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Mount Gibson Iron

Extension Hill Pty Ltd

Mason's Darwinia
Darwinia masonii

Conservation Action Plan Revision 1.5
2016-2025

Extension Hill Pty Ltd and Mount Gibson Mining Limited

June 2023

Abbreviations

BGPA	Botanic Gardens and Parks Authority
BIF	Banded Ironstone Formation
CALM	Department of Conservation and Land Management, Western Australia (changed to Department of Environment and Conservation in July 2006 and Department of Parks and Wildlife in July 2013)
DEE	Commonwealth Department of the Environment and Energy (formerly DoE)
DEC	Department of Environment and Conservation, Western Australia (changed to Department of Parks and Wildlife in July 2013)
DEWHA	Commonwealth Department of Environment, Water, Heritage and the Arts (changed to DSEWPaC on 14 September 2010)
DoE	Commonwealth Department of the Environment
Parks and Wildlife, DPaW	Department of Parks and Wildlife, Western Australia (formerly CALM and DEC)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EHPL	Extension Hill Pty Ltd
GDTFRT	Geraldton District Threatened Flora Recovery Team
GNHwy	Great Northern Highway
IBRA	Interim Biogeographical Regionalisation for Australia
IUCN	International Union for Conservation of Nature
MGIOIP	Mount Gibson Iron Ore Mine and Infrastructure Project
MGM	Mount Gibson Mining Limited
NAN	Nuts About Natives
SCB	Species and Communities Branch, Parks and Wildlife
TPFL	Threatened and Priority Flora Database
UWA	The University of Western Australia
WA	Western Australia

Foreword

This Conservation Action Plan (plan) has been prepared by Extension Hill Pty Ltd and Mount Gibson Mining Ltd to meet condition 6-3 of Ministerial Statement 753 (MS753), which authorises the implementation of the Mount Gibson Iron Ore Mine and Infrastructure Project (MGIOIP). Appendices

Appendix 10.1 demonstrates how this Plan meets condition 6-3. The Plan is consistent with the "Recovery Plan Guidelines for Nationally Listed Threatened Species and Ecological Communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*" (Appendix 10.2).

Information in this plan was accurate at December 2016.

Cover photograph by Ben McLernon, Extension Hill Pty Ltd.

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Summary

Species:	*Darwinia masonii*	**Common name:**	Mason's Darwinia
Family:	Myrtaceae	**Flowering period:**	April – November
IBRA Regions:	Avon Wheatbelt, Yalgoo	**IBRA Subregions:**	Avon Wheatbelt P1, Tallering
Shire:	Yalgoo	**NRM region:**	Rangelands NRM – Murchison subregion
DPaW Region:	Midwest	**Recovery team:**	Geraldton District Threatened Flora Recovery Team (GDTFRT)
DPaW District:	Geraldton		

Current status of taxon:

- *Environment Protection and Biodiversity Conservation Act* 1999: Vulnerable
- Specially protected under the Western Australia *Wildlife Conservation Act* 1950: Schedule 3, Extant and considered likely to become extinct or rare
- Ranked in Western Australia as Vulnerable D2 (under IUCN 2001 criteria)

Habitat critical to survival:

Darwinia masonii is ranked as VU in Western Australia and is known from Mt Gibson Ranges. Consequently, it is considered that known habitat for wild populations is critical to the survival of the species and that representations of wild populations are important. Habitat critical to the survival of *Darwinia masonii* includes:

- the area of occupancy of populations,
- areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators),
- additional occurrences of similar habitat that may contain undiscovered populations or a dormant seed bank of the species or be suitable for future translocations, and
- any local surface water drainage and infiltration that may affect the habitat of the species.

Threats:

The main threats to the species are:

1. Mining (direct removal);
2. Drying climate;
3. Inappropriate fire regimes;
4. Mining (threatening processes);
5. Weed invasion; and
6. Grazing.

Plan objective:

The objective of this plan is "*to maintain, and ultimately improve, the conservation status of D. masonii such that its conservation status is more secure in the Mt Gibson area*" (Ministerial Statement 753).

Criteria for success:

This plan will be deemed successful if, over the term of the plan, all of the following are achieved:

1. The number of *in-situ* mature individuals in areas of known occupancy, outside of areas approved for disturbance under Ministerial Statements remains stable[1] or increases.

2. The conservation category of the species remains at the current status or improves.

Criteria for failure:

This plan will be deemed unsuccessful if, over the term of the plan, any of the following occur:

1. The total number of all *in-situ* mature individuals in areas of known occupancy, outside of areas approved for disturbance under Ministerial Statements, has decreased by more than 20% beyond its natural variability* as a result of effects from threats identified in section 1.3 ;

2. The conservation status meets IUCN criteria for listing at a higher threat category than the status (at the time of publication of this Plan).

* Natural variability will be assessed through regular monitoring as described in Section 4.5 and 4.9

Recovery actions:
1. Coordinate recovery actions and liaise with stakeholders.
2. Develop and implement restoration strategy.
3. Maintain and use seed/germplasm collections to ensure material with a broad genetic base is available for conservation.
4. Promote awareness of *Darwinia masonii*.
5. Implement *Darwinia masonii* condition monitoring program.
6. Implement fire management strategy.
7. Manage threatening processes of mining.
8. Protect plants from herbivory.
9. Report any new occurrences of *Darwinia masonii*.
10. Review conservation status of the species.
11. Review this plan

[1] Stable means number of mature individuals plus or minus fifteen per cent.

Recovery team:

Recovery teams provide advice and assist in coordinating actions described in recovery plans. They include representatives from organisations with a direct interest in the recovery of species, including those involved in funding and those participating in actions that support the recovery of species. The co-ordination and implementation of any recovery plan will be overseen by Parks and Wildlife.

1 Background

1.1 The taxon

This section provides a summary of information pertinent to *Darwinia masonii* including its description, taxonomy, biology and ecology, habitat and distribution, population history and conservation status. More comprehensive information with respect to the taxon can be found at Appendix 10.3.

1.1.1 Description

Darwinia masonii is an erect shrub 1.5 to 3m tall, with narrow leaves approximately 1cm long, which are almost triangular in cross-section. These leaves are closely crowded towards the ends of the branchlets. The flowering inflorescences are approximately 3cm in diameter and are surrounded by numerous spreading pinkish bracts that are pendulous on the ends of small branchlets. The bracts are broad at the base but narrow to a pointed apex with a distinct midrib. Each bract is approximately 2cm in length and 5mm wide at the base. Each tubular flower is about 5mm long with a style approximately 1.5cm in length with hairs below the stigma (Brown *et al*., 1998).

Darwinia masonii has a known flowering period from April to November (Brown *et al*., 1998). As the rainfall in the region is unreliable, *D. masonii* responds opportunistically to rainfall events (i.e. tropical cyclonic summer rainfall events and southern winter cold fronts). Strong vegetative growth (but not reproductive stages) has been observed following summer rainfall events.

1.1.2 History, nomenclature and taxonomic relationships

Charles Gardner (Gardner, 1964) described *D. masonii* from specimens collected by D. Mason of White Wells Station (now Charles Darwin Reserve) in about 1960.

Investigations of the phylogeny of related genera *Chamelaucium*, *Darwinia*, *Verticordia*, *Actinodium*, *Homoranthus* and *Pileanthus* have been completed to more accurately determine their taxonomic status and phylogenetic position, specifically *D. masonii*. Key results of investigations by BGPA (2005) reported:

- Genetic status of Chamelaucium and Pileanthus is confirmed (i.e. they are monophyletic).
- Eastern and Western Australia *Darwinia* species belong in separate groups.
- The genera *Chamelaucium*, *Pileanthus*, *Darwinia*, *Homoranthus* and *Actinodium* are nested within *Verticordia* as currently circumscribed.
- *Darwinia masonii* has been shown to be most closely related to three other species, *D. acerosa*, *D. purpurea* and *D.* sp. Chiddarcooping (S.D. Hopper 6944).

1.1.3 Biology and ecology

Darwinia masonii is one of 65 Western Australian species of *Darwinia*. The genus is unusual in having a high proportion of species that are considered rare and endangered as a result of intrinsic rarity – i.e. a species that is naturally rare as a result of limiting natural factors such as edaphic requirements and/or breeding biology. *Darwinia masonii* is an intrinsically rare species.

Mature plants of *D. masonii* have a slow, irregular and modular growth form (BGPA, 2010). Seedling growth forms are more regular with increases in height and stem diameter correlated with age. Older plants may experience dying back of branchlets at their extremities during drought years, and branchlet growth within the canopy during good seasons. Their stems are often irregularly shaped, having cracks, swellings, or a presence or absence of spongy bark. Individuals may be prostrate or reclining, and the canopy is not uniform in shape.

Flowering of young plants begins to occur at six years (BGPA, 2010). Flower numbers are greater for old plants with wide canopies. Flower heads form on the terminal end of branches and new vegetative shoots are produced laterally from below the terminal flowering head. Plants have been recorded flowering between April and November (Brown *et al*., 1998). In 2009, the Botanic Gardens and Parks Authority (BGPA) recorded flowers opening between late August and late October (BGPA, 2010).

Darwinia masonii is thought to be predominantly pollinated by birds, with a brief study recording pollination solely by the White-fronted Honeyeater (*Phylidonyris albifrons*) (BGPA, 2010). *Darwinia masonii* is capable of producing low-viability, self-pollinated (selfed) seed. There was weak evidence that selfed seed were less fit than outcrossed seed (BGPA, 2010). However, due to the low viability of selfed seed, the production of outcrossed seed would be important for self-sustaining populations (BGPA, 2010).

Darwinia masonii seed production is moderately low, with between 15% and 30% of developed fruits in an infructescence containing filled seed (BGPA, 2010). The mean number of filled seeds per infructescence in BGPA's study (2010) was 2 to 4.5 and, on average, between 25 and 75 filled seeds were produced per flowering plant. Seed production takes place in spring and early summer with the peak of ripe seed production in the 2009 season occurring around mid-November (BGPA, 2010). The peak period for seed collection depends on the relative rates of seed development and seed drop and may vary between years and localities. Seed dispersal occurs by ants. Predation by moth larvae, and self-pollination resulting in inbreeding, contribute to reduced seed quality and quantity.

Large scale production of seedlings of *D. masonii* via germination of fresh or stored seed involves physical manipulation of small seeds for seed coat nicking or removal, or retrieval of seed buried for months or years (BGPA, 2010). Seed of *D. masonii* has physical and physiological dormancy process (removal/breakdown of fruit walls and stimulatory effect of smoke chemicals, respectively). Preliminary results of *in situ* seed burial trials which commenced in January 2009 indicate complex germination / dormancy strategies, combining a requirement for physical degradation of the seed coat, environmental (seasonal temperature) cuing - with seeds cycling in and out of dormancy, and smoke-related physiological responses. Germination rates of 90% were achieved with filled seed exhumed after 9 months (in September 2009) of burial and treated with smoke water. The trial ran for a period of 15 months (until March 2010), however seeds have been recovered as recently as May, 2014 and provided to BGPA. There are buried seed caches *in-situ* on the south western slope of Mt Gibson.

There is also evidence of limited inter-fire recruitment of *D. masonii*. Fire history mapping has been used to explain the demography of the *D. masonii* population (see Section 1.1.5).

Darwinia masonii plants are long-lived and can be killed by fire (Armstrong and Associates, 2004; BGPA, 2010 Section 1.1.5). Plants arising from seed germinate in a single cohort post-fire. A wildfire burnt out a significant area in southern and eastern portions of the Ranges in January 2003. None of the *D. masonii* plants burnt during this fire survived during the spring of 2003 (Armstrong and Associates 2004).

In the absence of fire, there is evidence of limited recruitment of *D. masonii* in older populations (BGPA, 2010). Plant sizes from data collected in 2007 during BGPA's demographic study ranged in height up to 240cm and 2.5m in canopy width. The largest stem diameter was 74mm. Plant size correlated with population age in frequency distribution graphs of the young (last burnt in 2003) and mature (last burnt in 1969) plots which showed distinct peaks in size and a narrow size range. The older (last burnt before 1968) plots were estimated to have been unburnt for over 85 years and had the oldest and largest plants in them. However, the frequency distribution graphs did not have distinct peaks in size, but rather a spread of plant sizes. The data from the older plots confirmed that *D. masonii* is long-lived and that some recruitment (although very limited in the number of recruits) occurs at infrequent intervals in the absence of fire.

Regeneration after fire is restricted exclusively to germination from seed held in long-lived soil-stored seedbanks (BGPA, 2010). Recruitment in plots within the boundary of an experimental fire conducted by BGPA in May 2009 confirmed that *D. masonii* germinates strongly after fire, with a seedling density in burnt areas of 1.2/m^2 and 3.2 seedlings per pre-fire adult (BGPA, 2010). A fire, which occurred on the 12th of May, 2009 was not as intense as anticipated and was patchy, such that 73 of the 93 pre-fire adults were burnt. However, it achieved what was intended: The fire killed the plants' canopy; there was a good amount of ash produced; and, seedlings emerged. Soil temperature at some of the probe sites did reach 250°C (B Miller 2013, pers. comm., 17 December). 233 seedlings were counted in 2009 (BGPA, 2010) and 41 seedlings were counted in 2013 (J. Sackmann 2014, pers comm 30 November) within the area burnt of the four experimental fire plots, in comparison to recruitment of only one seedling in the 15 unburnt plots over the course of the study (May 2007 to June 2010). This seedling was recorded in an older (pre-1968) plot on Mt Gibson South in July 2009. This corroborates with the findings of BGPA's population structure study - recruitment occurs in older populations, but is very limited in the absence of fire.

BGPA (2010) reported that, "*While mortality is rare among mature* Darwinia masonii *plants, drought over the winter of 2010 contributed to a significant level of mortality (>10% in one site)*" (p6).

There is significant spatial and temporal variation in mortality of *D. masonii* seedlings (BGPA, 2010). The death rate for seedlings monitored between 2007 and 2009 in five plots last burnt in 2003 ranged from 2.5% to 15% per year. Possible reasons for the variation in seedling mortality included seasonal variation in rainfall, soil water holding capacity and the microclimate of each plot. BGPA suggested that low survival rates of *D. masonii* seedlings (9% survival within one year of being tagged as having germinated over the winter period) in plots following an experimental burn may partly have been attributed to the drought over the following winter.

Darwinia masonii shares with co-occurring species the drought avoiding strategy of closing down transpiration and photosynthetic function to enter a period of physiological dormancy through drought, with the capacity to restore tissues as soils wet (BGPA, 2010).

Roots of *D. masonii* have a capacity to enter large cracks, pores and fissures in regolith and may achieve considerable root depths (BGPA, 2010). *Darwinia masonii* also has a clear association with Vesicular-Arbuscular Mycorrhizae (VAM) (BGPA, 2010). These attributes assist the species to persist in environments with low water and nutrient availability.

The *Darwinia masonii* Interim Recovery Plan (IRP) (DEC, 2008) stated that "only very minor grazing pressure from feral goats and rabbits of *D. masonii* has been observed to date" (p10) and BGPA (2010) found that grazing by vertebrates (presumed to be goats and rabbits) had no impact on *D. masonii*. BGPA (2010) conducted monitoring of 378 seedlings and adult plants between 2007 and 2010 in demography plots, and a further 277 seedlings in plots established in an area subjected to the experimental burn. No evidence of mammalian herbivory was observed on any plant (seedling or adult) monitored. Branch tip pruning of 4 tagged plants was observed in 2007 and was presumed to have been caused by parrots eating flowers or seeds. No evidence of herbivory on *D. masonii* has been recorded during monitoring which has been conducted annually since 2010 by MGM. Twenty two quadrat monitoring sites within 6 populations of *D. masonii* are monitored (refer to Table 1). BGPA (2010) thus concluded that grazing by vertebrates (presumed to be goats and rabbits) had a negligible impact on *D. masonii*.

Termites did not appear to be significant on the mean growth rates and health scores of *D. masonii* (BGPA, 2010).

Foliar loss or damage by insect attack was only noted in the form of galls on a very small number of *D. masonii* individuals (BGPA, 2010). Insect attack is thus not considered to be a significant threat to the species.

Modelling of species distributions against spatially mapped environmental data found that the principal environmental parameters predicting the distribution of *D. masonii* were slopes over 7-8°, elevation over 380m AHD and all geology types within the Mt Gibson Ranges except "White Rock (unclassified, including granite and its group, acidic dyke rocks, feldspar porphyry and meta-sediments phyllitic rock)" (BGPA, 2010). However, many areas in the Mt Gibson Ranges, where populations were predicted to occur by the modelling, do not necessarily support extensive records of *D. masonii* plants. This may, in part, be due to the historical *D. masonii* survey methodology. Recent surveys have made records in some of the areas (Maia 2014; Eco Logical Australia 2014) predicted by the models as being suitable habitat for the species. BGPA (2010) also reported that the distribution of *D. masonii* may have an association with unmapped sub-surface features such as regolith (soil depth, underlying rock structure) and longer-term (prior to the 1960s) fire history patterns, and this may also account for the absence of *D. masonii* plants in areas predicted as having suitable habitat.

1.1.4 Habitat and distribution

Darwinia masonii is found within the Mt Gibson Ranges, 350km north-east of Perth. *Darwinia masonii* is predominantly restricted in its distribution to the upper slopes, crests and ridges of the eleven major hills that comprise the 6km range. The current distribution of *D. masonii* is mapped in Figure 1. The most up-to-date collation of knowledge of the species and interpretations of impact management on the species ecology is contained within MGM (2016).

Research (Muir, 1995, Bennett, 2000, Paul Armstrong and Associates, 2004 and ATA Environmental, 2005) suggests that D. masonii is restricted in distribution to the Mt Gibson Ranges. Areas with similar geology (banded ironstone formation or chert) and vegetation to that at the Mt Gibson Ranges were surveyed by Paul

Armstrong & Associates (2004), ATA Environmental (2004), BGPA (2008) and Maia Environmental Consultancy (2014a, 2014b), however no additional records have been located to date during these surveys in places other than Mt Gibson Ranges (Figure 2). There is anecdotal evidence (Muir, 1995) that *D. masonii* may have been previously recorded from Mt Singleton, although brief later examinations of the site by Paul Armstrong and Associates (2004) and ATA Environmental (2004) did not identify the species at this location.

An anonymously collected specimen of *D. masonii* from the locality of Mt Gibson Station is held in the WA Herbarium (PERTH 01105450). The date of collection was not provided for the specimen, but it was databased in 1990, so was collected prior to 1990 (K Knight 2014, pers. comm.). The location of this specimen is provided in the WA Herbarium database as being between 1 and 2km north-west of Mt Gibson Homestead within the Mt Singleton Range. Due to the lack of detailed location description and no supporting maps or sketches, this location is unreliable, and actual location on Mt Gibson Station where the specimen was collected is unknown. Searches have been conducted on the Mt Singleton Range, as described in Section 1.1.4, and no occurrences of *D. masonii* have been recorded to date.

All other specimens of *D. masonii* held by the WA Herbarium were collected from the Mt Gibson Ranges.

The habitat where *Darwinia masonii* grows was described by Brown *et al.* (1998) as tall shrublands on yellow-brown clay loams on the Banded Ironstone Formations. ATA Environmental (2004) targeted survey recorded *Darwinia masonii* from eight vegetation communities. These were previously identified and mapped by Bennett Environmental Consulting (2000) and included one mallee, six thicket and one heath community:

T1 Dense Thicket of mixed species dominated by *Acacia* species, *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus paucifolius* and *Melaleuca nematophylla* over Low Shrubland in jaspilite rocks and pockets of loam.

T2 Dense Thicket dominated by *Acacia assimilis*, *A. stereophylla* var. *stereophylla*, *A. ramulosa* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over Low Shrubland of *Acacia acuaria*, *Hemigenia buccinata* and *Enekbatus* aff. *cryptandroides* in loam with scattered rocks on the surface.

T3 Dense Thicket dominated by *Acacia assimilis*, *Allocasuarina acutivalvis* subsp. *prinsepiana* and *Melaleuca nematophylla* over Low Shrubland of *Hemigenia buccinata* and *Hibbertia crassifolia* in loam pockets in jaspilite rocks.

T4 Dense Thicket of *Allocasuarina acutivalvis* subsp. *prinsepiana* with occasional *Eucalyptus oldfieldii* over an Open Scrub of Acacia species over Open Shrubland of *Hemigenia buccinata* or Open Herbs of *Xanthosia kochii*.

