

Donaldson Open-cut Coal Mine
Beresfield

Tetratheca juncea Management Plan

November 2000

Gunninah Environmental Consultants



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**DONALDSON OPEN-CUT COAL MINE
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***Tetradlea juncea* MANAGEMENT PLAN**

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1 INTRODUCTION

1.1 Background

Donaldson Projects has been granted conditional consent by the Minister of Urban Affairs & Planning - DUAP (DUAP Ref N9700147) to develop the Donaldson open-cut coal mine ('the subject site'), which is located to the west of Beresfield and to the southeast of Maitland, in the Lower Hunter Valley. The Project is the subject of 126 Conditions of Consent imposed by the Department of Urban Affairs & Planning (DUAP), including an array of investigations and Management Plans for the natural environment.

The subject site supports a population of *Tetratheca juncea* (Figure 1), a 'Vulnerable' plant listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* (TSC Act). Condition Nos.68 & 69 of the Conditions of Development Consent for the project relate to the protection and management of this population.

This document has been prepared to satisfy Condition No.69 of the Conditions of Development Consent, which requires the preparation of a Management Plan for the *Tetratheca juncea* Conservation Area on the Donaldson Mine site.

Condition No.69 states that:

"The Applicant shall prepare a Management Plan for the Tetratheca juncea Conservation Area in consultation with NPWS and to the satisfaction of the Director-General, prior to commencement of construction. The Plan shall be consistent with the Flora and Fauna Management Plan (Conditions 76-79), and include measures for fire management. The Applicant shall clearly mark the boundary of the Conservation Area and make provision for signage which specify that no dumping, clearing or other works are permitted in the Conservation Area. Such signage shall be replaced as required. The Applicant shall make copies of the Tetratheca juncea Management Plan available to NPWS, Councils and the Community Consultative Committee within 14 days of approval by the Director-General".

The *Tetratheca juncea* Conservation Area was defined in a previous report - the *Tetratheca juncea* Survey Report & Conservation Area Identification report (Gunninah 2000a).

1.2 Plan Aims & Structure

The main aim of the *Tetratheca juncea* Management Plan (TjMP) is to provide a comprehensive program for the *Tetratheca juncea* population in the southwestern portion of the mine site, throughout the mining activities on the site.

1.3 The *Tetratheca juncea* Conservation Area

The *Tetratheca juncea* Conservation Area (TjCA) was defined in accordance with Condition No.68 of the Conditions of Consent for the Project. A *Tetratheca juncea* Survey & Conservation Area Identification report (Gunninah 2000a) has been prepared, which accurately locates the *Tetratheca juncea* population in the southwestern portion of the site and identifies the boundaries of the TjCA (Figure 1).

The 5ha TjCA is located adjacent to the western boundary of the 'mine disturbance area' (Figure 1), and comprises 430 *Tetratheca juncea* clumps and 21 grass trees. The TjCA includes a 50m buffer zone around the *Tetratheca juncea* population (Figure 2).

The population is located on the low- to mid-slopes of an unnamed creek and its minor tributaries (Figure 2). The population is located in the upper part of a north-facing drainage catchment, at an elevation of between 50m and 70m. A small dam is located at the top of this small drainage catchment, south of the population (Figure 2). The site can currently be accessed via an unimproved track leading from the south to a small clearing adjacent to the dam (Figure 2).

The TjCA and the surrounding landscape are dominated by Spotted Gum-Northern Grey Ironbark Open Forest, with a canopy reaching 22m in height. The groundcover is generally characterised by a diverse range of grasses and herb species, and the understorey layer is relatively diverse (Gunninah 1998b). Climbing and trailing species are relatively uncommon (Gunninah 1998b) and exotic species are generally restricted to disturbed edges (particularly around the dam and track).

1.4 Integration with other Plans

The TjMP has been prepared to ensure consistency with the management protocols and requirements of the *Flora & Fauna Management Plan* (F&FMP), which has been prepared pursuant to Conditions No.76 and No.77 (Gunninah 2000b), and the *Bushland Conservation Area Management Plan* (BCAMP) which is required pursuant to Condition No.72(iii) of the Conditions of Development Consent (Figure 3). The F&FMP relates specifically to the rehabilitation and management of the 'mine disturbance area', whereas the BCAMP relates to the bushland areas beyond the 'mine disturbance area' (ie within the DUAP approved Bushland Conservation Area), and as defined in the "*Donaldson Coal Mine. Bushland Conservation Area Identification*" report (Gunninah 2000c).

Donaldson Flora & Fauna Management Reporting Requirements and their Relationship to each other.

