over *Kunzea praestans* open scrub over *Melaleuca calyptroides* open shrubland to shrubland.

- Vegetation Association KpDs: *Dryandra sessilis* var. *flabellifolia* high open shrubland over *Kunzea praestans* (*Xanthorrhoea* sp. Coomberdale) open scrub over *Hibbertia subvaginata* scattered low shrubs.

- Vegetation Association KpDsMc: *Dryandra sessilis* var. *flabellifolia* scattered tall shrubs to high open shrubland over *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.

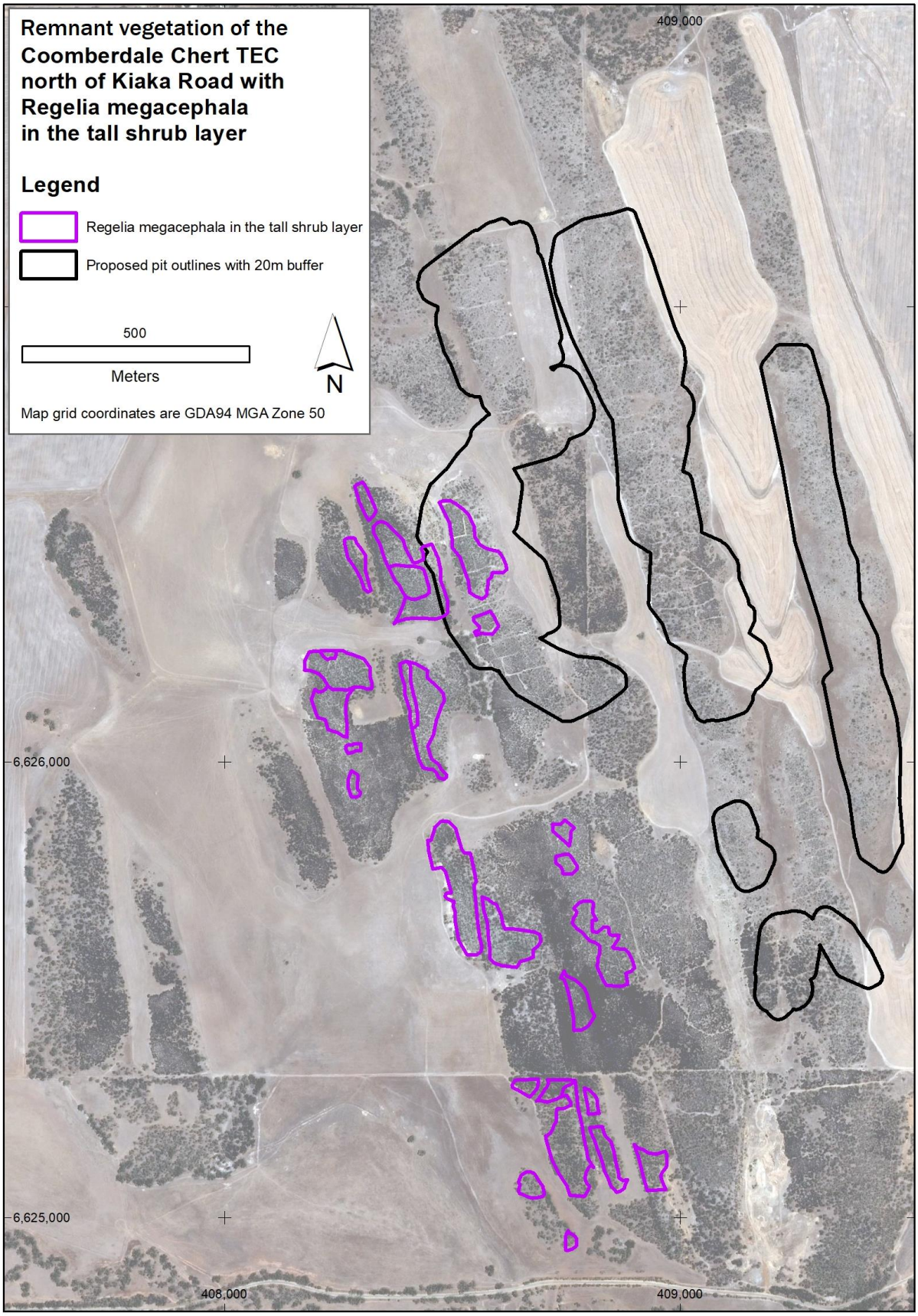
- Vegetation Association KpEe: *Eucalyptus eudesmioides* low woodland over *Kunzea praestans* open scrub over *Melaleuca calyptroides* and *Babingtonia cherticola* open shrubland.

- Vegetation Association KpHs: *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* (low) open shrubland to (low) open heaths over scattered to very open sedgeland/grassland/herbland.

4.5 Vegetation associations dominated by the geographically restricted priority flora species *Regelia megacephala*

Vegetation alliances dominated by *Regelia megacephala* were recorded in all the main sub-areas of bushland in the survey area, however there are significant structural differences between *Regelia megacephala* units across the survey area, although a proportion of the stands are fairly similar. For example, in the southern part of the survey area, some *Regelia megacephala* open scrub stands occurred under an overstorey of *Allocasuarina huegeliana* low open woodland to low open forest (Cairn Hill, Cairn Hill North and Gardener's Hill) and *Regelia megacephala* open scrub occurred under *Eucalyptus eudesmioides* scattered low trees to low open woodland (Cairn Hill Reserve). This scale of this variation is self-evident from the list of vegetation associations from the survey area with *Regelia megacephala* dominant or sub-dominant given here:

- Vegetation Association AhRm: *Allocasuarina huegeliana* low open forest over *Regelia megacephala* high open shrubland.
- Vegetation Association AcRm: *Regelia megacephala* high open shrubland to shrubland over *Allocasuarina campestris* open to closed scrub.
- Vegetation Association Rm: *Regelia megacephala* open scrub.
- Vegetation Association RmAh: *Allocasuarina huegeliana* low open woodland to low open forest over *Regelia megacephala* open scrub over scattered sedges and herbs.
- Vegetation Association RmB: *Regelia megacephala* (*Kunzea praestans*) open scrub over *Babingtonia cherticola* low open shrubland.
- Vegetation Association RmDs: *Regelia megacephala (Dryandra sessilis* var. *flabellifolia)* open scrub.
- Vegetation Association RmEe: *Eucalyptus eudesmioides* scattered low trees to low woodland over *Regelia megacephala* open to closed scrub.
- Vegetation Association RmHs: *Regelia megacephala* open scrub over *Hibbertia subvaginata* low open shrubland to low shrubland.
- Vegetation Association RmKp: *Regelia megacephala* high shrubland to open scrub over *Kunzea praestans* high open shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.
- Vegetation Association RmKpMc: *Regelia megacephala open to closed scrub and Kunzea praestans* high open shrubland to open scrub over *Melaleuca calyptroides* open shrubland to shrubland over *Hibbertia subvaginata* low open shrubland.



Map 27: Vegetation north of Kiaka Road with *Regelia megacephala* dominant or subdominant in the tall shrub layer

Floristically, the *Regelia megacephala* stands were quite different across the different sub-areas, as indicated by their floristic groupings (groups 1,3,5 and 8 in the 10 group analysis) in the floristic analysis. These differences are discussed in section 14 below. The extent of vegetation dominated by *Regelia megacephala*, or with this species fairly significant in the vegetation, is shown on Map 27. The distribution of the different associations listed above is shown by the alphabetic part of the community codes on Map 27.

The condition of the *Regelia megacephala* stands varied from Excellent in the Cairn Hill sub-area to Good to Very Good in Cairn Hill North, the Western Ore Body, the Eastern Ore Body and the Eastern Ridge sub-areas. Some weed invasion and grazing were the cause of degradation of the *Regelia* stands. However, the very rocky chert outcrop habitat typical favoured by the *Regelia* stands often limited the degradation. The *Regelia* stands in the Gardiner Hill and Kiaka Rd North sub-areas were also in good to very good condition. The Chester Property *Regelia* stands were in the poorest condition (+/-good), with more significant degradation from grazing and more severe weed invasion. The associated flora was also in the poorest condition in this area.

The *Regelia megacephala* stands in the Eastern Ridge sub-area were smaller stands than most other stands. The two quadrats located in these stands were recorded as in very good and good to very good condition respectively.

See section 5 below for further discussion of the condition of the vegetation north of Kiaka Road.

4.6 The vegetation of the haul road options for the proposed North Kiaka Mine area

The vegetation of the haul roads (see Map 28) for the proposed North Kiaka Mine area is a subset (see Table 9 above) of five of the vegetation alliances of the eight vegetation alliances in the proposed North Kiaka Mine area and a stand of one other alliance. The latter area is at the west end of the common part of the two haul road options, where there is small area of the *Eucalyptus salmonophloia* alliance (see Map 28). This stand is very degraded and is somewhat atypical for the vegetation alliance, vegetation association and plant community it has been assigned to.

In total, there are areas of six vegetation alliances in the haul road option areas with ten vegetation associations and plant communities in the areas concerned. These are represented by stands coded on Map 27 as: EsEl.1; El2; Ah1; AhAc5, Ah3 Ac1, Ac4, Ac3; Ac1/Ac4 (a

mosaic of Ac1 and Ac4); Aa1; and Mc4. The descriptions of these units are given below with the vgeetation allinaces they belong to. The ares of each alliance in the haul road options is given in Table 9.

Vegetation Alliance 1: *Eucalyptus salmonophloia* woodlands to open forests

Salmon gum open forest occurred in a few locations in the study area, in small valleys between low ridges and in a few places in the remnant vegetation at the base of the chert ridges on the edge of broad valley floors now largely cleared for farming.

EsEl.1: *Eucalyptus salmonophloia* woodland over *Eucalyptus loxophleba* subsp. *loxophleba* low woodland over (*Rhagodia preissii* ssp. *preissii* scattered shrubs) over *Ptilotus divaricatus* var. *divaricatus*, *Rhodanthe polycephala* scattered herbs

Vegetation Alliance 3: *Eucalyptus loxophleba* subsp. *loxophleba* low woodlands to low open forests

Vegetation Association El: *Eucalyptus loxophleba* subsp. *loxophleba* low woodland over scattered shrubs and very open herbland.

Plant Community: **El.2**: *Eucalyptus loxophleba* subsp. *loxophleba*, (*Acacia acuminata* subsp. *acuminata*) low woodland.

Vegetation Alliance 9: *Allocasuarina huegeliana* low woodlands to low open forests

Vegetation Association Ah: *Allocasuarina huegeliana* low woodland to low closed forest over scattered shrubs.

Plant Community: **Ah.1**: *Allocasuarina huegeliana*, (*Acacia acuminata* subsp. *acuminata*) low closed forest (over *Allocasuarina campestris* scattered tall shrubs) over *Crassula colorata* scattered herbs and very open annual grassland.

Plant Community: **Ah.3**: *Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata* low woodland to low open forest over *Allocasuarina campestris* scattered tall shrubs to high open shrubland over *Podolepis lessonii*, *Trachymene ornata* open annual herbland.

Vegetation Association AhAc: *Allocasuarina huegeliana* low woodland to low open forest over *Allocasuarina campestris* scattered shrubs to high open shrubland.

AhAc.5: *Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open forest over *Allocasuarina campestris, Ricinocarpos muricatus* scattered tall shrubs over *Hibbertia subvaginata* scattered low shrubs.

Vegetation Alliance 13: *Allocasuarina campestris* high shrublands to open and closed scrub

Vegetation Association Ac: *Allocasuarina campestris* open to closed scrub over scattered sedges/grasses/herbs.

Plant Community: **Ac.1:** *Allocasuarina campestris* open heath to closed heath over scattered sedges/grasses with *Borya sphaerocephala* (+) scattered herbs and *Cheilanthes adiantoides* scattered ferns.

Plant Community: **Ac.3:** *Eucalyptus loxophleba* subsp. *loxophleba*, (*Acacia acuminata* subsp. *acuminata, Allocasuarina huegeliana*) low open woodland over *Allocasuarina campestris* open scrub over *Calytrix* sp. Coomberdale low open shrubland over scattered sedges/grasses and *Borya sphaerocephala* very open herbland.

Plant Community: **Ac.4:** *Allocasuarina huegeliana*, (*Acacia acuminata* subsp. *acuminata*) low open woodland over *Allocasuarina campestris* closed scrub over *Neurachne alopecuroidea* scattered grasses with scattered herbs and *Cheilanthes adiantoides* scattered ferns.

Vegetation Alliance 11: *Acacia acuminata* low woodlands to low open forests

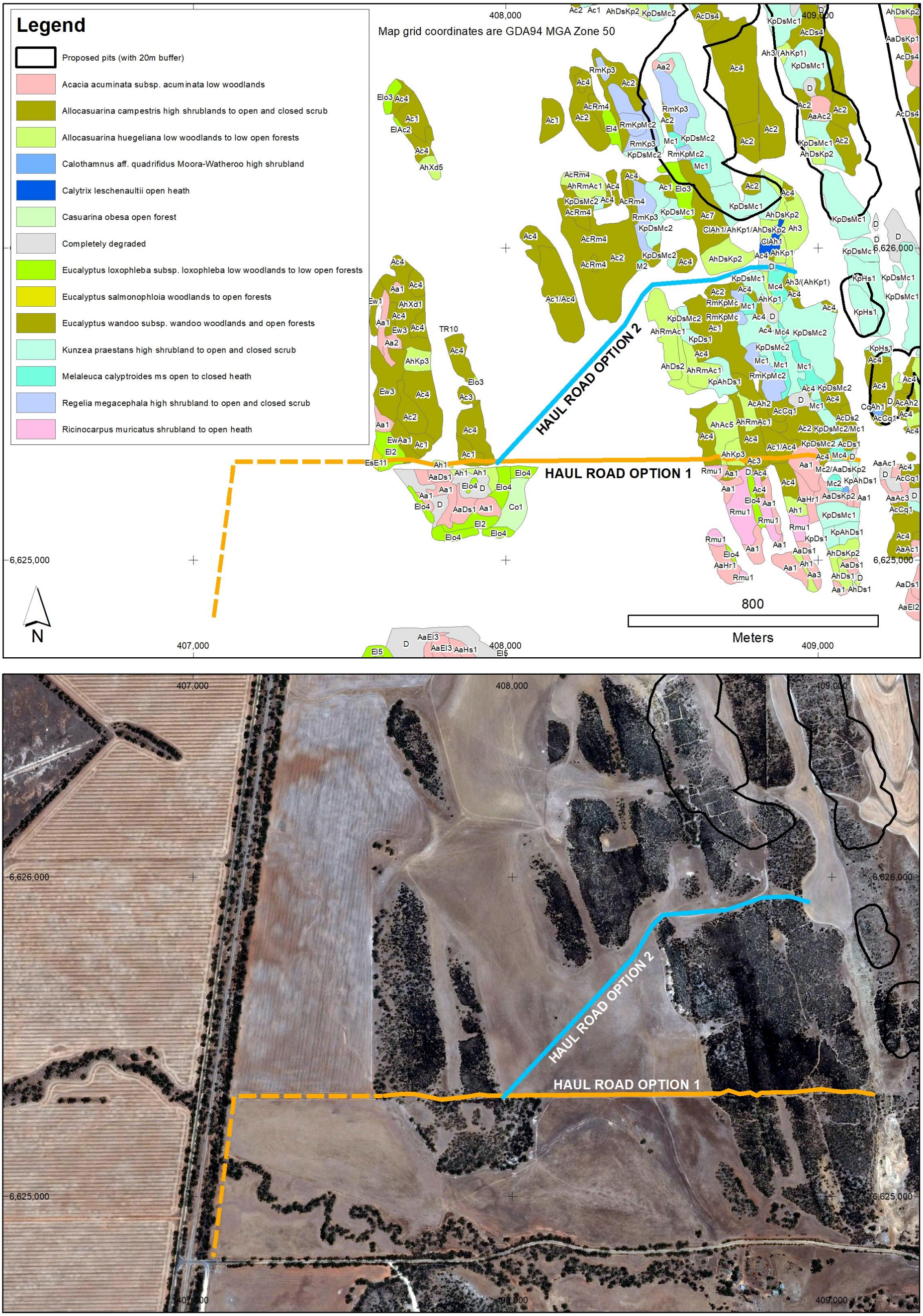
Vegetation Association Aa: *Acacia acuminata* subsp. *acuminata* low open forest over scattered grasses sedges and very open herbland.

Plant Community: **Aa.1:** *Acacia acuminata* subsp. *acuminata* low woodland to low open forest over *Cheilanthes adiantoides* very open fernland and *Hypoxis* sp., *Gilberta tenuifolia, Podolepis lessonii* open annual herbland.

Vegetation Alliance 17: *Melaleuca calyptroides* open to closed heath

Vegetation Association Mc: *Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata, Calytrix* sp. Coomberdale scattered low shrubs to low open shrubland.

Plant Community: **Mc.4:** *Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata* scattered low trees over *Kunzea praestans*, (*Xanthorrhoea* sp. *Coomberdale*) high open shrubland to high shrubland over *Melaleuca calyptroides* open heath over open herbland/sedgeland.



Map 28: Proposed haul road options on vegetation map and satellite image

5.0 CONDITION OF THE VEGETATION OF THE COOMBERDALE CHERT TEC INCLUDING THAT OF THE PROPOSED NORTH KIAKA MINE AREA

5.1 Condition mapping of the Coomberdale Chert TEC vegetation

At each of their detailed recording sites (quadrats) and most of their releves (less complete sites not pegged) Trudgen *et al.* (2012) assessed the condition of the vegetation using the scale of Trudgen 1988 (see Appendix 3). This information was used in conjunction with aerial photograph interpretation to produce a condition map of the remnant vegetation in their survey area (see their Map 6). They discussed the condition of the vegetation of each location (Cairn Hill, Western Ridge, Cairn Hill North etc.) in their survey area (see their section 13). The northern sheet of Map 6 of Trudgen *et al.* (2012) covers an area from just south of Kiaka Road to the northern end of their survey area and includes the area of the proposed North Kiaka Mine. It is reproduced here as Map 29, with the pit areas of the proposed North Kiaka Mine plus a 20 metre buffer shown on it. The description of vegetation condition north of Kiaka Road is also taken from Trudgen *et al.* (2012).

5.2 Changes in vegetation condition since the condition mapping was carried out

There have been changes in the condition of some parts of the Coomberdale Chert Threatened Ecological Community since the mapping was carried out, particularly increases in weed cover and changes in weed floristics have been recorded at some quadrats (Trudgen 2017a). However, field work in 2016 by the author indicated that such changes did not affect the validity of the condition mapping of the Coomberdale Chert TEC to the extent that the mapping needed revision. Rather, a small decrease in condition can be assumed for areas with more open vegetation, while areas with denser vegetation are mostly not significantly changed at least in regard to weed invasion levels. In the longer term however, weed invasion and grazing are likely to continue to reduce the condition of areas of the TEC, particularly in areas that are not fenced off from stock.

It is of course particularly difficult to pick up gradual changes in vegetation without detailed and specifically targeted monitoring. However, one species in the Coomberdale Chert Threatened Ecological Community may be an indicator that change is more significant than is easily apparent. The Grasstree species (*Xanthorrhoea* sp. Coomberdale) in the Coomberdale Chert TEC is an undescribed species that is almost entirely restricted to that vegetation. It was very noticeable (see section 3.8 above, where this species is discussed) during field work in 2016 that the adult population of this species is progressively dying and largely not being replaced. At some places ten or more dead plants (ranging from recently fallen plants to just the distinctive stumps with no stem remaining) were seen in areas with much fewer living

plants. Juvenile individuals were rarely seen, although one area on the easternmost ridge on the John Tonkin property had a number of small plants. The obvious changes in the population structure of *Xanthorrhoea* sp. Coomberdale in the Coomberdale Chert TEC vegetation may be an indicator that other changes that are not so easily observed are happening (and have happened). Another species that may indicate such changes are happening is *Cristonia stenophylla*. This species was only recorded at three quadrats in the Coomberdale Chert TEC and could not be refound at two of them in 2017. However, it may be a pyrosere species and re-appear after fire (see section 3.8 above) and one plant was seen at the east end of the area of the proposed haul road option 1.

5.3 Condition of the vegetation of the Coomberdale Chert TEC North of Kiaka Road

The area of the Coomberdale Chert Threatened Ecological Community north of Kiaka Road includes parts of three properties, those of: A & R Tonkin; J. Tonkin (although Simcoa have now bought the part of this property part of the proposed mine will be on) and G. Ridgway. The vegetation condition (see Map 29) of the area ranges from Completely Degraded (cleared farm land) to Very Good. This map shows that the better condition areas north of Kiaka Road are mainly in the southern part of the main central ridge system, and that the proposed North Kiaka Mine area mainly avoids the better condition areas.

It is not clear how much some areas, especially on the property of A. & R. Tonkin have been effected by grazing, as they appeared (at the time of the condition mapping) to be in good or better condition but have lower species numbers than other areas. It is likely that some of these areas naturally have lower species numbers and that the recording of quadrats on A. & R. Tonkin's during the 2010 drought accentuated this somewhat. Vegetation condition was generally better in the vegetation on rockier sites, steeper sites and where *Regelia megacephala* or *Allocasuarina campestris* was denser.

5.4 Condition of the vegetation of in the proposed North Kiaka Mine area

Table 10 gives the area of vegetation in different condition classes (see Appendix 3 for definitions) in the area of the proposed North Kiaka Mine. From this table it can be seen that the proposed mine does not impact areas of the Coomberdale Chert Threatened Ecological Community that are in Very Good or Excellent condition. It can also be seen that only a very small (less than 1%) of the area of the TEC in Good to Very Good condition is proposed to be impacted. On the other hand, the propose mine area would impact 7.28 hectares in Good condition of the 106.39 hectares of the TEC mapped as in that condition. Further, it can be

seen that the major impact (7.41 and 12.07 hectares) is on vegetation in Very Poor to Poor condition and Very Poor condition.

Table 10: Area of vegetation of different condition classes in the proposed North Kiaka Mine area compared to their area in the Coomberdale Chert TEC

Notes**:** Degraded is effectively parkland cleared.

Condition category	**Number of polygons in proposed mine**	**Total area for proposed mine (ha.)**	**Total area in Trudgen *et al.* survey area (ha.)**
Excellent	0	0	22.52
Very Good to Excellent	4	0	45.60
Very good	4	2.63	137.68
Good to Very Good	4	1.15	146.13
Good	5	7.285	106.4
Poor to Good	6	3.86	63.63
Poor	7	4.29	56.97
Poor to Very Poor	16	7.41	71.08
Very Poor	9	12.07	68.08
Degraded to Very Poor	10	5.27	35.41
Degraded	11	1.53	94.13
Totals		**42.86**	**641.83**

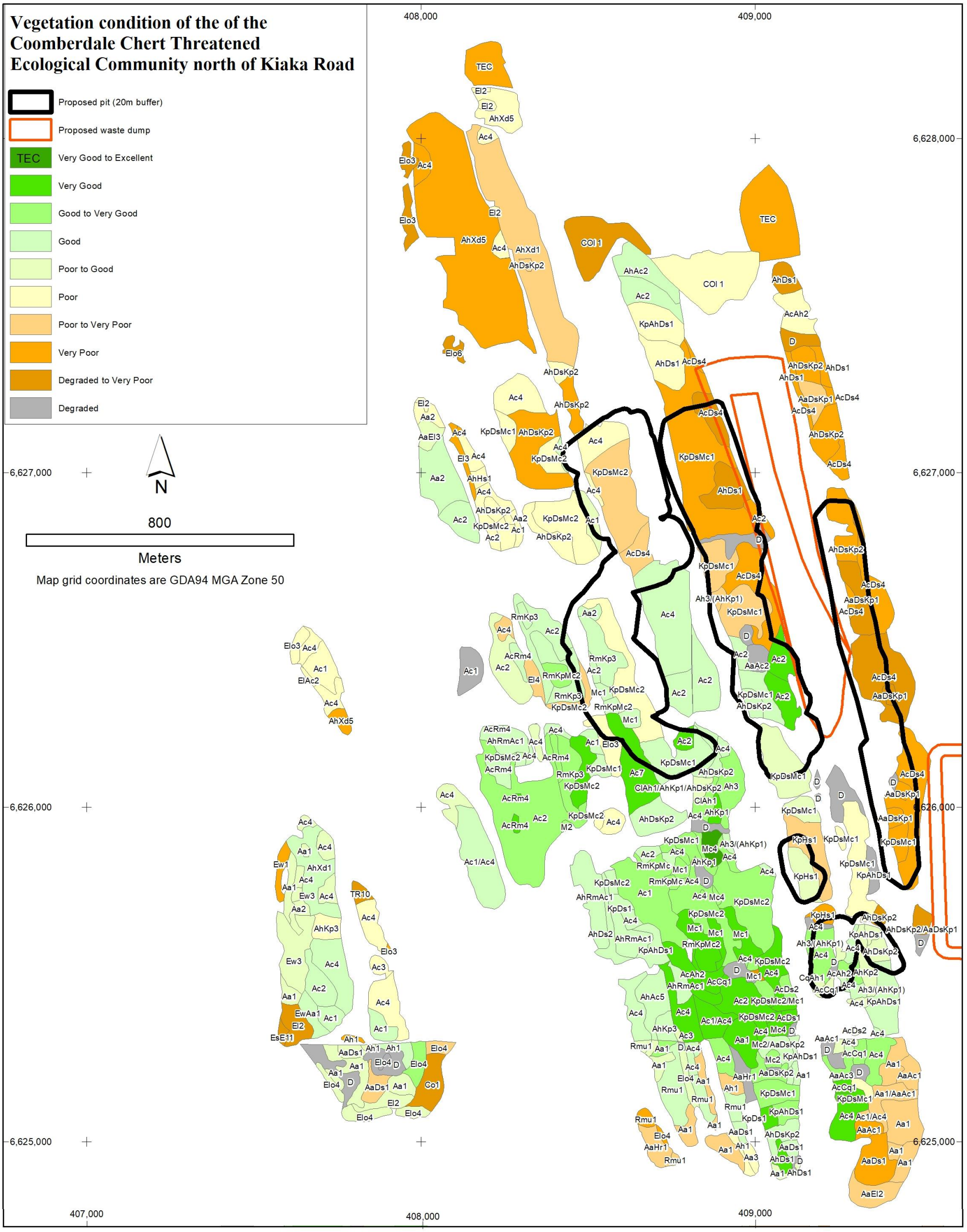
The distribution of areas of different vegetation condition in the different plant communities and the associations that form the vegetation alliances represented in the proposed North Kiaka Mine area is shown in Table 11.

Table 11: Areas of polygons of vegetation alliances, vegetation associations and plant communities of different condition classes in the proposed North Kiaka Mine area

Notes**:** The table is list each polygon on the condition map in the proposed mine area. Degraded is equivalent to parkland cleared. Alliances are given by name and number, associations and plant community by their alphanumeric code.