T5 Thicket of *Allocasuarina acutivalvis* subsp. *prinsepiana* and *Grevillea obliquistigma* with emergent *Callitris columellaris* over Low Shrubland dominated by *Darwinia masonii*, *Hibbertia crassifolia*, *Melaleuca radula* and *Philotheca brucei* over Herbs of *Xanthosia kochii* in loam pockets in dense jaspilite rocks.

T6 Thicket of *Acacia acuaria* and *Acacia stowardii* over Low Shrubland of mixed species with large numbers of *Darwinia masonii* in loam with abundant rocks on the surface.

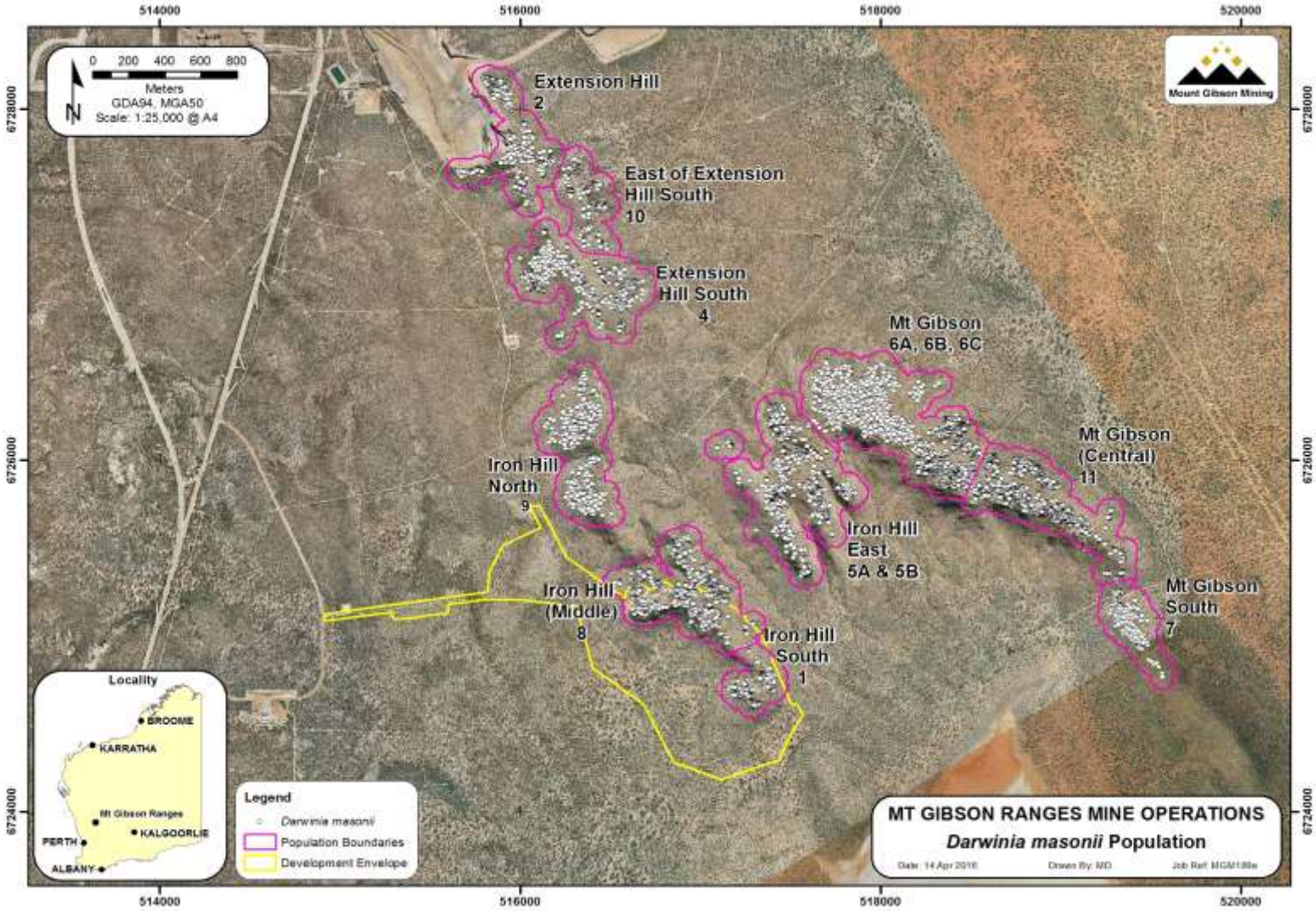


Figure 1. Distribution of *Darwinia masonii* [based on data from Eco Logical (2014)]. Parts of the Extension Hill hematite pit and mine infrastructure in the north can be seen and the Iron Hill Deposits (Statement 1045) development envelope is shown.

M4 Very Low Open Shrub Mallee of *Eucalyptus leptopoda* with emergent *Eucalyptus loxophleba* subsp. *supralaevis* over Thicket of *Acacia ramulosa* over herbland of Asteraceae in loam.

HS1 Low Heath of *Ptilotus obovatus* with emergent shrubs of *Acacia stowardii* and *Calycopeplus paucifolius* over Herbs in loamy clay large amongst large boulders.

Meissner and Caruso (2008) conducted a study of the flora and plant communities of the Mount Gibson Range and surrounding ironstone ranges on the Ninghan Pastoral Lease in 2005. Data was collected from 50 permanent quadrats established between September and October of that year to cover the geomorphology, floristic variation and geographical variation across the ranges. Seven community types were defined, and four of these were restricted to the Mt Gibson Range. *Darwinia masonii* was only present in two of the communities restricted to the Mt Gibson Ranges, and it was an indicator species in one of the communities:

Community 5 Open shrublands and shrublands of *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus paucifolius* and *Acacia tetragonophylla* over shrublands of *Philotheca brucei* subsp. *brucei* and *Ptilotus obovatus*. This community consisted primarily of sites on rocky outcrops on upper slopes and hill crests on Mt Gibson Ranges. It was not found on Extension Hill. This was the most species rich community (mean 38.5 +/- 1.2 species per quadrat). Indicator species were *Acacia exocarpoides*, *A. tetragonophylla*, *Cheilanthes adiantoides*, *Darwinia masonii*, *Hakea recurva*, *P. brucei* subsp. *brucei*, *Prostanthera magnifica*, *Prostanthera patens* and *P. obovatus* var. *obovatus*.

Community 6 Open woodlands, shrublands and sparse shrublands *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Melaleuca nematophylla*, *A. assimilis* subsp. *assimilis and Grevillea obliquistigma* subsp. *obliquistigma* over shrublands of *Hemigenia buccinata* and *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207). This community is found mainly on the crests and upper slopes of Extension Hill with mean species richness of 35.1 +/- 0.8 species per quadrat. Indicator species were *Allocasuarina acutivalvis* subsp. *prinsepiana, Cassytha nodiflora, Grevillea obliquistigma* subsp. *obliquistigma*, *Hemigenia buccinata*, *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207), *Melaleuca nematophylla* and *Melaleuca radula*.

The original work of Bennett (2000), ATA (2004) and Meissner & Caruso (2008) has been superseded by other more recent surveys (described below) and collated in MGM (2016).

1.1.5 Population history

Parks and Wildlife have collated the data from numerous surveys into the Threatened and Priority Flora database (TPFL) and identified 10 populations of *D. masonii*, all of which occur on the Mt Gibson Ranges (Table 1).

Previous surveys of *D. masonii* within the Mt Gibson Range were undertaken by Muir Environmental (1995), Bennett Consulting (2000), Paul Armstrong & Associates (2004) and ATA Environmental (2004). Bennett Environmental Consulting (2000) reported on nine populations. Muir Environmental (1995) recorded 10 populations, while Paul Armstrong and Associates (2004) recorded seven populations.

Maia (2014a) reported on their *D. masonii* targeted survey in December 2013 at Mt Gibson South (TPFL 7). Each plant within the area surveyed (which covered the entire population) was recorded, along with its location, height, age, reproductive status and health. Their survey also included two other study areas, one on a hill south of Iron Hill South, and the other to the north-west of Mt Gibson Homestead (Figure 2). The location of the latter corresponded to the specimen held in the WA Herbarium of *D. masonii* from the locality of Mt Gibson Station (PERTH 01105450). Commentary relating to the accuracy of the location of this specimen has been provided in Section 1.1.4. Maia (2014a) searched an area of 25.1 ha for this record and did not find evidence of *D. masonii* within the area searched. *D. masonii* was not found in either of these study areas on the hill south of Iron Hill South.

Maia (2014b) was also engaged to conduct a targeted regional survey for *D. masonii* in June 2014. Nine areas were surveyed, as shown in Figure 2. No *D. masonii* plants were located in any of the nine areas.

The most recent and comprehensive survey for *D. masonii* was conducted by Eco Logical (2015) across all ten populations in 2014 (four trips between May and October 2014).

Figure 2. Regional areas surveyed in recent years for *Darwinia masonii*. No records located in these areas

Population size

In 2004, a census of the *D. masonii* population recorded 16,573 individuals, comprising 14,307 mature individuals (86%), 1,725 seedlings (10%) and 541 senescent (dead) individuals (3%) (ATA 2004). That census formed the basis for the original environmental assessment for the approved mine operations at the Mt Gibson Ranges (ATA 2006a; EPA 2006a; WA Minister for Environment 2007), for which approximately 15% of the total *D. masonii* population were approved for removal; equating to approximately 17% of the mature *D. masonii* population.

Since the initial ATA (2004) census, additional surveys by Coffey (2008a), MBS (2013) and Maia (2014) have improved the knowledge on the *D. masonii* population at the Mt Gibson Ranges, with the population records subsequently increased prior to 2014 to 17,818 *D. masonii* individuals (DPAW 2014d).

Based on ATA (2004) and Coffey (2008a), a total of 1,702 *D. masonii* records coincided with the development of the approved mine operations to date (MGM & EHPL 2014a).

A census for *D. masonii* individuals was undertaken during 2014 to provide a contemporary record of the abundance and distribution of the *D. masonii* population at Mt Gibson Ranges. The census recorded 20,965 extant *D. masonii* individuals, comprising 19,132 mature individuals (91%), 1,580 juveniles (8%), 188 seedlings (less than 1%) and 65 senescent individuals (less than 1%) (Eco Logical 2015a).

Based on the Eco Logical (2015a) *D. masonii* census population data of 20,965 individuals, together with the 1,702 individuals removed to date by the as part of the existing approved Extension Hill mine development (MGM & EHPL 2014a), the total pre-disturbance *D. masonii* population is estimated at 22,667 individuals. This revised *D. masonii* population of 22,667 individuals is more than 6,000 individuals greater than the 16,573 individuals originally reported ten years before by ATA (2004); these 2014 data were used in the environmental assessment of the existing approved Extension Hill mine operations.

The notable increase in the total population records for *D. masonii* between the ATA (2004) and Eco Logical (2015a) census records is considered largely a result of the greater survey extent undertaken by Eco Logical (2015a), rather than an increase (greater than 30%) in the population over time (noting there were no environmental factors (e.g. fire) between the census periods which could have resulted in such an increase).

Key features are, since the IRP was published in 2008 (DEC, 2008) are:

- Approximately 1,702 whole plants have been taken from TPFL populations 2 and 3 for the approved MGIOIP hematite mine (under Permit to Take number 70b-0809). This comprises all of TPFL population 3 and part of TPFL population 2;
- As of December 2016, 1,327 records are authorised to be taken from TPFL populations 8 and 1 for Iron Hill Deposits (under Permit to Take number 80-1617)
- TPFL population 10, which was not listed in the IRP (2008), was partially surveyed in 2013 and 43 mature plants were recorded. Many additional records now exist as a result of the Eco Logical census (2015);
- TPFL population 7 on Mt Gibson South was surveyed in detail in December 2013, and the number of mature plants recorded was 837, which is 513 plants more that when it was

surveyed in 2004 (Maia, 2014a). Further records were also made in that area by Eco Logical (2015);

- Many additional records now exist in TPFL population 5A, 5B on Iron Hill East;
- The highest density and occurrence of records occurs on the northern part of Mount Gibson;
- There are only a small number of records (being 16) that are not situated in one of the ten areas grouped as TPFLs;
- A historical record of *D. masonii* in NatureMap lies on Mt Gibson Station towards Mt Singleton, although no detailed survey record exists. Maia (2014a) searched an area of 25.1 ha for this record and did not find evidence of D. masonii within the area searched.

The revised population of the 2014 census (Eco Logical 2015) indicates that there were more than 6,000 extra records when compared to ATA (2004).

Since the records made prior to 2013, which gave the sense of discrete groups on and around ridgetops, there is a blending of records through certain TPFL Population Numbers being:

- The southern part of Extension Hill and the northern part of Extension Hill South;
- The eastern part of Iron Hill East with the western part of Mount Gibson; and
- The southern part of Mt Gibson with the northern part of Mt Gibson South.

Well placed but arbitrary separators were made in order to 'assign' a plant record to the existing TPFL Population number in Table 1. These separators are shown in Figure 1.

Table 1. Summary of population history and records prior to 2013

TPFL Pop No.	IRP Pop No.	Date of first database record (database)	Broad location description	Take status	WA Herbarium Sheet (PERTH No.)	Quadrat monitoring site	Date of most accurate monitoring record (method)	Number of plants (IRP) Pre-2014	Number of plants Eco Logical (2014)	Comment
1	6	01/01/1994 (TPFL)	Iron Hill South	Extant	06874460	D4, D5, D6, D7, D8, D24	19/07/2004 (estimate) 11-17/06/2014 (actual)	1,601 (970) [133]	494	Majority of area was burnt in Jan 2003 wildfire. Last census in 2014.
2	2	11/05/1995 (TPFL)	Extension Hill	Partially taken - hematite pit	07356595	D1	19/07/2004 (estimate) 11-17/06/2014 (actual)	1,924 (12) [25]	1,876	Last census in 2014.
3	1	11/05/1995 (TPFL)	Extension Hill North	Taken	05313368; 06874495		19/07/2004 (estimate) Present	545 (12) [12] 0 (0) [0]	0	TPFL 3 has been taken.
4	3	01/10/2003 (TPFL)	Extension Hill South	Extant		D2, D3, D16, D17, D18	19/07/2004 (estimate) 11-17/06/2014 (actual)	1,874 (26) [32]	2,082	Last census in 2014.
5A, 5B	7	10/1950 (WA Herb)	Iron Hill East	Extant	01005820; 01005382; 01005790; 01005367; 01005812; 01005359; 01005804; 01005855; 01005375; 01005839; 01005340; 01005847; 00137626; 00719536; 02521741; 02521733; 06796680; 01000691		19/07/2004 (estimate) 11-17/06/2014 (actual)	70 (11) [8]	1,692	Did not survey areas (majority) burnt by Jan 2003 wildfire during census in 2004. Last census in 2014.
6A, 6B, 6C	8	28/07/1986 (WA Herb)	Mt Gibson	Extant	07290810 04977025 (no det)	D9, D10, D11, D12, D21, D22, D23	19/07/2004 (estimate) 11-17/06/2014 (actual)	7,021 (61) [278]	9743	July 2004 survey area did not include area burnt in Jan 2003 wildfire. Census in 2014 over Mt Gibson (6,226) and Mt Gibson (central) (3,517).

TPFL Pop No.	IRP Pop No.	Date of first database record (database)	Broad location description	Take status	WA Herbarium Sheet (PERTH No.)	Quadrat monitoring site	Date of most accurate monitoring record (method)	Number of plants (IRP) Pre-2014	Number of plants Eco Logical (2014)	Comment
7	9	01/01/1994 (TPFL)	Mt Gibson South	Extant		D13, D14, D15	19/07/2004 (estimate) 11-17/06/2014 (actual)	324 (1)	883	Eco Logical (2014) recorded additional specimens further south from those of Maia (2014).
8	5	11/05/1995 (TPFL)	Iron Hill Middle	Extant	06874509		19/07/2004 (estimate) 11-17/06/2014 (actual)	370 (597) [18]	1,657	Majority of area was burnt in Jan 2003 wildfire. Last census in 2014.
9	4	11/05/1995 (TPFL)	Iron Hill North	Extant		D19	19/07/2004 (estimate) 11-17/06/2014 (actual)	586 (33) [34]	1,951	Majority of area was burnt in Jan 2003 wildfire. Last census in 2004.
10	Not listed	12/2/2008 (TPFL)	E of Extension Hill South (~450m SE of TPFL pop 2)	Not taken			24/09/2013 (Partial survey, low quality) 12/02/2008 (estimate) 11-17/06/2014 (actual)	43 (0) [0] Several hundred	587	Partial survey, low quality in 2013. Last census in 2014.

* This population has been partially taken. Approximately 1,702 plants have been removed for the hematite mine, which infers that the number of plants remaining may be 767.

() = number of seedlings/juveniles; [] = number of dead

Plants related to past planting trials are not recorded in the above table. These may account for in the order of 200 plants.

Population genetics

Genetic research of *D. masonii* found low genetic differentiation demonstrating weak population structure between seven *D. masonii* groups (BGPA, 2010). Analysis of Molecular Variance (AMOVA) partitioned 94% of the variation within the groups, and 6% between groups. However, pairwise permutation tests between each of the tested groups showed that there is a distinction (a departure from completely random mating) between some of the groups. Two groups (TPFL no. 4 and 7) were statistically different from each other and all remaining sampled groups. Based on BGPA (2010), they were therefore interpreted as being genetically isolated from each other and all other tested groups. These TPFL's are located on Extension Hill South and Mount Gibson South. Various theories were put forward as potential reasons for this distinction between groups including: groups being disjunct; age of the population since fire causing the DNA analysis from that population skewed by older samples; and differential selection at loci linked to some microsatellite markers. As a result of this finding, BGPA (2010) recommended that genotypes of respective groups should not be mixed in species restoration activities. However, it should be noted that *Lepidosperma gibsonii* shows groups in those same locations (i.e. Extension Hill South and Mount Gibson South) being disjunct from each other. The alignment between the two species is the strongest evidence that this is not a genetic difference, but an external influence e.g. possibly soil type, soil water relations etc. that causes a difference in flowering time between sites (G. Dale 2015, pers. comm., 10 March, 2015).

Aside from these two groups, other groups showed no difference and are described as being a "*single panmictic, interbreeding population*" (BGPA, 2010).

Results from a recent assessment of *D. masonii*, however, confirm a weak genetic structure in the nuclear microsatellite data, with nearly all populations exhibiting isolation-by-distance (M Barrett 2013, pers. comm.). The further any two populations are from each other, the more different they are on average. Nearly all populations show unique chloroplast haplotypes, suggesting that seed dispersal is very limited, and has been for a considerable time. These recent findings imply that the genetic diversity of *D. masonii* is partly described by the populations of this taxon, and the inference is that loss of population diversity may have implications for the genetic diversity of the species.

Factors affecting population history

Fire

Fire history mapping indicates four major fires have occurred since 1969 over the extent of occurrence of *D. masonii* (BGPA, 2010). These have been dated at 1969, 1972, 7 to 10 February 2003 and December 2005. The dating of the first two recorded fires may be imprecise and vary by a year or two, but is considered insignificant relative to the long time since these fires. No information is available regarding the intensity of the fires, completeness of the fires or the timing of the fires dated 1969 or 1972.

Darwinia masonii is fire-killed (see Section 1.1.3), so the fire history of the populations can be used to determine the population age. The time since fire of the populations of *D. masonii* varies from four years (juvenile status) to greater than 50 years (old status) (Table 2). Population 7 on South Mt Gibson South is old and has not been burnt for over 50 years, while the majority of populations 2, 10 and 4 on Extension Hill South are mature and were last burnt in 1969. A small experimental fire was conducted in population 2 in 2009, but the remainder of the population has not been burnt since 1969. The western part of population 9 on Iron Hill North is mature,

having not been burnt since 1972, while the eastern part of population 6 (a, b and c) on Mt Gibson Hill has not been burnt since 1969 and is also mature.