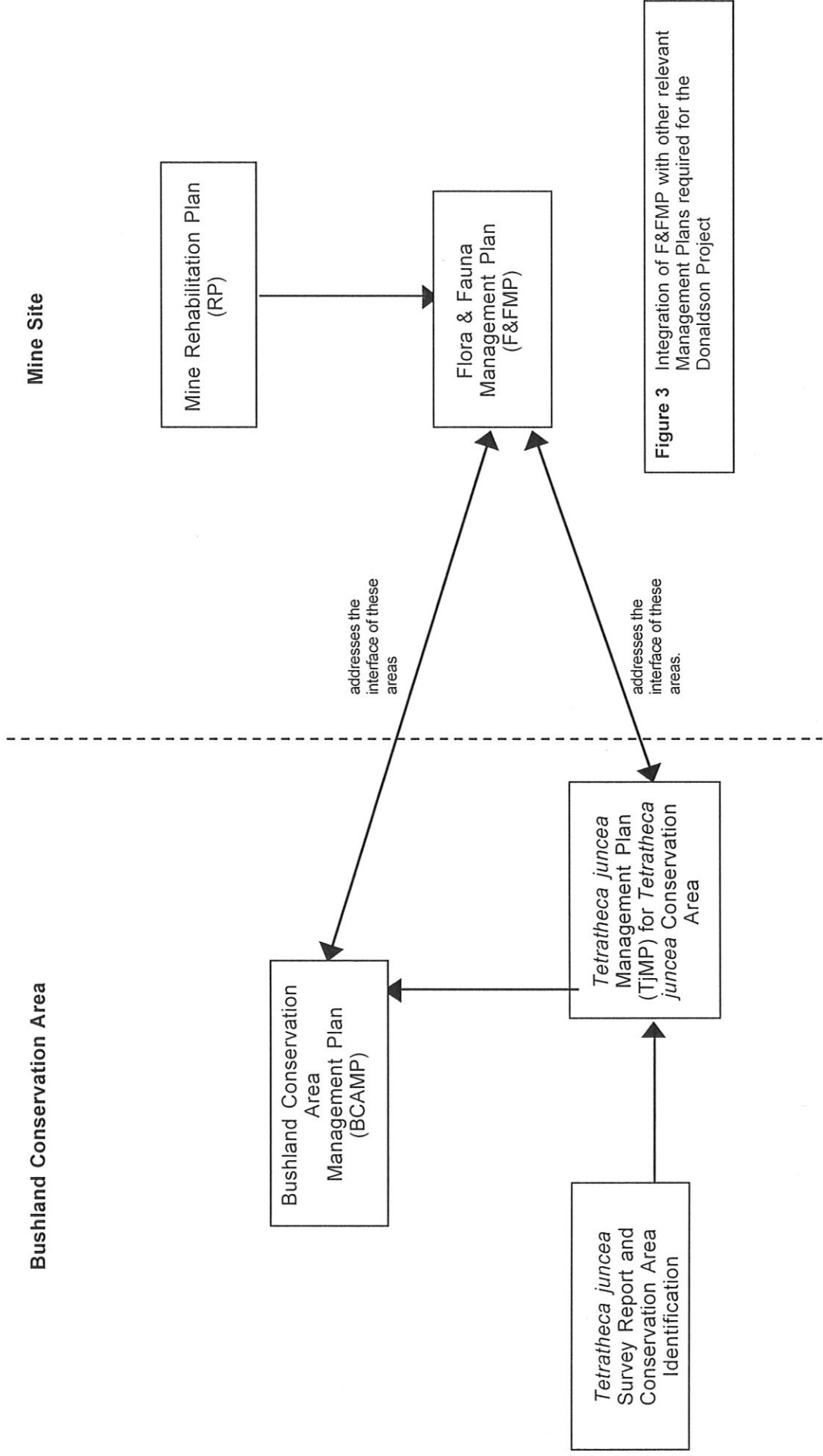


Figure 3 Integration of F&FMP with other relevant Management Plans required for the Donaldson Project

2 SPECIES DESCRIPTION & HABITAT REQUIREMENTS

2.1 Species Description

Tetralthea juncea is a threatened plant listed as 'vulnerable' on Schedule 2 of the *NSW Threatened species Conservation Act 1995* (TSC Act). It is also listed a vulnerable species according to the *Commonwealth Environmental Protection & Biodiversity Conservation Act 1999* (EPBC Act).

Tetralthea juncea (Photos 1 & 2) is a prostrate shrub, with sparse wiry stems to one metre in length, which grows as plant clumps which comprise either single or multiple stems that grow from a single rootstock (NPWS draft). The sparse stems of the plant become entangled in surrounding understorey vegetation and are generally leafless (NPWS draft). The narrow wings on the plant's leafless stems distinguish it readily from other *Tetralthea* species.

Tetralthea juncea flower colour ranges from deep lilac-pink to white and the flowers comprise four petals (NPWS draft). Flowers are borne singly or in pairs along the stem during the flowering period from July to December (Fairley & Moore 1989; Harden 1992), although flowering clumps have been recorded as early as April in the northwestern portion of the species' range (Gunninah 1997a, b).

Tetralthea juncea was thought to occur chiefly in coastal districts from Buladelah to Lake Macquarie, with historic records from presumably extinct populations in the Sydney coastal region (Payne 1998; Harden 1992). It is known to occur within the Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock Local Government Areas (NPWS draft). It appears that *T juncea* is more widely distributed in the western and northwestern parts of its range, in particular at Karuah (Gunninah 1999b), Beresfield (Gunninah 1998b), Wakefield (Gunninah unpubl data) and near Mt Sugarloaf (Gunninah unpubl data).

2.2 Habitat Description

Tetralthea juncea generally occurs on low nutrient soils and "grows in sandy, occasionally swampy heath and in dry sclerophyll forest" (Harden 1992, Norton 1994), primarily on pH neutral soils (ie pH 7), derived from clay or conglomerates (BHP 1994). The Donaldson *Tetralthea juncea* population occurs in the 'Shamrock Hill' soil landscape (Newcastle 1:100 000 soils map), which ranges from sandy loam to medium clay ranging from pH 5 to pH 6.

Tetralthea juncea is generally found in association with open woodland vegetation where *Angophora costata*, *Corymbia gummifera*, *Eucalyptus haemostoma* and *E capitellata* are the dominant canopy species (NPWS draft). It often occurs in a dense understorey of grass and Fabaceous species (NPWS draft).

Tetralthea juncea can occur on any aspect, although it appears to have a preference for southern aspects (NP&WS draft). The Donaldson population occurs on north, east and west facing slopes. This species occurs on upper slopes, mid-slopes, ridges and gullies, although it appears to have a preference for ridges (NP&WS draft). *Tetralthea juncea* has a preference for areas with low moisture and that are well drained (NP&WS draft).



Photo 1

Tetratheca juncea and juvenile grass tree on the subject site within the *Tetratheca juncea* Conservation Area (TjCA).

Photo 2

Tetratheca juncea on the subject site within the TjCA.

3 CONSULTATION

This report is being prepared in consultation with the NSW National Parks & Wildlife Service (NP&WS) and to the satisfaction of the Director-General of the Department of Urban Affairs & Planning (DUAP), in accordance with Condition No.69 of the Conditions of Consent for the Project.

The consultation process has involved:

- the delivery of correspondence to the National Parks & Wildlife Service (NP&WS) requesting advice on the content of the *Tetratheca juncea* Management Plan (TjMP);
- the receipt of correspondence from the NP&WS regarding the content of the TjMP;
- discussions with Julie Ravallion of NP&WS; and
- review of the final draft TjMP by NP&WS and the DUAP.

Copies of the correspondence received from the NP&WS and the DUAP, with regard to the preparation and approval of the *Tetratheca juncea* Management Plan for the Donaldson Mine, are provided in Appendix A.

4 MANAGEMENT ISSUES

4.1 Mining Operations

The mining operations at the Donaldson site will occur over a ten year period. Mining activities at Donaldson will only be in close vicinity of the TjCA during the final year of mining only and will continue for approximately one year in this area. The mining of the Donaldson site will not affect the existing water table level in the vicinity of the TjCA. This Management Plan focuses on the management of the buffer between mining activity and the *Tetralthea juncea* population in the southwestern corner of the subject site and also focuses on the management of the TjCA.

Notwithstanding the implementation measures contained within this Management Plan, there is some potential for mining activities to affect the *Tetralthea juncea* population within the TjCA (to a limited extent), especially during the period when mining operations are located in the immediate vicinity of the TjCA. Potential theoretical negative impacts may include:

- the spread of weed propagules into the TjCA;
- unauthorised access by mine workers into the TjCA;
- erosion from the 'mine disturbance area' (particularly from the bund) resulting in erosion and sediment deposition in the TjCA;
- the dumping or stockpiling of materials or overburden within the TjCA, resulting in disturbance or clearing of land within the TjCA;
- possible pollution and contamination events; and
- alterations to the drainage patterns and soil water conditions around the TjCA.