Vegetation Alliance	**Vegetation alliance**	**Vegetation association & plant community**	**Vegetation condition**	**Polygon area**
Acacia acuminata subsp. acuminata low woodlands	11	Aa2	G	0.218
Acacia acuminata subsp. acuminata low woodlands	11	AaAc2	D	0.450
Acacia acuminata subsp. acuminata low woodlands	11	AaDsKp1	VP	0.183
Acacia acuminata subsp. acuminata low woodlands	11	AaDsKp1	VP	0.270
Acacia acuminata subsp. acuminata low woodlands	11	AaDsKp1	D-VP	1.35
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac1	P-G	0.372
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	VG	0.913
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	VG	0.721
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	G	0.3666
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	VP	0.1768

Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	VG	0.306
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	G	0.100
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	G	0.174
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac2	G	0.0226
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	G	0.076
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	D	0.0773
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	G-VG	0.936
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	G	0.76
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	P	1.1962
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	P	0.141
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	G	0.0161
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac4	G	0.247
Allocasuarina campestris high shrublands to open & closed scrub	13	Ac7	VG	0.693
Allocasuarina campestris high shrublands to open & closed scrub	13	AcAh2	G-VG	0.211
Allocasuarina campestris high shrublands to open & closed scrub	13	AcCq1	P-G	0.136
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	VP	0.353
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	VP	0.193
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	VP	1.447
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	D-VP	0.623
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	P-VP	0.784
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	D-VP	1.95
Allocasuarina campestris high shrublands to open & closed scrub	13	AcDs4	VP	1.652
Allocasuarina huegeliana low woodlands to low open forests	9	Ah3/(AhKp1)	G	0.0194
Allocasuarina huegeliana low woodlands to low open forests	9	Ah3/(AhKp1)	P-VP	0.19
Allocasuarina huegeliana low woodlands to low open forests	9	Ah3/(AhKp1)	P-G	0.123
Allocasuarina huegeliana low woodlands to low open forests	9	AhDs1	D-VP	1.317
Allocasuarina huegeliana low woodlands to low open forests	9	AhDsKp2	G	0.102
Allocasuarina huegeliana low woodlands to low open forests	9	AhDsKp2	D-VP	0.0332
Allocasuarina huegeliana low woodlands to low open forests	9	AhDsKp2	P-G	0.396
Allocasuarina huegeliana low woodlands to low open forests	9	AhDsKp2	VP	1.068
Allocasuarina huegeliana low woodlands to low open forests	9	AhDsKp2	G	0.399
Allocasuarina huegeliana low woodlands to low open forests	9	AhKp2	P-G	0.2349
Calothamnus aff. quadrifidus Moora-Watheroo high shrubland	20/8	CqAh1	P-G	0.125
Eucalyptus loxophleba subsp. loxophleba low woodlands to low open forests	3	Elo3	P	0.286
Kunzea praestans high shrubland to open and closed scrub	16	KpAhDs1	G	0.127
Kunzea praestans high shrubland to open and closed scrub	16	KpAhDs1	P-G	0.194
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	P-G	1.362
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	VP	0.519
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	G	0.861
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	G	1.5741
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	VP	3.511
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	P	0.064
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc1	P-VP	2.5984
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc2	P-VP	0.239
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc2	P	0.021
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc2	P-VP	3.204
Kunzea praestans high shrubland to open and closed scrub	16	KpDsMc2	P	2.577
Kunzea praestans high shrubland to open and closed scrub	16	KpHs1	P-VP	0.397
Kunzea praestans high shrubland to open and closed scrub	16	KpHs1	P-G	0.914
Kunzea praestans high shrubland to open and closed scrub	16	KpHs1	VP	0.063
Melaleuca calyptroides open to closed heath	17	Mc1	G	0.311
Melaleuca calyptroides open to closed heath	17	Mc1	G	0.179
Regelia megacephala high shrubland to open and closed scrub	15	RmKp3	G	1.251
Regelia megacephala high shrubland to open and closed scrub	15	RmKp3	G	0.287
Regelia megacephala high shrubland to open and closed scrub	15	RmKpMc2	G	0.191



Map 29: Vegetation condition of the part of the Coomberdale Chert Threatened Ecological Community north of Kiaka Road

Notes: Condition is indicated by colouring. Vegetation alliances, vegetation associations and plant communities are shown by the alpha-numeric codes (see section 4.2 above).

6.0 FLORISTIC ANALYSIS OF THE COOMBERDALE CHERT TEC VEGETATION

6.1 Introduction to the floristic analysis

Vegetation is a surprisingly complex phenomenon. Most stands consist of numerous species of many different life forms, some of which are perennial and available for study all year, others are perennial but only above ground for part of the year (cryptophytes), and others again are annual. It can have one layer (stratum) or many. It can be dominated by one or a combination of species and the main contributor(s) by biomass can be the tallest species present or in any other stratum. This variability has led to different forms of description and analysis, including the most abundant species (dominance)/structure classification used in sections above for mapping, description and condition assessment. An alternative form of investigation of the variation in vegetation is *floristic analysis*, a form of *pattern analysis* using computer programs such as PATN (Belbin 1987). This methodology is used to allocate vegetation stands into groups that have the most similar suites of species present. A variation of this is to use a combination of species presence and cover (as an indicator of biomass) in the analysis.

Trudgen *et al.* (2012) detailed floristic analyses of data from ninety-nine quadrats (10 by 10 metre quadrats nested inside 30 by 30 metre quadrats) from their Coomberdale Chert Threatened Ecological Community study area. They also presented an analysis of twenty-nine sites recorded by E.A. Griffin for earlier studies, some of which are in the area surveyed by Trudgen *et al*., while the others are on chert areas further north. The objectives of these analyses were to:

- Determine the floristic variation in the vegetation present in the Trudgen *et al.* study area (most of the area of the Coomberdale Chert TEC);
- Evaluate the geographical extent <u>within</u> their study area of the floristic units identified;
- Evaluate the likely geographical extent of the floristic units identified in their study area <u>outside</u> their study area.

The quadrat data used by Trudgen *et al.* (2012) sampled the range of vegetation types in the Coomberdale Chert based on structure and dominance by different species in their study area. The sampling was carried out over a period of time (2000 to 2010) for different reports and the dates and data are given in their Appendix 6 for each quadrat. See Trudgen *et al.* (2102) for details of their methodology and discussion of issues relating to the use of different quality data sets.

6.2 Geographic restriction in floristics of the of the Coomberdale Chert TEC

The Proterozoic age Moora Group of rocks occurs from Moora to Three Springs, a distance of `over one hundred kilometres. This group of rocks is highly variable, having occurrences of the Coomberdale chert and a range of other altered sedimentary rocks. Outside the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al*, a limited number of chert areas have had their plant community composition recorded. This is partly due to the limited amount of native vegetation that remains on chert areas and partly due to the limited botanical survey work that has been carried out in the region.

To examine the issue of how restricted floristically the vegetation of the Coomberdale Chert Threatened Ecological Community is Trudgen *et al.* (2012) re-analysed data from 29 sites recorded by Griffin (1992, 1994) that were recorded from Cairn Hill to the southern end of Pinjarrega Nature Reserve. As the data was collected differently to the quadrats recorded by Trudgen *et al.* (2012), a combined analysis could not be carried out (the sites were not pegged as quadrats and were recorded less intensively).

The results of the floristic classification of the twenty-nine sites are shown as a dendrogram in Figure 1 and as a diagram showing the geographic distribution of thirteen units in Figure 2. The classification indicates that the vegetation of Cairn Hill, as a representative of the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012), is quite different from even the Jingemia area of Watheroo National Park (the closest area to Cairn Hill in the analysis and considered part of the Coomberdale Chert Threatened Ecological Community (Department of Parks & Wildlife 2013), which has some moderately dissected landscape with exposed chert. The Cairn Hill sites (the sites with "WA" at the beginning of their codes) form groups with very high dissimilarity to the sites from other areas. Also of interest, is that within the Cairn Hill section of the dendrogram there are groups with dissimilarity similar to groups within the remainder of the data, the sites of which are more spread out. This is a reflection of the significant diversity of habitat in Cairn Hill Reserve.

The data also suggest that the small islands of chert within a sea of sandplain between Watheroo and Three Springs have a somewhat different flora to the Coomberdale Chert Threatened Ecological Community sites. There are some plants typical of chert (e.g. Kunzea praestans), but also locally common species that do not occur in the Coomberdale Chert TEC. Such differences support the floristic analysis in indicating that the chert between Watheroo and Three Springs has plant communities of significantly different floristic composition to those in the Coomberdale area.

Figure 1: Dendrogram of regional floristic classification of sites on chert from Cairn Hill to Pinjarrega Nature Reserve

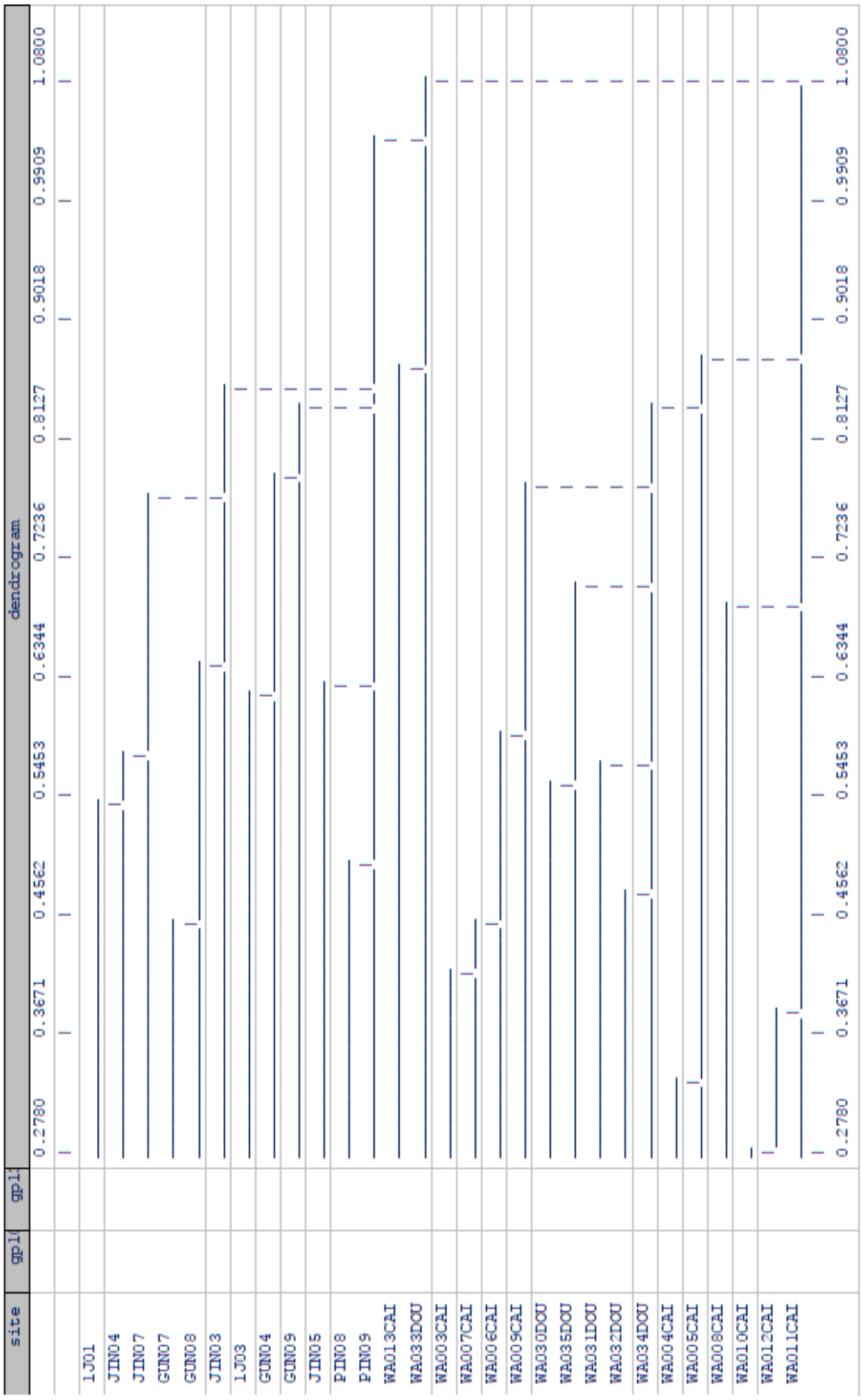
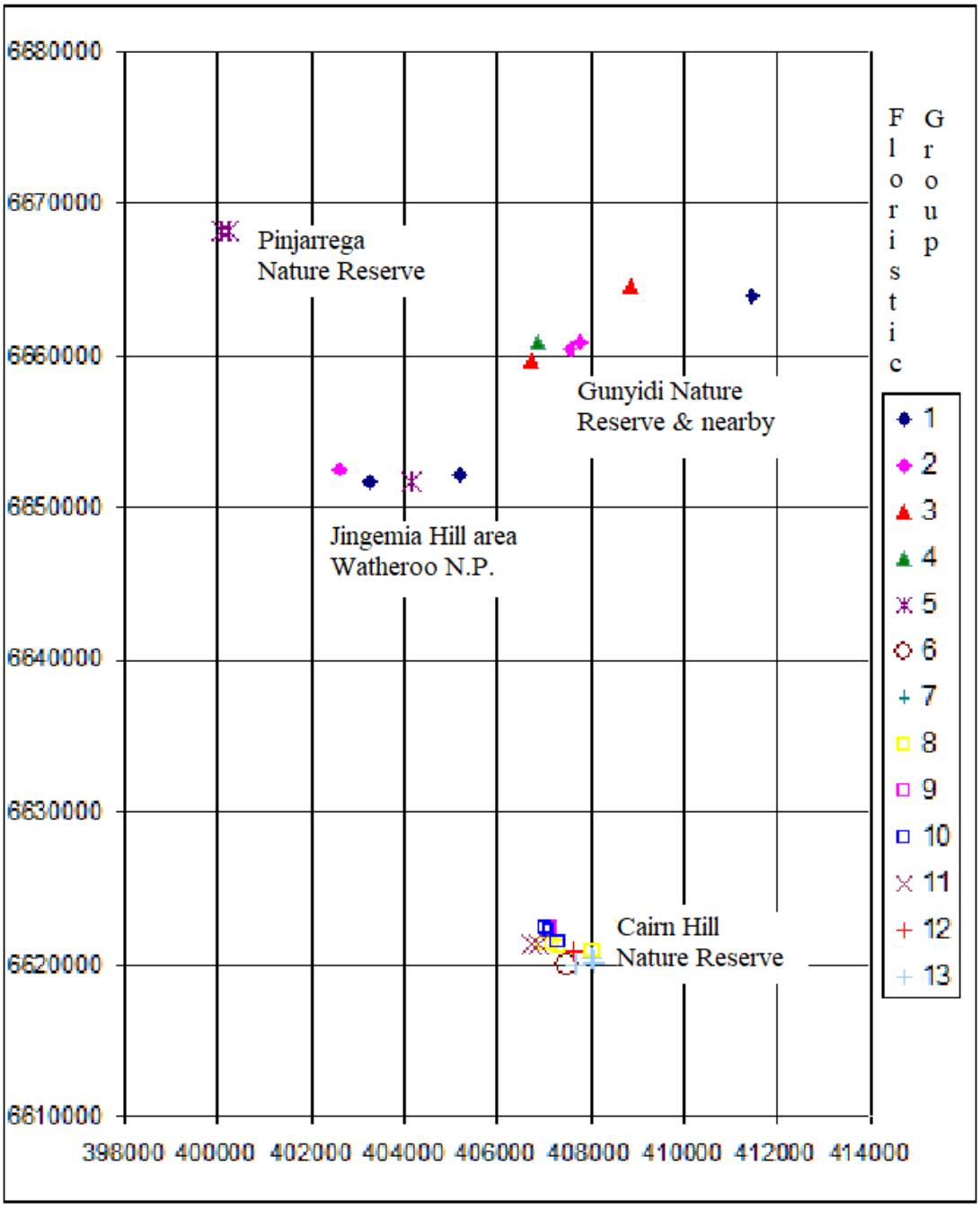


Figure 2: Geographic distribution of the floristic groups in the regional analysis
Notes: The east–west axis has been exaggerated to better separate the floristic group markers.



6.3 Floristic analysis of the quadrat data from the Coomberdale Chert TEC

The floristic analyses detailed in Trudgen *et al.* (2012, 2006) are quite extensive. The data analysed was collected at different times, but with the same methodology. The main analysis was carried out in 2006, with supplementary analyses in 2012 to fit the data from the A. & R. Tonkin property to the 2006 classification. This was necessary to avoid a result distorted by data quality, as the A. & R. Tonkin sites were recorded in a dry year. The 2006 analyses were done with and without weeds and including cover (without weeds) to determine if the results found were influenced by local variations in habitat (soil, topography), or by grazing history.

After comparison of the results of the different approaches, the classification including weeds was used as the basis for defining floristic groups. The results relevant to the proposed North Kiaka Mine will be summarised below and readers requiring further detail of the analyses carried out are referred to Trudgen *et al.* 2012 and 2006.

The locations of the quadrats used in the analyses are shown schematically in Figure 3. One important point for the current report is that the quadrats recorded on the John Tonkin property (much of the proposed North Kiaka Mine is located, with Simcoa having bought the relevant part) are all on the southern part of that property. This is because the remnant vegetation in the northern part of the property (see Map 28 above) is in poorer condition and data from quadrats installed there would not have been compatible with data from other areas. In fact, only one quadrat from the John Tonkin property is in the proposed North Kiaka Mine area because of this issue and no quadrats from the A. & R. Tonkin property are in the proposed impact area for the same reason.

Due to the lack of quadrats in the parts of the two Tonkin properties proposed to be mined, it is possible that there are floristic types at the level of those defined there that have not been sampled. Given the poorer condition of most of the vegetation of these areas this would be very difficult question to determine with any accuracy. However, the issue is a possibility, not a strong probability. It is more likely, that there are degraded representatives of lower order floristic groups present there that were not sampled elsewhere in the survey area, but the degree of degradation by grazing would make this very difficult to investigate.

The dendrogram in Figure 4 shows the classification from presence/absence data using all the species recorded in the quadrats (i.e. including weed species). From this classification a somewhat arbitrary classification of 20 groups ("floristic community types") was defined. The twenty groups of sites are coloured in the dendrogram to enable easier examination of it. This number of groups was found to be quite reasonable, in that it represented a maximum fusion with a dissimilarity co-efficient of about 0.5, which is roughly equivalent to that separating the Floristic Community Types of Gibson *et al.* (1994) for the Swan Coastal Plain. However, the 0.5 dissimilarity level suggests that there is significant variation within these twenty groups. Examination of the dendrogram in Figure 4, clearly show this variation within the groups, with the larger ones having several sub-groups.

Figure 3: Schematic representation of the location of the quadrats in the survey area sub-areas.

Notes: To provide better separation of the quadrats, the E-W scale is about 2x that of the N-S. CAH = Cairn Hill; CHN = Cairn Hill North; EOR = Eastern Ore body; ERG = Eastern Ridge; GH = Gardiner's Hill; JT = John Tonkin's; SW = Stan Ridgway's property; WDM = proposed Waste Dump; WOR = Western Ore body; ART = A. & R. Tonkin's.

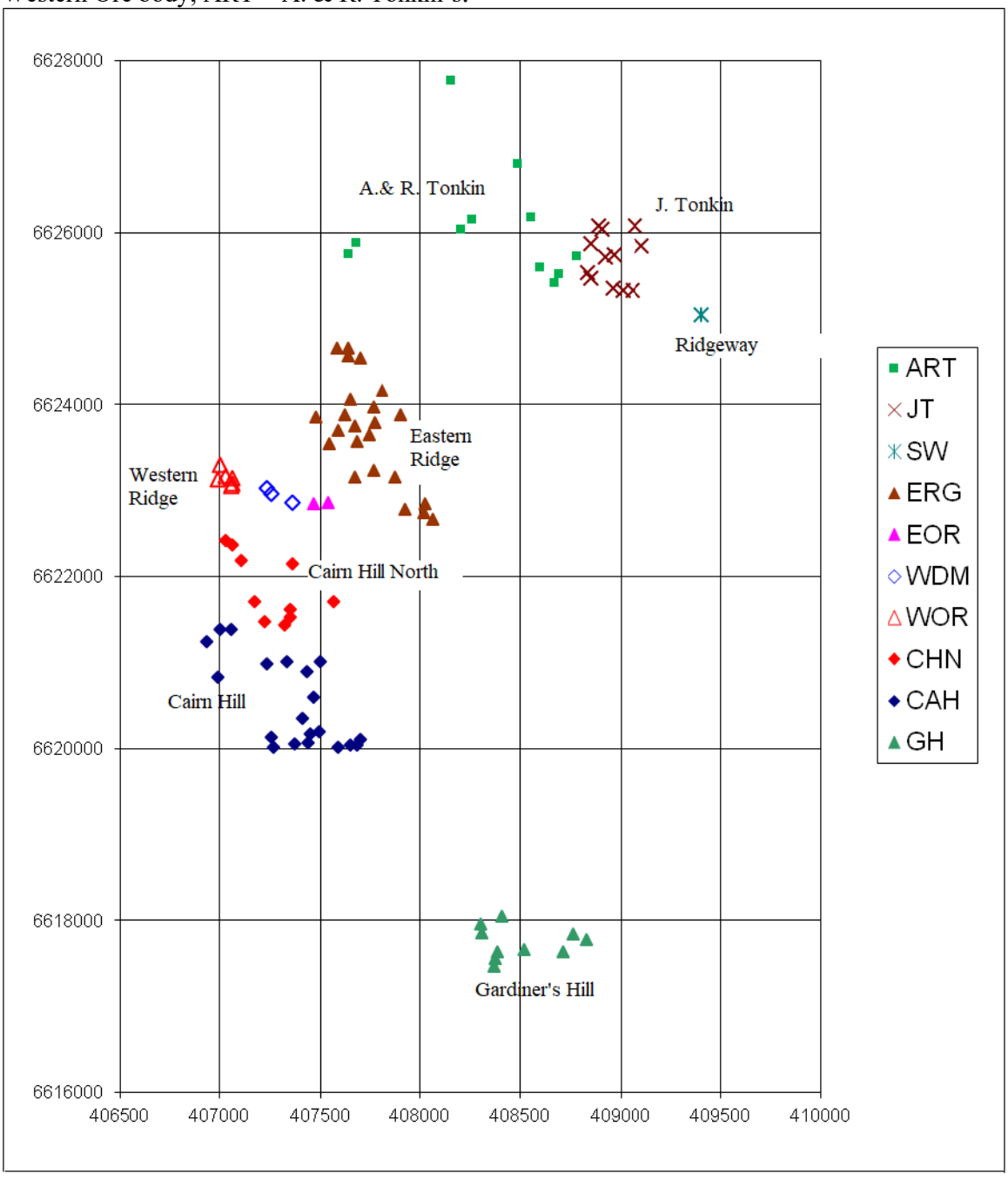
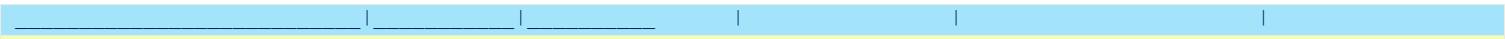
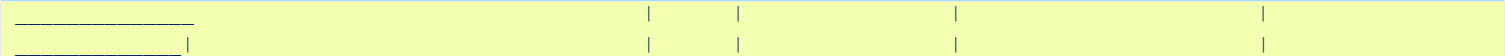
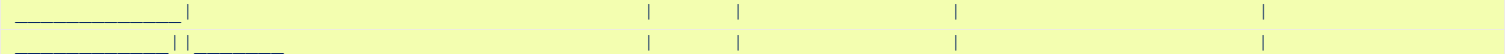
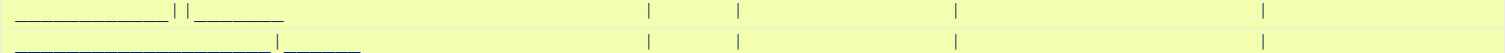
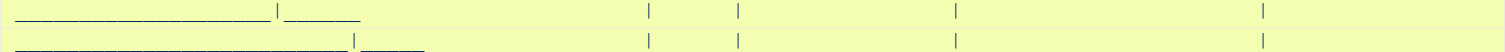
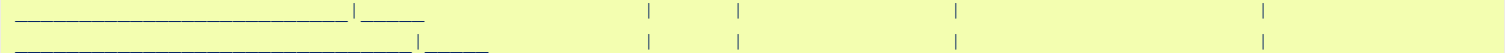
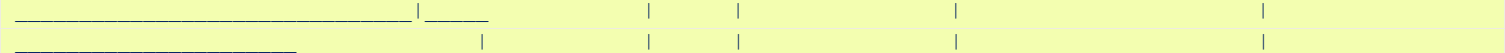
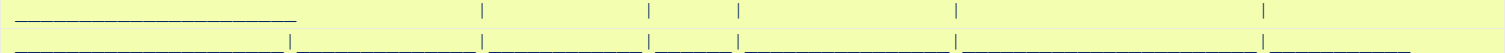
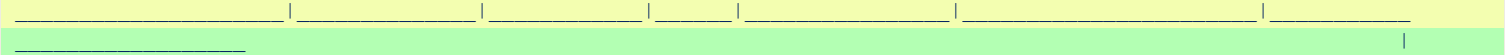
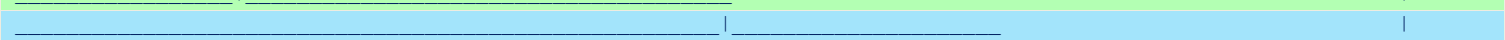
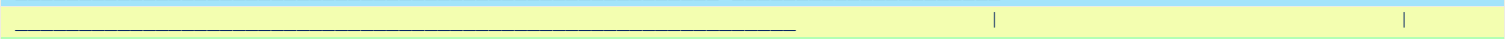
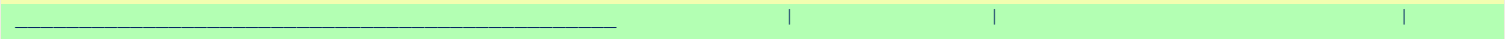
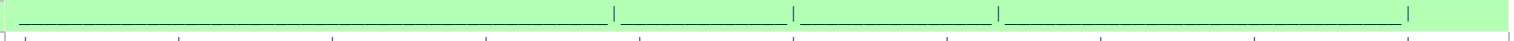


Figure 4: Dendrogram from the floristic analysis of the 88 quadrats from the 2006 report survey area

Notes: Based on all species (native and introduced). Gp10 and Gp20 are site classification numbers at the ten and twenty group classification levels respectively. The Gp 20 groups are coloured to allow them to be easily distinguished in the dendrogram.