Part or all of six populations (1; 3; 5A and B; 6A, B and C; 8; and 9) are young, having been last burnt in 2003 or 2005 (Table 2). Of the six young populations, only population 1 on Iron Hill South has been burnt once within the last 50 years (in 2003). The other five populations (3; 5A and B; 6A, B and C, 8; and 9) have been burnt twice. Within population 8 on Iron Hill Middle and 9 on Iron Hill North, the boundaries of the fires in 1972 and 2003 did not overlap to a large degree, so only a small proportion of this population has been burnt twice. A majority of population 3 on Extension Hill North was burnt in both of the fires in 1969 and 2005. This population has been taken during mining activities. A majority of populations 5A and 5B on Iron Hill East have been burnt in fires in 1969, and again about 10 years ago, in 2003. The western side and part of the top of Mt Gibson Hill (populations 6A, B and C) was burnt in these same fires.

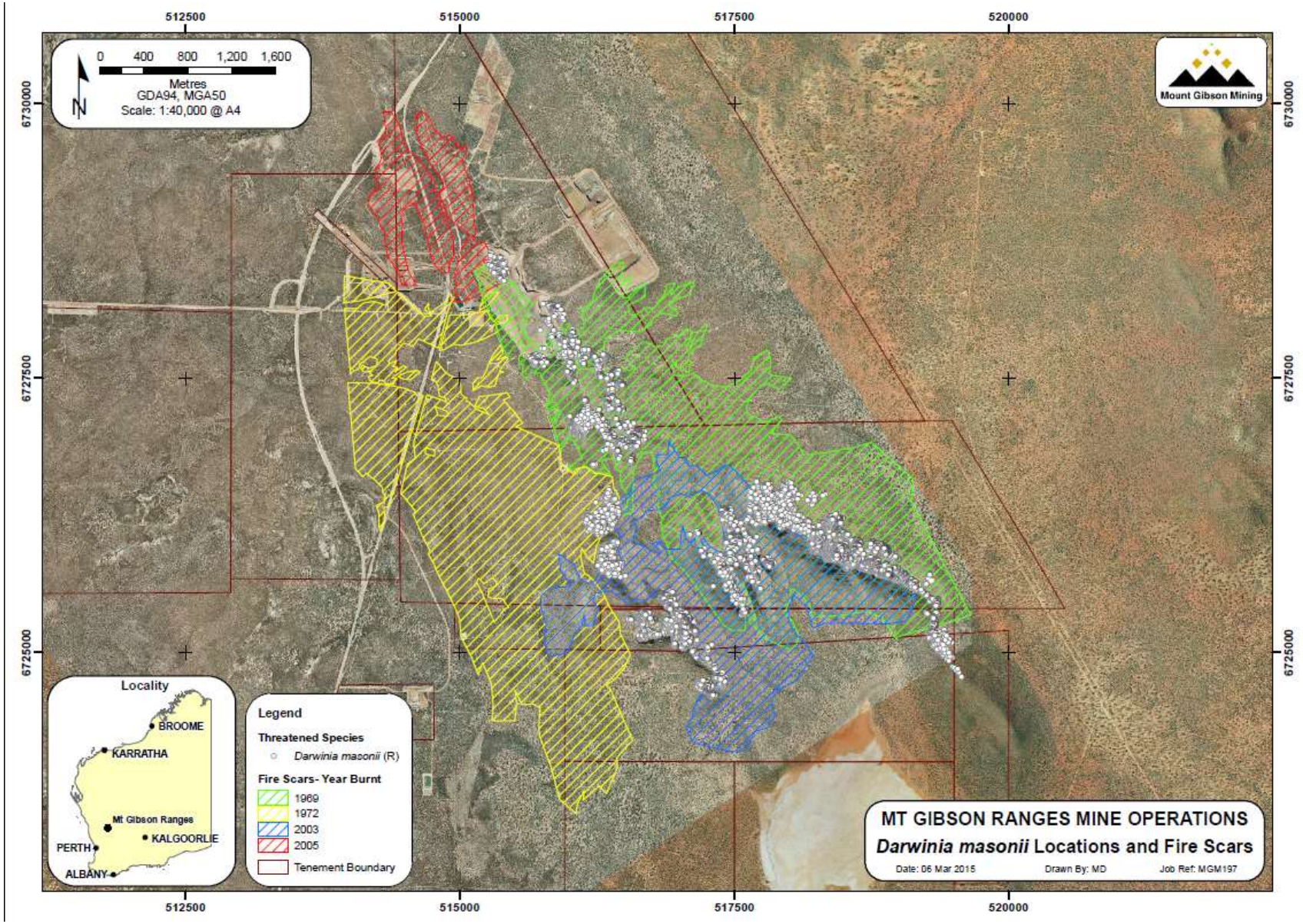
Additional individuals have been found in the southern areas of Mt Gibson south and appear to be an extension of TPFL population # 7. A fire event has not been recorded in this area.

Table 2. Fire history of *Darwinia masonii* populations

TPFL Population	Fire year/s	Time since fire (years)	Fire history status	Fire impacts
1	2003 (7-10 Feb) Pre-1968	12 >47	Young Old	Majority of population within fire boundary
2	2009 (12 May) 1969 Pre-1968	6 46 >47	Juvenile Mature Old	<2ha (small) experimental fire at track junction – patchy, but achieved intended result (killed canopy, ash produced, seedlings emerged). Majority of population within fire boundary
3	2005 (Dec) 1969 Pre-1968	10 46 >47	Young Mature Old	Majority of population within fire boundary Majority of population within fire boundary
4	1969	46	Mature	Entire population burnt
5A, B	2003 (7-10 Feb) 1969	~12 46	Young Mature	Entire population burnt Majority of population within fire boundary
6A, B, C	2003 (7-10 Feb) 1969	~12 46	Young Mature	Fire boundary includes west side of Mt Gibson and top of part of the hill only Entire population burnt
7	Pre-1968	>47	Old	
8	2003 (7-10 Feb) Pre-1968	~12 >47	Young Old	Not all burnt
9	2003 (7-10 Feb) 1972 Pre-1968	~12 43 >47	Young Mature Old	Not all burnt Fire boundary includes west side of Iron Hill North only

TPFL Population	Fire year/s	Time since fire (years)	Fire history status	Fire impacts
10	1969 Pre-1968	46 >47	Mature Old	Population boundary unknown

Figure 3 *Darwinia masonii* population structure in 2015 in relation to the fire history (1968-2010).



Mining and Infrastructure Development

Under MS753, MGM and EHPL have Ministerial approval and a permit to take approximately 2,100 adult plants which is inclusive of all vegetation within the approved footprint (Ministerial Statement (MS) No 753). Proportionally, this equated to 15% of the total number of plants known as at June 2008. A total of 1,702 mature individuals have been removed to date – corresponding to all of TPFL 3 and part of TPFL 2 (Table 1). Plants in the immediate vicinity of mining activities may be at greater risk of potential threatening processes of mining. Mining of the approved footprint (MS 753) began in 2010. A plant health monitoring program has occurred on a monthly basis since this time. To date, there have been no detectable effects as a result of threatening processes on this species from mining (Astron Environmental, 2014).

Planting trials

Plants grown from clones of the genotypes sourced from populations on Mt Gibson, Iron Hill, Extension Hill North and Extension Hill and established in two planting trials undertaken by BGPA (2010):

1. A trial investigating the effects of irrigation and herbivores was established in May 2005 in a fenced plot at Iron Hill East. This was re-visited in March 2014 and 168 plants (81% of the original 206 plants) within the fenced plot were still alive, despite having not been watered for 7 years (J. Sackmann 2014, pers comm., 6 May).
2. A trial investigating establishment on different soil substrates was established in the winter of 2009 north of the hematite mine. By April 2010, the only *D. masonii* plants, which had survived were in BIF rock and BIF gravel sites. None had persisted in sand or clay sites. In 2015, there are plants present at the BIF rock and BIF gravel trial sites, although this trial has not been re-visited since the technical research was reported in 2010.

1.1.6 Conservation status

Darwinia masonii is specially protected under the Western Australian *Wildlife Conservation Act 1950* and ranked as Vulnerable (VU) in Western Australia under the International Union for Conservation of Nature (IUCN) 2001 Red List criterion D2, due to a very restricted area of occupancy (typically less than 20km^2) with plausible future threats that could drive the taxon to a higher rank. Furthermore in July 2000, *D. masonii* was listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2 Habitat critical to survival of the species and important populations

Darwinia masonii is ranked as VU in Western Australia and, as of 2016, known only from the Mt Gibson Ranges. Consequently, it is considered that known habitat for wild populations is critical to the survival of the species and that representations of wild populations are important. Habitat critical to the survival of *Darwinia masonii* includes:

- the known area of occupancy of populations,
- areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators),

- additional occurrences of similar habitat that may contain undiscovered populations or a dormant seed bank of the species or be suitable for future translocations, and
- any local surface water drainage and infiltration that may affect the habitat of the species.

BGPA's (2010) modelled distribution of *D. masonii* against spatially mapped environmental data is the best information available on the habitat critical to survival of the species (Figure 4). This mapping should be considered in the context of the research findings:

- The modelling predicted *D. masonii* to potentially occur broadly across the Mt Gibson Ranges with a high probability (60-75 %) of occurrence (BGPA, 2010; Section 1.1.3). However, there were many areas in the Mt Gibson Ranges where *D. masonii* plants were most highly predicted to occur by the modelling, but do not support *D. masonii*. This has since, in part, been rectified with recent surveys (Eco Logical Australia 2014, Maia 2014) finding plants in some locations of predicted suitable habitat. BGPA (2010) also speculated that the distribution of *D. masonii* may have an association with unmapped sub-surface features such as regolith (soil depth, underlying rock structure) and longer-term fire history patterns. This information may further inform the habitat requirements of this species.

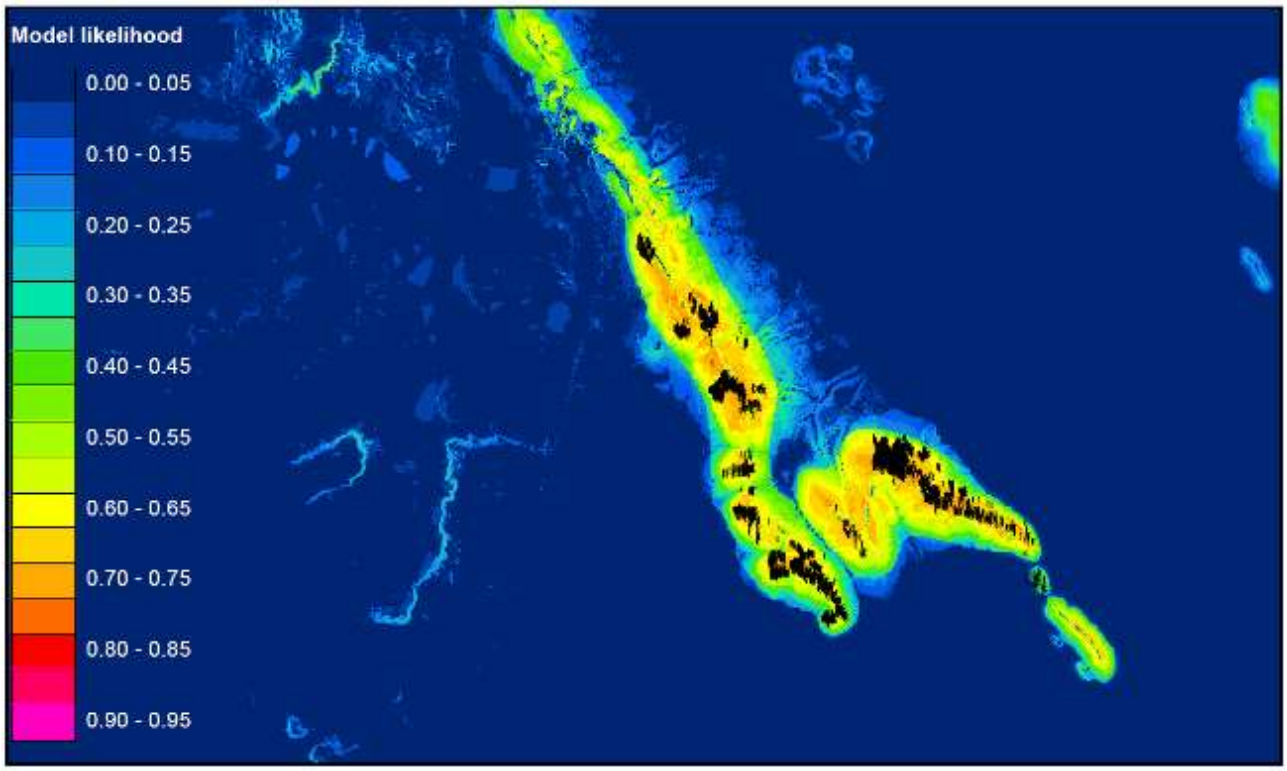


Figure 4. Modelled distribution of *Darwinia masonii* habitat across the Mt Gibson Ranges (source BGPA, 2010)

The remaining *D.masonii* population and habitat is subject to a significant level of enduring regulatory protection through a robust environmental approval process through which potential impacts are assessed under the Environmental Protection Act (Part IV – Environmental Impact Assessment) and the *Environment Protection & Biodiversity Conservation Act*. Approvals processes have specific mechanisms that can disallow or condition development in instances where the environmental impact is assessed as significant.

1.3 Threatening processes

Under the EPBC Act a threatening process is defined as a factor that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. The threatening processes listed below were identified by the Department of Parks and Wildlife as being of most significant concern to the survival of remaining *D. masonii:*

1. Mining (direct removal);
2. Drying climate;
3. Inappropriate fire regimes;
4. Mining (threatening processes);
5. Weed invasion; and
6. Grazing.

1.3.1 Risk assessment

Each of the identified threatening processes was the subject of a risk assessment based on the Australian and international standard for risk management AS/NZS ISO 31000 (2009). The output of the risk assessment (Table 3) is used to identify management priorities and guide the allocation of resources.

Risk assessment was also the basis for developing the management and mitigation measures applied through the approved "Extension Hill & Extension Hill North Environmental Management Plan", prepared to meet the conditions of Ministerial Statement No. 753 (in particular conditions 6 to 12 and 14 of Ministerial Statement No. 753).

The main elements of the risk assessment process involved:

- Identification of the potential threats, the cause of the threat, the potential impact on *D. masonii* and likelihood of occurrence in the absence of any controls resulting in a raw risk rating; and
- Estimating the likelihood of each threat occurring, the potential environmental consequences if it did occur and the subsequent determination of a controlled risk rating in context of the current controls;
- Consideration of useful actions to further mitigate risk; and
- Re-estimating the likelihood of each risk event occurring and the potential environmental consequences if it did occur, and the subsequent determination of a final residual risk rating.

Further details of the risk assessment criteria are included in Appendix 10.4.

Table 3. *Darwinia masonii* – risk assessment based on AS/NZS ISO 31000 framework

This risk assessment uses a consequence **(C)** and likelihood **(L)** matrix (Appendix 10.4) to determine Inherent Risk **(IR)** which considers risk if there are no controls in place; Controlled Risk **(CR)** which considers the risk after application of existing controls and Residual Risk **(RR)** which considers the final residual risk level after the application of additional controls proposed in this plan.

Risk Event (Threats)	**Cause**	**Potential Impacts**	**C**	**L**	**IR**	**Existing Controls**	**C**	**L**	**CR**	**Additional Risk Mitigation Plan (Recovery Actions)**	**C**	**L**	**RR**
Direct removal of *Darwinia masonii* from the Mt Gibson Ranges habitat.	Approval of developments that require extensive clearing of native vegetation impacting a significant number of *D. masonii*.	Worst case scenario is that a level of clearing occurs that results in a step change in the IUCN Ranking of the species due to the level of direct removal (ie greater than 31% of species)	2	C	**4**	1. Government regulation through a robust approvals process in which potential impacts are assessed including: - Environmental Protection Act (Part IV - Environmental Impact Assessment) - Environment Protection & Biodiversity Conservation Act Approvals processes have specific mechanisms that can disallow or condition development in instances where the environmental impact is assessed as significant.	2	D	**8**	1. Maintain and use seed/germplasm collections to ensure material with a broad genetic base is available for translocation and ongoing ex-situ conservation activities. 2. Develop and implement restoration program. 3. Promote awareness of *D. masonii* 4. Other actions specified in Section 4 of this Plan.	2	E	**12**

Risk Event (Threats)	Cause	Potential Impacts	C	L	IR	Existing Controls	C	L	CR	Additional Risk Mitigation Plan (Recovery Actions)	C	L	RR
						2. Conditional environmental approval process including Ministerial Statements and offset programmes to manage the environmental impact of projects should they be approved. MS753 authorises a development envelope with 17% of the *D. masonii* population. In 2015 the proposed Iron Hill development envelope was under assessment as a PER. 3. Regulatory and proponent inspections, audits, monitoring and reporting.							
Drying climate	Natural phenomena	Extended drought periods negatively impact adult plants and recruits.	2	C	**8**	1. Research to aid understanding of recruitment has been undertaken by BGPA (2010) and funded by Extension Hill Pty Ltd and Mount Gibson Mining. 2. Implement *D. masonii* condition monitoring program.	2	C	**8**	1. Maintain seed and germplasm collections. 2. Develop restoration program as a contingency measure. 3. Other actions specified in Section 4 of this Plan.	2	C	**8**

Risk Event (Threats)	Cause	Potential Impacts	C	L	IR	Existing Controls	C	L	CR	Additional Risk Mitigation Plan (Recovery Actions)	C	L	RR
Inappropriate fire regimes	Fire frequency increased as a result of mine site activities or lightning events.	Loss of large-scale adult population resulting in increased susceptibility of fire induced recruits.	2	C	**8**	1. Fire risk is managed within the operational mining area and response capabilities exist to provide assistance in surrounding areas to manage large scale fire events.	2	D	**12**	1. Additional controls not required at this time. Continue to implement fire management strategy as per existing controls.	2	D	**12**
Dust emissions and inadvertent disturbances such as cracking of rock faces. (sometimes referred to as "Secondary Impacts of Mining")	Mining operations	Potential impact on plant health or reproductive biology that may lead to a decline in growth and recruitment rates.	4	B	**14**	**1.** Implementation of approved Environmental Management Plan and site procedures to monitor and minimise dust emissions. 2. Vegetation health monitoring adjacent to operational mining areas to examine potential effects.	4	D	**21**	1. Continue to implement *D. masonii* condition monitoring program. 2. Continue to manage threatening processes from mining as per existing controls.	4	D	**21**

Risk Event (Threats)	Cause	Potential Impacts	C	L	IR	Existing Controls	C	L	CR	Additional Risk Mitigation Plan (Recovery Actions)	C	L	RR
Weed invasion throughout *D. masonii* habitat	Increase movement of vehicles coupled with poor control over vehicle hygiene. Increased activity of feral animals spreading weed species.	Potential to outcompete *D. masonii* resulting in poor recruitment.	4	C	**18**	1. Strict vehicle hygiene controls are in place for all vehicles and mobile equipment involved with mining operations. 2. The presence and distribution of weeds is surveyed annually in spring. 3. Weed eradication controls are applied in accordance with approved procedures within the mining areas and follow up inspections undertaken.	4	D	**21**	1. Additional controls not required at this time. Continue to manage weed invasions as a threatening process from mining as per existing controls.	4	D	**21**
Grazing by introduced species (goats and rabbits)	Potential for increased size of populations.	Grazing may have a significant impact on growth and reproduction of *D. masonii*. Repeated herbivory may impact on reproductive output.	4	C	**18**	1. Coordination meetings with land managers in areas surrounding Mt Gibson Ranges on introduced species management undertaken. 2. Reporting of feral fauna sightings in mining areas to inform the implementation of controls. 3. Implementation of approved Environmental Management Plan.	4	D	**21**	1. Protect plants from herbivory through the development and implementation of an adaptive management program to respond to increased herbivory from introduced species as necessary.	4	D	**21**

Risk Event (Threats)	Cause	Potential Impacts	C	L	IR	Existing Controls	C	L	CR	Additional Risk Mitigation Plan (Recovery Actions)	C	L	RR
						4. Water dams are securely fenced to prevent fauna access.							

1.3.2 Drying climate

Drying climate rates as the most significant risk to the abundance and survival of *D.masonii* primarily because there is no control that can currently be applied that will reduce the risk of climate change occurring.

Mortality among mature (last burnt on or before 1969) *D. masonii* plants is rare in normal years, but drought in 2010 was found to contribute to a significant level of mortality (10%) among mature *D. masonii* plants marked for a pollination study on Mt Gibson South (BGPA, 2010).