The TjMP has been prepared to address the management of these potential impacts, with the management of mining operation issues addressed in detail in Chapter 5.

4.1.1 Weed Control & Eradication

Weed eradication and control are important factors in managing the TjCA. The removal of weeds from the TjCA will benefit the area by decreasing the potential for competition between introduced species and *Tetralthea juncea* (and its preferred habitat). In addition to the eradication of weeds from the TjCA, it is also important to ensure that weed propagules are not accidentally introduced into the TjCA, which can be transported into the area on vehicles, other machinery or clothing. This can be achieved by maintaining access restrictions to the TjCA and also through the implementation of a comprehensive induction and training program for personnel working in the TjCA, or in its vicinity.

In addition to the control of access to the TjCA to prevent the accidental introduction of weeds, it will be necessary to implement weed control activities during mining activities as this will reduce the opportunity for weeds to establish within the TjCA. Weed control activities will include (Gunninah 2000b):

- the disposal or re-use of removed weed material off-site;
- the implementation of dedicated weed control and monitoring programs along the haul road or other access tracks, where there is a greater potential for weed species to occur and flourish;
- the immediate distribution of native plant mulch onto exposed areas, which decreases the potential for weeds to establish;
- cleaning of vehicles and equipment, where appropriate

Weed control and eradication is further discussed in Chapters 4.2.5 and 5.2.4.

4.1.2 Access Restriction

By controlling the access of personnel and equipment into the TjCA, several risks to the *Tetralthea juncea* population will be minimised. Potential risks include the dumping or stockpiling of material, pollution and contamination events, or the accidental import of weed propagules or *Phytophthora*. Management of access to the TjCA will include the erection of signage and the induction of all site relevant personnel (Chapter 5.2.5).

4.1.3 Erosion & Sedimentation

The potential effects of erosion and sedimentation from the 'mine disturbance area' on the *Tetralthea juncea* population within the TjCA are potentially detrimental to the population. The build of sediment within the TjCA may provide an opportunity for colonisation by weed propagules or may change the local environmental conditions (ie pH) placing *Tetralthea juncea* plants at a possible disadvantage. The management of erosion and sediment is addressed by the *Erosion & Sediment Control Plan* (Global 2000a; Chapter 5.2.6).

4.1.4 Dumping or Stockpiling of Material

The accidental dumping or stockpiling of material within the TjCA may cause a part of the population to be covered by the imported material. The avoidance of accidental dumping or stockpiling of material is achieved by restricting access to the TjCA and by informing relevant site personnel of the significance of the area (Chapter 4.1.2 & 5.2.5).

4.1.5 Pollution & Contamination

Pollution or contamination events within the TjCA could have a significant negative impact on the *Tetralthea juncea* population within the TjCA. By the restricting of access to the TjCA and by informing relevant site personnel of the significance of the area, potential pollution and contamination events within the TjCA will be avoided (Chapter 5.2.7).

4.1.6 Alteration to Drainage Patterns

Alteration to drainage patterns within the TjCA caused by mining activities has the potential to impact on the *Tetralthea juncea* within the TjCA by altering the quantity of soil water available to the population. This potential risk will be avoided by the implementation of the ESCP (Global 2000a) and by the continuous monitoring of the population during the lifetime of the mine (Chapter 5.2.7).

4.2 Biological Factors

Particular elements of the ecology and lifecycle of *Tetralthea juncea* are relevant in the management regime to be implemented by the TjMP, including:

- the reproductive ecology and requirements of the plant;
- pollinator habitat requirements, if known;
- the response of *Tetralthea juncea* to fire;
- competition with other native plants;
- the possible effects of exotic weed infestations; and
- the potential impacts of the introduced fungus, *Phytophthora*.

4.2.1 Reproductive Ecology

4.2.1.1 Pollination

The pollination mechanisms of *Tetratheca juncea* are poorly understood. There are several theories, including the buzz pollination or insect pollination of the *Tetratheca juncea* flowers, although there is no evidence to support these theories (Gunninah 2000a). *Tetratheca juncea* may have an association with only one or a few insect species as pollinators, although none has been observed directly (Gunninah 2000a).

Given the lack of comprehensive knowledge regarding the pollination mechanisms of *Tetratheca juncea* and with regard to whether pollination is crucial to the plant's survival, management of the *Tetratheca juncea* population will focus on ensuring the persistence of the existing population. This will be achieved by the maintenance of the population, its associated vegetation communities, native flora and fauna and potential fauna habitat. The maintenance of fauna habitat includes the retention and protection of the 21 grass trees, as they provide potential habitat for the native sonicating bee (*ie* the potential pollinators of *Tetratheca juncea*, although there is no evidence to prove that *Tetratheca juncea* is buzz pollinated by sonicating native bees).

4.2.1.2 Seed Germination & Seedling Survival

Observations of *Tetratheca juncea* have suggested that this species may produce a very low seed set (Payne 1998). An alternative theory suggests that it may be difficult to locate seed because generally seed appears on the plants following flowering, and there is a recognised difficulty of identifying *T. juncea* when it is not in flower (Appendix A – Letter from Robert Payne). Furthermore, there is no estimate of the number of *Tetratheca juncea* seeds that may accumulate in the soil within the populations ('seed bank') or of how long they may survive.

Tetratheca seeds may remain dormant in the soil awaiting a germination 'cue', such as a fire (Dixon *et al* 1995). Alternatively, seeds may be readily germinated in hot house conditions (*eg Tetratheca glandulosa*, Brown *pers comm*). Payne (1998) obtained only 14% germination of seeds within a few weeks of treating them with 'smoke water' in test conditions, compared to 100% germination in *Tetratheca glandulosa* following watering (Brown *pers comm*). This comparison suggests that *Tetratheca juncea* may require heat from fire to crack the seed coat, with the leaching of compounds causing dormancy following fire (*eg* rain and time).

Seedlings of *Tetratheca juncea* are rarely encountered in nature (Brown *pers comm*), and Norton (1994) has observed little germination within a few months following fire. Although it has been observed that seedlings are rarely encountered this may simply be due to the difficulty of locating *T. juncea* when it is not in flower.

Given the above information, the management of the *Tetratheca juncea* population with regard to seed germination and seedling survival will focus on the maintenance of the population as it is, which includes:

- no disturbance to the soil and potential seed bank of *Tetratheca juncea* seeds in the soil in the TjCA;
- monitoring surveys which will attempt to provide additional information regarding seedling survival (Chapter 6.1); and
- the implementation of an appropriate fire regime which takes into consideration the potential for fire to break seed dormancy in *Tetratheca juncea* seeds, particularly with regard to fire intensity (where possible).