Quadrat	Gp10	Gp20	Dendrogram
			0.1920 0.2724 0.3529 0.4333 0.5138 0.5942 0.6747 0.7551 0.8356 0.9160
CAH001	1	1	
CAH006	1	1	
CAH018	1	2	
CAH002	2	3	
CAH005	2	3	
CAH011	2	3	
CHN002	2	3	
CHN003	2	3	
CHN006	2	3	
CHN004	2	3	
CHN008	2	3	
CHN007	2	3	
ERG014	2	3	
WDM001	2	3	
WOR002	2	3	
CAH007	2	4	
CAH015	2	4	
CAH008	2	4	
CAH013	2	4	
CAH004	2	5	
CAH017	2	5	
CAH019	2	5	
EOR002	3	6	
EOR003	3	6	
WOR001	3	6	
WOR004	3	6	
WOR005	3	6	
WOR003	3	6	
WOR006	3	6	
GH001	4	7	
GH003	4	7	
GH002	4	7	
JT001	5	8	

JT008	5	8	
JT003	5	8	
JT007	5	8	
JT011	5	8	
JT010	5	8	
JT002	5	8	
JT005	5	8	
JT009	5	8	
JT004	5	8	
JT006	5	8	
CAH003	6	9	
CAH009	6	9	
CHN010	6	10	
CAH010	7	11	
GH005	7	11	
GH009	7	11	
GH004	7	11	
GH008	7	11	
GH010	7	11	
ERG004	7	11	
ERG016	7	11	
GH007	7	11	
CAH012	7	12	
GH006	7	12	
CHN001	7	13	
WDM002	7	13	
WDM003	7	13	
ERG017	7	14	
ERG019	7	14	
ERG018	7	14	
ERG020	7	14	
ERG022	7	14	
CHN005	7	15	
EOR001	7	15	
ERG002	7	15	
ERG021	7	15	
ERG009	7	15	
ERG011	7	15	
ERG003	7	15	
ERG010	7	15	

ERG012	7	15	
ERG001	7	16	
ERG005	7	16	
ERG007	7	16	
ERG013	7	16	
ERG008	7	16	
ERG006	7	16	
ERG015	7	16	
ERG023	7	16	
CAH014	8	17	
CAH016	8	17	
CHN009	8	18	
CAH020	9	19	
JT012	10	20	
SW1	10	20	
			
			0.1920 0.2724 0.3529 0.4333 0.5138 0.5942 0.6747 0.7551 0.8356 0.9160

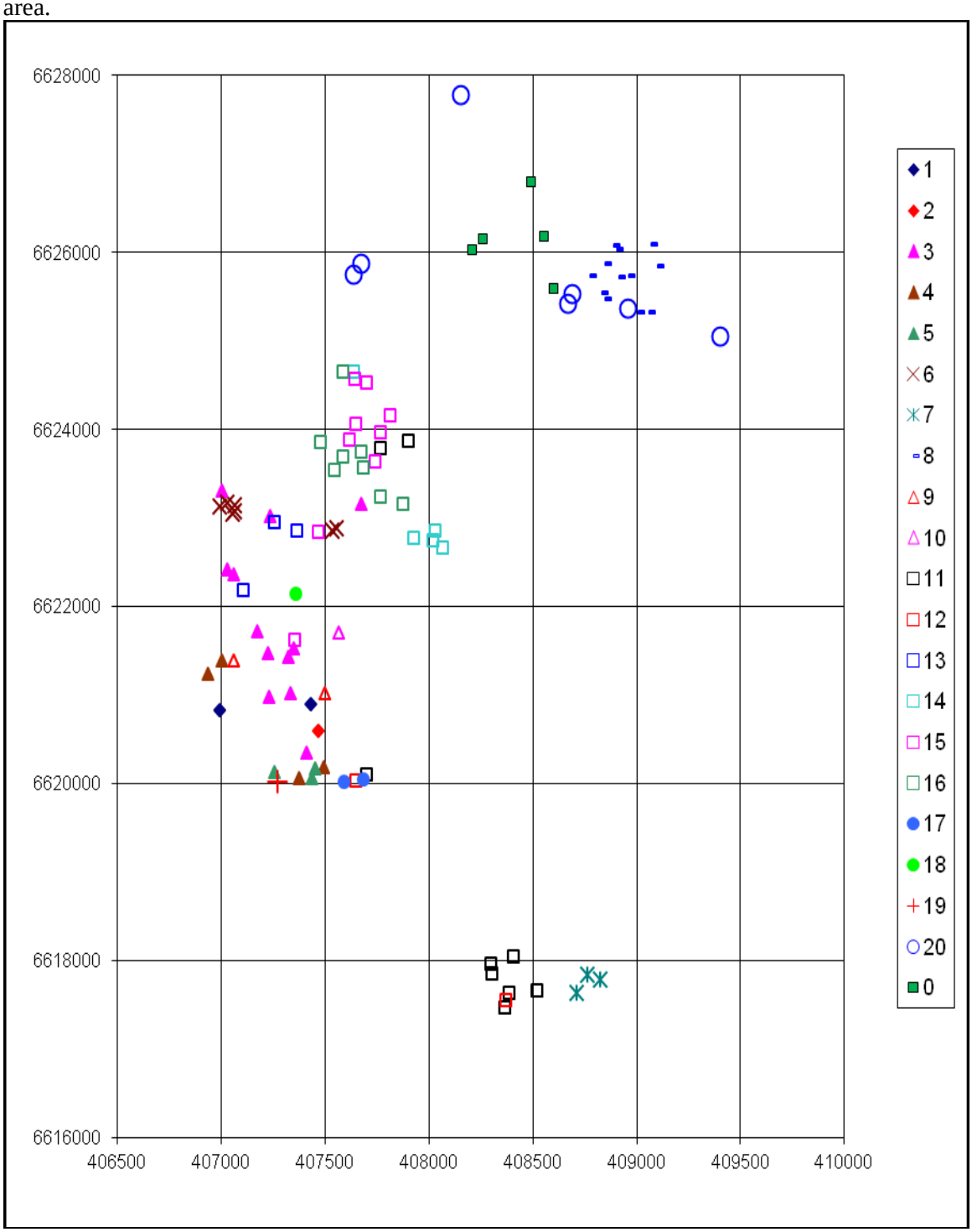
The dendrogram in Figure 4 also shows that most of the sites (quadrats) tended to group with sites from the same sub-area (vegetation remnant or cluster of remnants) of the survey area. Thus, the classification suggests that much of the variation between sub-areas is determined by geographically related factors, probably soil/geology and topographic differences. This can be seen more graphically in Figures 5, which shows the results of a classification of all native species (i.e. weeds excluded) and their cover. This shows similar strong localization of the variation in community composition (Trudgen *et al.* (2012). This suggested that the geographic localisation was not simply due to differences in grazing on the different properties, although this could still be a factor. Given the significant differences in topography (and consequent differences in soil) between some of the survey sub-areas, landscape features were considered to be the major driver of the presence of different floristic groups in the data sets.

Clearly, there are strong relationships between plant species and vegetation to soil and geology in the Coomberdale Chert Threatened Ecological Community. *Regelia megacephala* vegetation is an obvious example of vegetation from which many species are absent, because of the harsh habitat (massive chert with little topsoil) on which it occurs. *Allocasuarina campestris* vegetation is a contrasting example, where the density of the vegetation excludes a somewhat different set of species, but which grows on a much less massive state of the underlying chert. Between these extremes there is a range of soil types developed in the area studied, as well as a range of topographic positions.

To further investigate the issue of the influence of different factors on the floristic groups, a classification of species by sites was also carried out (showing both species and sites ordered in their respective classification order). This showed that some species appear to be largely ubiquitous (i.e. frequently present, although not abundant in all the types they occur in), these include *Hibbertia subvaginata, Allocasuarina huegeliana* and *Allocasuarina campestris* and formed one species group (see Trudgen *et al.* 2012). However, many of these more or less ubiquitous species are absent from the quite distinct communities of floristic groups 17 to 20. Due to their size, life span and ability to cope with disturbance, a number of these species are unlikely to be missing from these groups as a result of grazing.

Figure 5: Distribution in the Trudgen et al. (2012) survey area of the groups defined at the 20-group level in the classification using all (native and introduced) species, including A. & R. Tonkin property sites.

Notes: The same symbol shape indicates quadrats in a group at the 20-group level. To provide better separation of the quadrats, the E-W scale is about 2x that of the N-S scale. Especially note that this is the 2006 classification, with the A. & R. Tonkin's property sites (ART) assigned to it by a separate process. Particularly important is that Group 0 (green squares) is those ART sites that do not fit the 2006 analysis; these sites probably represent several units at this level new to the survey area.



Examination of the occurrence of other species groups in floristic groups gave the overall conclusion that some of the floristic groups on the chert hills are defined as much by "absences" of species as by presence of species. Standing out from these floristic groups there are a number of floristic groups with distinct *presences* of species that are *absent* from the other floristic groups. This again suggests the floristic groups are real, rather than artefacts caused by grazing and other land use factors.

6.4 Addition of sites from the A. & R. Tonkin property to the floristic classification

The sites on the A. & R. Tonkin property were recorded in a very dry year and had low native species richness (low number of native species), but similar numbers of weeds to other areas. As this could be caused by grazing or other land use history (e.g. herbicide drift), simply adding those sites to the data base and running a new analysis could result in spurious new groups. Consequently, it was considered that a more reliable inference of the floristic groups in the new data would be obtained from techniques to match them to the existing 2006 classification. A technique known as single-site-insertion (Trudgen 2010), where one new site is added and classified separately to avoid sites grouping on quality, was among those used. See Trudgen *et al.* (2012) for details of the techniques used (and their Table 7 for comparison of the data to other areas).

While some of the sites from the A. & R. Tonkin property were assigned to group 20 at the twenty-group level using these techniques (another one was close to group 8 but was not placed there), the others were not assigned to units from that classification. This is because the evidence is such that these sites appear to be significantly different from the groups defined in the earlier classification (Trudgen *et al*. 2006) and therefore represent new groups at the same level as the 2006 classification. The data suggests there are several new groups but the uncertainty about the impacts of the drought (and land use impacts) on the data means that it is not possible to be definitive in clarifying this.

The sites not assigned to a group at the twenty-group level are closest to the existing floristic groups 8, 16 and 6 at that level. These groups occur in nearby areas, particularly sub-areas JT, SW and to a lesser degree ERG and WOR. Table 12 lists the sites from the A. & R. Tonkin property with their vegetation descriptions and assignment.

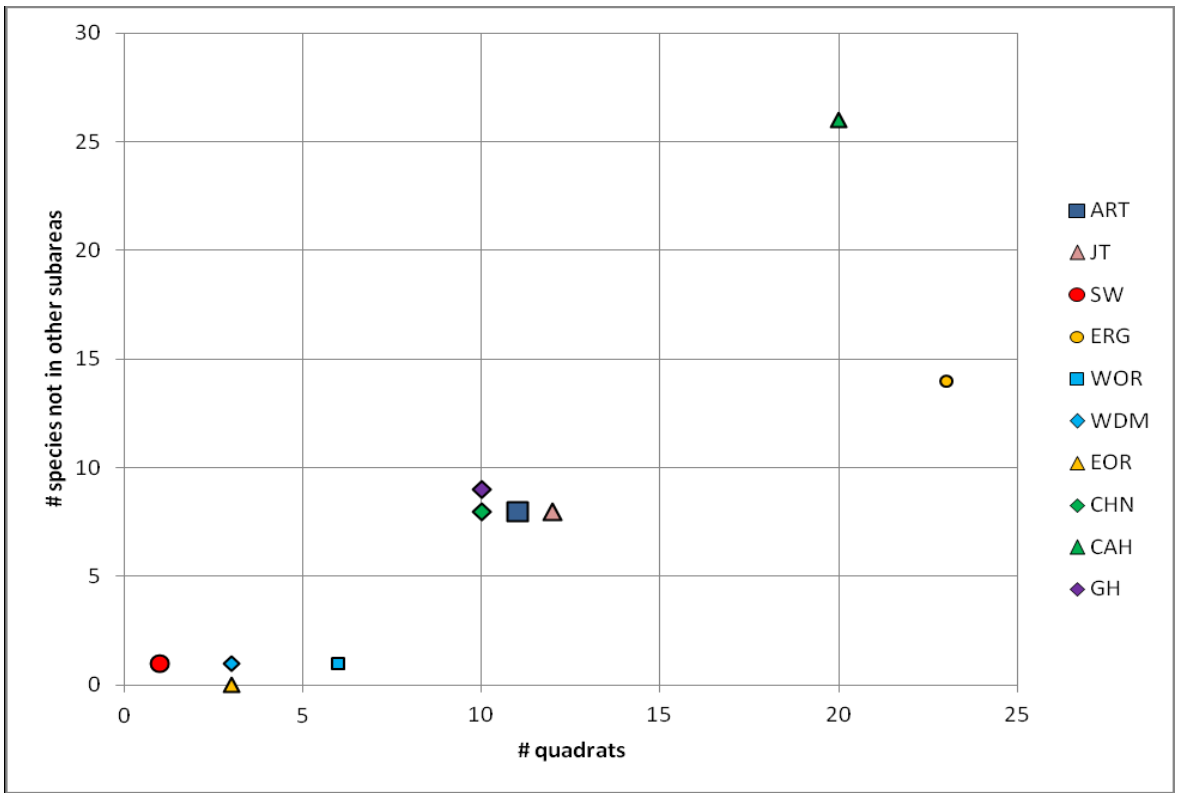
Table 12: List of quadrats recorded on A. & R. Tonkin's property with assignment to the groups from the 2006 classification and their vegetation descriptions

Notes. "New" in column two indicates probably belongs to a new group.

Site	Assigned to group	Vegetation Description
ART01	New (0)	Regelia megacephala open scrub over Ricinocarpos muricatus scattered shrubs over Dichopogon capillipes, Lepidosperma sp. (ART01-07), scattered herbs and sedges and *Ursinia anthemoides, Hypochaeris glabra, Ehrharta longiflora, *Vulpia myuros annual herb/g
ART02	New (0)	Allocasuarina humilis open heath over Stylidium septentrionale, Borya laciniata, Cheilanthes adiantoides open herbland/fernland.
ART03	New	York Gum low woodland to low open forest over Melaleuca concreta over Austrostipa sp. (perennial) scattered low tussocks (with scattered introduced herbs and grasses)
ART04	8	Acacia acuminata scattered low trees overs Kunzea praestans (Dryandra sessilis) open scrub over Hibbertia racemosa low shrubland over Desmocladus asperus low open shrubland and Cheilanthes adiantoides, Cheilanthes distans low open fernland.
ART05	New (0)	Allocasuarina huegeliana scattered low trees over Regelia megacephala high shrubland over Cheilanthes adiantoides low open herbland.
ART06	20	Allocasuarina huegeliana, Acacia acuminata low open woodland over Allocasuarina campestris high shrubland over Cheilanthes adiantoides open fernland and Asteraceae/Poaceae (native/weedy) annual herb/grassland.
ART07	20	Allocasuarina huegeliana low woodland over Xanthorrhoea preissii scattered shrubs over Hibbertia racemosa, Trymalium sp. low open shrubland over Cheilanthes austrotenuifolia low open fernland with Ursinia anthemoides, Dioscorea hastifolia
ART08	20	Allocasuarina huegeliana, Acacia acuminata low open forest over Xanthorrhoea preissii open shrubland over Lomandra sp. (ART08-02), Neurachne alopecuroidea, Austrostipa sp. (ART08-05) scattered low grasses and *Ehrharta longiflora, *Avena fatua annual grassland
ART09	New (0)	Kunzea praestans, Dryandra sessilis high shrubland to open scrub over Xanthorrhoea preissii open shrubland over Hibbertia racemosa low open shrubland over *Avena, *Bromus diandrus, Hypochaeris glabra annual grass/herbland.
ART10	20	Allocasuarina huegeliana low open forest over Allocasuarina campestris, Xanthorrhoea preissii shrubland/high shrubland over Hibbertia racemosa low open shrubland over Austrostipa sp. (ART10-14?, ART10-06) scattered grasses.
ART11	20	Eucalyptus accedens scattered trees over Acacia acuminata, Allocasuarina huegeliana low woodland over Xanthorrhoea preissii scattered shrubs/tall shrubs over annual grassland and herbland.

Supporting the inference from the floristic analyses that the quadrats on A. & R. Tonkin's property include new floristic types is that these quadrats have eight native species not in other sub-areas of the Trudgen *et al.* (2012) survey area. This degree of difference in flora composition appears consistent with other sub-areas (Figure 6), which also have species not found on A. & R. Tonkin's property or variously in other sub-areas. This further supports the conclusion that the A. & R. Tonkin property has genuine differences in its floristics to the other sub-areas of the survey area.

Figure 6: Number of species only in each area related to the number of sites in the area



6.5 General implications of the floristic analyses

While some ambiguity must remain around the issue of how much of the variation is a result of grazing, it is clear that the survey sub-areas of the Trudgen *et al.* (2012) report are largely not interchangeable in regard to the floristic variation in their vegetation at the twenty-group level and that this is not due to grazing or other land use impacts (although these are likely to have had some impact).

Table 14 is a summary of the distribution of the floristic groups (at the 10- and 20-group levels) in the different sub-areas of the survey. This table shows that a significant proportion of the variation sampled in the area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) is within Cairn Hill, which contains half of the groups defined at the 20-group level. Given that Cairn Hill has the largest topographic variation of the survey sub-areas, this indicates the importance of habitat range and type as an underlying cause of the development of the floristic groups found in the survey area.

Table 13 also shows that Cairn Hill North (CHN) has significant overlap with Cairn Hill, as six of the quadrats recorded in it are from the same floristic group at the 20-group level as three from Cairn Hill. The similarity is greater at the 10-group level, although at this level the groups defined are very broad. At the 20-group level the other four quadrats recorded in

Cairn Hill North are from different floristic groups, so while there is overlap, there is also significant difference between these two sub-areas.

Table 13: Summary of Site classification (all species) by sub-area at the 20-group and 10-group levels

Notes. The cell values are the number of quadrats in each combination at the 20-group level. The values in bold indicate floristic groups restricted to one survey sub-area. CAH = Cairn Hill; CHN = Cairn Hill North; EOR = Eastern Orebody; ERG = Eastern Ridge; GH = Gardiner's Hill; JT = John Tonkin's; SW = Stan Ridgway's property; WDM = Proposed Waste Dump; WOR = Western Ridge, ART = A. & R. Tonkin's.

Group numbers at the 10 & 20 group level		Sub areas									
gp10	gp20	CAH	CHN	ERG	WDM	WOR	EOR	GH	JT	SW	ART
1	1	**2**									
1	2	**1**									
2	3	3	6	1	1	1					
2	4	**4**									
2	5	**3**									
3	6					5	2				
4	7							**3**			
5	8								**11**		1
6	9	**2**									
6	10		**1**								
7	11	1		2				6			
7	12	1						1			
7	13		1		2						
7	14			**5**							
7	15		1	7			1				
7	16			**8**							
8	17	**2**									
8	18		**1**								
9	19	**1**									
10	20								1	1	5
Other (group "0")											5

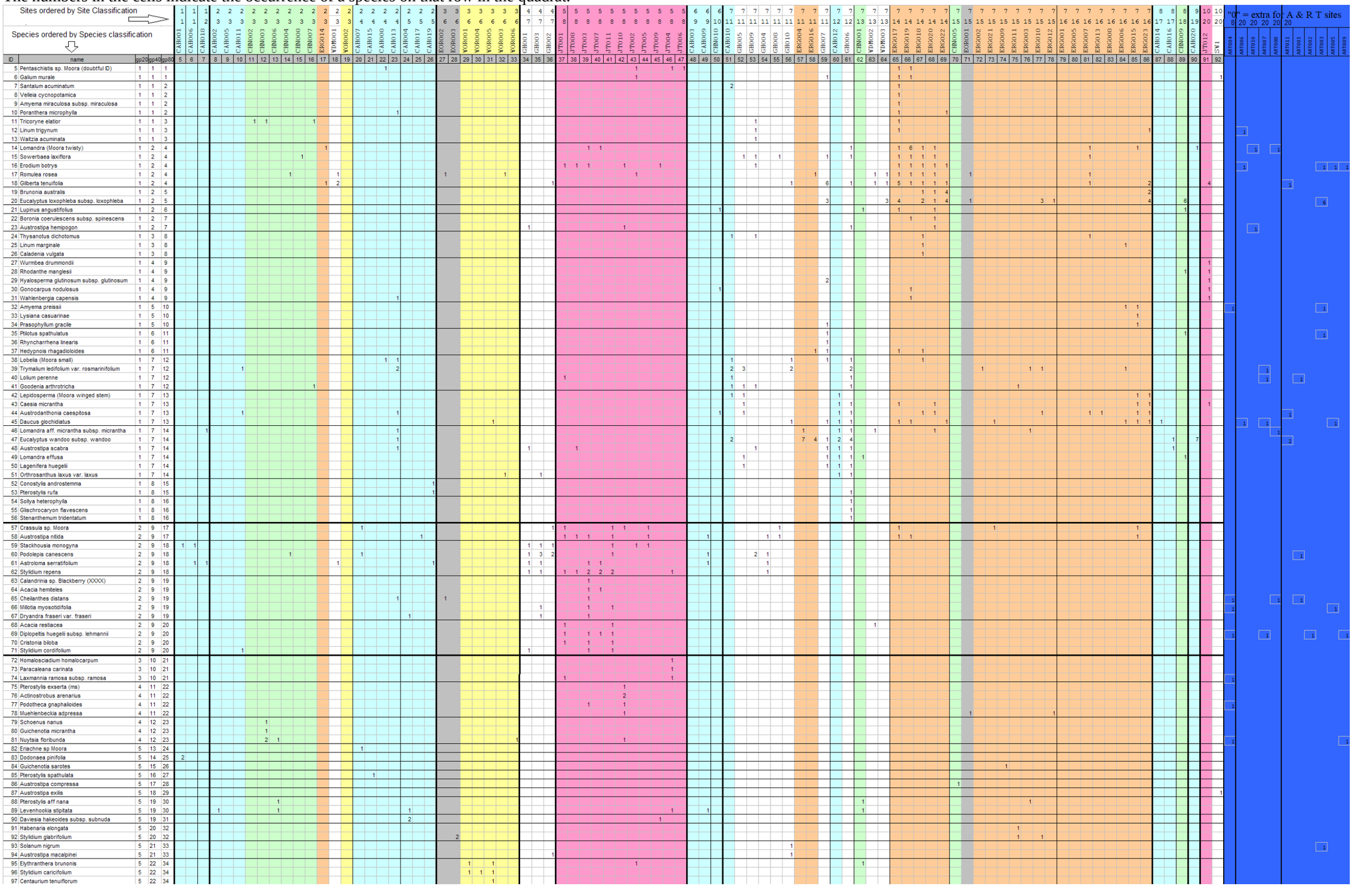
Similar comparisons can be made for the various other sub-areas of the Trudgen *et al.* (2012) report. Of interest here, is that the twelve quadrats on John Tonkin's property were referred to only two floristic community types, although the significant structural and dominance variation would have appeared to suggest more would be present. These groups were shared (Table 14) with A. & R. Tonkin's property (ART sites) and Ridgway's property

(SW site), *but not with sub-areas south of Kiaka Road*. Similarly, the sites on A. & R. Tonkin's assigned to Group 20 are from a group that only occurs north of Kiaka Road. The other five sites on A. & R. Tonkin's property (Group "0") appear to have floristically different vegetation from the other sub-areas. The data suggest these are from two different floristic types, which have some similarity to groups from south of Kiaka Road.

Figure 7 expands on the information in Table 14; it shows the placement of quadrats into the ten- and twenty-group levels of the floristic classification and shows the occurrence of species in the quadrats. Thus, it shows visually the basis of the classification in the occurrence of the species in different columns. Note the group of species at the bottom of the figure that only occur in the A. & R. Tonkin property quadrats.

Figure 7: Two way table of sites by species

Notes. The A. & R. Tonkin property sites (dark blue columns) and species (at end of figure) were added manually. The top row is the classification at the 10-group level, with the unassigned A. & R. Tonkin property sites forming an extra group ("0") at this level. The colours indicate sub-areas of the Trudgen *et al.* (2012) report. The individual columns are quadrats. The heavier vertical lines indicate the 10-group level groups. The numbers in the cells indicate the occurrence of a species on that row in the quadrat.



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98	Pterostylis vittata	5	22	35
99	Orobanche minor	5	22	35
100	Wahlenbergia preissii	5	22	35
101	Solanum oldfieldii	5	23	36
102	Ptilotus gaudichaudii var. parviflorus	5	23	36
103	Leucopogon sp. Yanchep (M. Hislop 19,861)	5	24	37
104	Agrostocrinum scabrum	5	24	37
105	Schoenus subflavus	5	25	38
106	Allocasuarina humilis	5	25	38
107	Centrolepis drummondiana	5	25	38
108	eudesmioides	5	25	38
109	Cryptandra glabriflora	5	25	39
110	Boronia ramosa subsp. anethifolia	5	25	39
111	Thysanotus multiflorus	5	25	40
112	Scaevola glandulifera	5	25	40
113	Lechenaultia (Moora blue)	5	26	41
114	Stylidium miniatum	5	26	41
115	Pterostylis sargentii	5	26	41
116	Goodenia hassallii	5	26	41
117	Acacia microbotrya	5	26	42
118	Isotoma hypocrateriformis	5	26	42
119	Schoenus brevisetis	5	27	43
120	Cassytha pomiformis	5	27	44
121	Calothamnus sanguineus	5	27	44
122	Acacia lasiocarpa var. bracteolata	5	27	45
123	Caesia (Moora hairy stem)	5	28	46
124	Calandrinia eremaea	5	28	46
125	Aira caryophyllea	5	28	47
126	Wahlenbergia gracilenta	5	28	47
127	Tripteris clandestina	5	28	47
128	Crassula peduncularis	5	28	48
129	Acacia pulchella	5	28	48
130	Rhodanthe laevis	5	28	49
131	Drosera macrophylla subsp. macrophylla	5	28	49
132	Cyanicula gemmata	5	28	49
133	Schoenus clandestinus	5	29	50
134	Haemodorum simulans	5	29	50
135	Lepidobolus chaetocephalus	5	29	51
136	Melaleuca radula	5	29	51
137	Haemodorum paniculatum	5	29	51
138	Leporella fimbriata	5	29	52
139	Tricoryne arenicola	5	29	52
140	Stylidium calcaratum	5	29	52
141	Exocarpos sparteus	5	29	52
142	Borya laciniata	5	30	53
143	Scaevola anchusifolia	5	30	53
144	Dampiera juncea	5	30	53
145	Calytrix depressa	5	30	54
146	Pimelea imbricata var. piligera	5	30	54
147	Quinetia urvillei	5	30	54
148	Platysace (Moora common)	6	31	55
149	Blennospora drummondii	6	31	55
150	Diuris aff. recurva	6	31	55
151	Anagallis arvensis	6	31	55
152	Eriochilus helonomos	6	31	55
153	Calandrinia calyptrata	6	31	56
154	Podotheca angustifolia	6	31	56
155	Opercularia vaginata	6	31	56
156	Austrostipa trichophylla	6	31	56
157	Bromus diandrus	6	31	57
158	Austrodanthonia acerosa	6	31	57
159	Comesperma integerrimum	6	31	57
160	Lepidosperma leptostachyum	6	31	57
161	Dianella revoluta var. divaricata	6	31	57
162	Austrostipa elegantissima	6	31	57
163	Austrostipa variabilis	6	31	57
164	Austrodanthonia setacea	6	31	57
165	Petrorhagia dubia	6	31	58
166	Silene gallica var. gallica	6	31	58
167	Goodenia berardiana	6	31	58
168	Waitzia nitida	6	31	58
169	Erodium cygnorum	6	31	58
170	Hyalosperma cotula	6	31	59
171	Olearia dampieri subsp. eremicola	6	31	59
172	Pterostylis setulosa	6	32	60
173	Drosera pallida	6	32	60
174	Acacia congesta subsp. congesta	6	32	60
175	Bossiaea sp. Cairn Hill (M Henson CH2-28)	6	32	61
176	Regelia megacephala	6	32	61
177	Acacia aristulata	6	32	61
178	Ptyrodia dilatata	6	32	61
179	Tripterococcus brunonis	6	32	61
180	Scaevola phlebopetala	6	32	61
181	Pterostylis recurva	6	32	62
182	Xanthosia fruticulosa	6	32	62
183	Baeckea sp.Moora(R.Bone 1993/1)	6	32	62
184	Lawrencella rosea	6	32	62
185	Lepidosperma tenue	6	32	63
186	Millotia tenuifolia var. tenuifolia	6	32	63
187	Amphipogon caricinus var. caricinus	6	32	64
188	Apium annuum	6	32	65
189	Hakea incrassata	6	32	66
190	Thomasia grandiflora	6	32	66
191	Isopogon divergens	6	32	67
192	Nemcia acuta	6	32	67
193	Daviesia dielsii	6	32	67
194	Calothamnus quadrifidus	6	32	67
195	Pleurosorus rutifolius	6	33	68
196	Trifolium repens var. repens	6	33	68
197	Urospermum picroides	6	33	69