D. masonii seedlings may also be less resilient to drought conditions than mature plants. BGPA (2010) reported that only 9% of the seedlings which were tagged within recruitment plots of an experimental fire in 2009 were still alive when these plots were revisited in October 2010. They stated "this low survival rate may partly result from the drought experienced over the 2010 winter at Mt Gibson, as well as a likely high failure rate of establishing young seedlings" (p43). Thus a drying climate and associated drought conditions may reduce the successful establishment of subsequent seedling recruits.

Thus, there may be implications for the species (e.g. population size, demography, and breeding biology) if there is a significant increase in drying or a significantly greater frequency of dry years in the region.

1.3.3 Mining (direct removal)

The known habitat for *D. masonii* comprises ironstone formations that are also prospective for iron ore and under live mining leases. The current MGIOIP approval (MS 753) will result in approximately 2,100 adult plants of *D. masonii* being taken, which represents approximately 10% of the combined known population size.

Future mining and exploration operations have the potential to directly impact the conservation status of *D. masonii,* if it were to significantly reduce the total population size, genetic diversity or area of occupancy of the species.

1.3.4 Inappropriate fire regimes

D. masonii is long-lived and killed by fire (Armstrong and Associates, 2004; BGPA, 2010). However, *D. masonii* exhibits poor recruitment under normal seasonal conditions and has specific requirements for good recruitment

- Recruitment occurs after fire, and there is limited inter-fire recruitment; and
- Ground disturbance has anecdotally been recorded as inducing recruitment.

Natural regeneration of *D. masonii* after fire is restricted exclusively to germination from seed held in long-lived soil-stored seedbanks (BGPA, 2010). The majority of plants arising from seed germinate in a single cohort post-fire. Furthermore, the youngest age of plants to be recorded as flowering is at six years, but flower number at this age was very low. Large old plants with wide canopies produce the most flowers. Therefore, fire occurring too frequently within habitat colonised by *D. masonii* threatens the long term survival of the taxon.

Research has shown that:

- The seed has a physical and physiological dormancy process (removal/breakdown of fruit walls and stimulatory effect of smoke chemicals, respectively).
- Preliminary results of *in situ* seed burial trials indicate complex germination / dormancy strategies for this species, combining a requirement for physical degradation of the seed coat, environmental (seasonal temperature) cuing - with seeds cycling in and out of dormancy, and smoke-related physiological responses.
- The longevity of *D. masonii* seed in the soil-stored seed bank is unknown, and may be a factor which affects recruitment of the species in the longer term.

1.3.5 Mining (threatening processes)

Populations at Extension Hill South and Iron Hill North are closest to the Extension Hill mining operations approved under MS 753. Possible threatening processes were previously identified (DEC, 2008) to include dust, inadvertent disturbance such as cracking of rock faces, or negative effects on pollinator activity arising from habitat disturbance. Threatening processes related to mining are summarised in the following table:

Table 4a. *Darwinia masonii* – Potential Risk and Indirect Impacts

Threatening Processs	**Sources of risk**	**Potential Duration**	**Potential impacts**	**Controls**
Dust	Pit blasts; ground clearing; crusher circuit operations; truck movements on unsealed roads	Infrequent; Temporary	Emitted or fugitive dust may settle on plant leaf surfaces and limit primary production or clog stomata.	Haul road speed control; civil methods; watering; plant health monitoring for feedback controls
Changed hydrology; changed microclimate; erosion	Slope truncations and re-directions; altered drainage by interception or redirection in flows	Constant; Permanent	Shadowing: run-on / run-off volume changes which alter the way in the future that plants may germinate or grow.	Construct-on-grade sympathetic with terrain; drainage structures and erosion control where needed.
Pollinators and reproductive success	Mine activity may dissuade animal (eg. bird and insect) pollinators	Infrequent; Temporary	Mine activity (presence; vibration; lighting) reduces rate at which pollinators visit flowers.	Seeds held in existing seedbank outside of project area.
Reduction of Genetic diversity	Ground clearing	One-off; Permanent	Reducing the abundance of populations may eliminate rare genes.	Apply species Conservation Action Plan; restore in situ populations with re-established stock
Fragmentation	Ground clearing	One-off; temporary	Removing ridgetop or creating elevated WRLs 'blocks' connectivity in space and/or time	Rehab and revegetation of domains at closure; retention of linkage corridors of natural terrain.

Threatening Processs	Sources of risk	Potential Duration	Potential impacts	Controls
Introduced weeds	Mine activity vehicles may introduce or spread seeds	Infrequent; permanent	Weeds infest significant areas of native vegetation.	Weed monitoring and treatments; quarantine protocols and vehicle inspections
Grazing pressure	Mine activity attracts non-native grazers	Infrequent; temporary	Grazers reduce the foliage and health of vegetation including rare plants.	Monitoring (no significant impacts on foliage of rare plants); eradication programs for ferals
Seed disperal	Mine infrastructure	Constant; temporary	Infrastructure may create barriers to dispersal by insects, wind and water	Decommissioing and rehabilitation of land at closure.
Fire	Man made ignition sources – hot work tools; cigarettes	Infrequent; temporary – permanent	Uncontrolled extensive blaze that permanently destroys native vegetation and rare flora	Fire management systems and procedures
Vibration	Blasting and road haulage	Infrequent; temporary	Rocks may dislodge and trample native vegetation	Civil works management (rock placement); blast operational procedures.

Management actions have been implemented to reduce the risk to the plants in the immediate vicinity of mining operations. Survivorship, health condition and height of *D. masonii* have been monitored annually since 2007. Analysis of this data by Astron Environmental Services (2014) found that "*the spatial and temporal variation in survivorship, health condition and height of D. masonii was not likely to be related to activities at the mine pit.*"

Future mining operations may have associated threatening processes to *D. masonii*. However, mitigation of these threatening processes (as per the Extension Hill mining operations) will maintain the risk as low.

1.3.6 Weed invasion

No significant weed invasion has been observed to date, although there are some small populations of weeds in some areas of the range (J. Sackmann 2014, pers comm.). Weed invasion after disturbance (e.g. fire or clearing of tracks) is a potential threat to *D. masonii*. Weed invasion is also a potential threat to the integrity of the habitat critical to the species.

1.3.7 Grazing

BGPA (2010) found that grazing by vertebrates (presumed to be goats and rabbits) had a negligible impact on *D. masonii*. However, vertebrates including rabbits and goats are present within the Mt Gibson Ranges, and their impact on the vegetation varies between sites. Grazing was reported by BGPA (2010) as having a significant impact on *Lepidosperma gibsonii* at certain sites on the lower slopes of the range (Iron Hill and Iron

Hill North only) and north east at a site (off range) near the emu-proof fence. In some areas *Lepidosperma gibsonii* co-occurs with *D. masonii* on the Mt Gibson ranges. The presence and abundance of faecal scats around the grazed *Lepidosperma gibsonii* indicated that grazing was attributable to rabbits and/or goats, and macropods. During the period of BGPA's research (2007 – 2010), and subsequent monitoring conducted by MGM, vertebrates have not been recorded as preferentially grazing *D. masonii*.

Grazing, however, is a potential threat to the integrity of the habitat of *D. masonii*. Grazing is also a potential future threat to *D. masonii* itself if the distribution and density of preferentially grazed plants decline within the habitat, resulting in *D. masonii* becoming relatively more palatable to vertebrates.

Since grazing pressure is not considered a static variable due to environmental or management factors, it remains a potential threat to the habitat and/or *D. masonii* individuals.

1.4 Broader biodiversity benefits

Actions that abate identified threats and maintain or enhance *in situ* populations of *D. masonii* will also likely maintain or improve the status of the associated native vegetation and habitat.

Two rare and eight priority flora taxa occur within 500 metres of *D. masonii* records (Table 5).

Table 5. Conservation–listed flora species occurring within 500m of *D.masonii*

Species name	Conservation status (WA)	Source of record
Eucalyptus synandra	Threatened (VU)	MGM/EHPL; TPFL; WA Herb
Lepidosperma gibsonii	Threatened (VU)	MGM/EHPL; TPFL; WA Herb
Acacia cerastes	Priority 1	MGM/EHPL; TPFL; WA Herb
Philotheca nutans	Priority 1	TPFL; WA Herb
Podotheca uniseta	Priority 3	TPFL; WA Herb
Rhodanthe collina	Priority 3	WA Herb
Verticordia venusta	Priority 3	TPFL; WA Herb
Allocasuarina tessellata	Priority 1	MGM/EHPL
Micromyrtus trudgenii	Priority 3	MGM/EHPL
Persoonia pentasticha	Priority 3	MGM/EHPL; WA Herb

Six fauna listed under the *Wildlife Conservation Act* 1950 (WA), and five priority fauna have previously been recorded to occur within the range of *D. masonii* populations (Table 6).

Table 6. Conservation–listed fauna species occurring within the range of *Darwinia masonii*

Species name	Conservation status (***Wildlife Conservation Act 1950***)	Conservation status (***Environment Protection and Biodiversity Conservation Act***)
Leipoa ocellata (Malleefowl)	T - Threatened (VU)	VU

Species name	Conservation status (*Wildlife Conservation Act 1950*)	Conservation status (*Environment Protection and Biodiversity Conservation Act*)
Merops ornatus (Rainbow Bee-eater)	IA – Migratory birds protected under an international agreement*	Listed Marine Listed Migratory (JAMBA)*
Cacatua leadbeateri (Major Mitchell's Cockatoo)	S – Other specially protected fauna	-
Falco peregrinus (Peregrine Falcon)	S – Other specially protected fauna	-
Aganippe castellum (Tree-stem Trapdoor Spider)	Priority 4	-
Charadrius rubricollis (Hooded Plover)	Priority 4	-
Hylacola cauta subsp. whitlocki (Shy Heathwren (western))	Priority 4	-
Oreoica gutturalis subsp. *gutturalis* (Crested Bellbird (southern))	Priority 4	-
Pomatostomus superciliosus subsp. *ashbyi* (White-browed Babbler (western wheatbelt))	Priority 4	-

* Migratory birds are protected under China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement, and Bonn Convention

D. masonii occurs within the Priority 1 listed ecological community 'Mt Gibson Range vegetation complexes (banded ironstone formation)' (5 occurrences, 3,216 hectares total). For a description of Priority Ecological Community (PEC) categories see DEC (2010).

No negative effects of the actions on other conservation significant taxa and the priority ecological community for *D. masonii* have been identified during the period when the Interim Recovery Plan was implemented. Actions will continue to be assessed to ensure there are no negative effects on other conservation significant taxa and the PEC.

2 Plan objectives and criteria

2.1 Plan objective

The objective of this plan is "*to maintain, and ultimately improve, the conservation status of D. masonii such that its conservation status is more secure in the Mt Gibson area*" (Ministerial Statement 753).

2.2 Plan criteria

Criteria for success:

This plan will be deemed successful if, over the term of the plan, all of the following are achieved:

1. The number of *in-situ* mature individuals in areas of known occupancy, outside of areas approved for disturbance under Ministerial Statements remains stable[2] or increases.

2. The conservation category of the species remains at the current status or improves.

Criteria for failure:

This plan will be deemed unsuccessful if, over the term of the plan, any of the following occur:

1. The total number of all *in-situ* mature individuals in areas of known occupancy, outside of areas approved for disturbance under Ministerial Statements has decreased by more than 20% beyond its natural variability* as a result of effects from threats identified in section 1.3 ;

2. The conservation status meets IUCN criteria for listing at a higher threat category than the status (at the time of publication of this Plan).

* Natural variability will be assessed through regular monitoring as described in Section 4.5 and 4.9

[2] Stable means number of mature individuals plus or minus fifteen per cent.

3 Past and existing recovery actions

Parks and Wildlife has reviewed the relevance and effectiveness of the 2008 *Darwinia masonii* Interim Recovery Plan (IRP; DEC, 2008) in the 2014 *Darwinia masonii* Review Paper (Parks and Wildlife, 2014).

The IRP identified eleven recovery actions associated with the taxon, listed below:

1. Coordinate recovery actions and liaise with stakeholders
2. Continue implementation of the *Darwinia masonii* research programme
3. Establish and implement *Darwinia masonii* condition monitoring programme
4. Implement Fire Management Strategy
5. Manage threatening processes of mining
6. Manage inappropriate grazing pressure on *Darwinia masonii*
7. Translocation trials
8. Maintain adequate seed/germplasm collections to ensure material with a broad genetic base is available for translocation and on-going ex situ conservation
9. Conduct further surveys and report any new populations of *Darwinia masonii*
10. Promote awareness of *Darwinia masonii*
11. Review ranking of the species and the need for a full Recovery Plan

Further detail relating to these actions, an evaluation of their implementation and related recommendations are provided in Table 7 with the contents of the table being excerpts from Parks and Wildlife, 2014.

Table 7. Past recovery actions in the *Darwinia masonii* IRP (DEC, 2008), evaluation of their implementation, and related recommendations.

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
3.1 Coordinate recovery actions and liaise with stakeholders				
Continue to coordinate the implementation of recovery actions for *Darwinia masonii*	Ongoing until 2012	GDTFRT	• GDTFRT have not coordinated the implementation of recovery actions for *Darwinia masonii*	This action is carried over in this Plan (Section 4.1). Responsibilities for some aspects have been re-allocated.
Ensure implementation of research, management and recovery actions for *Darwinia masonii* in consultation with Parks and Wildlife, DoE, BGPA, Geraldton District Threatened Flora Recovery Team, relevant land managers and indigenous groups.		MGM & EHPL	• Research as outlined in recovery action 2 has been implemented and completed. • Implementation of the majority of management and recovery actions for *Darwinia masonii* has been undertaken. • Consultation has been undertaken with a number of the stakeholders. This has been enhanced through employment of a Conservation Officer at Parks and Wildlife in August 2013.	
Annual progress report will be produced by 31 March each year.		Parks and Wildlife, GDTFRT, MGM & EHPL	• An annual progress report has not been produced. MGM and EHPL reported on the outcomes of research and monitoring of this species as part of their broader annual environmental reports.	
3.2 Continue implementation of the *Darwinia masonii* research programme				
A comprehensive programme of research into: • conservation genetics; • population demography; • breeding biology; • population viability analysis; • environmental interactions and plant health; • restoration and translocation; and, • *ex situ* conservation of *Darwinia masonii* is currently being implemented and is ongoing. The initial research programme will extend to December 2010, at which time the direction of future research will be reviewed. The nature of some of the research is longer term (5 years minimum).	2007 – 2010 (initially)	MGM, EHPL, BGPA & Parks and Wildlife (ex situ conservation only)	• The initial research programme was completed and was submitted by BGPA to MGM and EHPL in October 2010 in the form of a report entitled "*Darwinia masonii* and *Lepidosperma gibsonii* Conservation and Restoration Research. An integrated research program into the *ex situ* and *in situ* conservation, restoration and translocation requirements of *Darwinia masonii* and *Lepidosperma gibsonii* May 2007 – June 2010". • The findings of BGPA's (2010) research have provided much of the information in Section 1 (the Background) of this plan. • Recommendations on the direction of future research were provided by BGPA (2010). • A joint research project investigating soil plant atmosphere interactions and their influence on mine waste cover system performance commenced in 2014.	Further research to benefit of *Darwinia masonii* is included in this plan (Sections 4 and 5). This draws on the recommendations of BGPA's (2010) initial research.

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
3.3 Establish and implement *Darwinia masonii* condition monitoring programme				
Monitoring factors such as weed invasion, grazing, habitat degradation, population stability (expansion or decline), pollinator activity, seed production, recruitment, and longevity will be monitored. Rare Flora Report Forms will be prepared for monitoring undertaken.	2008 – 2012	GDTFRT, Parks and Wildlife	• Populations have not been monitored by GDFRT or Parks and Wildlife regularly. TPFL population 2b was inspected by Parks and Wildlife to confirm its presence and location in September 2013, and a partial count of numbers undertaken. Intermittent brief inspections of certain populations were undertaken by Parks and Wildlife up until 2007, but none were conducted again until October 2013.	This action is carried over in this Plan (Sections 4.5 and 4.9). Responsibilities for some aspects have been re-allocated.
The condition of the population not directly impacted by mining will be monitored for any indirect impacts from mining, of which the greatest risk may be excessive dust deposition, and other potential threats such as grazing by introduced or native animals and weeds that may impact on plant condition. A representative subset of 715 individual plants (5% of total pre—mining adult population) will be monitored in detail annually.		MGM & EHPL	• The condition of populations of *Darwinia masonii* not directly impacted by mining approved under MS753 has been monitored annually since 2007. A total of 653 plants were included in the annual monitoring program in April 2013 (MGM and EHPL, 2013). Some of these were dead and some could not be relocated, which resulted in a total of 511 plants which were scored, down from 569 in 2011. In 2013, plant height (or length for prostrate plants), reproductive status, plant age, plant condition and seedling recruitment and mortality were recorded. • Additional monitoring plots were established in the subsequent survey, conducted in November 2013, to ensure the target numbers were met. A total of 881 plants were scored (773 of these were alive) (J Sackmann 2014, pers. comm., 11 February).	

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
Ambient dust monitoring will be undertaken on a monthly basis in permanent quadrats to assess dust deposition on *D. masonii*. Populations closest to the mine (e.g. Extension Hill South) will be monitored monthly to assess any changes in condition prior to evidence of acute stress or mortality. Visual inspections of the populations closest to the mine (e.g. Extension Hill South) will be undertaken weekly. Populations located further away from the mine will be inspected quarterly. The results of the monitoring program will be used to guide subsequent management of the species.		MGM & EHPL	• TPFL population 4 is located closest to mining activities on Extension Hill South and is monitored monthly by MGM to assess detectable changes in condition prior to evidence of acute stress or mortality. TPFL population 6 is located on Mt Gibson is monitored as a control for comparison. At each plot, a photograph is taken, and plants are given a health score. Comments recorded at the plots include evidence of grazing and weed invasion. • Ambient dust monitoring is also undertaken by MGM on a monthly basis to determine if there is any correlation between dust deposition on *D. masonii* plants and their respective condition (i.e. plant health). Eleven dust deposition gauges are monitored in the locality of the Mt Gibson Ranges. The dust deposition gauges monitor whether or not dust levels exceed the standard: less than 4g/m^2/month of insoluble solids generated by mining activities in the vicinity of *D. masonii* plants (MGM and EHPL, 2008). • Visual inspection at TPFL population 4, closest to the mine on Extension Hill South is undertaken weekly by MGM. At each plot, a photograph is taken, and plants are given a health score. Comments recorded at the plots include evidence of grazing and weed invasion.	This action is modified and carried over in this Plan (Section 4.5).
The results of the monitoring program will be used to guide subsequent management of the species.	2008 – 2012	MGM, EHPL, Parks and Wildlife & GDTFRT	• Comprehensive analysis of condition monitoring data has been conducted by Astron Environmental Services (2014a). Generalised estimating equation, generalised linear models and permutation-based multivariate analysis of variance tests were used to analyse the data. Astron Environmental Services (2014a) concluded that "*there was no evidence showing that health condition or survivorship was impacted by mining activity*".	The requirement for comprehensive analysis of historical and future condition monitoring is captured in Section 4.5. It is expected that these results will be used to guide subsequent management of the species, and will be considered in the review of the Plan (Section 4.12)

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
The research program will investigate and develop measures to assess plant health and will collect detailed demographic data from approximately 2% of the population in long term monitoring plots as part of the research program.		MGM, EHPL, Parks and Wildlife & GDTFRT	• BGPA collected detailed data in order to complete the initial research program as outlined in action 2. BGPA (2010) recommended ongoing annual monitoring of all plants in permanently marked plots where individual plants should be tagged and measured. Additional variables recommended for collection were: survival, recruitment (new plants tagged and recorded as found), health, herbivory, infructescence production, and growth of seedlings and smaller plants. • Demographic data from *D. masonii* plants in all permanently marked plots is collected annually by MGM. These individual plants are tagged and measured as follows: survival and health score, recruitment (new plants are tagged and recorded as found), and notes about herbivory. Information is also collected relating to infructescence production, and growth of seedlings and smaller plants.	This action is carried over in this Plan (Section 4.5).
3.4 Implement Fire Management Strategy				
An Environmental Management Plan and fire management procedures are being developed that detail the frequency and intensity of fires and control measures necessary to prevent inappropriate fires which may impact on the species directly, or its habitat.	Ongoing for life of mine	MGM & EHPL	• Mt Gibson Ranges and the habitat of *Darwinia masonii* are currently under a no burn fire management regime. Any fires which would occur on the ranges are wildfires or unplanned man made fires. There has been no unplanned fire in habitat of *Darwinia masonii* since 2008. • An experimental fire within *Darwinia masonii* TPFL population 2 was conducted by BGPA on 12 May 2009, and monitoring of recruitment in plots within the fire boundary was subsequently undertaken (BGPA, 2010). This experiment confirmed that *D. masonii* germinates strongly after fire (see Section 1.1.3). An Environmental Management Plan and Fire Management Procedures have been developed and adopted.	This action is carried over in this Plan (Section 4.6). An assessment of controlled burning as a benefit to recovery will need to be made during regeneration trials, and implemented (if there is a benefit) through a recruitment strategy as a component of a broader restoration program (Section 4.2).
3.5 Manage secondary impacts of mining				
Implement Environmental Management Plan and associated procedures.	Ongoing for life of mine	MGM & EHPL	• This action has been implemented.	This action is carried over in this Plan (Section 4.7).