4.2.2 Plant Response to Fire

Tetratheca juncea occurs in fire-prone sclerophyll woodlands and exhibits numerous characteristics typical of fire adaptation (Whelan 1995; Payne 1998). Nevertheless, several studies also indicate that frequent fires (at one or two year intervals) substantially reduce the population, and are likely to cause local extinction (Payne 1993; Binns 1996; Gunninah

unpubl data). Frequent fires may also have a negative effect on flowering and subsequent seed set, since *Tetratheca juncea* plants require one to two years to flower following fire (Norton 1994).

On the other hand, a fire regime characterised by very infrequent fires may also be harmful to *Tetratheca juncea* through competition for resources from other plants species (Chapters 4.2.4 & 4.2.5), and through the increased potential for catastrophic fire as a result of significant fuel load build-up. As with other threatened plant species in fire-prone environments (Scott *et al* 1995), fire regimes in the TjCA must balance these two extremes.

Norton (1994) directly examined the response of *Tetratheca juncea* plants to fire in six study plots, and determined that the species has three mechanisms for regeneration following fires:

- regeneration from rootstock or peripheral roots, if above-ground plant tissue is destroyed in a very hot fire;
- regeneration from stems where they are not destroyed; and
- regeneration from seed.

Experimental burning of six plots of *Tetratheca juncea* demonstrates that plants may tolerate moderate intensity fires and re-sprout, either from remaining above-ground stems or from roots (Norton 1994). Slow cool fires, however, resulted in 100% mortality (Norton 1994), whilst intense fires resulted in regrowth from rootstock only. It is also noted that high mortality resulted at sites with high fuel loads.

Current information suggests that *Tetratheca juncea* regenerating from either rootstock or seed following fire will not flower for two years (Norton 1994). Seedlings have been observed in May 1994 following a hot fire in January 1994, although these seedlings could not be detected during September 1994 (Norton 1994).

An appropriate fire regime (Chapter 5.2.3) for the *Tetratheca juncea* population within the TjCA will ensure:

- the avoidance of slow cool fires are avoided, as far as possible;
- implementation of a fire regime where too frequent fires are avoided, as far as possible. In particular, a fire frequency of a minimum of three years is required;
- the avoidance of build up of a high fuel load within the TjCA; and
- the fire regime will implement moderate intensity fires.

4.2.3 Pollinator Habitat

As previously discussed in Chapter 4.2.1.1, there is a current theory that *Tetratheca juncea* is pollinated by a native sonicating bee, although this has not been proven (Gunninah 2000a). It is further known that the woody base of grass trees provides habitat for native sonicating bees (Gunninah 2000a).

The recent survey of the Donaldson *Tetratheca juncea* population revealed 21 grass trees located in the central part of the population (Figure 2). As a precautionary measure (given the uncertainty regarding whether *Tetratheca juncea* is pollinated by the native sonicating bee) the grass trees will be retained and protected as part of the management of the TjCA, and will include the protection of grass trees during prescribed fire events.

4.2.4 Competition with Native Plants

Indirect evidence (Norton 1994; Payne 1998; Gunninah 1998b) indicates that *Tetratheca juncea* does not occur in areas dominated by a dense understorey of grasses (such as Kangaroo Grass *Themeda australis*, Blady Grass *Imperata cylindrica* and Bracken). Experimental studies confirm that such dense undergrowth occurs at sites that are frequently burned (*ie* every one to two years - Ross Bradstock, NPWS *pers comm*) or have a history of frequent burning (Alan York, University of Wollongong *pers comm*).

The appropriate fire regime for the *Tetratheca juncea* population at Donaldson will avoid exposing the population to frequent burns and consequently to competition with the aforementioned native plants (Chapter 5.2.3).

4.2.5 Exotic Weed Infestation

Several exotic species have been recorded in the Spotted Gum-Ironbark Open Forest community, within which the *Tetratheca juncea* population occurs:

- Blackberry;
- Lantana;
- *Paspalum distichum*;
- Wild Tobacco Plant;
- Purple Top;
- Fireweed;
- Rhodes Grass;
- Catsear;
- Kikuyu;
- *Cirsium vulgare*;
- Madeira Winter Cherry;
- Crofton Weed; and
- Mickey Mouse Plant.

A few of these species occur in low numbers in the vicinity of the TjCA, in particularly along the track and around the dam. Although there is no evidence that any of these species pose any particular threat to *Tetratheca juncea*, they could potentially spread into *Tetratheca juncea* habitat following fire and/or other disturbances.

Management measures to control these exotic weeds will be implemented as part of the TjMP (Chapter 5.2.4) and in the *Bushland Conservation Area Management Plan* (Gunninah 2000d). Management measures will include:

- the removal of weeds from the TjCA;
- the careful disposal of removed weed material, or re-use as green fuel;
- the continuous suppression of regenerating weeds;
- the immediate distribution of native plant mulch onto exposed areas, which decreases the potential for weeds to establish;
- the restriction of access to the TjCA preventing the transport of new weed seeds or propagules into the area and the cleaning of vehicles or equipment, where appropriate; and
- the monitoring of the TjCA to indicate the success of the weed removal program or to identify potential weed issues;

4.2.6 Phytophthora

Phytophthora *Phytophthora cinnamoni* is an introduced soil fungus which can cause root rot and subsequent plant death in a wide variety of Australian plant species. Phytophthora is known to endanger *Tetratheca gunnii* in Tasmania (Barker 1996), although there is no evidence that Phytophthora is causing comparable declines in any *Tetratheca* populations in New South Wales. However, Phytophthora is known to be causing declines in other native species in some areas, including grass trees in Royal National Park (D Keith NP&WS pers comm).

Phytophthora is typically spread through the introduction of small amounts of soil contaminated with the fungus. It has been associated in Western Australia with earth-moving equipment and road-building activities, but could also be introduced in dried mud caked in boot soles or in mountain bike tyres.

The prevention of the spread of Phytophthora into the TjCA is addressed in Chapter 5.2.5. Management measures to prevent the spread of Phytophthora into the TjCA mainly rely on the restriction of access to the TjCA and ensuring that any equipment entering the TjCA is not transporting Phytophthora, as far as is possible.

5 MANAGEMENT ACTIONS

This Management Plan provides a comprehensive program for the maintenance of the population of *Tetradleca juncea* in the TjCA, located in the southwestern portion of the Donaldson Project site. Specific management measures to be implemented through the life of the Project include:

- maintenance of the existing *Tetradleca juncea* population, including:
 - the retention of potential pollinators and potential pollinator habitat;
 - the establishment of an appropriate fire regime;
 - protection of the population from indirect effects (such as weed invasions, native plant competition and possible pollution events); and
 - prevention of the potential spread of Phytophthora;
- control of soil disturbance in the vicinity of the population through prevention of direct or indirect mining impacts; and
- monitoring and the collection of relevant and useful data on the population.

Management actions for the TjCA¹ are provided for all stages of the Project, *ie* pre-mining, mining and post-mining).