198	Eriochilus dilatatus	6	33	70
199	Sonchus oleraceus	6	33	70
200	Trifolium arvense var. arvense	6	33	70
201	Kennedia prostrata	6	33	70
202	Caladenia denticulata	6	33	70
203	Grevillea biternata	6	34	71
204	Cyrtostylis huegelii	6	34	71
205	Aristida contorta	6	35	72
206	Schoenia cassiniana	6	35	72
207	Acacia stenoptera	6	35	72
208	Austrostipa mollis	6	35	72
209	Acacia lasiocarpa var. sedifolia	6	35	73
210	Austrostipa tenuifolia	6	35	73
211	Podolepis gracilis	6	36	74
212	Ptilotus polystachyus var. polystachyus	6	36	74
213	Centrolepis pilosa	7	37	75
214	Laxmannia omnifertilis	7	37	75
215	Hemiandra incana	7	37	75
216	Verticordia acerosa var. preissii	7	37	75
217	Pterochaeta paniculata	7	37	75
218	Caladenia flaccida	7	37	75
219	Eremophila (Moora small leaf)	8	38	76
220	Acacia (Moora falcate)	8	38	76
221	Eucalyptus salmonophloia	8	38	76
222	Daviesia benthamii subsp. benthamii	8	38	76
223	Parietaria debilis	8	38	76
224	Rhagodia drummondii	8	38	76
225	Pterostylis scabra	8	38	77
226	Maireana marginata	8	38	77
227	Ptilotus divaricatus var. divaricatus	8	38	77
228	Rhagodia preissii	8	38	77
229	Acacia erinacea	8	38	77
230	Trymalium daphnifolium	8	38	77
231	Plantago debilis	8	38	77
232	Calotis hispidula	8	38	77
233	Dodonaea inaequifolia	8	38	77
234	Rhodanthe polycephala	8	38	77
235	Eucalyptus obtusiflora	8	38	77
236	Melaleuca uncinata	9	39	78
237	Brachyscome perpusilla	9	39	78
238	Rhodanthe pygmaea	9	39	78
239	Caladenia remota	9	39	78
240	Drosera aff macrantha	10	40	79
241	Xanthorrhoea drummondii	10	40	79
242	Calytrix leschenaultii	10	40	79
243	Desmocladus flexuosus	10	40	79
244	Kunzea praestans	10	40	79
245	Stylidium septentrionale	10	40	79
246	Melaleuca calyptroides	10	40	79
247	Pterostylis sanguinea	10	40	79
248	Trachymene pilosa	10	40	79
249	Dryandra sessilis var. sessilis	10	40	79
250	Borya sphaerocephala	10	40	79
251	Drosera erythrorhiza subsp. erythrorhiza	10	40	79
252	Vulpia myuros var. hirsuta	10	40	80
253	Neurachne alopecuroidea	10	40	80
254	Chamaescilla corymbosa var. corymbosa	10	40	80
255	Dichopogon capillipes	10	40	80
256	Cheilanthes adiantoides	10	40	80
257	Hypochaeris glabra	10	40	80
258	Ursinia anthemoides	10	40	80
259	Thysanotus manglesianus	10	40	80
260	Dioscorea hastifolia	10	40	80
261	Avena barbata	10	40	80
262	Briza maxima	10	40	80
263	Ehrharta longiflora	10	40	80
264	Trachymene ornata	10	40	80
265	Pentaschistis airoides	10	40	80
266	Burchardia umbellata	10	40	80
267	Hibbertia subvaginata	10	40	80
268	Caladenia flava subsp. flava	10	40	80
269	Allocasuarina huegeliana	10	40	80
270	Allocasuarina campestris	10	40	80
271	Stypandra glauca	10	40	80
272	Hypoxis sp.	10	40	80
273	Drosera macrantha subsp. macrantha	10	40	80
274	Acacia acuminata subsp. acuminata	10	40	80
275	Parentucellia latifolia	10	40	80
276	Podolepis lessonii	10	40	80
277	Crassula colorata	10	40	80
278	Cyanicula deformis	10	40	80
279	Trachymene cyanopetala	10	40	80
280	Arctotheca calendula	10	40	80

Acacia ligustrina
Atriplex suberecta
Brachypodium distachyon
Cheilanthes austrotenuifolia
angustissimus
Cotula turbinata
Crassula exserta
Cynosurus echinatus
Dysphania melanocarpa forma melanocarpa
Ehrharta brevifolia var. cuspidata
Emex australis
Enchylaena tomentosa var. tomentosa
Euphorbia drummondii
Hordeum leporinum
Hypoxis glabella var. leptantha
Lamarckia aurea
Melaleuca concreta
Moraea setifolia
Petrorhagia prolifera
Polycarpon tetraphyllum
Ptilotus drummondii var. drummondii
Ricinocarpos muricatus
Schismus barbatus
Senecio glossanthus
Sonchus asper
Trifolium campestre var. campestre
Trifolium hirtum

7.0 COMPARISON OF THE FLORISTIC ANALYSIS TO THE STRUCTURE/ DOMINANCE CLASSIFICATION

As noted above, vegetation is a complex phenomenon that has various aspects, structure (the physical form of the vegetation), dominance (what species are most abundant) and floristics (the total species complement present). This section is intended to show that these aspects, while not very closely tied, are also not fully independent. The implication of this intermediate relationship is that all the aspects of vegetation need to be considered to give full assessment of the conservation value of an area.

The large variation in structure and dominance in the Coomberdale Chert Threatened Ecological Community means that only limited comparisons of these aspects of vegetation could be made to the floristics of this vegetation as the number of quadrats recorded was not large enough. However, it was possible to compare the floristic groups the quadrats were placed in with the plant community and vegetation alliance they were placed in.

Firstly, ten plant communities that had more than one quadrat recorded in them had quadrats placed in two or more floristic groups and of these, for six plant communities, quadrats were placed in different floristic groups at the 20-group level. This shows that these plant communities, while having similar structure and dominance are significantly variable floristically. Secondly, in the nine other cases where more than one quadrat was recorded for a plant community the two quadrats sampled were placed in the same floristic group at the 40-group level. This suggests that these communities are more tightly defined. Together, these points suggest that the ranking of the plant communities defined as mostly at that level, but with some varying to near the vegetation association level is likely to be correct (Trudgen *et al.* 2012).

One plant community (RmKp1, one of those dominated by *Regelia megacephala*) had three quadrats allocated to group 23 and two to group 25 at the 40-group level (both of which are in group15 at the 20-group level). Two other *Regelia* plant communities had two and three quadrats respectively placed in the same floristic group at the 40-group level, while another had one quadrat in one group and two in another. This suggests that a more detailed classification of the *Regelia* vegetation would define more plant communities, but that a proportion of those defined are close to the plant community level, while others are broader (Table 14).

Similar observations can be made for vegetation assigned to vegetation associations dominated by *Kunzea praestans* and *Allocasuarina campestris* (see Table 14). The main implication is

that simple reliance on either floristics or vegetation mapping can mean that aspects of conservation value are not taken into account for conservation assessment.

Table 14: Comparison of floristic analysis to structural/dominance classification

Notes: The table compares quadrats from floristic groups to the vegetation types they were mapped as occurring in. Ac = *Allocasuarina campestris*; Rm = *Regelia megacephala*; and Kp = *Kunzea praestans*. See Table 6 for other codes. The numbers in cells are numbers of quadrats. The table is derived from Table 10 of Trudgen *et al.* (2012).

	Floristic analysis GP20 ⇨	8	8	15	15	15	15	15	16	16	17	17	17	17	17	17	18	18	19	19
	Floristic analysis GP40 ⇨	12	13	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Vegetation Alliance	Plant community code																			
13	Ac3												1	1	1					
13	Ac4							1								1				
13	AcAs1												1							
13	AcAs2														1	1				
13	AcBsM4								1											
13	AcCq1							1												
13	AcId2				1															
13	AcId3				1															
13	AcMr2				1															
15	RmAh1			1											1					
15	RmAh3						1													
15	RmB1	1		2																
15	RmDs1										1									
15	RmHs1															1				
15	RmHs2					2										1				
15	RmKp1			2		3														
15	RmKp2			3																
15	RmMc1						1													
15	RmMc2							1												
16	Kp1														2					
16	Kp2			1																
16	KpAh1			1																
16	KpAh2							1							1					
16	KpAhB1			2																
16	KpAhB2								1											
16	KpAhB3			1																
16	KpAhDs2					2									1					
16	KpDs3							2												
16	KpDsMc1							1												
16	KpDsMc4										2									

8.0 CONSERVATION VALUE FOR FLORA

8.1 Context for assessing the conservation value for flora of the proposed North Kiaka Mine

The appropriate context for assessing the conservation value of the proposed North Kiaka Mine area for flora is that it is part of the Coomberdale Chert Threatened Ecological Community. And, that this ecological community is located in the South West Botanical Province of Beard (1980), that within this Province it is located in the Avon Botanical District, close to the border of the Darling Botanical District. And, that within the Avon Botanical District it lies in the Coomberdale Floristic Region of Griffin (1992).

The unusual geology the Coomberdale Chert Threatened Ecological Community is restricted to and the presence of several species restricted to it means that this should be an important aspect of the assessment of conservation value for flora of the proposed North Kiaka Mine.

8.2 General conservation value for flora of the proposed North Kiaka Mine

The general conservation value for flora of an area is its total population of native species. This is not a value of particular rare or otherwise particularly important species, but the value that populations of all the different species in an area have by their contribution to the overall maintenance of native flora species. It is important because of the high level of clearing of native vegetation in the Southwest of Western Australia that has led to fragmentation of native flora populations.

The area that would be cleared for the proposed North Kiaka Mine is 50.73 hectares (see Table 9 above) out of an area of the Coomberdale Chert Threatened Ecological Community surveyed by Trudgen *et al.* (2012) of 641.82 hectares and some additional areas. The additional areas south of Coomberdale include areas on Simcoa Block 2 that are in Poor condition. There are also some areas of the Coomberdale Chert TEC that were not surveyed by Trudgen *et al.*(2012) or the current survey, with the Department of Parks and Wildlife (2013, p. 8) giving at total area of 785hectares for the TEC. Some of the area included by the Department of Parks and Wildlife (north of Coomberdale, in the Jingemia area) have somewhat different floristics (see floristics section above) to the areas of the Coomberdale Chert TEC surveyed by Trudgen *et al*. These figures give a loss of area, and hence flora populations, if the area of the proposed North Kiaka Mine is cleared of 5.4% to 6.5% of the Coomberdale Chert TEC. This would be offset to some degree by the fact that the areas of vegetation that would be cleared are in poorer condition than many other areas of the Coomberdale Chert TEC mapped by Trudgen *et al* and therefore would have fewer species and smaller populations of some of those remaining.

The loss of area of the Coomberdale Chert TEC in the proposed North Kiaka Mine area would mean the loss of populations of one hundred and eight (108) of the three hundred and twenty-one (321) native flora species recorded for the Coomberdale Chert TEC by Trudgen *et al.* (2012). The degree of loss would vary for each species from quite small for widespread species with small populations in the area to significant for more restricted species with larger populations in the area. The impact would be greatest for species such as *Regelia megacephala*, *Calytrix* sp. Coomberdale and *Xanthorrhoea* sp. Coomberdale that are restricted to the Coomberdale Chert TEC or have most of their known population in it..

To put this in the wider context of the Avon Botanical District, these native flora populations persist in an area with a rich flora that has comparatively little native vegetation in secure conservation reserves and which has a high level of clearing. For many of the native species recorded in the survey area, this means that their populations have already been greatly reduced compared to their size before European settlement. Thus, the conservation value of these remaining populations is that the flora populations of the survey area persist in a context where the original extent of plant populations has been greatly reduced by clearing of native vegetation, largely for agriculture, and the proportion of the original vegetation (and thus of flora populations) of the botanical district in secure conservation reserves is well below international and national objectives for secure reservation.

The overall assessment for general value for native flora for the proposed North Kiaka Mine area is that it has moderate value for its size due to the flora present being of different composition to most other areas in the surrounding region, but that this is reduced somewhat because of the condition of the vegetation in the proposed mine area.

8.3 Conservation value of proposed North Kiaka Mine area for declared rare flora species

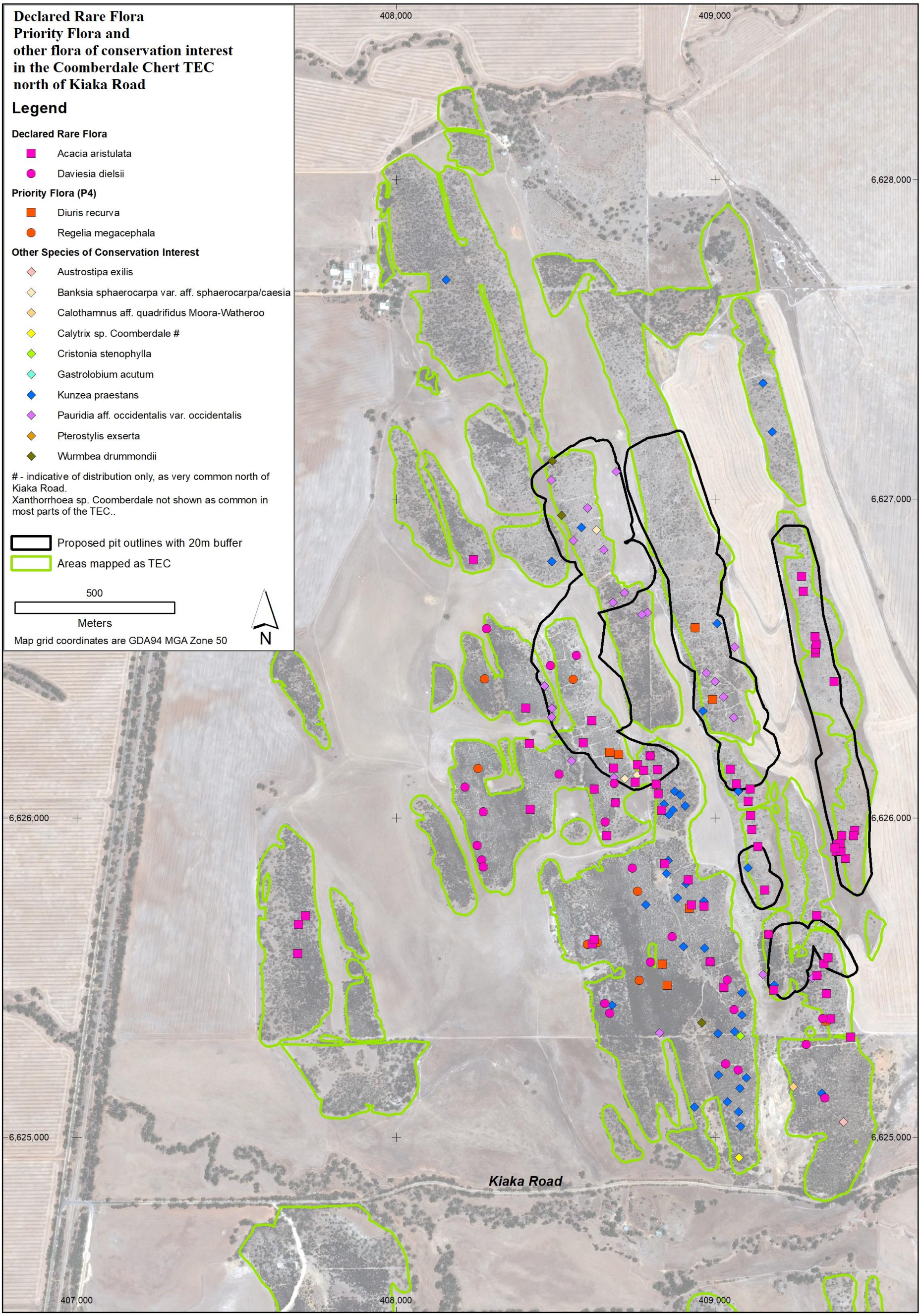
Two declared rare flora species, *Acacia aristulata* and *Daviesia dielsii*, have been recorded from the proposed North Kiaka Mine area. The proposed mine area has significant conservation value for *Acacia aristulata* and at least minor value for the *Daviesia*. It is possible that after fire that the declared rare flora species *Goodenia arthrotricha* would be found in the proposed mine area, but to date it has not been recorded north of Kiaka Road in the survey area of Trudgen *et al.* (2012). The distribution of declared rare, priority and other flora of conservation interest north of Kiaka Road is shown on Map 30 (see below).

While records are available for the locations these species have been recorded at from rare flora searches and vegetation site data, there must be some uncertainty as to the populations of these

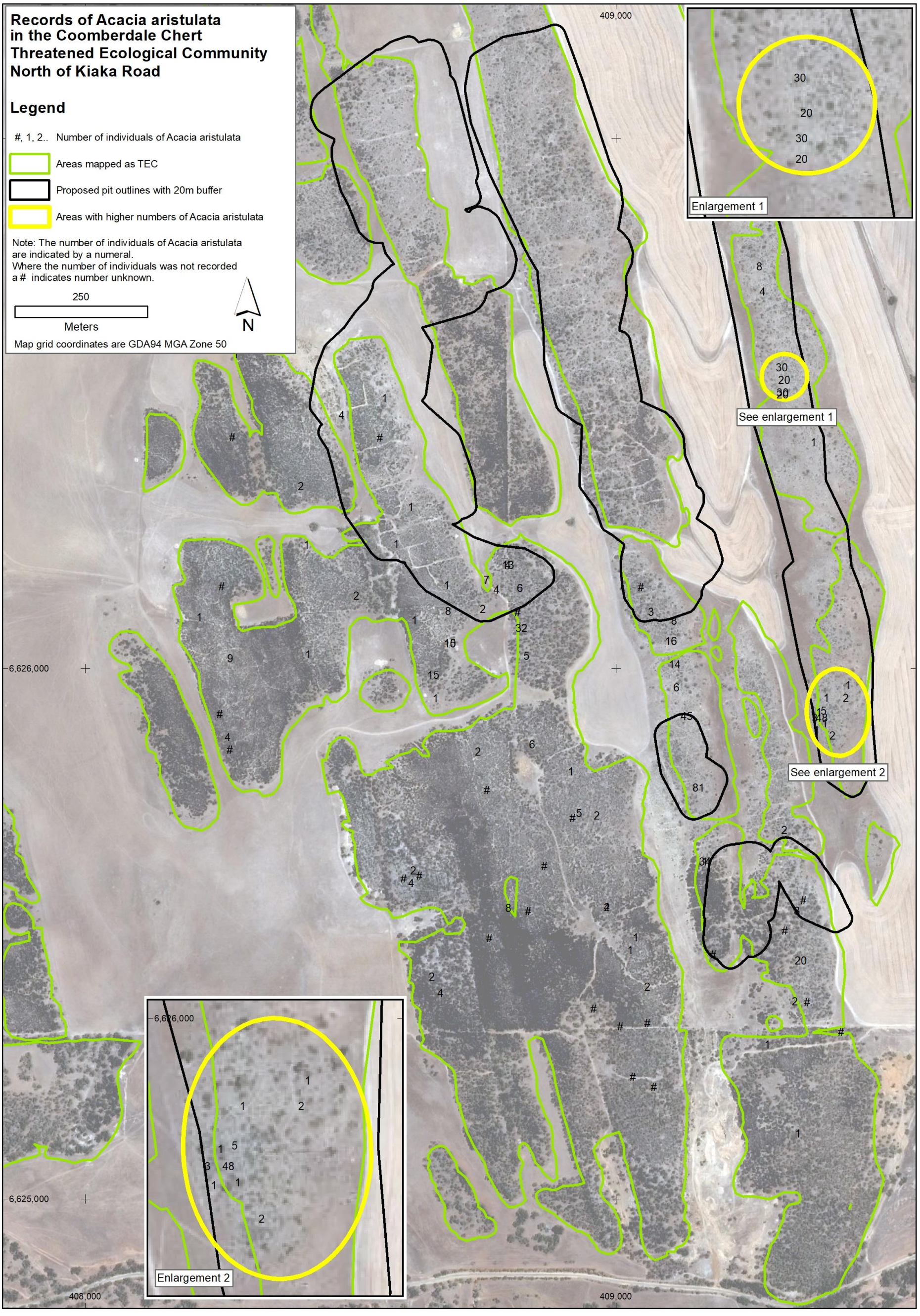
species in the proposed North Kiaka Mine area due to their long persistence as seeds and shorter persistence as shrubs. *Acacia aristulata* is almost certainly a pyrosere species and *Daviesia dielsii* may also be one. This means that the populations of these species cycle between a seed storage stage in the absence of fire (or other disturbance that removes competition) and a shrub phase for a period after fire (with plants dying out over time, but seed being stored in the soil). In fact disturbance on the most eastern ridge in the proposed North Kiaka Mine area seems to have suited *Acacia aristulata* at some stage between rare flora searches in 2006 and field work in 2017, as the population of shrubs of this species there at the latter time was much larger than in 2006.

Acacia aristulata

Acacia aristulata is restricted to an area from north of Moora to near Watheroo and appears to be largely restricted to the Coomberdale Chert Threatened Ecological Community. There are records from various parts of the Coomberdale Chert Threatened Ecological Community, with data from Trudgen *et al*. (2012) and the current survey indicating a population of about 1,100 plants from 220 locations in the Trudgen *et al*. survey area. Of these approximately 1,100 plants, some 230 occur in the proposed North Kiaka Mine area, mostly on the easternmost ridge on the John Tonkin property. This is about 20.3% of the population known from the survey area of Trudgen *et al.* (2012) and their loss would be a significant impact on the population of the species. However, the pyrosere strategy of this species means that basic research on the ecology of this species is needed to really understand its population structure (numbers, distribution) and the impact of other factors (such as weed invasion, grazing and climate change) on its population dynamics. The records of *Acacia aristulata* north of Kiaka Road with the outline of the proposed North Kiaka Mine area are shown on Map 31.



Map 30: Declared Rare Flora, Priority Flora, and other flora of conservation interest in the Coomberdale Chert TEC north of Kiaka Road
Notes: The markers for *Regelia megacephala* indicate the presence of vegetation with that species dominant (see Map 27) as do the records for *Kunzea praestans* (to a lesser degree). More detail of the records of *Acacia aristulata* are given on Map 5 and Map 31.



Map 31: Distribution of *Acacia aristulata* in the Coomberdale Chert TEC north of Kiaka Road.

Notes: See Map 5 for the distribution of *Acacia aristulata* in the whole Coomberdale Chert TEC survey of Trudgen *et al* (2012). The numbers indicate the number of plants recorded where a count was made. A hash mark (#) indicates a record of *Acacia aristulata* where a count was not made. Plants recorded prior to 2016 & 2017 may have been lost in the dry period prior to 2016.

Daviesia dielsii

The population of *Daviesia dielsii* recorded by Trudgen *et al.* (2012) in their survey area was 365 plants at 135 locations, 24 of which were north of Kiaka Road (Map 32). Of these locations, two will be impacted by the proposed North Kiaka Mine area, affecting nine (9) individuals of the *Daviesia* (or at least places where nine have been recorded, as this species was not observed in the field work north of Kiaka Road in 2016 and 2017).

Map 32: Records of *Daviesia dielsii* north of Kiaka Road

Notes: The blue pins are from rare flora searches and the yellow are records from vegetation site data.

8.4 Conservation value of proposed North Kiaka Mine area for priority flora species

Only two of the twelve priority flora species known from the Coomberdale Chert Threatened Ecological Community (Table 4) survey area of Trudgen *et al.* (2012) occur north of Kiaka Road. They are *Regelia megacephala* and *Diuris recurva* and both occur in the proposed North Kiaka Mine area.

Regelia megacephala (Priority 4)

Regelia megacephala is very geographically restricted, with all records but one between Moora and Coomberdale (the other is from south of Moora). It is also very habitat restricted, occurring only on massive chert that has skeletal soil on the surface (usually with some flat outcrop). In such situations it is usually the dominant large shrub species dominant species in the Coomberdale Chert Threatened Ecological Community. It would not be practical to count the numbers of this species, however as the vegetation of their study area has been mapped in detail by Trudgen *et al.* (2012) it is possible to give the areas of the different vegetation types where it is the dominant shrub species, or at least abundant in a stand. This shows that of the seventy-one (71) stands in the survey area of Trudgen *et al.* (2012), eight are north of Kiaka Road and one is in the area of the proposed North Kiaka Mine. This stand has an area of about 1.73 hectares, while the *Regelia megacephala* alliance vegetation has an area of about 50.73 hectares in the survey area of Trudgen *et al.* (2012).

Diuris recurva (Priority 4)

Diuris recurva is an orchid species that has three disjunct areas of occurrence that imply that the species may have undescribed sub-species or varieties (see Map 9A above). Trudgen *et al.* (2012) had records of this species (as *Diuris* aff. *recurva*) at twenty-seven locations and field work in 2016 added four more locations. The species has a scattered distribution in the Coomberdale Chert Threatened Ecological Community (see Map 9B) with three of the seven records north of Kiaka in the proposed North Kiaka Mine area. The impact on this species of the proposed mine would therefore be relatively small, with sixteen individuals at the three locations.

8.5 Potential for other priority flora species in the proposed North Kiaka Mine area

Given the significant amount of botanical survey work (rare/priority flora searches, recording of quadrats and collections for vegetation mapping) it is not likely that other priority flora species have populations in the proposed North Kiaka Mine area. However, there is a small possibility that small species such as *Austrostipa* sp. Cairn Hill, *Tricoryne* sp. Wongan Hills and *Stylidium*

glabrifolium are in the proposed North Kiaka Mine area. However, if they were to be present the populations would be very small.

8.6 Value of the proposed North Kiaka Mine area for other species of conservation interest

As well as declared rare flora and priority flora, the Coomberdale Chert Threatened Ecological Community has a number of other flora species that are of particular conservation interest because they either:

- Have very small populations;
- Are very restricted in distribution
- Their distribution suggests that they have undescribed subspecies; or
- The populations are near or at the ends of the ranges of the species.

Table 5 (see above) lists nineteen (19) such species that occur in the Coomberdale Chert TEC and summarises the reason why they are of interest. Table 15 lists the subset of ten of these nineteen species found in the proposed North Kiaka Mine area. As they are discussed individually in section 3.8 (see above) most will not be discussed in detail here, although brief comment will be made on the more significant species.

Xanthorrhoea sp. Coomberdale

This species is restricted to the Coomberdale Chert Threatened Ecological Community except for a small occurrence near Moora where it occurs on sand over other siliceous rock. It is prominent in the Coomberdale Chert TEC, although its population is declining (see Section 3.8). The decline is likely to be due to climate change, grazing and weed invasion (the latter two factors reducing recruitment) but, other factors may be involved. The population in the proposed North Kiaka Mine area is fairly large, but not disproportionate to other areas of the Coomberdale Chert TEC, so the value of the population there is significant, but not very high as the mine would clear some fifty (50) hectares of more than 600 hectares where the species is known to occur.