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
3.6 Manage inappropriate grazing pressure on *D. masonii*				
Undertake condition monitoring	Ongoing for life of mine	MGM & EHPL	• Grazing by introduced animals (goats and rabbits) has been assessed as part of monitoring the condition of *D. masonii* (see Section 3.3). Grazing has not been identified as having a significant effect on *D. masonii*. .	This action is carried over in this Plan (Section 4.5). The impacts of grazing on the integrity of *Darwinia masonii* habitat have not been monitored. It will be necessary for habitat health to be recorded at established plots during the annual condition monitoring program. This will enable assessment of the impacts of grazing on the habitat of *D. masonii*, and implementation of actions to mitigate grazing impacts.
Implement Environmental Management Plan and associated feral or other introduced animal procedures		MGM & EHPL	• This part of the recovery action is being implemented.	
3.7 Translocation trials				
Describe biotic and abiotic environments and habitat requirements. Trial *in-situ* planting methods.	2007 – 2010 (initially)	MGM, EHPL & BGPA	• BGPA (2010) described biotic and abiotic environments and habitat requirements for *D. masonii* and used a species distribution model to identify localities for possible *D. masonii* translocation sites (Sections 1.1.3 and 1.2). • *In situ* planting methods using cuttings have been trialled at Mt Gibson on four differing field soil substrates (BGPA, 2010; and Section 1.1.5). In total, 780 *Darwinia masonii* plants grown from cuttings were planted in July/August 2009 at the sites (3 plots per site with 65 plants per plot). The locations of the sites are provided in BPGA's report (2010). After 9 months, by April 2010, differences in success were evident, with the only successful plantings being on BIF rock and BIF gravel sites. BGPA (2010)	BGPA's (2010) recommendation for further translocation trials to investigate variation in BIF substrate and soil depth is captured in Section 4.2 of this Plan.

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
			suggested that texture, gravel/rock content, patterns of moisture content and Total Nitrogen may be the key soil properties to consider in selection of translocation sites. Plants on clay and sand sites to the east and west of the Mt Gibson Ranges, respectively, were not successful. The BIF rock and BIF gravel sites have not been re-visited to establish whether any plants from this trial survive. • BGPA (2010) recommended further research to investigate variation of composition of BIF rock and BIF gravel substrate, and varying degrees of soil depth and rockiness. • Irrigation during establishment of translocations may improve growth and survival of seedlings (BGPA, 2010). A preliminary planting trial of 206 *D. masonii* plants grown from cuttings and planted in a ripped drill pad at Iron Hill East was fenced to exclude herbivores and irrigated for an hour at a time twice a month over the first two summers. Twenty additional plants were planted outside of the fenced irrigated area. Two (10%) of the unwatered plants survived to 2010, while 89% of the watered plants survived the same period. Half of the plants within the watered plot flowered within their first year, and all had tripled in size in the first 18 months. BGPA (2010) reported no evidence of mammalian herbivory on *Darwinia masonii* during their three year research project undertaken between 2007 and 2010. Therefore, the improved growth and survival of the seedlings in this planting trial was attributed to the irrigation that they received. This plot was re-visited in March 2014 and 174 plants (80%) within the fenced plot were still alive, despite having not been watered for 7 years (Eco Logical Australia, 2014). The translocated plants in the trial and not watered outside the fenced area had all died, however second generation seedlings were observed growing outside of the fenced plot.	

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
Identify critical parameters for the long-term viability of re-established populations of *Darwinia masonii* and related species		MGM, EHPL & BGPA	• BGPA's (2010) species distribution model predicted *D. masonii* to potentially occur broadly across the Mt Gibson ranges with a high probability (60-75 %) of occurrence (BGPA, 2010; Section 1.1.3; and, Figure 4). They recommended that mapping of soil or regolith data for the region may assist with refining the distribution model to improve understanding and predictions of the habitat and restoration requirements for *D. masonii*. • It appears from the planting trials conducted by BGPA (2010) that *D. masonii* has broad habitat requirements on BIF sites, with substrate comprising BIF rock and BIF gravel. Irrigation during establishment of translocations may improve growth and survival of seedlings. Other parameters (e.g. pollination, seed production, seed viability, seed dispersion), which had not been gauged because of the relatively short length of time over which the BGPA research took place, may be critical for the long-term viability of re-established populations.	The knowledge gained from the habitat modelling and planting trials (BGPA, 2010) have assisted in improving knowledge of parameters which may be critical for the long-term viability of re-established populations of *D. masonii*. Further research to benefit recovery (Section 5) and translocations (Section 4.2) should continue to assist with identification of these parameters and refining those that are critical.
Derive quantitative completion criteria which demonstrate maintenance of viable population dynamics and resilience in *Darwinia masonii*		MGM, EHPL & BGPA	• Quantitative completion criteria which demonstrate maintenance of viable population dynamics and resilience in *D. masonii* have been derived in translocation proposals (currently being assessed by DPaW).	This action is carried over in this plan (Section 4.2).

Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
3.8 Maintain adequate seed/germplasm collections to ensure material with a broad genetic base is available for translocation and on-going ex situ conservation				
Maintain adequate seed/germplasm collections	Ongoing until 2012	MGM & EHPL through BGPA	• *Darwinia masonii* is able to be successfully cultivated and a stock of 56 genotypes from the Extension Hill mine footprint is in cultivation at Nuts About Natives (NAN), a specialist native plant nursery (B Croxford 2015, pers. comm; 7 April). Cuttings were collected (under DRF collection permits held by EHPL and BGPA) from 300 genotypes of *D. masonii* from within the mine footprint on Extension Hill and transported to NAN in October 2008. After 3 months, 12% of the total cuttings (385 *Darwinia masonii* cuttings) from 50% of the genotypes (150 different genotypes) had successfully initiated. • The intention of the germplasm collection was for clones of the *Darwinia masonii* genotypes from Extension Hill and Extension Hill North to be maintained as tube stock in two collections, with three clones of each genotype in each collection. However, some clones have not grown well and it has been necessary to pot up and maintain plants as new cuttings have not always been successful or numbers are low (B Croxford 2014, pers. comm., 27 January). Some clones are growing well with more than three clones per collection. The plants and clones are kept on unshaded external benches, regularly monitored, and watered at moderate intervals. The genotypes are subcultured annually from the parent stock. Flowers from the clones have been manually removed and disposed of before maturation, but some did reach maturation in 2013, and the seed has been collected and stored on site (B Croxford 2014, pers. comm., 27 January). • The 56 genotypes of *Darwinia masonii* currently held in parent stock (B Croxford 2015, pers. comm., 13 March) are not all healthy. The leaf tips of many clones are yellowed, and it is possible that this is due to a physical or chemical factor. This observed response to nursery conditions was also reported by BGPA (2010), which found that while *Darwinia masonii* cuttings survive and flower, they have not done so vigorously.	This action is carried over in this Plan (Section 4.3). Preservation of genetic material is essential to guard against extinction of the species if the wild populations are lost. The action has been worded to ensure this ex situ conservation, as well as ensuring that material is also available for use in translocation programs.

<table>
<tr><th>Part of recovery action</th><th>Timing</th><th>Responsibility</th><th>Evaluation of recovery action implementation</th><th>Recommendation</th></tr>
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The New Holland honeyeater and the Western Spinebill have been observed pollinating D. masonii flowers. Seeds (80% viability) have been collected from the nursery plants since 2013 (B Croxford 2015, pers. comm., 13 March).
A small number of genotypes of Darwinia masonii are still maintained in glasshouses at the Botanic Gardens and Parks Authority for experimental purposes.
While propagation of live plant material from wild collections and nursery stock may pose the most cost effective approach for the short-medium term storage and production of plants for restoration purposes, BPGA (2010) recommended further research into seedling production as this appears promising and may provide a preferable approach to providing a genetically diverse and numerous source of restoration plants. Drawbacks to the use of clones for population restoration were outlined by BGPA (2010).
Collection and storage of seed have been reported by BGPA (2010), and Landcare Services (2007; and, 2009). Western Botanical (2014) hold 1,024 g of D. masonii seed in storage.
Parks and Wildlife's Threatened Flora Seed Centre currently has three collections of D. masonii seed (Table 8):

Table 8. Darwinia masonii seed collections held by Parks and Wildlife's Threatened Flora Seed Centre
<table>
<tr><th>Accession</th><th>Collection date</th><th>Location</th><th>TPFL Pop</th><th>Seeds / fruit in storage</th><th>Germination (%)</th></tr>
<tr><td>01502</td><td>11/11/2004</td><td>Extension Hill North</td><td>3</td><td>466 seed</td><td>90%</td></tr>
<tr><td>01503</td><td>11/11/2004</td><td>Mt Gibson South</td><td>7</td><td>1634 fruit</td><td>Not yet tested</td></tr>
<tr><td>01519</td><td>11/11/2004</td><td>Mt Gibson</td><td>6</td><td>4941 fruit</td><td>Not yet tested</td></tr>
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Part of recovery action	Timing	Responsibility	Evaluation of recovery action implementation	Recommendation
3.9 Conduct further surveys and report any new populations of *D. masonii*				
Any new populations of *Darwinia masonii* that may be opportunistically located will be reported to Parks and Wildlife to ensure Parks and Wildlife has accurate data on the species.	Ongoing until 2012	MGM, EHPL, BGPA, Parks and Wildlife, GDTFRT	• The most recent and comprehensive survey was undertaken by Eco Logical (2014) was completed during 2014 (four trips between May and October 2014). The census recorded 20,965 individuals of *D. masonii*, comprised of 19,132 mature individuals, 1,580 juveniles, 188 seedlings and 65 senescent individuals. This census presents a significant increase to the recorded abundance of *D. masonii* at the Mt Gibson Ranges. • A broader regional survey for *Darwinia masonii* was undertaken and completed in June 2014 (Maia, 2014b). A survey of nine regional areas covering 1,032 ha occurred within 55 km of the Mt Gibson Ranges. *Darwinia masonii* was not located in any of the nine regional areas (Maia, 2014b).	This action is carried over in this plan (Section 4.10).
3.10 Promote awareness of *Darwinia masonii*				
Promote need for protection through poster displays and local print and electronic media	Ongoing	Parks and Wildlife, GDTFRT	• This action has not yet been implemented	This action is carried over in this Plan (Section 4.4).
Continue environmental inductions and Environmental Handbook dissemination	Ongoing	MGM & EHPL	• This action is being implemented	
3.11 Review ranking of the species and the need for a full Recovery Plan				
In accordance with Condition 6.3 of Ministerial Statement 753, the relevance and effectiveness of the plan (DEC, 2008) will be reviewed within 4 years of the commencement of ground disturbing activities and the plan updated as necessary. The ranking of the species (currently Vulnerable) will be reviewed as part of the review of the IRP.	June 2014	MGM, EHPL, Parks and Wildlife, GDTFRT, in association with BGPA	• This action has commenced, and has resulted in the preparation of this Plan. • A review of the IUCN status of *D. masonii* in relation to the cumulative impacts from the MGIOMIP and the proposed Iron Hill development found that there would be no change in its IUCN ranking (Globe Environments, 2014). • A review of the ranking of the species will be undertaken by DPaW.	It will be necessary to Review conservation status of the species (Section 4.11) and Review this plan (Section 4.12).

4 Future actions

There is a requirement that the actions identified in the plan stop the decline of and support the species long term survival in nature. The set of actions have been developed in response to the threatening processes outlined in Section 1.3. They have been formulated to achieve the objective of this plan, and are based on the outcomes of the research and the implementation of the *D. masonii* IRP to date, as well as aspects of the conditions of MS753 pertinent to *D. masonii*. They are:

1. Coordinate recovery actions and liaise with stakeholders;
2. Develop and implement restoration strategy
3. Maintain and use seed/germplasm collections to ensure material with a broad genetic base is available for conservation
4. Promote awareness of *Darwinia masonii*
5. Implement *Darwinia masonii* condition monitoring program
6. Implement fire management strategy
7. Manage threatening processes of mining
8. Protect plants from herbivory
9. Report any new occurrences of *Darwinia masonii*
10. Review conservation status of the species
11. Review this plan

A summary of risk ratings for *D. masonii* for each of the threatening processes before and after application of corresponding actions is shown in Table 9 (as derived in Table 3). These ratings relate to the magnitude of the risk to the species and the ability to manage that risk over the 10 year timeframe of this Plan.

Key actions have been developed to mitigate risks as part of the IRP and will be continued in this Plan.

Actions that are not directly related to threatening processes, but which are important for efficient and effective implementation of the Plan are:

- Coordinate recovery actions and liaise with stakeholders;
- Monitor populations;
- Report and protect existing and any new occurrences of *D. masonii*;
- Review assigned conservation status of the species; and,
- Review this plan and assess the need for an updated Plan.

Budget allocations are listed in Table 9.

Table 9. Summary of inherent, controlled and residual risks to the survival of *Darwinia masonii*

Risk Event (Threats)	Inherent Risk	Controlled Risk^	Actions	Residual Risk
Direct removal of *Darwinia masonii* from areas outside the currently approved development envelope.	**High (4)**	**Medium (8)**	1. Maintain and use seed/germplasm and other tissue collections to ensure material with a broad genetic base is available for translocation* and ongoing ex-situ conservation activities**. 2. Develop and implement restoration program using collected tissue. 3. Promote awareness of *D. masonii* 4. Other actions specified in Section 4 of this Plan.	**Medium (12)**
Drying climate	**Medium (8)**	**Medium (8)**	1. Maintain seed and germplasm and other tissue collections. 2. Develop restoration program as a contingency measure. 3. Other actions * specified in Section 4 of this Plan.	**Medium (8)**
Inappropriate fire regimes	**Medium (8)**	**Medium (12)**	1. Additional controls not required at this time. Continue to implement fire management strategy as per existing controls.	**Medium (12)**
Dust emissions and inadvertent disturbances such as cracking of rock faces (sometimes referred to as "Secondary Impacts of Mining")	**Medium (14)**	**Low (21)**	1. Continue to implement *D. masonii* condition monitoring program. 2. Continue to manage threatening processes from mining as per existing controls.	**Low (21)**
Weed invasion throughout *D. masonii* habitat	**Medium (18)**	**Low (21)**	1. Additional controls not required at this time. 2. Continue to manage weed invasions as a threatening process from mining as per existing controls.	**Low (21)**
Grazing by introduced species (goats and rabbits)	**Medium (18)**	**Medium (21)**	1. Protect plants from herbivory through the development and implementation of an adaptive management program to respond to increased herbivory from introduced species as necessary.	**Low (21)**

*The time frame to develop and implement translocations is within the term of the Plan (10 years) however the time frame to meet completion criteria for a translocation may be longer and requires establishment of a viable self-sustaining population (usually of at least 200 mature plants).

**Implementation of a recruitment strategy may only just have begun after 10 years as small scale trials testing various scenarios will need to be undertaken prior to this with a number of years of monitoring post-trial. This rating is expected to be reduced in the longer term.

^Taking into account past and present actions.

Actions that are not directly related to threatening processes, but which are important for efficient and effective implementation of the Plan and achievement of its objective are:

- Coordinate recovery actions and liaise with stakeholders;
- Monitor populations;
- Report and protect existing and any new occurrences of *D. masonii*;
- Review assigned conservation status of the species; and,
- Review this plan and assess the need for an updated Plan.

Budget allocations relating to stipulated actions are listed in Section 8.

4.1 Coordinate recovery actions and liaise with stakeholders

As part of its broader remit towards species conservation, Parks and Wildlife will coordinate the management of threatening processes (recovery actions) in relation to *D. masonii*.

MGM and EHPL will consult with and seek advice from Parks and Wildlife during implementation of the Plan for *D. masonii*.

As part of their broader conservation objectives, Parks and Wildlife may:

- Include information on progress of this Plan in annual reports to Parks and Wildlife's Corporate Executive and funding bodies.

Actions:

- Coordinate recovery actions, and liaise with stakeholders (Parks & Wildlife).
- Implement the Plan (EHPL and MGM).
- Provide an annual report on the species recovery to Parks and Wildlife's Corporate Executive and funding bodies (Parks & Wildlife).

Responsibility: Parks & Wildlife, EHPL and MGM

Timing: ongoing; annually for the report

Commencement date:	On adoption of the Plan
Completion date:	Life of Plan

4.2 Develop and implement restoration strategy

Condition 6.1.4 of MS753 requires that the proponent develops measures to offset the direct impacts of the proposal on the local population of *D. masonii* by regeneration, re-establishment or translocation of additional plants or sub-populations on suitable un-impacted areas of banded ironstone formations in the Mt Gibson area. This action captures all aspects of this condition.

Translocations

Translocations undertaken to fulfil the requirements of condition 6-1-4 are those which meet the requirements of the condition, as well as fulfilling the objective of this Plan and of establishing a self-sustaining population(s) of 200-250 plants of provenance.

BGPA modelled the distribution of *D. masonii* against spatially mapped characteristics (see Sections 1.1.3 and 1.1.5, and Figure 4). The model identified habitat that may be suitable to the species, but is not currently inhabited by it. The distribution of *D. masonii* may be limited by unknown factors, such as regolith (soil depth, underlying rock structure), longer-term fire history patterns, or other ecological factors (e.g. seed dispersal distances) which may refine potential habitat mapping. The predicted habitat is shown in Figure 4.

The knowledge gained from the habitat modelling (BGPA, 2010) and translocation trials, which have already been conducted (BGPA, 2010) will assist in identifying suitable habitat for *D. masonii* translocations, both in suitable areas of the Mt Gibson Range, other suitable habitat, and in the rehabilitation of areas disturbed by mining.

Future translocations should consider an allowance for irrigation of translocated plantings as this will increase the translocation success rate.

Propagation of live plant material from wild collections and nursery stock are likely the most cost effective approach for the short-medium term production of plants for restoration purposes. Seed germination and seedling establishment under glasshouse or field conditions may also provide an approach for a genetically diverse and numerous sources of restoration plants (BGPA, 2010).

Information on the translocation of threatened plants in the wild is provided in Parks and Wildlife's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna* (CALM 1995), and the Australian Network for Plant Conservation translocation guidelines (Vallee et al. 2004). Long-term monitoring of translocations will be included in all Translocation Proposals.

Rehabilitation

Mycorrhizal formation is potentially important for restoration success of *D. masonii* (e.g. for seeding survival and growth rate, as has been shown for a variety of VAM and ECM-forming species). This should be further investigated in comparative restoration trials, in particular whether or not restoration-planted seedlings are spontaneously able to form mycorrhizal associations in restoration surfaces, or whether inoculation is required or beneficial.

A research project, funded by MGM investigating soil plant atmosphere interactions and their influence on mine waste cover system performance is currently underway. Earthworks and plot preparation were completed in June 2014. Among other objectives, this research will investigate how topsoil thickness (comprised of a 2:1 waste rock: topsoil mix) and rooting depth influence the physiological performance of the taxa in the project. A translocation program has been approved (2015) to use *D. masonii* in the trials, however, the research is now well underway and propagation of sufficient *D. masonii* plant material will take 12 months. The logistics of getting approval to implement this trial may result in delays. .

These trials (and potentially others) will inform whether or not *D. masonii* can be used in future and broadscale rehabilitation of waste landforms in the Mt Gibson Range. Waste landforms may provide suitable habitat for the re-establishment of the species within the local geographic area in which it naturally occurs.