5.1 Adaptive Management

The management measures contained in the Management Plan are intended to be sufficiently flexible to respond to new information regarding *Tetradleca juncea*. Ongoing research may provide new biological information about *Tetradleca juncea* in general or evidence of a site-specific issue relevant to the Donaldson population (identified during the ongoing monitoring program) on the site.

Corrective actions (to be implemented in the event of detrimental changes to the *Tetradleca juncea* population) have been incorporated into this Management Plan (Chapter 5.4). However, the ongoing monitoring and management of the Bushland Conservation Area and the *Tetradleca juncea* population at Donaldson (or at other sites in the region) may reveal other (currently unexpected) situations which may require supplementary management measures, to be determined by the Project Environmental Officer in consultation with a biologist.

5.2 Pre-mining Protocol

Mining activities in the vicinity of the TjCA will not occur until 2010 (approximately), and a substantial baseline of information on the species and the population can be obtained during this period. The ten-year timeframe also allows for the development of adaptive management measures (Chapter 5.1) to be devised and implemented in response to research outcomes and monitoring activities.

The *Pre-mining Protocol* focuses largely on the establishment of monitoring sites and on the implementation of the monitoring surveys, and on implementing measures to protect the population prior to mining in the vicinity. The *Pre-mining Protocol* also requires the location of a boundary around the population to indicate the limits of the TjCA (in accordance with Condition No. 69 of the Conditions of Consent for the Project) and the implementation of general environmental management measures (such as weed control, restriction of access and the installation of erosion and sediment controls, as required).

The surveys to be implemented as part of the *Pre-mining Protocol* aim to collect information regarding:

- the likely response of the population to previous fires;

¹ Mining is not expected to occur in the vicinity of the TjCA until 2010, and will only continue for approximately 12 months in this area.

- an appropriate fire regime, including definition of the appropriate season, intensity and duration;
- identification of the pollinator(s) of *Tetratheca juncea*, if possible; and
- the identification of pollinator habitat (following determination of certain or likely pollinators).

5.2.1 Establishment of Monitoring Protocol & Initial Field Observations

Prior to the introduction of the prescribed fire regime or other management activities in the TjCA, the 'site monitoring program' (Chapter 6) will be established, which includes:

- random tagging of 25% of the population with fire-proof metal tags to enable demographic monitoring (Chapter 6.1.1); and
- establishment of ten permanent quadrats within each Fire Management Unit (FMU) of the population (Chapter 5.2.3.2) to allow measurement of pre- and post-fire seedling recruitment (Chapter 6.1.2), flowering and seed-production, as well as other relevant variables.

A Timeline (Appendix B) of the implementation of management actions is provided which outlines the appropriate timing and season for implementation of activities. The timeline will be amended accordingly as more detailed information regarding the ecology of *Tetratheca juncea* is provided.

5.2.2 Pollinator, Pollinator Habitat & Plant Rootstock Protection

Regardless of the lack of certainty regarding the pollinators (and pollinator habitat) of *Tetratheca juncea* (Chapter 4.2.1.1), the TjMP requires that potential habitat for sonicating bees (*ie* the grass trees located within the TjCA) will be protected during the management of the TjCA.

The rootstock of the *Tetratheca juncea* population will be protected by restricting access to the area, informing any staff working within the TjCA of its location, its conservation significance and the need to ensure that the rootstock should not be disturbed by activity conducted within the TjCA.

5.2.3 Fire Management

The management of fire within the TjCA will be determined by considering the relevant biological management issues (Chapter 4.2). The prescribed fire management regime is intended to ensure:

- the avoidance of overly frequent fires within the TjCA;
- prevention of the entire population being burnt in any one year (insofar as is possible);
- the minimisation of competition from native plant species (such as Blady Grass, Kangaroo Grass and Bracken);
- the management of fuel loads to prevent very intense or slow wildfires which apparently result in high mortalities in *Tetratheca juncea* populations;
- the avoidance of burning during the larval period of primary pollinators (if known and if possible);
- the avoidance of burning during the flowering and seed-set period of the plant; and
- the encouragement of seedling germination and establishment within the TjCA.

Consultation with adjoining landowners regarding for the possibility of co-operative management of *Tetratheca juncea* within the TjCA and on adjacent lands will be pursued.

Relevant aspects of co-operative management may include the implementation a fire regime that includes both the TjCA (and BCA) and adjacent properties where other *Tetralthea juncea* populations occur and co-operation in any propagation program. Advice from the NP&WS Fire research Team will be sought regarding the latest information regarding fire regimes in relation to *Tetralthea juncea*.

5.2.3.1 Fire Frequency

A fire frequency of less than every three years is regarded as likely to be disadvantageous for *Tetralthea juncea*, since existing evidence from other populations suggests that regenerating plants or seedlings do not flower reliably during the first year following fire. More frequent fires may increase the risk of the population declining (Chapters 4.2.4 & 4.2.5), and the monitoring program should be used to gauge whether this assumption is correct in the TjCA (Chapter 6).

The limits for the fire frequency regime are to be determined by the Project Environmental Officer (PEO), in consultation with a biologist and giving proper consideration to:

- the need for hazard reduction burns;
- existing fuel loads;
- changes in the abundance of purported native competitors; and
- changes in the fecundity, vigour or abundance of *Tetralthea juncea*.

It is suggested that the required fire frequency may be 6-12 years between fires, which provides a regenerating plant or seedling with several years in which to produce flowers.

5.2.3.2 Fire Management Units

Given the lack of certainty regarding the optimum fire regime for *Tetralthea juncea*, and the inherent variability in natural circumstances, the population in the TjCA will be divided into three separate sections for the purposes of fire management (Figure 4). The precise boundaries of the three Fire Management Units (FMUs) will be determined on-site by the PEO in consultation with a biologist on the basis of safety, geography, the distribution of fuel loads and other practical considerations.

The division of the TjCA into FMUs reflects a similar division of the Bushland Conservation Area (BCA) into FMUs. The TjCA is divided into FMU1, FMU2 and FMU3 (Figure 4).

The FMUs within the TjCA will not be burned within the same year, insofar as that is possible. The suggested fire regime is to burn FMU1 every six years, FMU2 every eight years and to leave FMU3 unburnt (Table 1). The FMUs can be delineated with a fire break (such as a rake-hoe or mineral earth fire break), but it is recommended that such a fire break be established in the presence of a qualified botanist to prevent accidental death of inconspicuous *Tetralthea juncea* clumps (Phytophthora - Chapter 5.2.5).