Banksia sphaerocarpa var. aff. *caesia*

While the material referred in this report to *Banksia sphaerocarpa* var. aff. *caesia* needs further taxonomic study to define its status, it is at least a range extension of an unusual form of variety *caesia*. However, that is a very conservative view and it is likely that the population on the Coomberdale Chert is part of a geographically restricted and uncommon taxon. The overall population seems likely to be quite small and the taxon needs survey to define its population

and probably needs special management. The value of the Chert population, particularly the population on the Gardiner property is significant.

***Calytrix* sp. Coomberdale (M.E. Trudgen MET 21184)**

This species is prominent in some vegetation types in the Coomberdale Chert TEC, to which it is largely restricted (it appears to have the same distribution as *Xanthorrhoea* sp. Coomberdale). The population does not seem to be declining significantly at present, but most plants seen were quite old (the species seems to be fairly long lived) and young plants were rarely seen during field work. The population in the proposed North Kiaka Mine area is quite large and the species is more common there than in some many other parts of the Coomberdale Chert TEC. Consequently, the proposed North Kiaka Mine area has significant value for this species.

Table 15: Other flora of conservation interest recorded for the proposed North Kiaka Mine area
Notes: The numbers in the table are records at vegetation recording sites. They are not population number counts. Where numbers of occurrences from quadrat & releve data would be misleading a comment is made as well. See Table 5 above for more detail of wider occurrence in the TEC.

Taxon	**Significance of taxon or TEC population of taxon**	**Number of occurrences for North Kiaka Mine impact area**
Banksia sphaerocarpa var. aff. *caesia*	Range edge, atypical habit & habitat if var. sphaerocarpa. Range extension and atypical habitat if var. caesia. Needs further study.	2 (6 plants)
Calothamnus aff. *quadrifidus* (Moora - Watheroo)	Moderately geographically restricted, edaphically restricted not very common.	1 stand dominated by the species
Calytrix sp. Coomberdale (M.E. Trudgen MET 21184)	Geographically restricted, common in some habitats in the TEC. Not recognised as distinct in earlier surveys of the TEC.	7 (Underestimates the large population in proposed Mine area.)
Cristonia stenophylla	TEC population outlying from main population by 60 km. Possibly locally extinct, or may be a pyrosere species.	1 record at a quadrat
Gastrolobium acutum (Previously P3 species)	Near northern limit, has disjunctions that may indicate unrecognised subspecies.	1 record
Kunzea praestans (Previously a P3 species)	More restricted than herbarium collections show (due to identification errors). May have unrecognised subspecies.	10 (underestimates the population in proposed mine area.)
Pauridia aff. *occidentalis* var. *occidentalis*	Probably an undescribed species, but the genus needs revision and the material needs further study. Locally common in the Coomberdale Chert TEC.	0 (No record for proposed mine area in site data, but recorded during flora searches)
Pterostylis exserta	Known from less than ten locations.	1

Quoya (*Pityrodia*) *dilatata*	Has three centres of occurrence, the southern one disjunct on current knowledge.	3 (underestimates the population in proposed mine area.)
Xanthorrhoea sp. Coomberdale	Quite geographically restricted, only observed on the Coomberdale Chert south of Coomberdale and one location near Moora. Not recognised as distinct in earlier surveys of the TEC.	9 (locally common; sample underestimates the population)

Pterostylis exserta

Pterostylis exserta is a small orchid species that is very uncommon (see maps in Section 3.8 above) and poorly known. One of the three records in the Coomberdale Chert Threatened Ecological Community is from the proposed North Kiaka Mine area, but the species is not common there. *Pterostylis* species were specifically recorded during the 2016 rare flora searches of the proposed North Kiaka Mine area and *Pterostylis exserta* was only (re)found at the same location it was found at earlier). The proposed North Kiaka Mine area therefore has low value for this species.

9.0 CONSERVATION VALUE FOR VEGETATION OF THE PROPOSED NORTH KIAKA MINE AREA

9.1 Conservation value implication of threatened ecological community status for the vegetation of the proposed North Kiaka Mine area

The classification of the vegetation known of the Coomberdale Chert as a Threatened Ecological Community means that it has been accepted by Government processes as:

- Firstly, vegetation of restricted distribution that has a level of difference from other native vegetation that is of conservation significance; and
- Secondly, that the vegetation is subject to processes such as grazing, clearing, weed invasion and climate change that threaten its ongoing existence.

The fact that the Coomberdale Chert Threatened Ecological Community is restricted in area means that all parts of it have high conservation value. The threatening processes noted above combined with the restricted area of occurrence are the rationale for giving this vegetation the status of *threatened* ecological community.

The high conservation value for vegetation of the Coomberdale Chert Threatened Ecological Community does not mean that at a detailed level there are not differences in the conservation value of the different plant communities, or even of different stands of the same plant community, found in the TEC. This TEC has a very significant range of vegetation associations and plant communities, some of which have much less total area than others. Also, some of the different vegetation types found in the TEC are dominated by species that themselves have restricted occurrence, while others are dominated by species that are more common but the vegetation unit as a whole is of different composition to stands outside the TEC that are dominated by the same species. This difference in composition includes species that while not dominant are of restricted distribution. Such differences in composition mean that some stands will have somewhat higher conservation value than others, but the difference will not great compared to the level of value of stands or plant communities within it implied by the threatened status of the TEC as a whole.

From the above, it can be seen that the vegetation of the proposed North Kiaka Mine area has significant conservation value as part of the remaining area of the Coomberdale Chert Threatened Ecological Community. The degree of the value will be depend partly on what different components (floristic units, vegetation alliances, plant communities) of the TEC are present in the area, floristic differences between different sub-areas of the TEC and the

condition of the vegetation in the proposed mine area and how that compares to the condition of the other parts of the TEC.

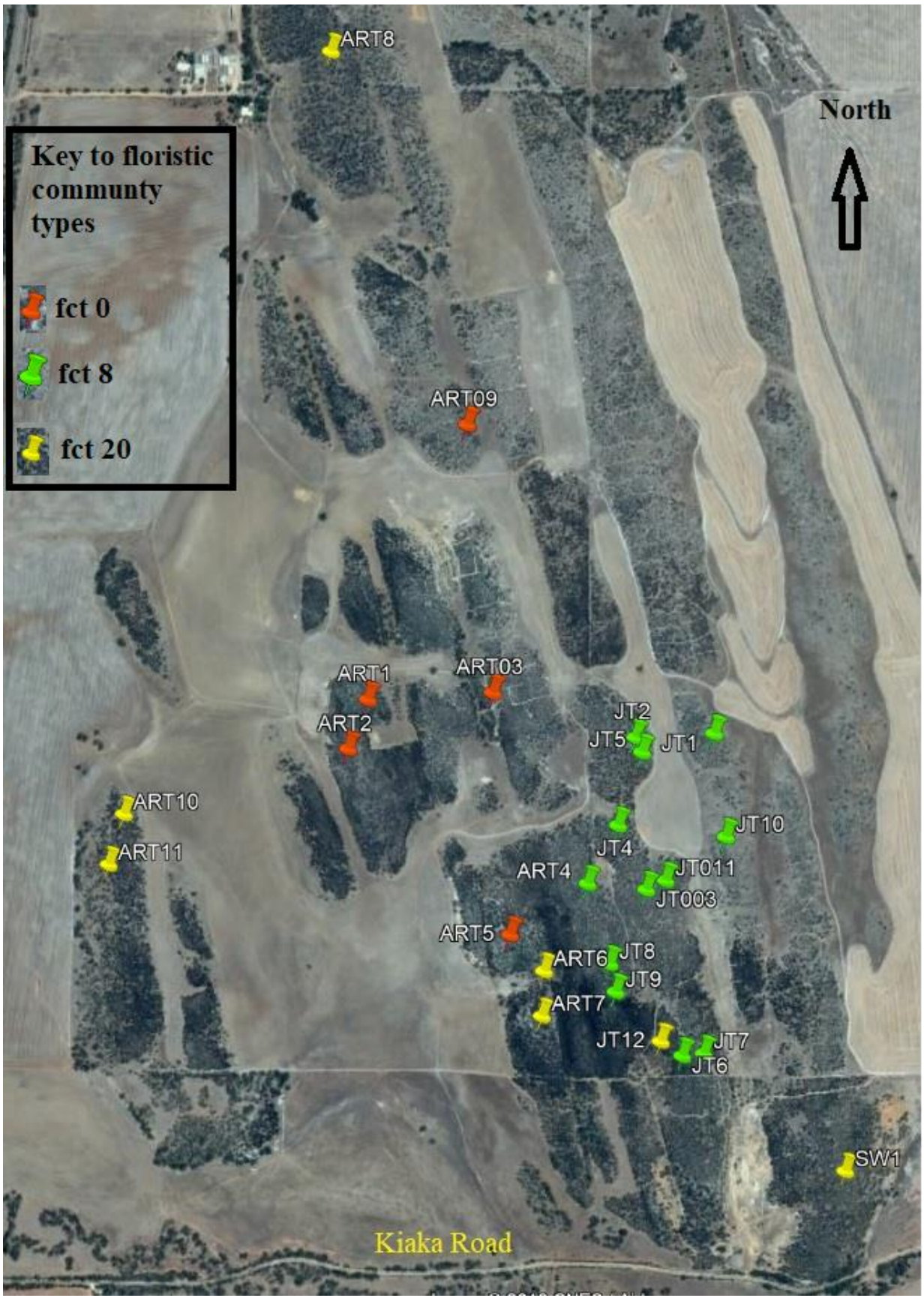
9.2 Differences in conservation value for floristic types of different sub-areas of the TEC and conservation value for floristic units of the proposed North Kiaka Mine area

What is meant here is not the differences between individual stands or plant communities, but the floristic differences in the vegetation between different sub-areas of the Coomberdale Chert Threatened Ecological Community, such as Cairn Hill, the Eastern Ridge (the area east of the current mine) and the three areas north of Kiaka Road. These are the J. Tonkin Property, the A. & R. Tonkin Property and the S. Ridgeway property. While some of these sub-areas are separate geomorphic features (such as the Eastern Ridge), others are based on land ownership. See Figure 3 above and Trudgen *et al* (2012) for location of the different sub-areas.

The relevant issue here is that the area north of Kiaka Road has vegetation with different floristic units to other sub-areas of the Coomberdale Chert Threatened Ecological Community. Also, that there are differences between the larger two of the properties north of Kiaka Road on which the mining is proposed to occur. Such differences occur between the other sub-areas surveyed by Trudgen *et al* (2006, 2012); see Section 6 above (especially 6.3 and 6.4). The differences relate to what combinations of species are present in the quadrats in the different sub-areas, but it should be noted that this includes species that are present in quadrats north of Kiaka Road, but not south of that road (i.e., it is not simply different combinations to other sub-areas) and vice versa.

Examination of Figure 5 (section 6.4, above) and Map 33 (below) shows that floristic community types 20, 8 and 0 (zero) are the floristic units defined at the 20-group level by Trudgen *et al* (2006, 2012) present north of Kiaka Road in their survey area. Their Floristic Community Type 0 includes those quadrats on the A & R. Tonkin property that could not be placed in the 2006 classification and may include more than one unit at the 20 group level (see Trudgen 2012). Of particular interest for assessment of the conservation value of the vegetation of the proposed North Kiaka Mine is that these floristic units only occur north of Kiaka Road.

On the J. Tonkin property Floristic Community Type 20 has only been sampled in the southern-most part of the property, south of the area of the proposed North Kiaka Mine. On the A. & R. Tonkin property, there are two records in the south part of the property and one in the north part, all away from the proposed mine area.



Map 33: Quadrats assigned to different floristic community types north of Kiaka Road

Notes: Floristic Community Type 0 (zero) has been used to place quadrats that did not fit the 20 group classification and may have two groups at that level.

On the J. Tonkin property, one record (quadrat JT01) of Floristic Community Type 8 is in the proposed mine area and three (quadrats JT10, 05 and 02) are close to proposed mine pits. On the A. & R. Tonkin property, there are two records (quadrats ART03 & 09) that are adjacent to proposed mine pits that have been assigned to Floristic Community Type 0. From these observations, we can conclude that it is likely that the areas proposed to be mined area mostly would have been assigned to floristic community types 8 and 0 if the vegetation condition in these areas had been good enough to enable quadrats to be recorded. See Map 33 for location of the quadrats referred to.

The implication of the floristic analysis for assessment of the conservation value of the area proposed to be mined is that it includes vegetation that is part of the Coomberdale Chert Threatened Ecological Community, but of floristic types only found north of Kiaka Road which are not currently represented in the conservation estate. However, as noted above, the value of the vegetation of the areas proposed to be mined will be partly dependant on condition.

9.3 Conservation value for vegetation alliances, vegetation associations and plant communities of the proposed North Kiaka Mine area and haul road options

There are eight vegetation alliances recorded in the proposed North Kiaka Mine area, with occurrences of twenty vegetation associations and twenty-two plant communities in them (Table 16). There are occurrences of five of the same eight vegetation alliances in haul road option 1 (see Table 16). As haul road option 2 is a subset of option 1, it will not be considered separately (see Table 16 for the difference).

The proposed North Kiaka Mine area has conservation value for the area of the three levels of vegetation units found there. The occurrences of native vegetation in the proposed North Kiaka Mine area combined are 43.4 hectares and the area in haul road option 1 is 1.62 hectares giving a total of 45.02 hectares for the combined impact. This is 6.12% of the area of the Coomberdale Chert Threatened Ecological Community area mapped by Trudgen *et al.* (2012) plus the area mapped on Simcoa Block 2 in 2017 and minus the area mined since 2012.

This impact is not great, but any reduction in the size of an area of native vegetation has a flow on impact on the ability of the area to sustain viable populations of flora species so the impact is not trivial either.

Assessment of the impact of the proposed mine must also take into account that the area of the Coomberdale Chert TEC north of Kiaka Road is somewhat different floristically to the areas

south of that road (see Section 8.2 and Section 6.0 above). This means that the vegetation south of Kiaka Road is dissimilar to that north of the road in an important aspect (floristics), although the structure/dominance units (alliances and lower units) are often described as the same. This simply reflects the fact that vegetation is a complex natural phenomenon.

Also relevant, is that none of the part of the Coomberdale Chert TEC north of Kiaka Road is in a conservation area and any loss there reduces the chance to get areas of the TEC there into a protected area. However, in this context it must be stated that currently the most significant threats in this area are grazing and climate change.

Table 16: Summary of vegetation alliances in the proposed North Kiaka Mine and haul road options with their area compared to area in the Coomberdale Chert TEC with number of vegetation associations and communities in the proposed mine area

Notes: The vegetated areas in haul road option 2 are a subset of those in option 1. See Table 11 for list of each vegetation type in the proposed mine area with area and condition of each polygon.

Vegetation alliances in the proposed North Kiaka Mine area	**Area in haul road option 1 (ha)**	**Area in haul road option 2 (ha)**	**Area in proposed North Kiaka Mine (ha.)**	**Total area in the area mapped by Trudgen *et al*. (ha)**	**Number of vegetation associations in proposed mine area**	**Number of plant communities in proposed mine area**
Kunzea praestans high shrubland to open and closed scrub	0	0	19.67	92.34	4	4
Allocasuarina campestris high shrublands to open and closed scrub	0.84	0.28	14.65	247.96	4	7
Allocasuarina huegeliana low woodlands to low open forests	0.23	0.26	3.88	128.71	4	4
Calothamnus aff. *quadrifidus* Moora-Watheroo	0	0	0.12	0.89	1	1

high shrubland						
Acacia acuminata subsp. acuminata low woodlands	0.23	0	2.47	97.94	3	3
Eucalyptus loxophleba subsp. *loxophleba* low woodlands to low open forests	0.18	0.18	0.29	114.13	1	1
Melaleuca calyptroides open to closed heath	0.14	0	0.49	3.37	1	1
Regelia megacephala high shrubland to open and closed scrub	0	0	1.73	50.73	2	2
	1.62 ha	**0.72 ha**	**43.3 ha**	**736.07 ha**	**20 associations**	**23 communities**

The impact on vegetation of the proposed North Kiaka Mine can therefore be summed up as significant, as the loss of any part of a threatened ecological community is significant. However, the proposed impact is not great as the area to be mined is a fairly small part of the overall area of the Coomberdale Chert Threatened Ecological Community.

9.4 Modification of value of proposed North Kiaka Mine area to be mined due to vegetation condition

The condition of different stands of vegetation in the Coomberdale Chert Threatened Ecological Community (TEC) varies very significantly (see section 5 above). This is largely because of grazing of stock, but also because of grazing by rabbits and kangaroos and because of different levels of weed invasion. What is relevant for the assessment of the conservation value of the vegetation of the proposed North Kiaka Mine is that much of the proposed pit area and associated access corridor options are in poorer condition than other parts of the TEC. This implies a lesser value than areas in better condition.

10.0 ACKNOWLEDGEMENTS

The contribution of the joint authors of earlier reports (Trudgen *et al.* 2012, 2006 etc.) in the accumulation of knowledge of the vegetation and flora of the Coomberdale Chert Threatened Ecological Community has been significant in the accumulation of the baseline data used for this report.

The permission to work on their properties by owners of the properties visited has also been essential for writing this report and is gratefully acknowledge. Especially A. & R. Tonkin and P Gardiner.

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12.0 APPENDICES

APPENDIX 1: Name changes for some flora species in Trudgen *et al.* (2012)

This appendix has changes to botanical names used in Trudgen *et al.* (2012) and earlier reports where specimens have been redetermined, there have been nomenclatural changes, or specimens previously referred to by an informal (geographic name) have been described.

Name used in earlier reports, particularly Trudgen *et al.* (2012)	**Name used in the current report**
Caesia sp. (Moora hairy stem) & *Caesia* (Moora hairy stem)	*Dichopogon preissii*.
Leucopogon sp. Moora	*Leucopogon* sp. Northern Scarp.
Chamaescilla corymbosa var. *corymbosa*	*Chamaescilla versicolor*
Corynotheca micrantha var. *micrantha*	*Thysanotus dichotomus*
Caesia alfordii [MS]	*Caesia* sp. Wongan
Drosera erythrorhiza subsp. *erythrorhiza*	*Drosera erythrorhiza* subsp. magna
Olearia dampieri subsp. *eremicola*	*Olearia dampieri* subsp. Eremicola (Diels & Pritzel s.n. PERTH 00449628)
Paracaleana carinata	*Paracaleana hortiorum*
Lobelia sp. small flowers (K.F. Kenneally 7705)	*Lobelia cleistogamoides*
Desmocladus flexuosus	*Desmocladus asper*
Caladenia flaccida subsp. *flaccida*	*Caladenia paradoxa*
Diuris aff. *recurva*	*Diuris recurva*
Hemigenia sp.	*Hemigenia conferta*
Pterostylis aff. *rufa*	*Pterostylis exserta*
Melaleuca calyptrata	*Melaleuca calyptroides*

APPENDIX 2: Specimens vouchered from collections made for studies of the vegetation and flora on the Coomberdale Chert TEC by M.E. Trudgen & Associates

Notes: All the specimens are held at the Western Australian Herbarium. Data derived from the following The Australasian Virtual Herbarium download: Atlas of Living Australia occurrence download at: http://biocache.ala.org.au/occurrences/search?&q=*%3A*&qc=data_hub_uid%3Adh9&wkt=POLYGON%28%28116.020716461353+-30.4698689586453%2C116.06878162594512+-30.4698689586453%2C116.06878162594512+-30.57499575586088%2C116.020716461353+-30.57499575586088%2C116.020716461353+-30.4698689586453%29%29 accessed on Wed Jul 19 12:11:35 UTC 2017. Records provided by Western Australian Herbarium, accessed through ALA website.

Collectors number	Collector	Species	Family
MET 21208	Trudgen, M.E.	Schoenus latitans	Cyperaceae
MET 21193	Trudgen, M.E.	Goodenia berardiana	Goodeniaceae
MET 21179	Trudgen, M.E.	Kunzea praestans	Myrtaceae
MET 21216	Trudgen, M.E.	Dichopogon capillipes	Asparagaceae
MET 21214	Trudgen, M.E.	Thysanotus multiflorus	Asparagaceae
MET 21213	Trudgen, M.E.	Chamaescilla corymbosa [versicolor]	Asparagaceae
MET 21212	Trudgen, M.E.	Laxmannia omnifertilis	Asparagaceae
MET 21189	Trudgen, M.E.	Millotia tenuifolia var. tenuifolia	Asteraceae
MET 21188	Trudgen, M.E.	Millotia myosotidifolia	Asteraceae
MET 21187	Trudgen, M.E.	Podolepis lessonii	Asteraceae
MET 21186	Trudgen, M.E.	Rhodanthe laevis	Asteraceae
MET 21220	Trudgen, M.E.	Gilberta tenuifolia	Asteraceae
MET 21219	Trudgen, M.E.	Hyalosperma cotula	Asteraceae
MET 21218	Trudgen, M.E.	Hyalosperma cotula	Asteraceae
MET 21217	Trudgen, M.E.	Lawrencella rosea	Asteraceae
MET 21215	Trudgen, M.E.	Borya sphaerocephala	Boryaceae
MET 21234	Trudgen, M.E.	Allocasuarina campestris	Casuarinaceae
MET 21240	Trudgen, M.E.	Tripterococcus brunonis	Celastraceae
MET 21239	Trudgen, M.E.	Stackhousia pubescens	Celastraceae
MET 21236	Trudgen, M.E.	Crassula colorata var. acuminata	Crassulaceae
MET 21209	Trudgen, M.E.	Lepidosperma leptostachyum	Cyperaceae
MET 21207	Trudgen, M.E.	Schoenus latitans	Cyperaceae
MET 21175	Trudgen, M.E.	Lepidosperma	Cyperaceae
MET 21233	Trudgen, M.E.	Drosera macrantha	Droseraceae
MET 21232	Trudgen, M.E.	Drosera macrantha	Droseraceae
MET 21231	Trudgen, M.E.	Drosera macrantha	Droseraceae
MET 21197	Trudgen, M.E.	Astroloma serratifolium	Ericaceae
MET 21174	Trudgen, M.E.	Astroloma serratifolium	Ericaceae
MET 21228	Trudgen, M.E.	Acacia lasiocarpa var. sedifolia	Fabaceae
MET 21227	Trudgen, M.E.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
MET 21226	Trudgen, M.E.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
MET 21225	Trudgen, M.E.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
MET 21192	Trudgen, M.E.	Scaevola glandulifera	Goodeniaceae
MET 21222	Trudgen, M.E.	Haemodorum simulans	Haemodoraceae

MET 21235	Trudgen, M.E.	Orthrosanthus laxus var. gramineus	Iridaceae
MET 21196	Trudgen, M.E.	Quoya dilatata	Lamiaceae
MET 21195	Trudgen, M.E.	Quoya dilatata	Lamiaceae
MET 21185	Trudgen, M.E.	Calytrix depressa	Myrtaceae
MET 21184	Trudgen, M.E.	Calytrix sp. Coomberdale (as C. leschenaultii)	Myrtaceae
MET 21183	Trudgen, M.E.	Eucalyptus eudesmioides	Myrtaceae
MET 21182	Trudgen, M.E.	Calothamnus quadrifidus subsp. angustifolius [Moora to Watheroo form]	Myrtaceae
MET 21181	Trudgen, M.E.	Melaleuca calyptroides	Myrtaceae
MET 21180	Trudgen, M.E.	Verticordia chrysanthella	Myrtaceae
MET 21178	Trudgen, M.E.	Calothamnus quadrifidus subsp. angustifolius [Moora to Watheroo form]	Myrtaceae
MET 21206	Trudgen, M.E.	Ehrharta longiflora	Poaceae
MET 21205	Trudgen, M.E.	Brachypodium distachyon	Poaceae
MET 21204	Trudgen, M.E.	Amphipogon caricinus var. caricinus	Poaceae
MET 21203	Trudgen, M.E.	Amphipogon caricinus var. caricinus	Poaceae
MET 21224	Trudgen, M.E.	Comesperma integerrimum	Polygalaceae
MET 21223	Trudgen, M.E.	Comesperma integerrimum	Polygalaceae
MET 21173	Trudgen, M.E.	Isopogon divergens	Proteaceae
MET 21238	Trudgen, M.E.	Hakea incrassata	Proteaceae
MET 21211	Trudgen, M.E.	Lepidobolus chaetocephalus	Restionaceae
MET 21210	Trudgen, M.E.	Desmocladus asper	Restionaceae
MET 21194	Trudgen, M.E.	Opercularia vaginata	Rubiaceae
MET 21221	Trudgen, M.E.	Stylidium miniatum	Stylidiaceae
MET 21237	Trudgen, M.E.	Pimelea imbricata var. piligera	Thymelaeaceae
BM 113	Morgan, B.	Ursinia anthemoides subsp. anthemoides	Asteraceae
BM 130	Morgan, B.	Daucus glochidiatus	Apiaceae
BM 129	Morgan, B.	Xanthosia fruticulosa	Apiaceae
BM 128	Morgan, B.	Xanthosia fruticulosa	Apiaceae
BM 127	Morgan, B.	Trachymene ornata	Araliaceae
BM 70	Morgan, B.	Lomandra	Asparagaceae
BM 68	Morgan, B.	Dichopogon capillipes	Asparagaceae
BMor 67	Morgan, B.	Olearia sp. Eremicola (Diels & Pritzel s.n. PERTH 00449628)	Asteraceae
BMor 66	Morgan, B.	Lawrencella rosea	Asteraceae
BMor 65	Morgan, B.	Gilberta tenuifolia	Asteraceae
BMor 64	Morgan, B.	Gilberta tenuifolia	Asteraceae
BMor 63	Morgan, B.	Blennospora drummondii	Asteraceae
BM 116	Morgan, B.	Waitzia nitida	Asteraceae
BM 115	Morgan, B.	Waitzia nitida	Asteraceae
BM 114	Morgan, B.	Waitzia nitida	Asteraceae
BM 112	Morgan, B.	Podolepis lessonii	Asteraceae
BM 106	Morgan, B.	Wahlenbergia preissii	Campanulaceae
BM 40	Morgan, B.	Silene gallica var. gallica	Caryophyllaceae
BM 39	Morgan, B.	Petrorhagia dubia	Caryophyllaceae
BM 38	Morgan, B.	Petrorhagia dubia	Caryophyllaceae