Recruitment

Fire has been recognized as an effective means of germinating *D. masonii* in the wild. The role of other natural disturbance events (physical or drought) in promoting recruitment of *D. masonii* have not been established and should be investigated (i.e. soil disturbance and drought response of populations). Records will need to be maintained for future research. Any regeneration trials involving fire may need to be undertaken in conjunction with weed control.

Actions:

- Prepare *D. masonii* Restoration Strategy and program (inclusive of translocation, regeneration and re-establishment) that complies with Parks and Wildlife policy. The restoration strategy and program includes offsetting the direct impacts of proposal/s on local population/s of *D. masonii* through translocation on suitable areas of the Mt Gibson Range (EHPL & MGM, 2014).
- Commence implementation of Restoration Strategy to maintain the integrity of the genetic diversity of *D. masonii* (EHPL & MGM, 2015).
- For rehabilitated landforms, further assessment of BIF rock and BIF gravel substrate patterns, and varying degrees of soil depth and rockiness and growing media required for establishment of *D. masonii* (taking into consideration landform stability requirements) (EHPL & MGM, 2015-2017).
- Monitor the survival and sustainable establishment of the plants remaining from the preliminary planting trial of *D. masonii* at the disused drill pad on Iron Hill East (EHPL & MGM, 2014-2017).
- Monitor the survival of the plants from the planting trial established on the BIF rock and BIF soil substrates north of Extension Hill (EHPL & MGM, 2014).
- Identify parameters for long-term viability of re-established populations of *D. masonii* (EHPL & MGM, ongoing).
- Monitor translocations and supplement them as necessary (EHPL & MGM, ongoing).
- Monitor and report on the implementation of the Restoration Strategy (EHPL & MGM, 2015-2018).
- Review and update Restoration Strategy in order to meet criteria for this Plan (see Section 2.2, EHPL & MGM).

Responsibility: MGM, EHPL

Timing: Ongoing

Commencement date:	November 2014
Completion date:	Life of MGIOMIP, and subsequent mine closure

4.3 Maintain and use seed/germplasm collections as a broad genetic base for conservation

A review of the seed held in storage, its quality, and the populations from which it originates, is necessary.

Preservation of genetic material is essential to guard against extinction of the species if the wild populations are lost. Suitable quantities of viable seed representing the genetic diversity of the species will be collected and maintained at the Threatened Flora Seed Centre (TFSC). This should be made available for on-going *ex situ* conservation and for future use in translocation programs. Quantities of seed used in translocation programs can be supplemented with seed from the same TPFL or nearby sources.

The optimal time for seed collection is late October to early November (Landcare Services, 2007; BGPA, 2010).

Maintenance of the *D. masonii* germplasm collection, which has a representation of the genotypes cleared for the MGIOMIP footprint, should continue until such a time as viable populations preserving the genetic diversity of the pre-mining *D. masonii* population are re-established, or sufficient seed from target populations has been

collected and stored. Multiple (>100) genotypes of live plants (BGPA, 2010) should be maintained, monitored and supplemented to represent each of the groups (including TPFL 2 and 3) cleared during mining activities under Ministerial Statements.

Actions:

- Develop a seed collection plan to identify representative species in the PEC, their composition and abundance required to meet objectives (to be determined) for collecting the seed in the first place (EHPL & MGM, 2014).
- Collate and annually check records of retained seed stock in storage (EHPL & MGM, 2014).
- One-off viability test of retained seed stock in storage (EHPL & MGM, 2015)
- Targeted seasonal collection of seeds from key Mt Gibson Ranges populations (late October to early November) to give seed representation (EHPL & MGM, late Spring 2015-2016).
- Propagation of live *D. masonii* plants from wild collection seed stock (2015-2017) for the purposes of translocation (Section 4.2; EHPL & MGM).
- Provision of nominated seed samples to the Threatened Flora Seed Centre (EHPL & MGM, 2015-2016)
- Review adequacy of *ex situ* collection to inform future actions (EHPL & MGM, 2017)
- Supplementation of seed in storage (upon identification of inadequate stock levels (EHPL & MGM, 2018 – 2019)

Responsibility: MGM and EHPL, upon advice from Parks & Wildlife

Timing: applicable seasonal timing for collection and handling

Commencement date:	Ongoing
Completion date:	Life of MGIOMIP

4.4 Promote awareness of *Darwinia masonii*

The status of *D. masonii* and measures to manage risk to the species will be promoted to staff at the MGIOMIP (while operational). The significance of the species will be communicated to personnel working at and around the mine site (i.e. environmental induction) by mining proponents.

Note that Parks and Wildlife will promote the awareness of the species to the wider community.

Actions:

- Promote need for protection through poster displays on the mine site (EHPL & MGM);
- Promote awareness to the wider community (Parks & Wildlife); and
- Promote awareness of *D. masonii* to mine site personnel through inductions (EHPL & MGM).

Responsibility: MGM and EHPL; Parks & Wildlife

Timing: Ongoing for life of MGIOMIP

Commencement date:	Ongoing
Completion date:	Life of MGIOMIP

4.5 Implement *Darwinia masonii* condition monitoring program

While mining occurs on the tenements affected by MS753, MGM and/or EHPL will continue to implement a program for *D. masonii* condition monitoring.

The condition of *D. masonii* will be monitored for potential effects from dust, weeds, grazing and a drying climate. Individual plants will be monitored annually at sites across the Range between September and November. Parameters monitored for each plant will include: height (or length); reproductive status; infructescence production; life stage (seedling, juvenile, adult, dead); health; and herbivory. Newly recruited seedlings shall be tagged and monitored. These results will also be used to measure natural variability of population abundance.

Routine inspections of plants in established quadrats will be continued, with plants assessed according to a plant health scale developed by BGPA (2010). The monitoring results will be used to identify detectable effects, should they occur, not characteristic of natural seasonal variation, in a timely manner. Monitoring will continue for the life of mining at the site. Should monitoring not show any evident declining trend or step change in plant health or abundance, then the frequency of monitoring may be varied, with approval of the OEPA.

Dust deposition will be monitored using dust deposition gauges on a monthly basis to determine if there is any evidence of a correlation with dust generation in the event of a detrimental impact on *D. masonii* plants being identified.

Analysis of historical annual condition monitoring data was completed in 2014. Data have been collected in years from before the start as well as after commencement of mining in 2010. Detailed data analysis and interpretation of the outcomes of monitoring activities was conducted for MGM & EHPL by Astron Environmental Services (2014). Interpretation of the results from the data analysis were summarised as follows:

- There was strong temporal variation in survivorship, health condition and height between August 2007 and November 2013.
- In 2010 and 2013, poor health and lower survivorship were recorded. Survivorship at Mt Gibson South was lower than that of other monitoring sites. Death of up to 80% of individuals was recorded in some monitoring plots, and may be attributed to the age of the plants (i.e. natural attrition).
- Strong spatial variation in survivorship, health condition and height was not related to distance from the mine pit. The strong spatial variation was evident between monitoring sites (defined by location across the range) as well as between groups of monitoring sites (within a location; small-scale spatial variation).

Astron Environmental Services (2014) concluded that "*there was **no evidence** showing that health condition and survivorship of* D. masonii *was impacted by mining activity*".

In 2014, MGX engaged MBS Environmental (2015) to increase monitoring plots adjacent to the mine pit at Extension Hill. A total of 84 plants were monitored at distances between 30 and 60m from the edge of the pit. Dust deposition and evidence of fly rock from blasting activities were observed in certain spots of monitoring plots close to the mine pit, however, there was no significant statistical difference in survivorship and plant health in comparison to plants in plots at greater distances from the mine pit (MBS Environmental 2015).

Implementation of the above recommendations and a rolling analysis of plant condition monitoring data collected in the future will be undertaken to improve the *D. masonii* monitoring program. The results of the rolling analysis will be used to assess the effectiveness and improve actions using an adaptive management approach.

Actions:

- Implement the condition monitoring program based on continual improvement (EHPL & MGM, 2015).
- Habitat health will be monitored annually in established plots using the plant condition criteria of Keighery (1994; EHPL & MGM, life of MGIOIP).
- Conduct dust deposition monitoring on a monthly basis (when mining occurs) using the dust deposition gauges around the mine (EHPL & MGM).
- Conduct annual monitoring of plants in 'fire' plots (EHPL & MGM).
- Report upon the condition monitoring program using a standardised reporting format on an annual basis (EHPL & MGM).

Responsibiity: MGM, EHPL

Comencement date:	Ongoing
Completion date:	Life of MGIOMIP

Note that since the advent of MS753 Condition 6, Mount Gibson Mining applied, for the duration of Ministerial Statement 1045, an approved Flora & Vegetation Monitoring and Management Plan across the Mt Gibson Range to conduct regular monitoring of native vegetation including D.masonii. The plan methods generated results against a number of plant health and habitat condition indicators to detect temporal and seasonal changes in plant condition and identify indirect effects from mining. Overall, because of MGM's commitment to a meso-scale survey across the range, plant survival and leaf chlorophyll content (pigment fluorescence) is repeatedly recorded in tagged D.masonii (and well over four hundred native plants) on at least eight consecutive occasions during 2017 at sites from Extension Hill South to Mount Gibson South.

4.6 Implement Fire Management Strategy

Mt Gibson Range and the habitat of *D. masonii* are currently under a 'no controlled burn' fire management regime. Any fires occurring on the Mt Gibson Ranges are wildfires, or unplanned fires, which have the potential to occur as a result of mining activities.

MGM and EPHL are required to manage fire as a threatening process to *D. masonii* through the conditions that apply to the MGIOMIP under MS753.

Actions:

- Implement actions required to manage fire as a threatening process through the conditions that apply to the MGIOIP under MS753 (MGM and EHPL).
- Minimise the risk of fire occurring in the habitat of the populations, except where it is being used in regeneration trials (Parks and Wildlife).

Responsibility: MGM and EHPL; Parks and Wildlife

Timing: ongoing for life of mine

Commencement date:	Ongoing
Completion date:	Life of MGIOMIP for mine-related actions, and otherwise life of the Plan

4.7 Manage threatening processes from mining

MGM and EPHL are required to manage threatening processes from mining to *D. masonii* through conditions that apply to the MGIOMIP under MS753.

Action:

- Implement actions required to manage threatening processes from mining through the conditions that apply to the project under MS753 and the Environmental Management Plan (EHPL & MGM, 2008).

Responsibility: MGM and EHPL

Timing: ongoing for life of mine

Commencement date:	Ongoing
Completion date:	Life of MGIOMIP

4.8 Manage the risk of herbivory

Grazing has not been identified as having a significant effect on *D. masonii* (Section 1.3.7). Non-native vertebrates, including rabbits and goats, are present within the Mt Gibson Ranges, and their impact on the vegetation varies between sites (BGPA, 2010). Grazing is a potential threat to the integrity of the areas of habitat of *D. masonii*. Grazing is also a potential threat to *D. masonii* if the distribution and density of preferentially

grazed plants decline within the habitat, resulting in *D. masonii* becoming relatively more palatable to vertebrates.

The reporting from the annual condition monitoring program will continue to include an assessment of impacts of grazing on *D. masonii* and its habitat.

In the event that grazing pressure significantly affects *D. masonii*, either directly or through damage to associated habitat, the feral animal population will be controlled on the mining tenements through consideration of:

- Fencing (financial provision and logistic capability required); and
- Feral animal eradication (pastoral consent required).

Action:

- Continue to review grazing effects in annual *D. masonii* condition monitoring data (see Section 4.5); and
- If grazing is having significant adverse impacts on *D. masonii* or its habitat, MGM and EHPL will facilitate an appropriate feral animal control program in consultation with relevant stakeholders.

Responsibility: MGM and EHPL; Parks and Wildlife

Timing: Annually

Commencement date:	Ongoing
Completion date:	Life of MGIOMIP

4.9 Monitor the populations

Known populations of *D. masonii* will be surveyed for the purpose of conducting a stocktake of the abundance of *D. masonii* in the wild. This compares to plant condition monitoring, which focusses on a subset and monitors the condition of individuals in that subset (see Section 4.5). This is a comprehensive form of monitoring that will occur once every five years, unless the results from the condition monitoring program indicate that:

- the population or health of mature plants is estimated to be outside of the stable population range at which time it would be undertaken more frequently; or,
- the population or health of mature plants is shown to be stable based on quantitative ecological results at which time a census would only need be completed once during the life of the Plan.

A comparison of abundances through time will be used to assess the effectiveness of and if necessary improve the Plan's actions.

Action:

- When mining is occurring at the site, survey the entire population within one year and at the stipulated rate; otherwise, a rate of every three years if the populations or health of mature plants is estimated

outside of the stable population range (taking variations resulting from fire and other effects into account). See Section 2.2 for definition of stable population numbers. The most recent census was by Eco Logical (2015).

Responsibility: MGM and EHPL

Timing: As required

Commencement date:	On adoption of the Plan
Completion date:	Life of Plan

4.10 Report any new occurrences of *Darwinia masonii*

MGM and EHPL will report to Parks and Wildlife any new plants or populations of *D. masonii* that MGM and EHPL may find, in accordance with the Threatened and Priority Flora Report Form, to ensure Parks and Wildlife have accurate data on the species.

Action:

- Report opportunistic observation of any 'new' plants or population record to Parks and Wildlife.
- MGM to re-survey areas at Mount Gibson Station (eg. parts of DmRS08 in Figure 2)

Responsibility: MGM and EHPL

Timing: Ongoing

Commencement date:	2015
Completion date:	Life of Plan

4.11 Review conservation status of the species

For the purposes of planning, changes to conservation status include significant changes and trends in the:

- number of individuals;
- number of populations;
- number of locations;
- habitat quality and extent;
- extent of occurrence;
- area of occurrence; and,
- threats.

For example, a successful translocation trial or future regional discovery of additional records that has natural recruitment would change the conservation status by increasing both area of occurrence and abundance, but may not necessarily result in the IUCN category being altered or the species delisted.

The IUCN category of the species is currently 'Vulnerable'. A review of the current status of the species and comparison with the status at the time of its 'Vulnerable' classification indicates that there have been insufficient significant changes to justify a change of its current status.

Whilst there are significantly more known individuals due to further population census and research, and additional sub population discoveries, the species is still geographically restricted.

Actions:

- Review the conservation status of the species every five years; or more frequently when there are indications of significant change to the conservation status of the species.
- Liaison by Parks & Wildlife with EHPL & MGM

Responsibility: Parks and Wildlife; with advice invited from MGM and EHPL

Timing: Upon indications of significant change to conservation status

Commencement date:	2015
Completion date:	Life of Plan

4.12 Review this plan

MGM and EHPL shall review and revise this Plan as and when directed by the CEO, OEPA (condition 6-7 of MS753), or every five years, whichever comes first.

Actions:

- Review and revise this Plan.

Responsibility: MGM & EHPL

Timing: 2020

Commencement date:	2020
Completion date:	Life of Plan

5 Further research to benefit the species

MGM and EHPL are required under conditions 6-1 and 6-4 of MS753 respectively to prepare and implement a *D. masonii* Research Plan. They are required to review and revise the Research Plan as and when directed by the CEO, OEPA (condition 6-7 of MS753), and to implement revisions of the *Darwinia masonii* Research Plan (condition 6-8).

BGPA (2010) identified the need for further research, which is listed here if it has not already been included in the actions in Section 4:

- Mapping of soil or regolith data for the region is suggested to refine distribution models to improve understanding and predictions of the habitat and restoration requirements for *D. masonii*. However the conduct of a species census in 2014 gives greater confidence in the area of occupancy of the species and so the need for a predictive model of distribution is considerably reduced.
- Identify the seed-eating moth species and survey for its occurrence in co-occurring species and related *Darwinia* species.
- Annual collection of a sample of (>10) infructescences of *D. masonii* from each major population to assess rates of seed predation and seed fill.
- Further research into seedling production under laboratory, glasshouse or field conditions to consider the feasibility of providing a genetically diverse and numerous source of restoration plants.
- Review the role of birds including the White-fronted Honeyeater in *D. masonii* pollination.

Actions:

- Prioritise the above tasks and implement according to resourcing and budget considerations over a five year period.
- Review and revise the *Darwinia masonii* Research Plan.

Responsibility: MGM & EHPL

Timing: 2015-2025

Commencement date: Commencement of the Plan

Completion date: Life of Plan

6 Legislative and decision making controls and obligations

6.1 International obligations

This plan is consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. The species is not listed under Appendix II in the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES), and this plan does not affect Australia's obligations under any other international agreements.

6.2 Guide for decision makers

Preceding sections of this Plan provide details of current and possible future threats to *D. masonii,* and the risk of each of the threatening processes on the species. Any further development in the vicinity of existing or potential habitat for *D. masonii* will require assessment under established referral and/or environmental assessment mechanisms of State and Commonwealth governments.

Significant actions which may compromise the objective of this Plan could have a significant impact on the species.

Decision makers should refer to this Plan, specifically the threatening processes, the objective of the Plan, and associated actions, in making determinations relating to development in the vicinity of existing or potential habitat for *D. masonii*.

7 Interest groups, social and economic impacts and benefits

7.1 Role and interest of Aboriginal groups

The Badimia people were registered native title claimants in the area (Badimia People WC96/98), however, the Badimia claim was determined by the Federal Court of Australia in March 2015 and, in May 2015, the Court made a determination that native title does not exist in the area.

Registered ethnographic and archaeological sites exist within the *D. masonii* habitat.

MGM and EHPL has undertaken consultation through stakeholder meetings since commencement of the IRP in 2008 and including the period during the preparation of this Recovery Plan. MGM and EHPL will continue to consult the Badimia people about any issues raised in relation to the company's activities in this area. Input and involvement will be welcome from any Aboriginal groups that have an active interest in areas in which *D. masonii* occurs. The works of Tehnas (2010) should be referenced to obtain information of the existence and status of aboriginal heritage sites and regional ethnography.

7.2 Affected interests

The known populations of *D. masonii* occur across a variety of land tenures including pastoral leases, Crown Reserve (Reserve 17367), Unallocated Crown Land and mining leases. Based on the current records and known area of occurrence of *D. masonii*, interests potentially affected by, or involved in the implementation of this plan include:

- MGM, EHPL, Pindiddy Aboriginal Corporation (Ninghan Station), Australian Wildlife Conservancy (Mt Gibson Station) and the Badimia People.

Interests of others may be potentially affected by this Plan. In most cases, no undue impediment or restriction on current land use is likely to arise because of this Plan. Landholders and land management agencies may be affected through statutory planning and approval processes outside this Plan when seeking to alter the landscape or undertake actions that may impact on *D. masonii*.

Parks & Wildlife will seek permission from relevant managers and/or those with entitlements to lands where *D. masonii* occurs or may occur before recovery actions are undertaken on any such land.

7.3 Social and economic impacts and benefits

The presence of MGM and EHPL in the region and their proactive approach to supporting the implementation of this plan will provide both economic impact and certain benefits to the species, as well as economic and social advantages from mining activities on the Mt Gibson Range.

The known habitat for *D. masonii* comprises ironstone formations that are also prospective for iron ore and exist under live mining leases. This Plan provides guidance for decisions by government with respect to further development proposals in the vicinity of existing or potential habitat for *Darwinia masonii*.

8 Implementation and evaluation

This plan has been prepared to the requirements of the Minister for the Environment (WA) on advice of the Environmental Protection Authority and Parks and Wildlife.

MGM and EHPL will implement the Plan as required by condition 6-6 of MS753, specifically the assigned actions.

Parks and Wildlife, as funded through offset 4 under condition 16 of MS753, may assist with the implementation of the Plan as assigned by nominated actions and responsibilities.

Actions associated with evaluation and review of this Plan are provided in Section 4 include:

- Conduct an annual review (Appendix 10.5) to assess effectiveness of the implementation of this Plan;
- Provide an annual report on the Plan's progress to Parks and Wildlife's Corporate Executive and funding bodies (Section 4.1).
- MGM and EHPL shall review and revise this Plan as and when directed by the CEO, OEPA (condition 6-7 of MS753), or after five years, whichever comes first (Section 4.12).

This plan will continue to apply from the date of adoption for a minimum of 10 years, or until replaced by a revised Plan.

The Commonwealth Department of the Environment may evaluate the plan.