Table 1 Suggested regime within the TjCA

Characteristics	FMU1	FMU2	FMU3
Burn Frequency	Every 6 years	No burning	Every 8 years
Burn Intensity	Moderate	-	Moderate
Burn Timing			
First Burn	Autumn 2002	-	Autumn 2003
Second Burn	Autumn 2008	-	Autumn 2011
Third Burn	Autumn 2014	-	Autumn 2019

5.2.3.3 Fire Season

Managed fires should not be conducted in the TjCA during plant flowering period, or fruit set. Although these phenomena will vary between years, it is suggested that the suitable season for managed fires is autumn (Table 1).

5.2.3.4 Fire Intensity & Duration

As discussed in Chapter 4.2.2, it is suggested that a moderate intensity fire is appropriate, as slow cool fires and too frequent fires are detrimental to *Tetratheca juncea* populations. To assist in the maintenance of the appropriate fire intensity, attention will be given to fuel loads within the TjCA prior to any burn.

The burning regime is designed to provide a variety of circumstances, and of regeneration conditions (Table 1). The burning regime will be modified, doubtless, by unplanned bushfires.

5.2.4 Weed Control and Eradication

It is noted that the current weed intensities in the vicinity of the *Tetratheca juncea* population is generally low, except in the immediate vicinity of the dam and access track. Weeds will be removed from within the TjCA (and also from other parts of the BCA) to improve the quality of the bushland in these areas. Weed removal within the TjCA will be conducted using hand removal techniques.

The timing of weed control and eradication measures will be dependent on the weeds encountered within the TjCA. However, the most important aspect of weed removal and control within the TjCA is to ensure that the *Tetratheca juncea* population remains unharmed by any control activities. The timing of weed control activities within the TjCA will be determined by the PEO in consultation with a biologist.

As mentioned previously in Section 4.2.5, specific weed management measures within the TjCA will include:

- the removal and careful disposal of weeds from the TjCA;
- the continuous suppression of regenerating weeds;
- the immediate distribution of native plant mulch onto exposed areas;
- the restriction of access to the TjCA; and
- the monitoring of the TjCA to indicate the success of the weed removal program or to identify potential weed issues;

5.2.5 Access Restriction

Vandalism near the dam site indicates that unauthorised access to the clearing south of the TjCA poses a risk of arson burns, direct destruction of plants or habitat and (potentially) the introduction of weed seeds and *Phytophthora* spores. Access to unauthorised personnel will be closed at this location. Potential access controls include establishment of vehicle-proof barriers (such as a fence, large rocks, bollards or a gate) and the installation of a boundary fence along John Renshaw Drive.

In accordance with Condition No. 69 of the Conditions of Consent signage is to be installed along the TjCA boundary, and it must specify that “no dumping, clearing or other works are permitted in the Conservation Area”. Signage will be replaced as necessary. During the initial part of the Project the TjCA will be defined by markers in the field, although not be a fence as this could potentially draw unwanted attention to the area. Signs defining the TjCA will not be erected until approximately Year 8 of the Project. This will assist in the conservation of the *Tetratheca juncea* population given the current level of vandalism on the site and the likelihood of deliberate damage to the population if the TjCA is marked.

5.2.6 Erosion & Sediment Control

The *Erosion & Sediment Control Plan* (ESCP) prepared for the project (Global 2000a) indicates the location of erosion and sediment control features across the mine site. The ESCP will ensure that an effective drainage system will be installed between the 'mine disturbance area' and the TjCA. A drain is to be located alongside the boundary fence to draw off any eroding material from the bund around the 'mine disturbance area' to a sediment pond located beyond the limit of the TjCA.

Drainage lines installed within, or adjacent to, the TjCA need to be maintained regularly, and monitored to ensure their continued effectiveness.

5.2.7 Pre-mining Protocol

A summary of the measures listed above is presented (Table 2) and provides a basis for the Pre-mining Verification Report. It summarises each of the pre-mining management measures that must be implemented within the TjCA prior to mining along its eastern boundary.

Table 2 Pre-mining Protocol Summary

Pre-mining Action	Specific Action	Responsibility	Timing
Establish Monitoring Locations	Tag 25% of the population Establish ten permanent quadrats Collection of monitoring data (baseline and subsequent monitoring events)	PEO, in consultation with a suitably qualified biologist (SQB)	During Year 1 of mining and continues prior to mining
Protection of Pollinator, Pollinator Habitat & Plant Rootstock	Restriction of access to TjCA (including the erection of signage) Induction of staff working within the TjCA	PEO, in consultation with a SQB	Establish during Year 1 of mining and continues prior to mining As required
Fire Management	Determine boundaries of Fire Management Units Implement the recommended fire regime (Table 1)	PEO, in consultation with a SQB	Establish during Year 1 of mining As required
Weed Control & Eradication	Determine intensity & location of weeds Determine timing of weed removal Removal of weeds Disposal of removed weed material Restriction of access	PEO, in consultation with a SQB PEO, in consultation with a SQB PEO, in consultation with a SQB PEO, in consultation with a SQB PEO, in consultation with a SQB	Establish during Year 1 of mining Establish during Year 1 of mining Ongoing As required Establish during Year 1 of mining and continues prior to mining
Access Restriction	Install boundary fence along John Renshaw Drive Indicate boundary of TjCA	PEO PEO, in consultation with a SQB	Establish during Year 1 of mining Establish during Year 8 of mining

Table 2 (contd) Pre-mining Protocol Summary

Pre-mining Action	Specific Action	Responsibility	Timing
Access Restriction (contd)	Erect signage restricting access to the TjCA (Condition No.69)	PEO, in consultation with a SQB	Establish during Year 1 of mining and continue its maintenance prior to mining
	Induction of site staff regarding the significance of the TjCA	PEO	During Year 1 of mining, and as required
Erosion & Sediment Control	Implement the <i>Erosion & Sediment Control Plan</i> (Global 2000a)	PEO	Prior to mining activity in vicinity of the TjCA
Dumping or Stockpiling of Material	Restriction of access, including the erection of signage	PEO	Establish during Year 1 of mining and continue its maintenance prior to mining
	Induction of site staff regarding the significance of the TjCA	PEO	During Year 1 of mining, and as required
Pollution & Contamination Events	Restriction of access, including the erection of signage	PEO	Establish during Year 1 of mining and continue its maintenance prior to mining
	Induction of site staff regarding the significance of the TjCA	PEO	During Year 8 of mining, and as required
Alteration of Drainage Patterns	Implement the <i>Erosion & Sediment Control Plan</i> (Global 2000a)	PEO	Prior to mining activity in vicinity of the TjCA
	Monitoring of the population	SQB	Prior to and during mining

5.3 Mining and Post-mining Protocol

The *Mining & Post-mining Protocol* includes similar management actions as described for the pre-mining stages of the Project (Table 2). Mining and post-mining activities will include:

- implementing adaptive management based on the findings of the monitoring surveys (Chapter 5);
- the continued monitoring of the *Tetratheca juncea* population for a variety of information, including the population's response to fire, survivorship and absence or presence of seedlings (Chapter 6), incorporating any adapted management requirements;
- continued protection of pollinators and pollinator habitat, unless the ongoing monitoring provides additional information regarding *Tetratheca juncea* pollination;
- continued protection of the plant rootstock by the restriction of access and induction of staff entering the TjCA. Staff will be inducted regarding the conservation significance of the area and the importance of the protection of the rootstock;

- implementation of appropriate fire regime (Table 1) that considers both the survival of the *Tetratheca juncea* population and the need for hazard reduction burning and the consideration of further information gained from implementation of the fire regime within the TjCA (Chapter 5.2.3);
- continuation of weed control and eradication activities, should any weeds remain by that time (Chapter 5.2.4);
- restriction of access to the area for construction workers and their vehicles (Chapter 5.2.5) to prevent the possibility of spread of weed seed, stockpiling of materials and to reduce the risk of pollution or contamination events within the TjCA;
- the maintenance of erosion and sediment controls installed to protect the TjCA (Chapter 5.2.6) in accordance with the ESCP (Global 2000a), by monitoring the boundary between the TjCA and the 'mine disturbance area';
- prevention of the dumping or stockpiling of material by restriction of access to the TjCA and the induction of site personnel;
- reduction of the risk of pollution and contamination events by the restriction of access to the TjCA; and
- the protection of the TjCA from altered drainage by the implementation of the ESCP at an appropriate time prior to mining in the vicinity of the TjCA,

A summary of the measures listed above is presented (Table 3) and provides a basis for the Mining and Post-mining Verification Reports. It summarises each of the pre-mining management measures that must be implemented within the TjCA prior to mining along its eastern boundary.

5.4 Risk Assessment, Emergency Response & Incident Management

There is some potential risk that mining operations will affect the *Tetratheca juncea* population within the TjCA, particularly during the period when mining operations are in the immediate vicinity of the TjCA. Potential negative impacts include:

- changes to drainage patterns within the TjCA;
- erosion from the 'mine disturbance area', resulting in erosion and sedimentation into the TjCA;
- unauthorised access by mine workers (or others) into the TjCA;
- the spread of weed propagules into the TjCA;
- the dumping or stockpiling of materials within the TjCA; and
- possible pollution and contamination events as a result of an accidental spill.

Where unforeseen incidents occur, the emergency response will be to contact the Project Environmental Officer (PEO), who may then contact a suitably qualified biologist who will provide advice regarding the appropriate response. The Donaldson Mine Internal Incident Report will be used to document incidents as they occur on site. In most instances, the appropriate response will initially involve:

- termination of the activity or its modification to prevent further adverse impacts;
- containment of the problem;
- implementation of an incident report, to determine the precise cause of the incident and the measures necessary to rectify any impacts; and
- implementation of any appropriate impact amelioration or remediation measures.

Table 3 Mining & Post-mining Protocol Summary

Mining & Post-mining Action	Specific Action	Responsibility	Timing
Monitoring	Monitoring of tagged clumps and permanent quadrats	Suitably Qualified Biologist	During Year 1 of mining
Protection of Pollinator, Pollinator Habitat & Plant Rootstock	Restriction of access to TjCA (including the erection of signage) Induction of staff working within the TjCA	PEO	During and post-mining As required
Fire Management	Implement the recommended fire regime (Table 1)	PEO, in consultation with SQB	As per Table 1
Weed Control & Eradication	Removal of weeds	PEO, in consultation with SQB	Ongoing
	Disposal of removed weed material	PEO, in consultation with SQB	Ongoing
	Restriction of access	PEO	Ongoing
Access Restriction	Presence of signage restricting access to the TjCA (Condition No.69)	PEO	Ongoing
	Induction of site staff regarding the significance of the TjCA	PEO	As required
Erosion & Sediment Control	Monitoring of installed erosion and sediment controls between TjCA and 'mine disturbance area'	PEO, in consultation with SQB	During and post-mining
Dumping or Stockpiling of Material	Restriction of access, including the presence of signage	PEO	During and post-mining
	Induction of site staff regarding the significance of the TjCA	PEO	As required
Pollution & Contamination Events	Restriction of access, including the erection of signage	PEO	During and post-mining
	Induction of site staff regarding the significance of the TjCA	PEO	As required
Alteration of Drainage Patterns	Monitoring of installed erosion and sediment controls between TjCA and 'mine disturbance area'	PEO, in consultation with SQB	During and post-mining

5.5 Other Measures

Several other management measures will be implemented by this Management Plan that will protect the *Tetraloche juncea* population within the TjCA off-site. Off-site protection of the Donaldson *Tetraloche juncea* population is required to protect the population against a 'worst-case scenario' event, such as a large bushfire that destroys the entire population. The protection of the population off-site will also allow for the retention of the population's genetic material if a catastrophic event occurs.

Measures of protecting the *Tetraloche juncea* population off-site that will be implemented by this Management Plan will include:

- conservation of the *Tetralthea juncea* population outside of the designated TjCA, through the establishment of cuttings from TjCA population² (Montalvo *et al* 1997);
- collection and storage of seeds, where possible; and
- germination and propagation from seeds, where possible.

The effectiveness of these measures to re-establish *Tetralthea juncea* populations outside of the TjCA will be continually reviewed as part of the *Tetralthea juncea* research and monitoring program.

A further result of the protection of the Donaldson *Tetralthea juncea* population off-site and for *Tetralthea juncea* management in general will be the additional information gathered regarding the establishment of successful propagation and translocation techniques specifically for *Tetralthea juncea*.

² It is important to note that establishing a population requires consideration of the genetic diversity of the source population. This means attempting representative sample of the genetic diversity by a) sampling enough plants randomly and b) not over-representing any one or group of plants (Montalvo *et al* 1997)

6 MONITORING SURVEYS & REPORTING

The aim of the implementation of the TjMP is to maintain the population of *Tetralochea juncea* within the TjCA. To ensure that the TjMP is succeeding it is necessary to conduct regular monitoring of the TjCA that will provide information on the current condition and health of the *Tetralochea juncea* population. Whilst populations are expected to fluctuate naturally, consistent downward trends may indicate a risk of extinction of the local population. Considering that the species appears to rarely produce seeds and to have poor seedling survival (Chapter 4.2.1.2), the maintenance of adult clumps may be crucial to survival of the population.

6.1 Monitoring Schedule

6.1.1 Demographic Monitoring of *Tetralochea juncea*

Simple counts of individuals are often used to determine population trends, but this approach is not regarded as appropriate for *Tetralochea juncea* for several reasons:

- the species is inconspicuous when not in bloom;
- individuals are generally difficult to discern;
- individuals appear to be sporadic in producing flowers;
- the species could have a dormant seed bank present in the soil; and
- the species may be clonal.