BM 37	Morgan, B.	Petrorhagia dubia	Caryophyllaceae
BM 45	Morgan, B.	Allocasuarina campestris	Casuarinaceae
BM 44	Morgan, B.	Allocasuarina campestris	Casuarinaceae
BM 43	Morgan, B.	Allocasuarina campestris	Casuarinaceae
BM 42	Morgan, B.	Allocasuarina campestris	Casuarinaceae
BM 28	Morgan, B.	Tripterococcus brunonis	Celastraceae
BM 26	Morgan, B.	Tripterococcus brunonis	Celastraceae
BM 41	Morgan, B.	Crassula colorata var. acuminata	Crassulaceae
BM 80	Morgan, B.	Lepidosperma tenue	Cyperaceae
BM 79	Morgan, B.	Lepidosperma tenue	Cyperaceae
BM 78	Morgan, B.	Lepidosperma tenue	Cyperaceae
BM 77	Morgan, B.	Lepidosperma leptostachyum	Cyperaceae
BM 76	Morgan, B.	Lepidosperma leptostachyum	Cyperaceae
BM 75	Morgan, B.	Lepidosperma pubisquameum	Cyperaceae
BM 135	Morgan, B.	Lepidosperma scabrum	Cyperaceae
BM 32	Morgan, B.	Hibbertia subvaginata	Dilleniaceae
BM 58	Morgan, B.	Dioscorea hastifolia	Dioscoreaceae
BM 57	Morgan, B.	Dioscorea hastifolia	Dioscoreaceae
BM 56	Morgan, B.	Dioscorea hastifolia	Dioscoreaceae
BMor 54	Morgan, B.	Trifolium arvense var. arvense	Fabaceae
BMor 53	Morgan, B.	Trifolium arvense var. arvense	Fabaceae
BM 52	Morgan, B.	Daviesia hakeoides subsp. subnuda	Fabaceae
BM 50	Morgan, B.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
BM 50	Morgan, B.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
BM 49	Morgan, B.	Acacia stenoptera	Fabaceae
BM 48	Morgan, B.	Acacia stenoptera	Fabaceae
BM 143	Morgan, B.	Acacia hemiteles	Fabaceae
BM 142	Morgan, B.	Acacia daphnifolia	Fabaceae
BM 141	Morgan, B.	Daviesia hakeoides subsp. subnuda	Fabaceae
BM 109	Morgan, B.	Scaevola phlebopetala	Goodeniaceae
BM 108	Morgan, B.	Scaevola phlebopetala	Goodeniaceae
BM 107	Morgan, B.	Scaevola phlebopetala	Goodeniaceae
BMor 59	Morgan, B.	Haemodorum simulans	Haemodoraceae
BM 103	Morgan, B.	Quoya dilatata	Lamiaceae
BM 102	Morgan, B.	Quoya dilatata	Lamiaceae
BM 104	Morgan, B.	Parentucellia latifolia	Linderniaceae
BM 101	Morgan, B.	Phyllangium sulcatum	Loganiaceae
BM 100	Morgan, B.	Phyllangium sulcatum	Loganiaceae
BM 31	Morgan, B.	Thomasia grandiflora	Malvaceae
BM 30	Morgan, B.	Alyogyne sp. Hutt River (B.J.Lepschi & T.R.Lally 2310)	Malvaceae
s.n.	Morgan, B.	Calothamnus quadrifidus subsp. angustifolius [Moora to Watheroo form]	Myrtaceae
BM 126	Morgan, B.	Melaleuca calyptroides	Myrtaceae
BM 126	Morgan, B.	Melaleuca radula	Myrtaceae
BM 125	Morgan, B.	Melaleuca calyptroides	Myrtaceae
BM 124	Morgan, B.	Kunzea praestans	Myrtaceae

BM 123	Morgan, B.	Eucalyptus wandoo subsp. pulverea	Myrtaceae
BM 122	Morgan, B.	Calothamnus quadrifidus subsp. angustifolius [Moora to Watheroo form]	Myrtaceae
BM 120	Morgan, B.	Calytrix sp. Coomberdale (as C. leschenaultii)	Myrtaceae
BM 119	Morgan, B.	Calytrix sp. Coomberdale (as C. leschenaultii)	Myrtaceae
BM 118	Morgan, B.	Calytrix sp. Coomberdale (as C. leschenaultii)	Myrtaceae
BM 87	Morgan, B.	Bromus diandrus	Poaceae
BM 83	Morgan, B.	Neurachne alopecuroidea	Poaceae
BM 82	Morgan, B.	Neurachne alopecuroidea	Poaceae
BM 81	Morgan, B.	Neurachne alopecuroidea	Poaceae
BM 35	Morgan, B.	Aristida contorta	Poaceae
BM 34	Morgan, B.	Muehlenbeckia adpressa	Polygonaceae
BM 36	Morgan, B.	Hakea incrassata	Proteaceae
BM 35	Morgan, B.	Banksia fraseri	Proteaceae
BM 148	Morgan, B.	Banksia sphaerocarpa var. sphaerocarpa	Proteaceae
BM 74	Morgan, B.	Desmocladus asper	Restionaceae
BM 73	Morgan, B.	Desmocladus asper	Restionaceae
BM 72	Morgan, B.	Desmocladus asper	Restionaceae
BM 71	Morgan, B.	Lepidobolus chaetocephalus	Restionaceae
BM 105	Morgan, B.	Opercularia vaginata	Rubiaceae
BM 55	Morgan, B.	Boronia ramosa subsp. anethifolia	Rutaceae
BM 150	Morgan, B.	Santalum acuminatum	Santalaceae
BM 29	Morgan, B.	Dodonaea pinifolia	Sapindaceae
BM 62	Morgan, B.	Stylidium androsaceum	Stylidiaceae
BM 61	Morgan, B.	Stylidium caricifolium	Stylidiaceae
BM 60	Morgan, B.	Stylidium caricifolium	Stylidiaceae
BM 33	Morgan, B.	Pimelea imbricata var. piligera	Thymelaeaceae
MJH 70	Henson, M	Acacia hemiteles	Fabaceae
MJH 16	Henson, M	Acacia lasiocarpa var. sedifolia	Fabaceae
MJH 53	Henson, M.	Xanthosia fruticulosa	Apiaceae
MJH 52	Henson, M.	Trachymene pilosa	Araliaceae
MJH 25	Henson, M.	Thysanotus manglesianus	Asparagaceae
MJH 42	Henson, M.	Podolepis lessonii	Asteraceae
MJH 41	Henson, M.	Podolepis gracilis	Asteraceae
MJH 24	Henson, M.	Blennospora drummondii	Asteraceae
MJH 11	Henson, M.	Petrorhagia dubia	Caryophyllaceae
MJH 6	Henson, M.	Tripterococcus brunonis	Celastraceae
MJH 28	Henson, M.	Centrolepis pilosa	Centrolepidaceae
MJH 29	Henson, M.	Lepidosperma tenue	Cyperaceae
MJH 14	Henson, M.	Drosera macrantha	Droseraceae
MJH 13	Henson, M.	Drosera macrantha	Droseraceae
MJH 64	Henson, M.	Leucopogon sp. Northern Scarp (M.Hislop 2233)	Ericaceae
MJH 72	Henson, M.	Acacia erinacea	Fabaceae
MJH 71	Henson, M.	Acacia hemiteles	Fabaceae

MJH 68	Henson, M.	Acacia scirpifolia	Fabaceae
MJH 67	Henson, M.	Isotropis drummondii	Fabaceae
MJH 2-28	Henson, M.	Bossiaea sp. Cairn Hill (M.Henson MJH 2-28)	Fabaceae
MJH 20	Henson, M.	Trifolium repens var. repens	Fabaceae
MJH 19	Henson, M.	Gastrolobium acutum	Fabaceae
MJH 18	Henson, M.	Gastrolobium acutum	Fabaceae
MJH 60	Henson, M.	Scaevola glandulifera	Goodeniaceae
MJH 22	Henson, M.	Haemodorum simulans	Haemodoraceae
MJH 54	Henson, M.	Glischrocaryon flavescens	Haloragaceae
MJH 26	Henson, M.	Stypandra glauca	Hemerocallidaceae
MJH 12	Henson, M.	Cassytha pomiformis	Lauraceae
MJH 10	Henson, M.	Thomasia grandiflora	Malvaceae
MJH 51	Henson, M.	Melaleuca calyptroides	Myrtaceae
MJH 50	Henson, M.	Kunzea praestans	Myrtaceae
MJH 49	Henson, M.	Kunzea praestans	Myrtaceae
MJH 48	Henson, M.	Eucalyptus loxophleba subsp. loxophleba	Myrtaceae
MJH 47	Henson, M.	Calothamnus quadrifidus subsp. angustifolius (Moora to Watheroo form)	Myrtaceae
MJH 46	Henson, M.	Eucalyptus eudesmioides	Myrtaceae
MJH 45	Henson, M.	Calytrix sp. Coomberdale (as C. leschenaultii)	Myrtaceae
MJH 0004	Henson, M.	Melaleuca calyptroides	Myrtaceae
MJH 35	Henson, M.	Aristida contorta	Poaceae
MJH 34	Henson, M.	Ehrharta longiflora	Poaceae
MJH 40	Henson, M.	Lysimachia arvensis	Primulaceae
MJH 75	Henson, M.	Grevillea biternata	Proteaceae
MJH 39	Henson, M.	Cheilanthes distans	Pteridaceae
MJH 9	Henson, M.	Trymalium ledifolium var. rosmarinifolium	Rhamnaceae
MJH 8	Henson, M.	Cryptandra myriantha	Rhamnaceae
MJH 7	Henson, M.	Cryptandra myriantha	Rhamnaceae
MJH 65	Henson, M.	Boronia ramosa subsp. anethifolia	Rutaceae
MJH 21	Henson, M.	Boronia ramosa subsp. anethifolia	Rutaceae
MJH 79	Henson, M.	Dodonaea inaequifolia	Sapindaceae
MJH 23	Henson, M.	Stylidium caricifolium	Stylidiaceae
MJH 58	Henson, M.	Ustilago tepperi	Ustilaginaceae

APPENDIX 3: Condition scale of Trudgen (1988)

E = Excellent. Pristine or nearly so, no obvious signs of damage caused by the activities of European man.

VG = Very good. Some relatively slight signs of damage caused by the activities of European man. E.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* spp., or occasional vehicle tracks.

G = Good. More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.

P = Poor. Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* spp.

VP = Very poor. Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.

D = Completely degraded. Areas that are completely or almost completely without native species in the structure of their vegetation. I.e. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX 4: Flora list for the area of the Coomberdale Chert TEC surveyed by Trudgen *et al.* (2012) with occurrences North of Kiaka Road and in proposed North Kiaka Mine area

Notes: The abbreviations in the top of the top row are those used in Trudgen *et al.* (2012), they are followed by the number of quadrats recorded in the relevant sub-area, note that releves were also recorded. The right hand column has records from areas of vegetation that were mapped, but did not have quadrats located in them (usually because they are small areas, or are degraded). An asterix in the third column indicates an introduced or alien (weed) species. Specimens not identifiable due to poor material are recorded as "sp." have been included in the list, but not counted for the number of species recorded, these records are shown in grey text (i.e. grey). Records at quadrats are indicated by a "q" and at releves by an "r". Specimens collected opportunistically (rather than at a quadrat or releve) are indicated by an "o" (these are not all indicated). The Australasian Virtual Herbarium has some systematic error types, including that old specimens in eastern states herbaria are often mis-determined or have vague/incorrect localities (such as records plotted near Perth that are from further inland). Distribution comments in the table attempt to take these types of errors into account. Species that are new records from the current survey for the TEC are highlighted in pale green in the name column. Conservation taxa are highlighted light blue in the name column. Species that should be considered for priority or declared rare flora species status are highlighted light orange. Wsd = Widespread

Higher group or plant family	**NAME**	**Weed ***	**North of Kiaka Road**	**North Kiaka Mine areas**	**John Tonkin Property JT (12)**	**A & R Tonkin property ART (11)**	**Distribution, conservation status, comments Notes: green highlight in name column indicates a new record for the TEC and grey highlight indicates a conservation taxon. Wsd = widespread.**	**Cairn Hill Reserve CAH (20)**	**Cairn Hill North CHN (10)**	**Current mine [= E Ore Body] EOR (3)**	**Eastern Ridge ERG (23)**	**Gardin-er's Hill GH (10)**	**Waste Dump Area WDM (3)**	**Western Ridge WOR (6)**	**Other areas survey-ed**
FERNS															
Adiantaceae	Cheilanthes adiantoides		Recorded	Recorded	11q, 15r	4q	Wsd in WA W of Ravensthorpe, N of Perth to Shark B & some outlying records.	17q, 37r	9q, 21r	3q	23q, 40r	8q, 21r	3q, 1r	6q, 1r	32r
Adiantaceae	Cheilanthes austrotenuifolia		Recorded	Recorded		5q, 1o	Wsd in SW WA, some outlying records, disjunct to SA, NSW, Vict. & Tas.								
Adiantaceae	Cheilanthes distans		Recorded	Recorded	1q	3q, 3r	Wsd in SW, Eastern States & NZ!	1q		1q					
Aspleniaceae	Pleurosorus rutifolius		Recorded	Recorded	1q		Wsd in Aust. S of tropics			1q	2q	1q			
Ophioglossaceae	Ophioglossum lusitanicum		Recorded	Recorded	o		Wsd in Aust. mainly S of tropics with some disjunctions. Also in NZ.								
PINES															
Cupressaceae	Actinostrobus arenarius		Recorded	Recorded	1q		Small population (six plants) on the Chert at quadrat JT010. One dead tree seen nearby. Griffin record from North Cairn Hill, not refound during surveys. Population apparently in decline.								
ANGIOSPERMS Monocotyledons															
Poaceae	Aira caryophyllea	*	Recorded	Recorded	5q			10q			5q	1q			
Poaceae	Amphipogon caricinus var. caricinus						Wsd in Aust. S of tropics.	5q, 2r	1r		4q	1q, 3r		2q	
Poaceae	Aristida contorta						Occurs over most of Aust.	1q					1q	1q	
Poaceae	Austrostipa compressa						Coastal from Geraldton area to Perth, then scattered in far SW. TEC record small inland range extension.		8q						
Poaceae	Austrostipa elegantissima		Recorded	Recorded	2q	1q, 1r,	Wsd in SW WA & nearby Eremaean, also SA, NSW & Vict.	8q, 5r	2q	1q	8q	6q, 5r	2q	2q	2r
Poaceae	Austrostipa eremophila						Wsd in southern Aust.	1r							
Poaceae	Austrostipa exilis						Sporadic in SW WA, also in SA, Vict.	2r							
Poaceae	Austrostipa hemipogon		Recorded		1q	1q	Wsd in SW WA, also SA, Vict, 1 record Tas.				1q	2q	1q	3q	
Poaceae	Austrostipa macalpinei						Common in a band from N of Geraldton to Perth, disjunct to S coast & disjunct to SA & Vict.					2q			
Poaceae	Austrostipa mollis						Wsd in SW WA, disjunct to SE Aust. & Tas.				1r				1r
Poaceae	Austrostipa nitida		Recorded	Recorded	5q		Wsd in southern Aust.	2q			4q, 3r	2q			3r
Poaceae	Austrostipa scabra		Recorded		1q		Wsd in southern Aust. & Tas.	3q				4q			1r
Poaceae	Austrostipa sp.		Recorded		1q, 2r			1q	1q		1q				
Poaceae	Austrostipa sp. Cairn Hill (M.E. Trudgen 21176)						Priority 3 species. Sporadic from Geraldton area to Perth & E of Perth.	1q							
Poaceae	Austrostipa tenuifolia						Wsd in SW WA & nearby Eremaean, also near coastal SA & 2 records in Vict.			1q	1q		1q		
Poaceae	Austrostipa trichophylla		Recorded	Recorded	1q	8q, 1r	Wsd in SW WA & nearby Eremaean, also NT, SA, NSW & Vict., 1 record in Q.	8q	5q	1q	12q	3q, 2r	2q	5q	
Poaceae	Austrostipa variabilis		Recorded	Recorded	3q, 2r		Wsd in SW WA & nearby Eremaean, few records in SA, NSW.	4q		1q	3q	6q		1q	
Poaceae	Avena barbata	*	Recorded	Recorded	11q, 20r	9q, 7r		8q	5q	3q	23q, 17r	9q, 10r	2q	6q	67r
Poaceae	Brachypodium distachyon	*	Recorded			3q									
Poaceae	Briza maxima	*	Recorded	Recorded	12q, 6r	7q		10q	8q	3q	23q, 8r	8q, 35r	3q	6q	17r
Poaceae	Bromus diandrus	*	Recorded	Recorded	9q, 2r	5q, 1o		3q	2q	3q	12q, 5r	4q, 1r	1q	5q	9r
	Bromus madritensis	*	Recorded	Recorded											

Higher group or plant family	NAME	Weed *	North of Kiaka Road	North Kiaka Mine areas	John Tonkin Property JT (12)	A & R Tonkin property ART (11)	Distribution, conservation status, comments Notes: green highlight in name column indicates a new record for the TEC and grey highlight indicates a conservation taxon. Wsd = widespread.	Cairn Hill Reserve CAH (20)	Cairn Hill North CHN (10)	Current mine [= E Ore Body] EOR (3)	Eastern Ridge ERG (23)	Gardin-er's Hill GH (10)	Waste Dump Area WDM (3)	Western Ridge WOR (6)	Other areas survey-ed
Poaceae	Cynosurus echinatus	*	Recorded			1q, 1r									
Poaceae	Ehrharta brevifolia var. cuspidata	*	Recorded	Recorded		1q									
Poaceae	Ehrharta calycina	*													2r
Poaceae	Ehrharta longiflora	*	Recorded	Recorded	9q, 5r	10q, 3r		12q	6q	3q	19q,6r	7q, 5r	1q	6q	1q,25r
Poaceae	Eriachne ovata						Wsd in WA W of Esperance, disjunct to SA, NT & Q.	1q							
Poaceae	Hordeum leporinum	*	Recorded	Recorded		1q									
Poaceae	Lamarckia aurea	*	Recorded	Recorded		1q									
Poaceae	Lolium perenne	*	Recorded	Recorded	1q	2q		1q				1q			1r
Poaceae	Neurachne alopecuroidea		Recorded	Recorded	12q, 10r	7q, 4r	Wsd in SW WA disjunct to SA & Vict.	16q, 55r	10q, 34r	2q, 1r	20q, 38r	10q, 33r	3q, 2r	6q, 1r	1q, 21r
Poaceae	Pentaschistis airoides	*	Recorded	Recorded		8q, 1r		3q	7q	3q	15q		3q	5q	2r
Poaceae	Pentaschistis pallida	*	Recorded	Recorded	7q, 6r			1q			3q	7q, 6r		1q	11r
Poaceae	*Pentaschistis sp.	*				2q					1q	1q			
Poaceae	Pentaschistis sp. Moora (doubtful ID)	*	Recorded		3q		This was a field/interim ID, not meant to be a phrase name. Probably = Lamarkia aurea.	1q			2q				
Poaceae	Rytidosperma acerosum		Recorded	Recorded	3q	2q	Wsd in SW WA. But not common..	4q,2r			2q, 4r	4q, 1r	2q	4q	1r
Poaceae	Rytidosperma caespitosum		Recorded			1q, 1o	Wsd in SW WA, continuous to SA, Vict, NSW & Tas. Also NZ.	5q	1q		8q, 7r	3q, 3r		1q	4r
Poaceae	Rytidosperma setaceum		Recorded	Recorded	2q, 1r		Wsd in S Aust. TEC population somewhat isolated..	7q, 3r	7q	3q	10q, 4r	3q, 1r	1q	4q	2r
Poaceae	Rytidosperma sp.		Recorded		1q	1r,		1q				2q			7r
Poaceae	Schismus barbatus	*	Recorded	Recorded		1q 1o									
Poaceae	Vulpia myuros	*	Recorded	Recorded	11q, 7r	11q, 3r		17q, 1r	8q	2q	5q	9q, 3r	3q	5q	
Cyperaceae	Gahnia drummondii						Moderate distribution in SW W.A.								1r
Cyperaceae	Lepidosperma aff. leptostachyum (Moora: ERG18-7)		Recorded		1q		Probably a restricted species. The genus is in need of detailed revision.	5q	1q		4q	5q		1q	
Cyperaceae	Lepidosperma costale						Wsd in SW WA W of Ravensthorpe.	4q, 1r			2q	1q, 2r			
Cyperaceae	Lepidosperma leptostachyum						Wsd in SW WA S of Gingin. The Moora area records are disjunct from the main population. The TEC records are on unusual habitat. Three other records from surrounding areas are on different soils, or are very old collections with poor localisation. Genus needs revision.	4q, 14r	4r	2q	13q, 3r	2q, 1r	1q	4q	5r
Cyperaceae	Lepidosperma pubisquameum		Recorded			1o	Moderately Wsd in SW WA S of Lancelin. The TEC records are part of a disjunct population that extends to near Coorow (3 records on The AVH).		1r		1q	1r			
Cyperaceae	Lepidosperma sp.		Recorded	Recorded	2r			1q	1q, 1r		1q	1r	1q		
Cyperaceae	Lepidosperma sp. P1 small head (M.D. Tindale 166A)						Moderately Wsd in SW WA south of Cervantes, 6 records N of there.	2r							
Cyperaceae	Lepidosperma tenue		Recorded	Recorded	3r	1q, 1r	Wsd in SW WA.	8q, 10r	1q, 4r		5q, 35r	8r	1r	2q, 1r	7r
Cyperaceae	Schoenus brevisetis						Wsd in SW WA.	1q, 4r	1q						
Cyperaceae	Schoenus clandestinus		Recorded	Recorded	5q, 8r	1o	Wsd from Mandurah to S of Shark B.	4q, 13r	1q, 9r		3q, 7r	28r	2q, 1r	1q, 1r	
Cyperaceae	Schoenus nanus						Wsd in SW WA, disjunct to SA & Vict.	1r	1q						
Cyperaceae	Schoenus pleiostemoneus						Moderately Wsd in SW WA.	1q						1q	
Restionaceae	Desmocladus asper		Recorded	Recorded	11q, 24r	8q, 2r, 1o	Wsd in SW WA W of Ravensthorpe. (TEC material referred to D. flexuosus in earlier reports)	14q, 39r	7q, 15r	1q, 1r	5q, 10r	9q, 19r	2q, 1r	4q, 1r	17r
Restionaceae	Desmocladus flexuosus						See Desmocladus asper.								
Restionaceae	Lepidobolus chaetocephalus		Recorded	Recorded	2r		Moderately Wsd in SW WA.	4q, 8r	1q, 1r			4r	1q		
Centrolepidaceae	Centrolepis drummondiana						Wsd in SW WA mainly near the coast. TEC population shortly disjunct.	2q	1q						
Centrolepidaceae	Centrolepis pilosa						Wsd in SW WA W of Bremer Bay. TEC population shortly disjunct.	1q		1q			1q		
Centrolepidaceae	Centrolepis sp.								1q						
Dasypogonaceae	Lomandra sp. (Moora		Recorded		2q	2q	May be the same as *Lomandra micrantha*.	1q			4q	1q			

Higher group or plant family	NAME	Wed *	North of Kiaka Road	North Kiaka Mine areas	John Tonkin Property JT (12)	A & R Tonkin property ART (11)	Distribution, conservation status, comments Notes: green highlight in name column indicates a new record for the TEC and grey highlight indicates a conservation taxon. Wsd = widespread.	Cairn Hill Reserve CAH (20)	Cairn Hill North CHN (10)	Current mine [= E Ore Body] EOR (3)	Eastern Ridge ERG (23)	Gardin-er's Hill GH (10)	Waste Dump Area WDM (3)	Western Ridge WOR (6)	Other areas survey-ed
	twisty)														
Dasypogonaceae	Lomandra aff. micrantha subsp. micrantha		Recorded	Recorded		1q	Wsd in SW W.A. also in eastern states.	3q			3q	1q	1q		
Dasypogonaceae	Lomandra effusa		Recorded	Recorded			Wsd in SW & SE Aust.	1q, 5r	1q			3q, 5r			1r
Dasypogonaceae	Lomandra sp.							1q							1r
Xanthorrhoeaceae	Xanthorrhoea sp. Coomberdale (MET 25047)		Recorded	Recorded	10q, 15r	7q, 4r	Geographically restricted. Population declining significantly. Referred to X. drummondii in earlier reports.	16q, 39r	9q, 22r	2q, 1r	10q, 27r	8q, 20r	3q	6q, 1r	1q
Phormiaceae	Dianella revoluta var. divaricata		Recorded			1o	Wsd in southern WA and in SA.	6q, 2r	3q, 1r		2r	3q, 2r	2q	3q	
Phormiaceae	Stypandra glauca		Recorded	Recorded	4q, 2r	5q, 2r	Common in SW WA, NSW and Vict, few records in SA.	12q, 39r	5q, 15r	3q	17q, 19r	3q, 5r	2q, 1r	5q	
Anthericaceae	Agrostocrinum scabrum subsp. scabrum		Recorded			1q	Has clusters of occurrence in the SW of WA that suggest variation. Needs review. TEC material atypical.	1q				2q			
Anthericaceae	Caesia alfordii [MS]						Now referred to Caesia sp. Wongan (K.F. Kenneally 8820)								
Anthericaceae	Dichopogon preissii.		Recorded	Recorded	5q		Called *Caesia* sp. Moora & *Caesia* (Moora hairy stem) in Trudgen *et al.* (2012). Common in proposed mine area.	4q	1q		1q			1q	
Anthericaceae	Caesia sp. Wongan (K.F. Kenneally 8820)		Recorded		1q		This species (complex?) has disjunct southern and norther populations, the TEC population is a small range extension for the southern population. It is also disjunct. Called *Caesia alfordii* [MS] in earlier reports.	1q, 1r			5q	2q			
Anthericaceae	Chamaescilla versicolor		Recorded	Recorded	11q, 4r		Patchy distribution from Geraldton area to east of Perth. Specimens referred to *C. corymbosa* in earlier reports.	15q, 13r	9q, 10r	1q, 1r	22q, 15r	10q, 4r	3q	6q	7r
Anthericaceae	Dichopogon capillipes		Recorded	Recorded	9q, 2r	7q, 1r	Has a moderate distribution in the west of SW W.A. with some disjunctions.	17q, 42r	7q, 16r	3q	22q, 28r	10q, 10r	3q, 1r	6q	1q,22r
Anthericaceae	Laxmannia omnifertilis						On NE edge of range.	1q							
Anthericaceae	Laxmannia ramosa subsp. ramosa		Recorded	Recorded	2q	1q	Small disjunction within range.								
Anthericaceae	Sowerbaea laxiflora						Wsd in SW W.A, but with disjunctions, the TEC population is at the N end of the main area. Needs revision.		1q		5q, 1r	5q			
Anthericaceae	Thysanotus dichotomus		Recorded			1o	Wsd in SW W.A, but with disjunctions. TEC population part of a small disjunct group of records. Needs revision.	1q			2q, 3r	1q, 1r			1o
Anthericaceae	Thysanotus manglesianus		Recorded	Recorded	11q	3q, 1r	Wsd, common in W.A. west of Kalgoorlie and south of Pilbara.	18q, 5r	9q, 9r	3q	20q, 2r	8q, 1r	3q	4q	
Anthericaceae	Thysanotus multiflorus		Recorded		1q		Disjunct population, needs taxonomic study.	1q							
Anthericaceae	Thysanotus patersonii						Wsd, common in SW W.A. disjunct to eastern states.				1q				
Anthericaceae	Thysanotus sp.							1q			1q				
Anthericaceae	Tricoryne arenicola (MS)						See Tricoryne sp. Wongan Hills (B.H. Smith 794)								
Anthericaceae	Tricoryne sp. Wongan Hills (B.H. Smith 794)						Priority 2 species [Referred to Tricoryne arenicola (MS) previously.] Sporadic, moderate distribution in SW W.A.	1q	1q, 3r				1q		
Anthericaceae	Tricoryne elatior		Recorded			2o	Wsd in SW WA, E Aust., also CA Kimb., & northern NT. Needs revision.		3q, 2r		3q, 2r	1q			
Colchicaceae	Burchardia bairdiae [Probably B. congesta.]						Determination unlikely on habitat grounds. One collection from the Eastern Ridge [specimen not refound in 2016].				1q				
Colchicaceae	Burchardia congesta (syn. = B. umbellata)		Recorded	Recorded	7q, 1r	2q	TEC population at the edge of the main population, small disjunction, unusual habitat.	15q, 21r	9q, 8r	3q, 1r	18q, 16r	8q, 6r	1q	6q	3r
Colchicaceae	Wurmbea drummondii		Recorded	Recorded	2q		Previously P4, moderately Wsd in SW WA.								
Boryaceae	Borya laciniata		Recorded			3q, 1o	Genus needs review.	1q	1q						
Boryaceae	Borya sphaerocephala		Recorded	Recorded	7q, 1r	1r,	Genus needs review.	10q, 29r	5q, 15r	1r	7q, 19r	76q, 35r	3q, 1r	1q	15r
Haemodoraceae	Conostylis androstemma						TEC population has short disjunction from main population.	1q							
Haemodoraceae	Haemodorum paniculatum		Recorded	Recorded	1q		Sporadic from Green Head to forests E of Bunbury, one record near Geraldton. TEC population outlying.	2q	1q				1q		
Haemodoraceae	Haemodorum simulans		Recorded	Recorded	2q	1o	Occurs in a band from S of Shark B to N of Albany.	4q	2q				1q	1q	1r
Hypoxidaceae	Pauridia aff. glabella						See Pauridia aff. occidentalis var. occidentalis	1q							
Hypoxidaceae	Pauridia glabella var.		Recorded			1q	Genus needs review in W.A.	3q	1q			3q	1q		