The estimated cost of implementing this Plan is described in Table 9. However, this estimated figure does not include site operational costs associated with implementing actions that reduce threats from mining activities or associated restoration of post-mining landforms, other government agencies and private land owners.

Table 10 Summary of actions over five years and indicative costs

Section	Action	Responsibility	2016 Budget ($)	2017 Budget ($)	2018 Budget ($)	2019 Budget ($)	2020 Budget ($)
4.1 Coordinate recovery actions and liaise with stakeholders							
4.1	Coordinate relevant actions, and liaise with stakeholders.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.1	Coordinate relevant recovery actions, and liaise with stakeholders.	Parks & Wildlife					
4.1	Implement the relevant actions in the Plan.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.1	Implement the relevant actions in the Plan.	Parks & Wildlife					

Section	Action	Responsibility	2016 Budget ($)	2017 Budget ($)	2018 Budget ($)	2019 Budget ($)	2020 Budget ($)
4.1	Provide an annual report on the Plan's progress to Parks and Wildlife's Corporate Executive and funding bodies.	Parks & Wildlife					
4.2 Develop and implement restoration strategy							
4.2	Prepare *Darwinia masonii* restoration strategy and program (inclusive of translocation, recruitment and rehabilitation).	MGM & EHPL	10,000	-	-	-	-
4.2	Commence implementation of Restoration Strategy	MGM & EHPL	10,000	20,000	10,000	10,000	10,000
4.2	For rehabilitated landforms, further assessment of patterns of BIF rock and BIF gravel substrate, and varying degrees of soil depth and rockiness and growing media will be made to support growth of *Darwinia masonii*.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	-	-
4.2	Monitor the survival and sustainable establishment of the plants remaining from the preliminary planting trial of *Darwinia masonii* at the disused drill pad on Iron Hill East.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.2	Monitor the survival of the plants (if they remain) from the planting trial established on the BIF rock and BIF soil substrates north of Extension Hill	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.2	Identify parameters for the long-term viability of re-established populations of *Darwinia masonii*.	MGM & EHPL	-	10,000	10,000	-	-
4.2	Monitor translocations and supplement them as necessary.	MGM & EHPL			15,000	15,000	15,000
4.2	Review and update Restoration Strategy in order to meet criteria for success.	MGM & EHPL	-	-	10,000	-	-
4.3 Maintain and use seed/germplasm collections to ensure material with a broad genetic base is available for conservation							
4.3	Develop a seed collection plan to identify representative species in the PEC, their composition and abundance required to meet	MGM & EHPL	5,000	-	-	-	-

Section	Action	Responsibility	2016 Budget ($)	2017 Budget ($)	2018 Budget ($)	2019 Budget ($)	2020 Budget ($)
	objectives (to be determined) for collecting the seed in the first place.						
4.3	Collate and annually check records of retained seed stock in storage.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.3	One-off viability test of retained seed stock in storage.	MGM & EHPL	2,000	-	-	-	-
4.3	Targeted seasonal collection of seeds from key Mt Gibson Ranges populations (late October to early November).	MGM & EHPL	7,500	7,500	7,500	-	-
4.3	Propagation of live *Darwinia masonii* plants from wild collection seed stock and cuttings for the purposes of translocation.	MGM & EHPL	20,000	20,000	20,000	-	-
4.3	Provision of nominated seed samples to the Threatened Flora Seed Centre and BGPA	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.3	Review adequacy of *ex situ* collection to inform future actions	MGM & EHPL	-	-	-	$2,000	-
4.3	Supplementation of seed in storage (upon identification of inadequate stock levels)	MGM & EHPL	-	-	-	-	$7,500 (if req'd)
4.4 Promote awareness of *Darwinia masonii*							
4.4	Promote need for protection through poster displays on the mine site	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.4	Promote awareness to the wider community	Parks & Wildlife					
4.4	Promote awareness of *Darwinia masonii* to mine site personnel through environmental inductions.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.5 Implement *Darwinia masonii* condition monitoring program							
4.5	Implement the condition monitoring program for *Darwinia masonii* based on continual improvement.	MGM & EHPL	25,000	25,000	25,000	25,000	25,000

Section	Action	Responsibility	2016 Budget ($)	2017 Budget ($)	2018 Budget ($)	2019 Budget ($)	2020 Budget ($)
	Habitat health will be monitored annually in established plots.						
4.5	Conduct dust deposition monitoring on a monthly basis using dust deposition gauges.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.5	Conduct annual monitoring of plants in 'fire' plots.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.5	Report upon the condition monitoring program using a standardised reporting format on an annual basis.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.5	Ascertain the role of drought in recruitment of D.*masonii*	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.6 Implement Fire Management Strategy							
4.6	Implement actions required to manage fire as a threatening process through the conditions that apply to the MGIOIP under MS753.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.6	Minimise the risk of fire occurring in the habitat of the populations, except where it is being used in regeneration trials.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.7 Manage threatening processes from mining							
	Implement management actions required to manage threatening processes from mining through the conditions that apply to the MGIOMIP under MS753.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.8 Protect plants from herbivory							
4.8	Continue to review grazing effects in annual *Darwinia masonii* condition monitoring data.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.8	If grazing is having an adverse impact on populations of *Darwinia masonii* or its habitat, MGM and EHPL will facilitate an appropriate feral animal control program in	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets

Section	Action	Responsibility	2016 Budget ($)	2017 Budget ($)	2018 Budget ($)	2019 Budget ($)	2020 Budget ($)
	consultation with relevant stakeholders.						
4.9 Monitor populations							
4.9	Monitor the entire population within one year and at a rate of every 5 years; otherwise at a rate of every 3 years.	MGM & EHPL	-	-	-	-	110,000
4.10 Report any new occurrences of *Darwinia masonii*							
4.10	Report opportunistic observation of any 'new' plant or population record to Parks and Wildlife.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets
4.11 Review conservation status of the species							
4.11	Review the conservation status of the species every 5 years.	Parks & Wildlife					
4.12 Review this plan							
4.12	Review and revise this Plan.	MGM & EHPL	-	-	-	-	15,000
5.0 Further research to benefit the species							
5.0	Prioritise the listed tasks and implement according to resourcing and budget considerations over a five year period.	MGM & EHPL	-	20,000	20,000	20,000	-
5.0	Review and revise the *Darwinia masonii* Research Plan.	MGM & EHPL	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets	Site operation budgets

* Parks and Wildlife is funded through offset 4 of condition 16 of MS753 by the proponents. The funding value is $110,000 p.a. Two of four environmental objectives pertain to the Plan and are: to assist with the development and implementation of the Plan for *D. masonii*; and, coordinate the management of the threatening processes (recovery actions) in relation to *D. masonii*.

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J. Sackmann — Senior Environmental Engineer, Mount Gibson Mining Ltd – Extension Hill Operations, Western Australia

Table 11. Exact locations of populations of *Darwinia masonii* (not for publication)

Pop	Location	Vesting	Purpose	Mining Tenements	Manager	Latitude	Longitude
1A	Unnamed, unvested Reserve 17367. "Iron Hill South". Furthest ridge W of summit of Mt Gibson.	RDL	COM	M59/338 M59/454 M59/609	Department of Lands Extension Hill Pty Ltd	-29.6032429	117.1756703
2	UCL. "Extension Hill".	NON	UCL	M59/339	Department of Lands Extension Hill Pty Ltd	-29.5799896	117.1651914
3	Lot 4280/Lease 3114-602. "Extension Hill North". Boundary of Mt Gibson and Ninghan Stations. Ca. 800m E along fenceline from Gt Northern Hwy opposite a landing ground and then 400m north up ridge. [Extinct]	PLB NON	PAS UCL	M59/339	Ninghan Pastoral lessee and Department of Lands Extension Hill Pty Ltd	-29.5733333	117.1572778
4	UCL. "Extension Hill South". Between Iron Hill North and Extension Hill.	NON	UCL	M59/338 M59/339	Department of Lands Extension Hill Pty Ltd	-29.5855916	117.1672760
5A	Unnamed, unvested Reserve 17367. "Iron Hill East". Continues onto UCL to the north (pop 5B).	RDL	COM	M59/338 M59/454	Department of Lands Extension Hill Pty Ltd	-29.5987403	117.1806088
5B	UCL. "Iron Hill East". Continues onto Reserve 17367 to the south (pop 5A).	NON	UCL	M59/338	Department of Lands Extension Hill Pty Ltd	-29.5956782	117.1769584
6A	Unnamed, unvested Reserve 17367. "Mt Gibson". Extending north into UCL (pop 6B) and Lot 4282/Lease 398-616 (pop 6C).Between Mt Gibson and Mt Gibson South.	RDL	COM	M59/338 M59/454	Department of Lands Extension Hill Pty Ltd	-29.5985840	117.1963885

Pop	Location	Vesting	Purpose	Mining Tenements	Manager	Latitude	Longitude
6B	UCL. "Mt Gibson". Extending south into Reserve 17367 (pop 6A) and east into Lot 4282/Lease 398-616 (pop 6C).	NON	UCL	M59/338	Department of Lands Extension Hill Pty Ltd	-29.5935264	117.1862897
6C	Lot 4282/Lease 398-616. "Mt Gibson". Extending south into Reserve 17367 (pop 6A) and west into UCL (pop 6B).	PLB	PAS	M59/338	Mt Gibson pastoral lessee Extension Hill Pty Ltd	-29.5961174	117.1920878
7	Unnamed, unvested Reserve 17367. "Mt Gibson South". On ridge ca 1.2-2.2km SE from summit of Mt Gibson.	RDL	COM	M59/454 M59/609 M59/550	Department of Lands Extension Hill Pty Ltd	-29.6036016	117.1999798
8	Unnamed, unvested Reserve 17367. "Iron Hill North". Furthest ridge W from Mt Gibson summit, on middle part of the ridge.	RDL	COM	M59/338	Department of Lands Extension Hill Pty Ltd	-29.5980882	117.1697750
9	UCL. "Iron Hill North". Furthest ridge W from Mt Gibson summit, northern most population of ridge.	NON	UCL	M59/338	Department of Lands Extension Hill Pty Ltd	-29.5932879	117.1689925
10	UCL. Extension Hill-East. East of Extension Hill on top of BIF breakaway above rock shelter and at the base of a valley on BIF substrate.	NON	UCL	M59/339	Department of Lands Extension Hill Pty Ltd	-29.5816667	117.1690000

10 Appendices

Appendix 10.1 How This Plan Meets The Requirements of MS753

Ministerial Statement 753 (MS753) authorises the implementation of the Mount Gibson Iron Ore Mine and Infrastructure Project (MGIOIP), being the proposal to mine and produce iron ore from Extension Hill and Extension Hill North, within the Mount Gibson Ranges, construct a pipeline to transport the magnetite concentrate to Geraldton Port, and construct infrastructure at the port to dewater the concentrate for export.

Mount Gibson Mining Ltd (MGM) and Extension Hill Pty Ltd (EHPL) are both proponents for the purposes of MS753.

This Plan (Plan) has been prepared to meet condition 6-3 of Ministerial Statement 753 (MS753), which authorises the implementation of the Mount Gibson Iron Ore Mine and Infrastructure Project (MGIOIP) (Table 12). It has been informed by the findings of the *Darwinia masonii* Research Plan and the *D. masonii* IRP which were developed and implemented pursuant to conditions 6-1, 6-2, 6-4 and 6-5 of MS753. A summary of the outcomes of the Research and IRP is provided by way of background in sections 1.1, 1.2 and 3 of this plan.

Table 12. Aspects of the Plan which address the matters stipulated by Condition 6-3 of MS753

MS753 Condition	Matters	Section
6-3(1)	*Habitats which are critical to the survival of the species* *Actions needed to protect those habitats*	Section 1.2; Table 1; Figure 4. Section 4
6-3(2)	*Threats to the species and areas and populations under threat*	Section 1.3
6-3(3)	*Objectives to be achieved*	Section 2.1
6-3(4)	*Criteria against which achievement of the objectives is to be measured*	Section 2.2
6-3(5)	*Management actions based on the outcomes of the implementation of the Research Plan and Interim Recovery Plan that will remediate the impacts of the project and provide for a net improvement on the pre-mining status of the species*	Section 4
6-3(6)	*Further research required into the management or recovery of the species*	Section 5

The objective of this Plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term conservation of *D. masonii* in the wild (see Section 2.1). This objective meets condition 6-3 of

MS753, which required the preparation of a plan "*to maintain, and ultimately improve, the conservation status of D. masonii such that its conservation status is more secure in the Mt Gibson area*".

MS753 includes several conditions which regulate the implementation of the MGIOIP in a manner that will manage the effects of the MGIOIP on *D. masonii* e.g., condition 8 (conservation of significant flora and communities), condition 9 (weeds) and condition 10 (bushfires). This Plan is intended to work alongside those obligations (and particularly the management plans that operate under those conditions) to meet the Plan objectives and maintain an efficient process. Where conditions are directly related to the management or recovery of *D. masonii* they have been referenced in the relevant actions in this Plan (Section 4).

Appendix 10.2 Legislative Requirements

The Plan has been developed using the structure and addresses the matters outlined in the "Recovery Plan Guidelines for Nationally Listed Threatened Species and Ecological Communities" under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Recovery Plan Guidelines). Table 132 is a condensed version of the Department of the Environment's compliance checklist:

Table 13. Aspects of the Plan which address the Guidelines under the *EPBC Act* 1999.

	Requirements of the Guidelines	**Section of this Plan**
1	Consultation with relevant departments	Consultation with relevant government departments and Decision Making Authorities has been on-going since MGIOIP was Referred under the EPBC and EP Acts. Since that time, on-going consultation has occurred in the development and implementation of the IRP, through the funding of a Parks and Wildlife officer position, and through the development of this Plan.
2	Consultation with other stakeholders	Consultation with scientists and specialists has also occurred during the MGIOIP development, approvals and operations with regard to *D. masonii*. Refer to the Foreword and Section 7 of this Plan.
3	Public consultation	The Public Environmental Review document was made available for public comment and the IRP is publically available.
4	Objects of the Act	Objects a-c: the *Darwinia masonii* Recovery Plan Object d: Consultation (as above (1-3)) Object e: International responsibilities (Section 6.1) Objects f & g: The role and interests of indigenous people (Section 7.1)
5	International agreements	Section 6.1
6	Indigenous People	Section 7.1
7	Social and economic impacts	Section 7.3
8	Efficient and effective use of resources	Section 8
9	Species listed as threatened (EPBC Act)	*Darwinia masonii* is listed as Vulnerable under the EPBC Act.
10	Taxonomic or common names used	The taxonomic name, *Darwinia masonii*, is used throughout the document.
11	Distribution of the species	Section 1.1.4 and Table 11. Exact locations of populations of *Darwinia masonii* (not for publication)
12	Population(s)	Section 1.2
13	Define habitat critical to survival	Section 1.2

	Requirements of the Guidelines	Section of this Plan
14	Description of habitat - spatial	Section 1.2
15	Threats	Section 1.3
16	Areas affected by threats	Section 1.3
17	Population(s) under pressure of survival	Section 1.3
18	Recovery objectives	Section 2.1
19	Measurable criteria	Section 2.2
20	Evaluation of performance	Section 8
21	On-ground actions	Section 4
22	Cost	Section 8
23	Management practices	Section 4
24	Biodiversity benefits/impacts	Section 1.4
25	Affected interests	Attachment 7.2
26	Social and economic benefits/impacts	Attachment 7.3

Appendix 10.3 Biology and Ecology of *Darwinia masonii*

Illustrations and/or further information

Brown, A., Thomson-Dans, C. and Marchant, N. (eds). (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia.

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Biology and Ecology

Darwinia masonii is one of 65 Western Australian species of *Darwinia*. The genus is unusual in having a high proportion of species that are considered rare and endangered as a result of intrinsic rarity – i.e. a species naturally limited as a result of limiting natural factors such as edaphic requirements and/or breeding biology. *Darwinia masonii* represents a highly specialised case of a nationally significant, intrinsically rare species.

Population Demography

BGPA (2010) studied the demography of *Darwinia masonii* populations on Extension Hill South, Iron Hill South, Mt Gibson Hill and Mt Gibson Hill South between 2007 and 2010 (2010). Tagged plants were monitored in fifteen 10 by 10m plots, with 5 plots each within vegetation characterised by 3 fire histories (2003; 1969; or, older – pre-1968). Four additional plots with total area of 250m^2 were added in May 2009 within the boundary of an experimental fire at the northern end of Extension Hill South. Parameters measured in the plots included: location of plant within the plot; plant structure (seedling, adult); height (or length for reclining or prostrate plants); canopy diameter in 2 perpendicular dimensions; stem basal diameter in 2 perpendicular dimensions; inflorescence numbers; and, 'health'.

Growth

Mature plants of *Darwinia masonii* have a slow, irregular and modular growth form (BGPA, 2010). Seedling growth forms are more regular with increases in height correlated with age. Older plants may experience dying back of branchlets at their extremities during drought years, and branchlet growth within the canopy during good seasons. The growth rate of *D. masonii* seedlings in plots burnt in 2003 averaged 3.4cm/yr, while the rate of mature and old plants was neutral or negative with an average of -0.9cm/yr during the period between 2007

and 2009 (BGPA, 2010). The average growth rate also varied for each year in this range, demonstrating that the plant growth responded to the annual growing conditions.

The growth patterns of *Darwinia masonii* change once the plants become reproductive, and can be used to explain differences in growth rate. Seedlings have a vertical growth direction, and the growing tip persists from year to year. BGPA (2010) found that this pattern of growth persisted until the plants were between 50 and 70cm tall. Once *Darwinia masonii* starts to reproduce, the flowering heads form on the terminal end of the branches, and new vegetative shoots are produced laterally from below the terminal flowering head. Older plants therefore are characterised by spreading, laterally branched canopies, with ever increasing levels of branching complexity. Their height (or length for reclining or prostrate plants) varies from year to year dependant on the growth conditions experienced.

Seedling growth forms of *Darwinia masonii* display a correlation between stem diameter and growth patterns (BGPA, 2010). In contrast, stem diameter of mature and old plants was found to be unsatisfactory as an assessment measure of growth rate on an annual basis. The stems of seedlings are regular in shape, and the change in stem diameter of *Darwinia masonii* seedlings in plots burnt in 2003 averaged 0.34mm/yr during the period between 2007 and 2009. This varied for each year within this range, indicating that stem diameter responded to annual growing conditions. The stems of mature and old plants are often irregularly shaped, having cracks, swellings, or a presence or absence of spongy bark. Furthermore, the bark can swell, shrink or be sloughed off. These are all characteristics which elucidate why stem diameter is an unsatisfactory parameter for measuring growth of mature and older individuals of *Darwinia masonii*.

Fecundity

Plants have been recorded flowering between April and November (Brown *et al*., 1998). In 2009, BGPA (2010) recorded flowers opening between late August and late October.

Flowering of *Darwinia masonii* has been recorded in plants as young as six years (BGPA, 2010). Six of 115 plants recorded in plots burnt in 2003 at Iron Hill South were recorded to be flowering for the first time in 2009. These plants were in the tallest height category (51 to 95cm), but only represented 13% of the individuals within that category.

Tall (old) individuals of *Darwinia masonii* that have a wide canopy are more likely to produce flowers, and in greater numbers, than smaller (young) individuals with narrow canopy diameter (BGPA, 2010). The proportion of plants recorded to be flowering during the period between 2007 and 2009 increased with plant height (or length, for reclining or prostrate individuals). This proportion was comparable for all plants with a canopy diameter of over 1 metre wide. However, the number of flowers per plant was proportional to canopy diameter.

The percentage of plants flowering and the number of inflorescences varied for each year within the period between 2007 and 2009 (BGPA, 2010), but the reason for this has not been determined. 62% of all plants in older sites (burnt during or before 1969) flowered in 2007, while this dropped to 36% in 2008, and increased once more to 90% in 2009. The number of flowers per plant displayed the same pattern.