A simple demographic study (in which a percentage of the population is tagged with fire-proof numbered tags and continuously monitored) will provide information on the fate of clumps and of the population. The study will also be used to monitor the response of the species to fire, along with data from permanent quadrats (Chapters 5.2.3.2 & 6.1.2).

To monitor the population and its vitality, approximately 25% of the population should be selected at random and tagged. Demographic monitoring should primarily occur in the latter half of the peak flowering period of plants annually. In addition, data collected should include information regarding plant survivorship, new growth of plants, budding or flowering and seed production (Table 4).

Table 4 Data to be collected in demographic census of the *Tetralochea juncea* population

DATA	MEASURES	PURPOSE
Survivorship	Alive/Dead	Some plants may be expected to die in any population each year by chance or old age. Conversely, the population may increase following fire. Dramatic increases in frequency of death could also indicate disease or other crisis (Chapter 6.2).
New Growth	Yes/No	Norton (1994) noted that re-sprouting plants produce a distinctive growth form. Re-sprouting plants could be assumed to be 'healthy' because re-sprouting requires stored carbohydrates, and is an indicator of succession following fires.
Budding or Flowering	Yes/No	Plants appear to require at least a year (and possible two) following fires to begin flowering. Additionally, some plants may flower consistently across years, whilst others do not flower.

Care will be required to ensure that intertwined clumps are not confused, by tracing stems to the base of the plant. As the growth form of the plant may lead to confusion in subsequent surveys, tags should also be placed at the base of each stem, using stiff wire rods (1-2m long) to aid the subsequent location of tagged stems.

Results of the demographic study will be analysed each year to determine fluctuations in the population, although it should be noted that these parameters would be expected to fluctuate

naturally. These data may also be useful to the preparation of a Recovery Plan for the species.

6.1.2 Monitoring Response of *Tetratheca juncea* to Fire

The population parameters (Table 4) will also be collected in post-fire monitoring surveys (involving quarterly surveys during the first year and six-monthly surveys during the next two years or until flowering is observed) in each of the Fire Management Units (FMUs) of the population (Chapter 5.2.3). Approximately 30 clumps should presumably fall into each FMU.

In addition to the baseline demographic data (Table 4), ten permanent 10m by 10m monitoring quadrats will be established within the population to provide an even geographic coverage. These will be monitored during annual censuses and during post-fire monitoring surveys for *Tetratheca juncea* seedlings. Each quadrat will be carefully examined for the presence or absence of seedlings, with any seedlings present being measured (total stem length) and tagged for subsequent measurements.

Previous studies suggest that seedling densities are likely to be low. If no seedlings are recorded in the ten quadrats following a fire event, the whole of the site should be carefully surveyed for seedlings. If any seedlings are located, they are to be tagged and monitored (as detailed as above).

6.1.3 Monitoring Changes in Native Competitors

The presence or absence, and the relative abundance, of potential native plant competitors (such as Blady Grass, Kangaroo Grass and Bracken) will be recorded in each annual census for each of the survey quadrats (Chapter 6.1.1). A standardised survey approach will be implemented for repeatability, involving counting of the total number of blades or fronds in each quadrat.

The presence or absence of each of these species in the survey quadrats will provide an indication of the spatial extent of these species in the TjCA. Given their growth form (eg rhizomes for Bracken) and their seed dispersal (dropping) mechanisms, these 'competitor' species could potentially spread gradually through the *Tetratheca juncea* population under suitable conditions.

The relative cover of the 'competitor' species generally increases under a frequent fire regime. The rate of any increase would provide another measure (along with a decrease in the appearance of new shoots of *Tetratheca juncea* - Table 4) of fire frequencies.

6.2 Reporting

The initial biological reporting required for the Donaldson Mine is the presentation of the baseline information that is to be collected prior to mining activities commencing adjacent to the TjCA. This information will form the comparison basis for future monitoring surveys undertaken throughout the operation of the mine. This baseline report will provide comments regarding the condition of the *Tetratheca juncea* population within the TjCA and will refer to information previously collected regarding this population (Gunninah 2000a).

A baseline monitoring report will be produced which will detail the condition of the TjCA, and in particular the *Tetratheca juncea* population and the grass trees located within it.

In addition to the above, verification reports will be produced which ensure that all the actions recommended within the 'Pre-mining Protocol' and the 'Mining & Post-mining Protocol' have been implemented. There will be a 'Pre-mining Verification Report', 'Mining Verification Report' and a 'Post-mining Verification Report' for the TjCA.

A monitoring report will be provided that will include the information required by the Proponent to fulfil Condition 13(1) of the Conditions of Consent, which requires the provision of a six-monthly environmental monitoring report to the various relevant stakeholders.

Reporting required for the Donaldson Coal Mine includes:

- baseline report detailing the condition of the TjCA;
- pre-mining, mining and post-mining verification reports for the TjCA, which require sign-off by a suitably qualified biologist or other relevant personnel to ensure that all relevant management measures have been implemented prior to the initiation of mining activities; and
- six-monthly monitoring reports which summarises the results of monitoring surveys conducted during the previous six months.

6.3 Timeline for Monitoring Surveys & Other Events

The main annual survey will occur during the flowering period of *Tetratheca juncea*, which is most commonly between October and November (Appendix B), although the flowering period for this plant does vary each year, depending on climatic circumstances.

During the first year of implementation of the TjMP, the permanent monitoring quadrats will be established during the flowering period of the plant, so that plants can be accurately located (Appendix B), and the clumps to be monitored will be tagged.

Following an ecological burn within the population (Table 3) post-fire monitoring surveys will be conducted to monitor the recovery of the plants, with ecological burns occurring during autumn (Appendix B). Burning during autumn avoids the flowering and seeding time of *Tetratheca juncea*.

7 INDUCTION & AWARENESS TRAINING

Condition 8(iv) of the Conditions of Consent for the Project requires the appointed Project Environmental Officer (PEO) to conduct an induction and training program for staff working at the Donaldson Coal Mine. With regard to the management of the Donaldson *Tetratheca juncea* population, the compulsory induction and awareness training will include reference to:

- the occurrence and precise location of the *Tetratheca juncea* population in the southwestern portion of the site;
- the restriction of access to the *Tetratheca juncea* Conservation Area, at all times, with the exception of staff members employed to manage the area (*ie* the PEO, a suitably qualified biologist and qualified bush regenerators);
- weed management issues, including relevant measures to control the spread of weed propagules; and
- general construction issues in respect to the TjCA, including the reporting of spillages or other incidents in the vicinity of the TjCA.

Further details regarding the general staff induction and awareness training are provided in Chapter 6 of the *Flora & Fauna Management Plan* for the Project (Gunninah 2000b) and the *Donaldson Coal Mine – Environmental Management Strategy (EME-1 “Training and Awareness Program”)*.

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