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	leptantha														
Hypoxidaceae	Pauridia aff. occidentalis var. occidentalis		Recorded	Recorded	4q		Genus needs review in W.A. Appears to be undescribed, but the taxonomy of the group needs significant work.	1q	4q	1q	20q	6q	3q	1q	
Hypoxidaceae	Pauridia sp.		Recorded		1q										1q
Dioscoreaceae	Dioscorea hastifolia		Recorded	Recorded	4q, 3r	9q, 4r	Occurs in a band parallel to the coast from Shark B to south of Perth.	15q 19r	7q, 5r	3q	23q, 24r	7q, 4r	2q	6q	1q, 8r
Iridaceae	Moraea setifolia	*	Recorded	Recorded		1q, 1o									
Iridaceae	Orthrosanthus laxus var. gramineus						Occurs in a band fromS of Geraldton to S of Perth. Species needs review.	1r,1q				4q, 2r		2q	
Iridaceae	Romulea rosea	*	Recorded	Recorded	1q				1q	2q	7q		3q	2q	
Orchidaceae	Caladenia denticulata ssp. rubella		Recorded	Recorded	6q		Moderately Wsd, but records sporadic.			1q	9q		2q	1q	
Orchidaceae	Caladenia flaccida subsp. flaccida						Mis-applied name, see Caladenia paradoxa (Florabase 8/2017).	1q					1q		
Orchidaceae	Caladenia flava subsp. flava		Recorded	Recorded	9q	3q	Wsd in SW W.A. Common in the Coomberdale Chert TEC.	9q	9q	3q	17q	9q	1q	4q	
Orchidaceae	Caladenia paradoxa						Moderately Wsd, outlying record.	1q					1q		
Orchidaceae	Caladenia sp.								3r						
Orchidaceae	Caladenia vulgata		Recorded			1q	Very Wsd in SW W.A.				1q	1q			
Orchidaceae	Cyanicula gemmata		Recorded		4q		Very Wsd in SW W.A.		1q		1q				
Orchidaceae	Cyrtostylis huegelii						Moderately Wsd in SW W.A. but sporadic occurrence north of Perth.	1q		1q	1q				
Orchidaceae	Diuris aff. recurva						See Diuris recurva.								
Orchidaceae	Diuris brumalis		Recorded	Recorded	o		Moderate distribution from the Eneabba area to east of Bunbury.								
Orchidaceae	Diuris aff. recurva						See Diuris recurva.								
Orchidaceae	Diuris recurva		Recorded	Recorded	3q		A priority 4 species. Moderate distribution, but of disjunct small areas and a few outlying records. Called *Diuris* aff. *recurva* in earlier reports.	5q	6q		6q	5q	1q	1q	
Orchidaceae	Diuris tinkeri		Recorded	Recorded	o		Fairly small distribution from north of Kalbarri to north of Perth. TEC records a small range extension to the east.								
Orchidaceae	Elythranthera brunonis		Recorded	Recorded	1q		Moderately Wsd in SW W.A.		1q					2q	
Orchidaceae	Eriochilus dilatatus subsp. undulatus		Recorded	Recorded			Wsd in SW W.A. One plant seen in North Kiaka Mine area.	1q		1q	2q		3q	1q	
Orchidaceae	Eriochilus helonomos		Recorded				Moderate distribution in SW W.A. but not common north of Perth.	7q	4q		1q	4q			
Orchidaceae	Leporella fimbriata						Fairly Wsd in SW W.A.	1q	1q			2q	1q		
Orchidaceae	Paracaleana hortiorum		Recorded		1q		Specimen not refound. Would be a long range extension. Not recorded during 2016 field work. On geography possibly *P. nigrita*.								
Orchidaceae	Pheladenia deformis		Recorded	Recorded	10q		Very Wsd in SW W.A. with a large disjunction to the eastern states.	3q	9q	3q	17q	8q	3q	1q	
Orchidaceae	Prasophyllum gracile						Very Wsd in SW W.A. extending into adjacent Eremaean.				1q	1q			
Orchidaceae	Pterostylis aff. nana								2q		1q				
Orchidaceae	Pterostylis aff. rufa						See Pterostylis exserta.	1q				1q			
Orchidaceae	Pterostylis exserta		Recorded		1q										
Orchidaceae	Pterostylis recurva		Recorded		1q			6q	2q	1q				1q	
Orchidaceae	Pterostylis sanguinea		Recorded	Recorded	4q			12q		2q	9q	8q	2q	1q	
Orchidaceae	Pterostylis sargentii											1q			
Orchidaceae	Pterostylis scabra							3q		1q	1q				
Orchidaceae	Pterostylis setulosa		Recorded	Recorded	2q			5q	8q	3q	7q	1q	2q		
Orchidaceae	Pterostylis sp.		Recorded		2q			1q, 2r	1q		1q				
Orchidaceae	Pterostylis spathulata		Recorded			1o		1q							
Orchidaceae	Pterostylis vittata								1q					2q	
ANGIOSPERMS Dicotyledons															

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Casuarinaceae	Allocasuarina campestris		Recorded	Recorded	8q, 18r	3q, 6r	Wsd.	15q, 62r	9q, 33r	2q, 1r	17q, 40r	1q, 22r	3q, 1r	4q, 1r	40r
Casuarinaceae	Allocasuarina huegeliana		Recorded	Recorded	8q, 25r	6q, 6r	Wsd.	10q, 51r	7q, 29r	3q, 1r	19q, 48r	9q, 26r	2q, 1r	3q, 1r	59r
Casuarinaceae	Allocasuarina humilis		Recorded			2q	Wsd.	1q, 5r							
Casuarinaceae	Allocasuarina microstachya						Wsd.					1r			
Casuarinaceae	Casuarina obesa		Recorded			3r	Wsd.								3r
Urticaceae	Parietaria debilis						Wsd.	2q							
Proteaceae	Banksia prionotes														2r
Proteaceae	Banksia sphaerocarpa var. sphaerocarpa/caesia		Recorded	Recorded		1r, 1o	The material needs expert determination, it may represent a new taxon, a range extension of var. caesia (but atypical) or atypical var. sphaerocarpa. The species has five varieties and needs revision.								1r
Proteaceae	Dryandra fraseri var. fraseri		Recorded	Recorded	1q	1o	Wsd	1q, 5r				1q, 3r			1o
Proteaceae	Dryandra nivea ssp. nivea						Wsd in SW W.A.								1r
Proteaceae	Dryandra sessilis var. *flabellifolia*		Recorded	Recorded	6q, 19r	2q, 1r	Wsd [A complex?]	5q, 17r	3q, 14r	1r	4q, 2r	6q, 9r	1q	5q, 1r	33r
Proteaceae	Grevillea amplexans subsp. semivestita						Priority 2 taxon.								2r
Proteaceae	Grevillea biternata						Wsd				1q				1o
Proteaceae	Hakea incrassata						Wsd	4q, 6r							
Proteaceae	Hakea lissocarpha		Recorded	Recorded			Wsd.	5r	1r		4r	3r			1r
Proteaceae	Hakea preissii		Recorded			1r	Wsd.								
Proteaceae	Hakea recurva subsp. recurva		Recorded			1o	Wsd.		1r			7r			1r, 1o
Proteaceae	Isopogon divergens		Recorded		1r		Wsd	7q, 7r	1q			2q, 3r			1o
Proteaceae	Petrophile brevifolia						Material atypical. The distribution of this Wsd suggests more than 1 taxon..								1r
Proteaceae	Synaphea quartzitica						Declared rare flora. Very restricted. Known for TEC, but not in the North Kiaka Mine area.								
Santalaceae	Leptomeria preissiana						Wsd . Distribution suggests variation	1r							
Santalaceae	Santalum acuminatum		Recorded			4o	Extremely Wsd	1q, 2r	1r						1o
Santalaceae	Santalum spicatum		Recorded			1o	Very Wsd				1q				
Loranthaceae	Amyema miraculosa subsp. miraculosa		Recorded			1r, 1o	Wsd				1q				
Loranthaceae	Amyema preissii		Recorded	Recorded		2q, 1r, 1o	Extremely Wsd				2q, 1o				1o
Loranthaceae	Lysiana casuarinae						Wsd				1q				
Loranthaceae	Nuytsia floribunda		Recorded	Recorded	1q, 1r	2q, 1r	Wsd	5r	2q			2r		1q	6r
Polygonaceae	Emex australis	*	Recorded	Recorded		1q									
Polygonaceae	Muehlenbeckia adpressa		Recorded	Recorded	1q		Very Wsd			1q	1q				
Chenopodiaceae	Atriplex suberecta		Recorded	Recorded		1q, 1r	Very scattered records in WA, but very Wsd					1r			
Chenopodiaceae	Dysphania melanocarpa forma melanocarpa		Recorded	Recorded		1q	Very Wsd. The record is a small range extension.								
Chenopodiaceae	Enchylaena tomentosa var. tomentosa		Recorded	Recorded		2q	Extremely Wsd, on the SW edge of distribution.	1r							
Chenopodiaceae	Maireana brevifolia		Recorded			1r	Wsd in WA, disjunct to ES					1r			
Chenopodiaceae	Maireana enchylaenoides						Moderate distribution in WA; disjunct to ES Small range extension.					2r			
Chenopodiaceae	Maireana marginata		Recorded	Recorded		1q	Moderate to large distribution in WA	2q				2r			
Chenopodiaceae	Rhagodia drummondii						Large distribution in WA S of Shark B, just into SA.	3q, 1r							
Chenopodiaceae	Rhagodia preissii subsp. preissii						Wsd WA & SA	2q, 1r	1q						
Chenopodiaceae	Salsola australis	?	Recorded	Recorded	o	o	At edge of remnant. Probably weedy.								

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Amaranthaceae	Ptilotus declinatus		Recorded			1o	Moderate distribution in WA	2r							
Amaranthaceae	Ptilotus divaricatus var. divaricatus						Large distribution in WA	2q, 1r	2r			2r			1o
Amaranthaceae	Ptilotus drummondii var. drummondii		Recorded			1q, 2o	Large distribution in WA	2r	1r			1r			
Amaranthaceae	Ptilotus gaudichaudii ssp. gaudichaudii		Recorded			1q	Wsd across Australia, except tropics and southern ES.				1q				
Amaranthaceae	Ptilotus holosericeus						Moderate to large distribution in WA.		1q						
Amaranthaceae	Ptilotus manglesii						Moderate to large distribution in WA.	1r							
Amaranthaceae	Ptilotus polystachyus var. polystachyus		Recorded	Recorded	1q	1q, 1r	Extremely Wsd, all mainland states.	1r			1q, 2r			1q	
Amaranthaceae	Ptilotus spathulatus forma spathulatus		Recorded	Recorded		1q, 1r	Moderate to large distribution in WA.		1q			1q			
Nyctaginaceae	Boerhavia coccinea		Recorded			1o	Extremely Wsd, all mainland states. A complex.								
Gyrostemonaceae	Gyrostemon ramulosus						Very Wsd, WA, SA, NT & Q.								1o
Portulacaceae	Calandrinia calyptrata		Recorded	Recorded	3q	5q, 1o	Wsd, WA to NSW, but disjunct in WA.	4q			5q	5q			
Portulacaceae	Calandrinia eremaea		Recorded	Recorded	1q		Extremely Wsd, all mainland states & Tasmania.	1q	1q						
Portulacaceae	Calandrinia remota		Recorded			1q	Fairly large distribution in WA, disjunction to NT & SA, another to Q.		1q						
Portulacaceae	Calandrinia sp. (inadequate material or not collected)							5q, 1r	4q	1q	8q	2q, 3r	1q	1q	1r
Portulacaceae	Calandrinia sp. Blackberry (D.M. Porter 171)		Recorded		1q		Moderate distribution in WA, scattered records.								
Caryophyllaceae	Petrorhagia dubia	*	Recorded	Recorded	8q	3q, 1r,			1q		10q	1q	1q	1q	
Caryophyllaceae	Petrorhagia prolifera	*	Recorded			6q									
Caryophyllaceae	Polycarpon tetraphyllum	*	Recorded	Recorded		1q									
Caryophyllaceae	Silene gallica var. gallica	*	Recorded	Recorded	9q	5q			3q		5q	4q		1q	1q
Caryophyllaceae	Spergula arvensis	*												1q	
Lauraceae	Cassytha pomiformis		Recorded			1o		3q	1q			1q, 1r			
Brassicaceae	Brassica barrelieri subsp. oxyrrhina	*	Recorded		1q						1q				
Brassicaceae	Lepidium rotundum						Wsd in southern WA, extends to SA.	1r							
Droseraceae	Drosera aff. macrantha		Recorded	Recorded	6q	4q	Fairly Wsd?	13q	5q	2q	3q	6q	2q	6q	
Droseraceae	Drosera erythrorhiza subsp. magna		Recorded		3q	1q	Restricted distribution from near Eneabba to Perth area.	7q	4q		+	6q	2q		
Droseraceae	Drosera macrantha subsp. macrantha		Recorded	Recorded	7q		Large distribution in SW WA, disjunct to SA & Vict.	10q	4q	1q	20q	9q	2q	2q	1q
Droseraceae	Drosera macrophylla subsp. macrophylla		Recorded		3q		Small to moderate distribution from Perth area to north of Moora.	1q			1q				
Droseraceae	Drosera pallida						Moderate to large near coastal distribution Geraldton area to E of Albany.	1q	5q	1q	3q				
Crassulaceae	Crassula colorata (ssp. indet)		Recorded		2r	1q		1r							6r
Crassulaceae	Crassula colorata var. acuminata		Recorded	Recorded		3q, 1r	Extremely Wsd, all mainland states.								
Crassulaceae	Crassula colorata var. colorata		Recorded	Recorded	11q	2q	Very Wsd, WA, SA, NT, NSW.	7q, 4r	4q	3q	9q	5q, 3r		1q	2r
Crassulaceae	Crassula decumbens var. decumbens		Recorded		1q		Very Wsd, WA, SA, NSW, Tas.	1q							
Crassulaceae	Crassula exserta		Recorded	Recorded	5q	3q	Quite Wsd, WA, SA, Vict.	3q	3q	1q	7q	2q	2q	2q	
Pittosporaceae	Billardiera (Sollya)						Wsd in southern WA, also in SA, Vict, NSW & Tas. Range extension in	2r				1q, 1r			1o

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	heterophylla						TEC.								
Surianaceae	Stylobasium australe						Common from south of Shark B to east of Perth.	3r							1o
Mimosaceae	Acacia acuminata subsp. acuminata		Recorded	Recorded	10q, 20r	6q, 5r, 3o	Wsd in SW WA.	5q, 33r	3q, 31r		20q, 40r	7q, 22r	1q	2q	72r
Mimosaceae	Acacia aestivalis						Moderate range in SW WA.		1q						
Mimosaceae	Acacia aristulata		Recorded	Recorded	5q, 3r	1o	Declared Rare Flora. Very limited range from just N of Moora to NW of Watheroo.	9q, 9r	4q	2q	6q, 3r	4q, 2r	1q	5q	
Mimosaceae	Acacia congesta subsp. congesta		Recorded		1q	1o	Patchy distribution between Geraldton and E of Perth. Species distribution suggests needs review	5q, 10r	1q, 1r	3q, 1r	5q, 8r		1q	2q	1r
Mimosaceae	Acacia ericksoniae						Patchy distribution between Geraldton and E of Perth.					1r			
Mimosaceae	Acacia erinacea		Recorded			1r,	Wsd in SW WA.	2q, 2r	1q, 1r			1r			2o
Mimosaceae	Acacia hemiteles		Recorded		2q		Wsd in SW WA.								1o
Mimosaceae	Acacia lasiocarpa var. sedifolia						Wsd in SW WA	1q	1q, 1r	1q, 1r	2q, 2r	1q, 1r	1q	2q	1r
Mimosaceae	Acacia ligustrina		Recorded	Recorded		1q, 1r	Moderate distribution from SW of Geraldton to E of Perth.	1q							
Mimosaceae	Acacia microbotrya		Recorded			1o	Wsd in SW WA.	1q, 2r			1o	1r			1r
Mimosaceae	Acacia pulchella						See subspecies.	1q, 1r							
Mimosaceae	Acacia pulchella var. glaberrima						Wsd in SW WA. Needs review.								1r
Mimosaceae	Acacia pulchella var. goadbyi						Wsd in SW WA. Needs review.	1q, 1r							
Mimosaceae	Acacia restiacea		Recorded	Recorded	2q, 3r	1o	Wsd in SW WA north of Perth. Needs review.	3r					1q		1r
Mimosaceae	Acacia saligna (ssp?)						Very Wsd in SW WA & in ES.	1r							
Mimosaceae	Acacia scirpifolia						Common from Geraldton area to E of Perth.	1r							1o
Mimosaceae	Acacia stenoptera						Common from Geraldton area to Albany.			2q	1q			5q	
Papilionaceae	Bossiaea sp. Cairn Hill (M Henson CH2-28)						Very restricted, only known from the Coomberdale Chert TEC.	6q, 13r	4q, 2r		2q			6q	1r
Papilionaceae	Cristonia stenophylla		Recorded	Recorded	3q		Disjunct, possibly a restricted form, needs investigation.								
Papilionaceae	Daviesia benthamii subsp. benthamii						Moderately Wsd, needs review.	1q							
Papilionaceae	Daviesia dielsii		Recorded		2q, 1r	1o	Declared Rare Flora. Quite restricted	7q, 6r	1q	1r	1q	3r	1q		5r
Papilionaceae	Daviesia hakeoides subsp. subnuda		Recorded		1q		Wsd in a band from Kalbarri to Albany.	1r							1o
Papilionaceae	Gastrolobium acutum		Recorded	Recorded	2q, 1r		The Coomberdale Chert TEC population is disjunct from the main population, not large and likely to be a variety or subspecies.	6q, 1r	1q	1q [Since mined]		3q, 1r	1q		1r
Papilionaceae	Gastrolobium obovatum						Fairly Wsd in SW WA.					4r			
Papilionaceae	Gompholobium glutinosum						Moderately localised with two populations.	2r							1o
Papilionaceae	Isotropis drummondii						Wsd in SW WA.								1o
Papilionaceae	Jacksonia floribunda						Common between Geraldton & SE of Perth.								1r
Papilionaceae	Jacksonia foliosa						Modest range, Mingenew to Goomalling.								1r
Papilionaceae	Kennedia prostrata		Recorded	Recorded		1q	Wsd in SW WA & SE Australia.			1q	7q	1q			2r
Papilionaceae	Lupinus angustifolius	*	Recorded	Recorded					3q		2q				
Papilionaceae	Templetonia smithiana						Small range extension, Gairdner's Property.					1r			
Papilionaceae	Trifolium arvense var. arvense	*	Recorded		1q	2q			2q	2q	3q		3q	3q	
Papilionaceae	Trifolium campestre var. campestre	*	Recorded			1q									
Papilionaceae	Trifolium hirtum	*	Recorded	Recorded	8q	1q			1q		1q	1q			

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Papilionaceae	Trifolium repens var. repens	*								1q	6q			1q	
Papilionaceae	Trifolium subterraneum	*	Recorded	Recorded	2q				2q		11q			1q	1q
Geraniaceae	Erodium botrys	*	Recorded	Recorded	5q	4q, 1r					5q	3q			3r
Geraniaceae	Erodium cygnorum		Recorded		1q		Very Wsd, all mainland states.	4q	2q	1q	4q	1q		1q	1q
Geraniaceae	Pelargonium littorale						Wsd in a band // to the coast from Cervantes to Cape Arid, then disjunct to ES. TEC population disjunct.				1o				
Oxalidaceae	Oxalis corniculata	*						1q	1q			1q			
Linaceae	Linum trigynum	*	Recorded			1q					4q	1q			1r
Rutaceae	Boronia coerulescens subsp. spinescens						Wsd in SW WA.		2r		2q				1o
Rutaceae	Boronia ramosa subsp. anethifolia						Wsd in SW WA.	1q	3q					3q	
Polygalaceae	Comesperma integerrimum		Recorded	Recorded	3q	1q, 1o	Wsd in SW WA, also SA & NSW.	4q, 1q	1q, 1r	2q	8q	2q	3q	6q	1r
Polygalaceae	Comesperma virgatum						Fairly Wsd in SW WA. NEEDS REDET					1q			
Polygalaceae	Comesperma volubile		Recorded		2q		Common in SW WA and near coast SA, VICT, NSW & Tas.	2q							
Euphorbiaceae	Beyeria lechenaultii						Fairly common SW WA, also SA, Vict, NSW & Tas.								1o
Euphorbiaceae	Euphorbia drummondii subsp. drummondii		Recorded	Recorded	1q	1q	Wsd WA.								
Euphorbiaceae	Phyllanthus calycinus		Recorded	Recorded			Wsd SW WA, also in SA.				4r				1o
Euphorbiaceae	Poranthera microphylla		Recorded		1q		Very Wsd in Aust., except Eremaean	1q			2q				
Euphorbiaceae	Ricinocarpos muricatus		Recorded	Recorded		1q, 5r, 1o	Moderate distribution. Small range extension.								
Stackhousiaceae	Stackhousia monogyna		Recorded		3q		Wsd in SW WA & in ES.	2q				3q, 1r			
Stackhousiaceae	Tripterococcus brunonis		Recorded		1q		Wsd in SW WA.	5q	4q		1q	3q		2q	
Sapindaceae	Diplopeltis huegelii subsp. lehmannii		Recorded	Recorded	4q, 1r	4q, 1r, 1o	TEC record isolated from other records. Moderate distribution. Species needs review.								
Sapindaceae	Dodonaea inaequifolia		Recorded			1o	Wsd SW WA No f Perth.	4q, 19r							1o
Sapindaceae	Dodonaea pinifolia						Wsd SW WA.	1q,7r	1r			2r			
Rhamnaceae	Cryptandra glabriflora						Records redetermined as C. myriantha.								
Rhamnaceae	Cryptandra myriantha						Wsd SW WA.	3q, 1r			1q		1q	2q	
Rhamnaceae	Stenanthemum tridentatum						Moderate distribution in SW WA.					1q, 5r			
Rhamnaceae	Trymalium daphnifolium						Moderate distribution in SW WA.	2q	1q, 1r						
Rhamnaceae	Trymalium ledifolium var. rosmarinifolium		Recorded	Recorded	2r	1q, 1r, 1o	Wsd from Hill River to E of Albany.	3q, 6r			4q, 4r	3q, 6r			
Malvaceae	Alyogyne hakeifolia		Recorded			1o	Wsd in SW WA & SA, rare Vict.		1o						1o
Malvaceae	Alyogyne huegelii var. grossulariifolia						MS name, not in use. See Alyogyne sp. Sothern Coast.	1r							
Malvaceae	Alyogyne sp. Southern Coast (A.S. George 289)		Recorded	Recorded			Sporadic in SW WA, mainly S coast. Alyogyne needs taxonomic review. One large plant in North Kiaka Mine area on easternmost ridge.								
Sterculiaceae	Guichenotia micrantha						Wsd in SW WA.		1q		1o				
Sterculiaceae	Guichenotia sarotes						Wsd in SW WA.				1q				
Sterculiaceae	Guichenotia tuberculata						Priority 3 species. Known from Morawa to inland from Lancelin, sporadic.								1o
Sterculiaceae	Thomasia grandiflora						Fairly Wsd in SW WA. TEC population disjunct.	2q, 3r		1q	1r			2q	
Dilleniaceae	Hibbertia acerosa						Wsd in SW WA.	1q							
Dilleniaceae	Hibbertia subvaginata		Recorded	Recorded	8q, 18r	6q, 6r	Fairly Wsd in SW WA. TEC population disjunct.	14q, 33r	8q, 13r	3q, 1r	19q, 6r	7q, 8r	2q, 1r	6q	24r
Thymelaeaceae	Pimelea imbricata var. piligera						Wsd in SW WA.	1q, 1r	3q						
Myrtaceae	Babingtonia cherticola						Priority 3. Restricted habitat and restricted to a small area inland from Jurien Bay & Cervantes..	8q, 28r	5q, 12r						