Population structure

Darwinia masonii is long-lived and killed by fire (Armstrong and Associates, 2004; BGPA, 2010; Section 1.1.5). A wildfire burnt out a significant area in southern and eastern portions of the Ranges in January 2003. None of the *D. masonii* plants burnt during this fire were observed to have survived during the spring of 2003 by

Armstrong and Associates (2004). Regeneration is restricted exclusively to germination from seed held in long-lived soil-stored seedbanks (BGPA, 2010). Plants arising from seed germinate in a single cohort post-fire. There is also evidence of limited post-fire recruitment of *D. masonii* in older populations. Plant sizes from data collected in 2007 during BGPA's (2010) demographic study ranged in height up to 240 cm and 2.5m in canopy width. The largest stem diameter was 74mm. Plant size correlated with population age in frequency distribution graphs of the young (2003) and mature (1969) plots which showed distinct peaks in size and a narrow size range. The older (pre-1968) plots were estimated to have been unburnt for over 85 years and had the oldest and largest plants in them. However, the frequency distribution graphs did not have distinct peaks in size, but rather a spread of plant sizes. The data from the older plots confirmed that *D. masonii* is long-lived and that limited recruitment occurs at infrequent intervals in the absence of fire.

Recruitment

Recruitment in the plots within the boundary of the experimental fire of May 2009 confirmed that *D. masonii* germinates strongly after fire, with a seedling density in burnt areas of 1.2/m^2 and 3.2 seedlings per pre-fire adult (BGPA, 2010). The fire on 12 May 2009 was not as intense as anticipated and was patchy, such that 73 of the 93 pre-fire adults were burnt. However, it achieved what was intended: it killed the canopy; there was a good amount of ash produced; and, seedlings emerged. Soil temperature at some of the probe sites did reach 250°C (B Miller 2013, pers. comm., 17 December). 233 seedlings were counted within the area burnt in the experimental fire plots, in comparison recruitment of only one seedling in the 15 unburnt plots over the course of the study (May 2007 to June 2010). This seedling was recorded in an older (pre-1968) plot on Mt Gibson South in July 2009. This corroborates the findings of the population structure study - that post-fire recruitment is limited in older populations but does occur.

Survival/Mortality

BGPA (2010) reported that, "While mortality is rare among mature *D. masonii* plants, drought over the winter of 2010 contributed to a significant level of mortality (>10% in one site)" (p6). Two plants out of 249 recorded in the older (pre-1968) plots died between 2007 and 2009. This equates to an average of 0.5% deaths per year. The rainfall total over 2010 was one of the lowest on record, and mortality in a sample of 261 plants resurveyed at Mt Gibson South during BGPA's pollination study was 10.3%. The magnitude of the mortality after this single drought year is of concern, as it indicates that populations of *D. masonii* could be significantly impacted by drought, and there may be implications for the taxon if climate change results in increased drying or a greater frequency of dry years in the region.

There is significant spatial and temporal variation in mortality of *D. masonii* seedlings (BGPA, 2010). Between 2007 and 2009, 33 seedlings died out of the 128 seedlings recorded in 5 plots which were last burnt at Iron Hill South in 2003. The death rate for these plots varied each year, ranging from 2.5% to 15% per year. It also varied between the plots at Iron Hill South. BGPA (2010) suggest possible reasons for the variation in seedling mortality, including seasonal variation in rainfall, soil water holding capacity and microclimate of the plots.

It is also possible that seedlings of *Darwinia masonii* are less resilient to drought conditions than mature plants. Of the seedlings tagged in the recruitment plots within the boundary of the experimental fire of May 2009, only 9% were still alive when these plots were revisited in October 2010. BGPA (2010) stated "this low survival rate may partly result from the drought experienced over the 2010 winter at Mt Gibson, as well as a likely high failure rate of establishing young seedlings" (p43).

Pollination

Flowers of *Darwinia masonii* exhibit pollen presentation, with the pollen exuding from the anthers and being deposited within an oily pollenkitt on a band of hairs just below the tip of the style before the flower opens (anthesis) (BGPA, 2010). Pollen presentation is efficient at depositing pollen in a single area on a pollinator's body, but also may increase the likelihood of self-pollination.

Darwinia masonii is capable of producing low-viability, self-pollinated (selfed) seeds but the production of outcrossed seed is a critical requirement for self-sustaining populations, as there was weak evidence that selfed seed was less fit than outcrossed seed BGPA (2010). BGPA (2010) reported that *D. masonii* is able to self-pollinate at a low rate (6.6%) in the absence of pollinators, however full access to pollinator activity significantly increased seed set (to 23%). The study was not powerful enough to unambiguously separate the actions of pollinator classes (birds versus insects), however the trend agrees well with pollinator observations: rare insect visitation increases the outcrossing rate (and seed set), however birds are much more effective pollinators and more common visitors, resulting in a higher seed set.

Darwinia masonii is known to be pollinated by the White-fronted Honeyeater (*Phylidonyris albifrons*) (BGPA, 2010).

Seed production and seed biology

Darwinia masonii seed production takes place in spring and early summer with the peak of ripe seed production occurring around mid-November in 2009 (BGPA, 2010). The peak period for seed collection depends on the relative rates of seed development and seed drop and may vary between years and localities. Seed fill rates varied between years from 15 to 30%. Seed dispersal occurs by ants. *Darwinia masonii* seed production is moderately low, varying between years from 9 to 59 seeds per plant in mature populations. Inbreeding and predation by moth larvae contribute to reduced seed quality. Seed predation rates varied between years from 6 to 22%.

Seed germination and dormancy

BGPA (2010) stated that large scale production of seedlings of *Darwinia masonii* via germination of fresh or stored seed involves physical manipulation of small seeds for seed coat nicking or removal, or retrieval of seed buried for months or years. They reported that:

- *Darwinia masonii* seed has a physical and physiological dormancy process (removal/breakdown of fruit walls and stimulatory effect of smoke chemicals, respectively). The germination rate of fresh *Darwinia masonii* seed was low but was improved by a combination of detailed physical treatments and smoke application.
- Preliminary results of *in situ* seed burial trials indicated complex germination / dormancy strategies for *D. masonii*, combining a requirement for physical degradation of the seed coat, environmental (seasonal temperature) cuing - with seeds cycling in and out of dormancy, and smoke-related physiological responses. Germination rates of 90% were achieved with filled seed exhumed after 9 months of burial and treated with smoke water.

The seed buried for seed bank demography trials established for *D. masonii* is still in place. These experiments were designed to continue for up to 5 years.

Environmental adaptations

Darwinia masonii shares with co-occurring species the drought avoiding strategy of closing down transpiration and photosynthetic function to enter a period of physiological dormancy through drought with the capacity to restore tissues as soils wet.

Roots of *D. masonii* have a capacity to enter large cracks, pores and fissures in regolith and may achieve considerable root depths (perhaps to >10m), but the species did not show root growth adaptations that were significantly different from close relatives from other habitats.

Biotic interactions

Pollination, seed predation and seed dispersal has already been discussed in this section.

The IRP (DEC, 2008) stated that "only very minor grazing pressure from feral goats and rabbits of D. masonii has been observed to date" (p10). However, BGPA (2010) found that grazing by vertebrates (presumed to be goats and rabbits) had a negligible impact on *D. masonii*. They conducted monitoring of over 350 seedlings and adult plants between 2007 and 2010 in demography plots, and in excess of 200 seedlings in plots established in an area subjected to an experimental burn. No evidence of mammalian herbivory was observed on any plant (seedling or adult) monitored. Branch tip pruning of 4 tagged plants was observed in 2007 and was presumed to have been caused by parrots eating flowers or seeds.

Darwinia masonii has a clear association with Vesicular-Arbuscular Mycorrhizae (VAM) (BGPA, 2010). No obvious Ectomycorrhizal (ECM) formation was recorded in field-collected root systems of the plant. BGPA (2010) suggested that comparative restoration trials be used to further investigate the importance of mycorrhizal formation to the restoration success of *D. masonii*.

Competition or facilitation was not observed by BGPA (2010), but they suggested that future restoration research include manipulative experiments under field conditions to best determine the extent of these interactions.

The impact of termites on *D. masonii* has not appeared to be significant. Proportionally, they have been recorded on a small number of plants – they were observed on the stems of 15 tagged individuals in demography plots burnt during or before 1969 (BGPA, 2010). The mean growth rates and health scores of these individuals did not vary greatly from other termite-free individuals in the same areas.

Foliar loss or damage by insect attack was only noted in the form of galls on a very small number of D. masonii individuals during BGPA's (2010) research.

Wood rots are likely to have a very minor impact on *D. masonii* (BGPA, 2010). No evidence of fungal rotting was recorded on wood of dead or burnt plants which had persisted for many years after death. An unidentified fruiting bracket fungus was found on the trunks of live plants during BGPA's research.

Abiotic associations

BGPA (2010) used two approaches to determine the environmental associations of *D. masonii*: an analysis of site factors at demographic and physiological monitoring plots; and, modelling of species distributions against spatially mapped environmental data. The environmental parameters interrogated by the modelling were

geology, short term fire history (since 1968), solar radiation receipt, aspect, slope, curvature and elevation. Of these, slopes over 7-8º, elevation over 380m and all geology types within the Mt Gibson Ranges except "White Rock (unclassified, including granite and its group, acidic dyke rocks, feldspar porphyry and meta-sediments phyllitic rock)" were the principal environmental parameters predicting the distribution of *D. masonii*. When each of these was considered alone they had an associated probability of 50 to 60% of predicting the *D. masonii* distribution.

The modelling predicted *D. masonii* to occur broadly across the Mt Gibson ranges with a high probability (60-75%) of occurrence (BGPA, 2010). It is interesting to note that the modelling also predicted suitable habitat for *D. masonii* on Yandanhoo Hill to the east of the Mt Gibson Ranges. Many areas in the Mt Gibson Ranges where populations were most highly predicted to occur by the modelling do not support *D. masonii*. BGPA concluded that the distribution of *D. masonii* may have an association with unmapped sub-surface features such as regolith (soil depth, underlying rock structure) and longer-term fire history patterns. They postulated that some areas of the Mt Gibson range are more prone to fire than others.

In situ planting methods using cuttings were trialled by BGPA (2010) at Mt Gibson on 4 differing field soil substrates. These were on the deep red loam/clay plains east of Extension Hill (clay), white-yellow sands of sandplains west of Extension Hill (sand), and gravelly and rocky loams of the north Extension Hill slope and ridge (BIF gravel and BIF rock respectively). *Darwinia masonii* survival after 9 months of planting was only successful in sites with BIF rock and BIF gravel substrate. The highest survival was at the BIF rocky loam site which averaged under 40%. Both sites had significantly higher Organic Carbon (%) and Total Nitrogen (%) than the clay and sand sites. The BIF rock and BIF gravel sites had slower soil drying curves than the sand and clay sites. *Darwinia masonii* is not currently known from sandy or clayey sites like those selected for the restoration trial, and perhaps the factors contributing to the lack of success of the cuttings planted provides some explanation for this. Conversely, BGPA (2010) concluded that sites with BIF rock and BIF gravel are suitable for translocations, and texture, gravel/rock content, patterns of moisture content and Total Nitrogen may be the most critical soil properties to consider in site selection. These properties may also contribute more broadly in defining the current and potential habitat of *D. masonii*.

Appendix 10.4 Risk Assessment Criteria

The *Darwinia masonii* risk assessment was based on the framework of the Australian and international standard for risk management AS/NZS ISO 31000 (2009).

Risk assessment is the basis of management and mitigation measures applied through the approved "Extension Hill & Extension Hill North Environmental Management Plan", prepared to meet the conditions of Ministerial Statement No. 753 (in particular conditions 6 to 12 and 14 of Ministerial Statement No. 753).

The main elements of the risk assessment process required:

- identification of the potential threats, cause of the threat and potential impact on the species (Table 3; termed 'Inherent Risk'); and
- estimating the likelihood of each threat occurring, the potential environmental consequences if it did occur and the subsequent determination of an inherent risk rating in context of the current controls (Table 3; termed 'Controlled Risk');
- consideration of actions to further mitigate risk; and
- re-estimating the likelihood of each risk event occurring and the potential environmental consequences if it did occur, and the subsequent determination of a residual risk rating (Table 3; termed 'Residual Risk').

Risk Assessment Matrix

RISK MATRIX		Likelihood				
		A Certain	B Probable	C Possible	D Remote	E Improbable
Rating	**Consequence**	**(Common)** *It is expected to occur in most circumstances.* *Guide (> 90%)*	**(Likely)** *Will probably occur in most circumstances.* *Guide (51-90%)*	**(Could Happen)** *Should occur at some time.* *Guide (21-50%)*	**(Not Likely)** *Could occur at some time.* *Guide (10-20%)*	**(Rare)** *May occur only in exceptional circumstances.* *Guide (<10%)*
1 **Catastrophic**	Severe reduction in population between 71-100% of known records. Intergenerational timeframe for restoration if at all. High cost, long term involvement.	**1**	**2**	**5**	**7**	**11**
2 **Major**	Reduction of 31-70% of known records Long term restoration, high cost and involvement 21 – 100 years.	**3**	**4**	**8**	**12**	**16**
3 **Moderate**	Reduction of between 11-30% of known records Medium reversibility estimate 6 - 20 year recovery timeframe.	**6**	**9**	**13**	**17**	**20**
4 **Minor**	Reduction of 1-10 % of known records Should be reversible within 6 year timeframe.	**10**	**14**	**18**	**21**	**23**
5 **Insignificant**	No discernable effect	**15**	**19**	**22**	**24**	**25**

* Environment descriptors have been modified to align with description of severity from WWF 2007

Appendix 10.5 Annual Review Checklist

All parties responsible for implementing actions in this plan shall be audited to determine the effectiveness of assigned actions and inform future revisions of this Plan. An audit checklist (Table 13) clearly identifies the specific future actions (as listed in the Plan) required for *D. masonii* on the Mt Gibson Range, the party responsible for implementation, the timing for implementation and a suitable audit mechanism by which the action may be assessed (although further evidence may be requested by the audit team).

Table 14 Review Checklist

Section	Action	Responsibility	Timing	Reporting mechanism
4.1 Coordinate recovery actions and liaise with stakeholders				
4.1	Coordinate relevant actions, and liaise with stakeholders.	MGM & EHPL	On-going	Stakeholder register and records
4.1	Coordinate relevant recovery actions, and liaise with stakeholders.	Parks & Wildlife	On-going	Annual progress report
4.1	Implement the relevant actions in the Plan.	MGM & EHPL	On-going	Annual Environmental Report
4.1	Implement the relevant actions in the Plan.	Parks & Wildlife	On-going	Annual progress report
4.1	Provide an annual report on the Plan's progress to Parks and Wildlife's Corporate Executive and funding bodies.	Parks & Wildlife	Annually	Annual progress report
4.2 Develop and implement restoration strategy				
4.2	Prepare Darwinia masonii restoration strategy and program (inclusive of translocation, recruitment and rehabilitation).	MGM & EHPL	2014	Restoration strategy
4.2	Commence implementation of Restoration Strategy	MGM & EHPL	2015	Annual Environmental Report

Section	Action	Responsibility	Timing	Reporting mechanism
4.2	For rehabilitated landforms, further assessment of patterns of BIF rock and BIF gravel substrate, and varying degrees of soil depth and rockiness and growing media will be made to support growth of *Darwinia masonii*.	MGM & EHPL	2015-2017	Annual Environmental Report
4.2	Monitor the survival and sustainable establishment of the plants remaining from the preliminary planting trial of *Darwinia masonii* at the disused drill pad on Iron Hill East.	MGM & EHPL	2014-2017	Annual Environmental Report
4.2	Monitor the survival of the plants (if they remain) from the planting trial established on the BIF rock and BIF soil substrates north of Extension Hill	MGM & EHPL	2014-2017	Annual Environmental Report
4.2	Identify parameters for the long-term viability of re-established populations of *Darwinia masonii*.	MGM	On-going	Restoration strategy
4.2	Monitor translocations and supplement them as necessary.	MGM	2016-2019	Annual Environmental Report
4.2	Review and update Restoration Strategy in order to meet criteria for success.	MGM	Annually	Restoration strategy (revision # and date)
4.3 Maintain and use seed/germplasm collections to ensure material with a broad genetic base is available for conservation				
4.3	Develop a seed collection plan to identify representative species in the PEC, their composition and abundance required to meet objectives (to be determined) for collecting the seed in the first place.	MGM & EHPL	2014	Seed collection plan
4.3	Collate and annually check records of retained seed stock in storage.	MGM & EHPL	Annually	Spreadsheet of seed records
4.3	One-off viability test of retained seed stock in storage.	MGM & EHPL	2015	Annual Environmental Report

Section	Action	Responsibility	Timing	Reporting mechanism
4.3	Targeted seasonal collection of seeds from key Mt Gibson Ranges populations (late October to early November).	MGM & EHPL	2015-2016	Spreadsheet of seed records
4.3	Propagation of live *Darwinia masonii* plants from wild collection seed stock and cuttings for the purposes of translocation.	MGM & EHPL	2015 - 2017	Annual Environmental Report
4.3	Provision of nominated seed samples to the Threatened Flora Seed Centre and BGPA	MGM & EHPL	2014-2017	Annual Environmental Report
4.3	Review adequacy of *ex situ* collection to inform future actions	MGM & EHPL	2017	Annual Environmental Report
4.3	Supplementation of seed in storage (upon identification of inadequate stock levels)	MGM & EHPL	2018 - 2019	Annual Environmental Report
4.4 Promote awareness of *Darwinia masonii*				
4.4	Promote need for protection through poster displays on the mine site	MGM & EHPL	On-going	Posters
4.4	Promote awareness to the wider community	Parks & Wildlife	On-going	Annual Progress Report
4.4	Promote awareness of *Darwinia masonii* to mine site personnel through environmental inductions.	MGM & EHPL	On-going	Induction materials
4.5 Implement *Darwinia masonii* condition monitoring program				
4.5	Implement the condition monitoring program for Darwinia masonii based on continual improvement. Habitat health will be monitored annually in established plots.	MGM & EHPL	Monthly; Annually	Technical Report
4.5	Conduct dust deposition monitoring on a monthly basis using dust deposition gauges	MGM & EHPL	Monthly	Annual Environmental Report

Section	Action	Responsibility	Timing	Reporting mechanism
4.5	Conduct annual monitoring of plants in 'fire' plots.	MGM & EHPL	Annually	Annual Environmental Report
4.5	Report upon the condition monitoring program using a standardised reporting format on an annual basis.	MGM & EHPL	Annually	Annual Environmental Report
4.5	Ascertain the role of drought in recruitment of D.masonii	MGM & EHPL	Annually	Annual Environmental Report
4.6 Implement Fire Management Strategy				
4.6	Implement actions required to manage fire as a threatening process through the conditions that apply to the MGIOIP under MS753.	MGM & EHPL	On-going	Annual Environmental Report
4.6	Minimise the risk of fire occurring in the habitat of the populations, except where it is being used in regeneration trials	MGM & EHPL	On-going	Annual Environmental Report
4.7 Manage threatening processes from mining				
	Implement management actions required to manage threatening processes from mining through the conditions that apply to the MGIOIP under MS753.	MGM & EHPL	On-going	Annual Environmental Report
4.8 Protect plants from herbivory				
4.8	Continue to review grazing effects in annual Darwinia masonii condition monitoring data.	MGM & EHPL	Monthly; Annually	Annual Environmental Report
4.8	If grazing is having an adverse impact on populations of *Darwinia masonii* or its habitat, MGM and EHPL will facilitate an appropriate feral animal control program in consultation with stakeholders.	MGM & EHPL	As required	Stakeholder consultation register; Annual Environmental Report
4.9 Monitor populations				

Section	Action	Responsibility	Timing	Reporting mechanism
4.9	Monitor the entire population within one year and at a rate of every 5 years; otherwise at a rate of every 3 years.	MGM & EHPL	As required	Annual Environmental Report
4.10 Report any new occurrences of *Darwinia masonii*				
4.10	Report opportunistic observation of any 'new' plant or population record to Parks and Wildlife.	MGM & EHPL	On-going	Threatened and Priority Flora Report Form
4.11 Review conservation status of the species				
4.11	Review the conservation status of the species every 5 years.	Parks & Wildlife	2015	Annual Progress Report
4.12 Review this plan				
4.12	Review and revise this Plan.	MGM & EHPL	2020 or as required.	Revision number and date of this Plan
5.0 Further research to benefit the species				
5.0	Prioritise the listed tasks and implement according to resourcing and budget considerations over a five year period.	MGM & EHPL	2015	Annual Environmental Report
5.0	Review and revise the *Darwinia masonii* Research Plan.	MGM & EHPL	2016 - 2018	Annual Environmental Report