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Myrtaceae	Baeckea crispiflora (smaller leaf form)						Wsd in SW WA.	2r							1r
Myrtaceae	Baeckea crispiflora var. tenuior						Moderately Wsd in SW WA, north of Perth.	3r			2r	2r			2r
Myrtaceae	Baeckea preissiana						See Tetrapora preissiana								1r
Myrtaceae	Tetrapora preissiana						A complex, Wsd in W.A.								1r
Myrtaceae	Baeckea sp. Moora (R. Bone 1993/1)						See Babingtonia cherticola	8q, 28r	5q, 12r						
Myrtaceae	Calothamnus aff. quadrifidus Moora-Watheroo		Recorded	Recorded	3q, 4r	1o	Included in Calothamnus quadrifidus ssp. angustifolius in a recent treatment, but a distinct taxon associated with chert from Moora to Watheroo.	8q, 23r	1q		1r	4q, 7r			3r
Myrtaceae	Calothamnus sanguineus		Recorded		1q	1o	Wsd in SW WA.	3q, 6r	2q			2q, 2r			
Myrtaceae	Calytrix depressa		Recorded	Recorded			Wsd in SW WA.	2r	1q, 2r		1q	3r			
Myrtaceae	Calytrix sp. Coomberdale (M.E. Trudgen 21184)		Recorded	Recorded	10q, 15r	2q, 2r,	A geographically restricted species that is common in the Coomberdale Chert TEC, favouring more open areas. Old plants in more weedy areas. May regenerate mostly after fire.	14q, 34r	9q, 22r	1q, 1r	7q, 22r	9q, 23r	2q, 1r	4q	17r
Myrtaceae	Calytrix strigosa						Common from Shark B to SE of Perth.								1r
Myrtaceae	Eremaea beaufortioides var. lachnosanthe						Restricted to an area between Geraldton and Cervantes. TEC record is disjunct.								1r
Myrtaceae	Eremaea sp. Cairn Hill (B. Morgan BMor 351)						Priority 1 species. Very restricted distribution.								1o
Myrtaceae	Eucalyptus camaldulensis (forma)						Common from the Kalbarri area to E of Lancelin.	1o							1r
Myrtaceae	Eucalyptus eudesmioides						Common from the Shark B area to E of Lancelin.	3q, 16r							3r
Myrtaceae	Eucalyptus horistes						Wsd in SW WA & nearby Eremaean.	1r	1r,2o						1r
Myrtaceae	Eucalyptus loxophleba subsp. loxophleba		Recorded	Recorded	1r	1q, 2r,	Common in a broad band from S of Shark B to near Albany.	6r	1q, 12r	1q	7q, 16r	1q, 8r	1q		21r
Myrtaceae	Eucalyptus obtusiflora						Common in a broad band from Carnarvon to E of Perth.	1q, 1r	1r						1o
Myrtaceae	Eucalyptus pruiniramis						Declared Rare Flora. Restricted to a few localities between Three Springs & Mogumber.								1r, 4o
Myrtaceae	Eucalyptus salmonophloia		Recorded			1o	Wsd in SW WA S of Geraldton.	1r				3r			1r
Myrtaceae	Eucalyptus wandoo subsp. wandoo		Recorded			1q, 1r	Wsd in the western part of the SW of WA.	5q, 12r			2q, 3r	2q, 3r			3r
Myrtaceae	Hypocalymma angustifolium						Common in the western half of the SW of WA. A complex.					4r			
Myrtaceae	Kunzea praestans		Recorded	Recorded	11q, 21r	4q, 3r	Limited distribution that suggests not one taxon. Needs review.	13q, 42r	8q, 16r	1r	7q, 15r	5q, 10r	1q, 1r	6q	25r
Myrtaceae	Leptospermum aff. erubescens (Moora Chert; B. Morgan 133)						Recorded for the TEC, but not in the North Kiaka Mine area. Very limited distribution. Specimen vouchered but taxon not on FloraBase.					1o			1o
Myrtaceae	Leptospermum erubescens						See: Leptospermum aff. erubescens (Moora Chert; B. Morgan 133)								3r. 1o
Myrtaceae	Melaleuca calyptroides		Recorded	Recorded	9q, 8r	2q, 3r,	Wsd in about half of the SW of WA. Distribution suggests needs review.	10q, 31r	5q			5q, 7r	1q		5r
Myrtaceae	Melaleuca concreta		Recorded	Recorded		1q	Common in a band from Shark B to near Perth.	1r	1q, 1r			1r			1o
Myrtaceae	Melaleuca coronicarpa						Common in a band from Shark B to Esperance. Needs review.					1r			1r
Myrtaceae	Melaleuca lateriflora						Wsd in SW of WA.		1o						
Myrtaceae	Melaleuca radula		Recorded	Recorded		1o	Common in the N half of the SW, scattered otherwise.	6q, 16r	1q, 7r		1r	1q, 11r			1r
Myrtaceae	Melaleuca sclerophylla						Priority 3 species. Restricted to an area from Three Springs to E of Lancelin.					3r			
Myrtaceae	Melaleuca sp.		Recorded		1q										
Myrtaceae	Regelia megacephala		Recorded	Recorded	1q	2q, 5r	Priority 4 species. Very restricted range N of Moora.	9q, 26r	5q, 5r	3q	2q, 1r	3q, 1r	1q	4q	
Myrtaceae	Verticordia acerosa var.						Wsd in SW WA.	1q							

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	preissii														
Myrtaceae	Verticordia densiflora var. densiflora						Wsd in SW WA.	1r				1r			1o
Myrtaceae	Verticordia huegelii var. stylosa						Fairly Wsd S of Moora, uncommon N of Moora.	1r							
Myrtaceae	Verticordia pennigera						Wsd from Kalbarri area to south of Perth and E of Albany.								1o
Haloragaceae	Glischrocaryon flavescens						Wsd in southern WA, also in SA.	1r				1q			1o
Haloragaceae	Gonocarpus nodulosus		Recorded		1q		Wsd in WA S of Carnarvon & E of Cape Arid.		1q		1q				
Apiaceae	Apium annuum		Recorded		1q		WA S of Shark B in a band then along coast to SA, Vic & Tas.	3q		2q	2q				
Apiaceae	Daucus glochidiatus		Recorded			3q	Wsd in Australia south of tropics.	2q			7q	3q		1q	
Apiaceae	Homalosciadium homalocarpum		Recorded		1q		Common in a broad band from S of Shark B to near Albany and to cost.								
Apiaceae	Platysace cirrosa		Recorded		2q		From near Geraldton to E of Perth in a widening band, not common.	10q	6q	1q	14q	2q	1q	1q	
Apiaceae	Trachymene cyanopetala		Recorded	Recorded	9q	5q	Wsd in WA S of Shark B & E of Cape Arid, also in SA, Vict & NSW.	5q, 14r	7q, 5r		10q, 1r	5q, 1r	2q	2q	
Apiaceae	Trachymene ornata		Recorded	Recorded	7q, 1r	6q	Wsd in WA S of Carnarvon & E of Cape Arid, also in SA, Vict & NSW.	14q, 6r	6q, 2r	3q	19q, 1r		3q	4q	1q
Apiaceae	Trachymene pilosa		Recorded	Recorded	5q, 1r		Wsd in SW WA, also in SA, Vict & NSW	12q, 21r	1q, 7r		7q, 4r	7q, 6r		3q	
Apiaceae	Trachymene sp.							2q			1q	1q			
Apiaceae	Xanthosia fruticulosa						Sporadic from Green Head to S of Perth, uncommon.	14q, 33r	7q, 7r						
Epacridaceae	Astroloma serratifolium		Recorded		2q, 1r		Wsd in a broad band from Geraldton to Albany & Esperance.	4q, 8r	1r			3q, 2r	1q		
Epacridaceae	Leucopogon sp. Northern Scarp (M. Hislop 2233)						Restricted distribution. TEC record an outlying record, but not greatly.								
Epacridaceae	Leucopogon sp. Yanchep (M. Hislop 19,861)						Material redetermined as L. sp. Northern Scarp.					1q			1o
Primulaceae	Lysimachia arvensis	*	Recorded	Recorded		1q		5q	4q	3q	4q	5q	1q	3q	
Loganiaceae	Phyllangium sulcatum		Recorded		4q		Wsd in SW WA, disjunct to SA, Vict, NSW.	2q	3q		13q	2q			
Gentianaceae	Centaurium tenuiflorum	*												1q	
Asclepiadaceae	Rhyncharrhena linearis						Found over much of Australia.					1q			
Convolvulaceae	Convolvulus angustissimus subsp. angustissimus		Recorded			1q	Uncommon in SW WA, but common in ES. Needs review.								
Chloanthaceae	Quoya dilatata		Recorded	Recorded	5q, 2r	2q, 1r	Uncommon in a band from Three Springs to Wannamal, with 4 outlying records (2 in ES Herbaria need checking). Needs review.	6q, 4r	4q, 1r	1q, 1r	9q, 7r	3r	1q	5q	
Lamiaceae	Hemiandra incana						Sporadic distribution from E of Cervantes to E of Margaret River. Needs review.	1q							1o
Lamiaceae	Hemigenia conferta						Priority 4 species. Restricted to a very small area in the TEC (Cairn Hill NR and nearby).								
Lamiaceae	Hemigenia sp.						See Hemigenia conferta.								
Solanaceae	Lycium australe						Wsd in S WA, SA, also in Vict & NSW.		1o						
Solanaceae	Solanum nigrum	*	Recorded	Recorded		1q						1q			
Solanaceae	Solanum oldfieldii		Recorded			1o	Common in a broad band from Shark B to N of Albany, some coastal records.				1q, 2r				
Scrophulariaceae	Dischisma capitatum	*									1o				
Scrophulariaceae	Parentucellia latifolia	*	Recorded		6q	2q		3q	4q	1q	17q	4q	3q	4q	1r
Scrophulariaceae	Zaluzianskya divaricata	*									1q				
Orobanchaceae	Orobanche minor	*												1q	
Myoporaceae	Eremophila lehmanniana						Occurs in an irregular broad band from S of Geraldton to N of Albany, some coast records. Needs review.	1q							
Plantaginaceae	Plantago debilis						Wsd in S WA, disjunct to CA & ES.	2q	1q				1q		
Rubiaceae	Galium murale	*	Recorded		1q						2q	1q			1q
Rubiaceae	Opercularia vaginata		Recorded	Recorded	6q, 2r	1q	Wsd in SW WA. A complex?	5q, 7r	6q, 1r		4q, 1r	5q, 14r		2q	7r

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Campanulaceae	Wahlenbergia capensis	*	Recorded	Recorded	1q			1q			1q				
Campanulaceae	Wahlenbergia gracilenta		Recorded		1q	1r	Wsd in the W of WA S of Carnarvon. Disjunct to SA, Vict, NSW, Tas.	6q		1q	1q			1q	
Lobeliaceae	Isotoma hypocrateriformis						Wsd in SW WA.	1q							
Lobeliaceae	Lobelia cleistogamoides						Sporadic in SW WA and nearby								
Lobeliaceae	Lobelia sp. small flowers (K.F. Kenneally 7705)						See Lobelia cleistogamoides	3q			1q	3q			
Goodeniaceae	Brunonia australis						Wsd over Australia, a complex.				4q				1r
Goodeniaceae	Dampiera lavandulacea						Wsd in SW WA & nearby, uncommon in SA.	2q, 3r	1q			1q, 3r			
Goodeniaceae	Goodenia arthrotricha						Declared Rare Flora. Geographically restricted. Probably a pyrosere species.	1q	1q		1q	3q, 2r			1r
Goodeniaceae	Goodenia berardiana		Recorded	Recorded	2q	1q	Common W WA, disjunct to NT, SA, NSW, Q.	4q	5q, 1r		13q, 3r	3q	1q	1q	
Goodeniaceae	Goodenia glareicola						Wsd in a broad band from Geraldton to Cape Arid. Needs review.	1r							
Goodeniaceae	Goodenia hassallii						Moderate occurrence from Kalbarri to Wannamal & Wongan Hills. Needs review.	1q, 1r	1q, 3r			1q, 3r			
Goodeniaceae	Goodenia sp.											2q	1q		
Goodeniaceae	Lechenaultia biloba						Wsd in SW WA.	2q				1q			
Goodeniaceae	Scaevola anchusifolia						Coastal from Carnarvon to Albany, with some inland records. Needs review.		1q						
Goodeniaceae	Scaevola glandulifera						Occurs in a broad band // to the coast from Geraldton to E of Albany.	1q			1r				
Goodeniaceae	Scaevola phlebopetala		Recorded		1q		Occurs in a broad band // to the coast from Geraldton to Perth.	3q	4q					1q	
Goodeniaceae	Velleia cycnopotamica						Wsd in SW WA and nearby, disjunct to SA.	1r			1q				
Stylidiaceae	Levenhookia stipitata		Recorded		1q		Wsd in SW WA and nearby, disjunct to SA.	2q	1q						
Stylidiaceae	Stylidium calcaratum		Recorded	Recorded			Wsd in SW WA and nearby, disjunct to SA.	1q	1q				1q		
Stylidiaceae	Stylidium caricifolium		Recorded		3q		Wsd in a widening belt from Geraldton to N of Stirling Range.	1q, 1r				2q		3q	
Stylidiaceae	Stylidium cordifolium		Recorded		2q		ENTRY ERROR (a Kimberley species) Redetermined as S. caricifolium.	1q, 1r				1q			
Stylidiaceae	Stylidium glabrifolium						Priority 2 species. Specimen sterile.			1q	2q				
Stylidiaceae	Stylidium miniatum						Moderate distribution from S of Geraldton to N & NE of Perth.	2q				1q			
Stylidiaceae	Stylidium repens		Recorded	Recorded	6q	1r	Wsd in SW WA					3q			
Stylidiaceae	Stylidium septentrionale		Recorded	Recorded	9q, 1r	2q	Sporadic from N or Geraldton to NE of Perth, needs review.	13q, 28r	9q, 7r		1q, 2r	6r		1q	
Asteraceae	Actinobole uliginosum					1o	Wsd in the southern 2/3 of Australia. A complex?								
Asteraceae	Trichocline [Amblysperma] sp. Moora (GH7-57)						Only known from a sterile specimen. May not be *Trichocline*.					1q			
Asteraceae	Arctotheca calendula	*	Recorded	Recorded	11q	6q		6q	8q	1q	15q	3q	3q+	1q	
Asteraceae	Blennospora drummondii		Recorded	Recorded	1q. 1r		Wsd in SW WA, disjunct to SA & Vict.	7q, 11r	9q, 2r	2q	8q, 2r	2q, 4r		1q	
Asteraceae	Brachyscome perpusilla		Recorded	Recorded		1q	Wsd in SW WA, disjunct to SA, NSW & Vict.		1q						
Asteraceae	Calotis hispidula						Wsd over Aust. S of the tropics.		1q		1q				
Asteraceae	Cotula turbinata	*	Recorded	Recorded		1q									
Asteraceae	Erymophyllum tenellum						Wsd in SW WA & a few Eremaean records.		1r						
Asteraceae	Gilberta tenuifolia		Recorded	Recorded	1q, 1r	1q, 1o	Wsd in SW WA & nearby Eremaean.	2q	1q, 5r		9q, 20r	4q, 3r	3q		13r
Asteraceae	Hedypnois rhagadioloides	*									3q	1q			
Asteraceae	Hyalosperma cotula		Recorded	Recorded	1q	1o	Wsd Geraldton to Albany // to the coast, scattered records in NSW & Vict.		2q		2q	9q, 2r	2q	1q	4r
Asteraceae	Hyalosperma demissum		Recorded		o										
Asteraceae	Hyalosperma glutinosum subsp. glutinosum		Recorded		1q		Wsd in SW WA, disjunct to SA, NSW & Q.		1r		1q				2r
Asteraceae	Hypochaeris glabra	*	Recorded	Recorded	12q, 13r	10q, 1r		17q	9q	3q	22q, 2r	7q, 4r	3q	4q	1q,10r
Asteraceae	Hypochaeris radicata	*						3q							
Asteraceae	Isoetopsis graminifolia		Recorded	Recorded	o										

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Asteraceae	Lagenophora huegelii						Wsd in W SW WA, disjunct to SA, NSW & Tas.	1q				3q			
Asteraceae	Lawrencella rosea		Recorded	Recorded		1r	Wsd in SW WA, adjacent Eremaean.	8q, 19r	8q, 10r		9q, 5r	1q, 4r		1q	1r
Asteraceae	Millotia aff. tenuifolia (Moora: CH20-11)						CHECK SPECIMEN	1q							
Asteraceae	Millotia myosotidifolia		Recorded	Recorded	2q	2q	Wsd in SW WA, disjunct to SA, NSW & Vict.					1q			
Asteraceae	Millotia tenuifolia var. tenuifolia		Recorded	Recorded	2q, 1r	1q, 1r	Wsd in SW WA, disjunct to SA, Tas. & Vict.	4q, 5r		1q	4q	1q		1q	2r
Asteraceae	Olearia dampieri subsp. Eremicola (Diels & Pritzel s.n. PERTH 00449628)		Recorded	Recorded	1q, 1r	1o	Wsd in SW WA.				9q, 9r	6q, 11r			4r
Asteraceae	Podolepis canescens		Recorded	Recorded	1q	1q, 1r, 2o	Wsd in Aust. S of tropics.	3q, 5r	2q		2q	5q, 20r			
Asteraceae	Podolepis capillaris		Recorded	Recorded	o		Wsd in Aust. S of tropics, except far ES.								
Asteraceae	Podolepis gracilis						Wsd from Geraldton to Albany in a band // to the coast, scattered records to E.							1q	
Asteraceae	Podolepis lessonii		Recorded	Recorded	10q, 14r	2q, 1r	Wsd in WA S of Carnarvon & E of Cape Arid, one SA record.	5q, 9r	8q, 11r		19q, 31r	8q, 15r	3q, 2r	6q	1q
Asteraceae	Podotheca aff. gnaphalioides (Moora WDM1-65)						Not uncommon, fairly Wsd (not restricted to TEC).						3q		
Asteraceae	Podotheca angustifolia		Recorded	Recorded	4q, 3r		Wsd in SW WA, disjunct to SA, NSW & Vict, 1 record from Tas.	3q, 6r	6q, 3r		11q, 1r	7q, 5r	3q	1q	
Asteraceae	Podotheca gnaphalioides		Recorded	Recorded	2q	1q	Wsd in WA S of Carnarvon & W of Ravensthorpe								
Asteraceae	Pterochaeta paniculata						Wsd in SW WA.	1q							
Asteraceae	Quinetia urvillei		Recorded	Recorded			Wsd in SW WA, disjunct to SA, & Vict.		2q		4q				
Asteraceae	Rhodanthe laevis		Recorded	Recorded	4q		Wsd in SW WA, disjunct to SA, NSW & Vict & 2 records each in Q & NT.				3q		1q		
Asteraceae	Rhodanthe manglesii		Recorded		1q		Wsd in SW WA, also in adjacent Eremaean.		1q						
Asteraceae	Rhodanthe polycephala		Recorded			2q	Wsd in a band from Shark B to N of Albany, with a few records to the E.	5q, 3r	1q, 3r		1r	1r			
Asteraceae	Rhodanthe pygmaea		Recorded	Recorded			Wsd in S WA & SA, Wsd in Vict & NSW		1q						
Asteraceae	Schoenia cassiniana		Recorded	Recorded	1q	4q	Wsd in WA, S NT & SA.	3q			3q	3q		1q	
Asteraceae	Senecio glossanthus		Recorded	Recorded		1q	Wsd in Aust. S of Tropics.								
Asteraceae	Siloxerus humifusus						CHECK SPECIMEN. Habitat??? Wsd in a band // to coast from S of Geraldton to Cape Arid area.				1q				
Asteraceae	Sonchus asper	*	Recorded	Recorded		1q									
Asteraceae	Sonchus oleraceus	*	Recorded	Recorded	1q, 1r			1		1q	2q	1q	2q		
Asteraceae	Trichocline sp. [??]						Specimen sterile. If Trichocline undescribed.								
Asteraceae	Monoculus monstrosus	*	Recorded	Recorded	8q	1q		5q	2q	2q	7q	2q	1q	1q	1q
Asteraceae	Urospermum picroides	*	Recorded		3q	8q, 1r		2q		2q	5q	4q		2q	1q
Asteraceae	Ursinia anthemoides	*	Recorded	Recorded	12q, 2r	10q, 6r		18q, 1r	9q	3q	23q, 2r	10q, 4r	3q	6q	1q
Asteraceae	Waitzia acuminata						Wsd in Aust. S of tropics.					1q			
Asteraceae	Waitzia nitida		Recorded	Recorded	5q	1q	Wsd in SW WA.	1q, 7r	1q, 4r		13q, 8r	4q, 9r			

APPENDIX 5: The Department of Conservation and Land Management Priority Flora Categories

Definition of CALM Declared Rare and Priority Flora categories (from Atkins 1998).

Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

Declared Rare Flora - Presumed Extinct Flora

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

Priority One - Poorly Known Taxa.

Taxa which are known from one or a few (generally < 5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Two - Poorly Known Taxa.

Taxa which are known from one or a few (generally < 5) populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered). Such taxa are under consideration for declaration as "rare flora", but are in urgent need of further survey.

Priority Three - Poorly Known Taxa.

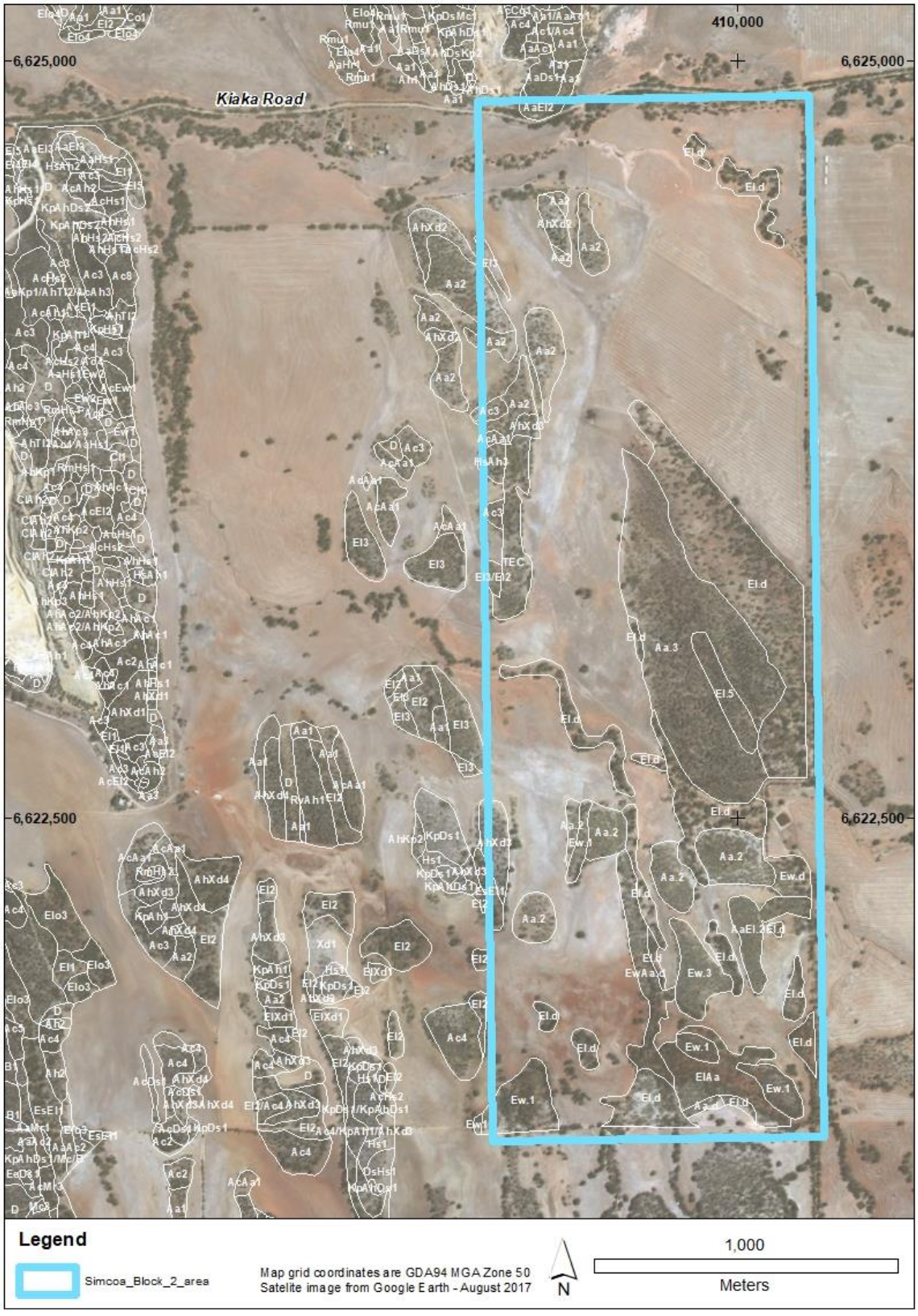
Taxa which are known from several populations, and the taxa are not believed to under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally > 5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further study.

Priority Four - Rare Taxa.

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

APPENDIX 6: Additional area of TEC ("Simcoa Block 2") searched for rare flora and mapped

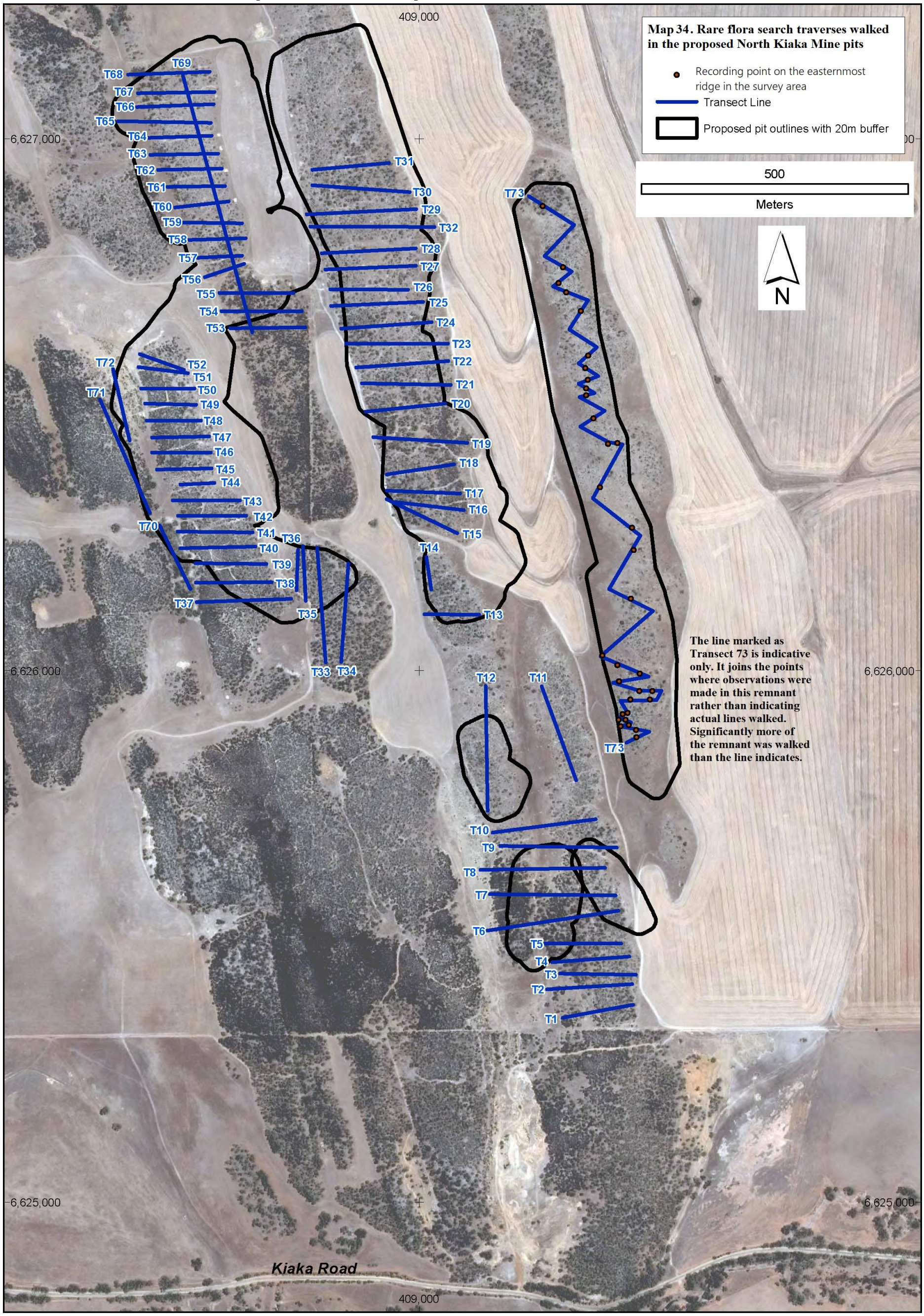
The area outlined in blue on the map has been purchased by Simcoa. As it is near one of the two locations of the *Banksia sphaerocarpa* form found in the Coomberdale Chert Threatened Ecological Community, it was visited in 2017 to search for that species. During the visit, the areas of the TEC in the block not mapped previously were mapped and flora records made.



M.E. Trudgen & Associates, March 2018

APPENDIX7: Map of rare flora search traverses walked in the proposed North Kiaka Mine pits

Notes: The lines marked for transects 1-72 marked the line from the beginning to the end point. The line actually walked was zig-zag. The line for Transect 73 (on the easternmost ridge) is indicative as it joins the points where observations were made. Significantly more of this remnant was walked. The searches for the haul road options are marked on Map 28.



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