Prasophyllum Offset Management Plan:

Mangoola Coal Continued Operations Project

Prepared for

Mangoola Coal

July 2022

Dr Stephen Bell

Eastcoast Flora Survey
PO Box 216
Kotara NSW 2289

Report produced by:

Dr Stephen A.J. Bell
Eastcoast Flora Survey
PO Box 216 Kotara NSW 2289 Australia

Telephone (02) 4953 6523
Email: sajbell@bigpond.com

This document should be cited as:

Bell, S.A.J. (2022) *Prasophyllum Offset Management Plan: Mangoola Coal Continued Operations.* Unpublished Report to Mangoola Coal. 28 July 2022. Eastcoast Flora Survey.

Document cover: Flowering *Prasophyllum* sp. Wybong at Mangoola Coal.

Report produced for:

Mangoola Coal
Wybong Road
Muswellbrook NSW 2333

Contents

1.0 Background

The Mangoola Open Cut (MOC) is an open cut coal mine located near Wybong, approximately 20 kilometres west of Muswellbrook and 10 kilometres north of Denman in the Muswellbrook Local Government Area. The MOC has been in operation since 2010.

On 26 April 2021, the NSW Independent Planning Commission (IPC) approved the Development Application (DA) for the Mangoola Coal Continued Operations (MCCO) project State Significant Development (SSD) 8642, and on 1 October 2021 the Commonwealth Minister for the Environment also approved the MCCO Project (EPBC 2018/8280). The MCCO Project provides for the continuation of existing mining operations, allowing the extraction of a further 52 million tonnes of coal to 2030.

Nine Biodiversity Offset Areas (BOAs) have been established to compensate for the predicted ecological impacts of the MCCO operations. The BOAs cover 5,521 hectares of land located adjacent and proximal to the MOC and are divided into ecological management domains based on their locations and differing management purposes. Two BOAs, Mangoola Offset Area (MO) and Mangrove Offset Area (MgO), were (amongst other reasons) selected due to the known presence of *Prasophyllum*. sp. Wybong and include dedicated offsetting for this species. The remaining seven BOAs are:

- Aboriginal Cultural Heritage Offset Area (ACHO)
- Habitat Enhancement Offset Area (HEO)
- Southern Offset Area (SO)
- Northern Corridor (NC)
- Western Corridor (WC)
- Wybong Heights Offset Area (WHO) and
- Highfields Offset Area (HO)

A Biodiversity Offset Management Plan and Strategy (BOMPS) has been prepared to guide the management of these offsets and to ensure that consent conditions are adhered to into the future. Part of these conditions relate to the management of the critically endangered terrestrial orchid *Prasophyllum* sp Wybong (also known by NSW authorities as *Prasophyllum petilum*, listed as Endangered), present in the MCCO Project area.

The Commonwealth Department of Arts, Water and the Environment (DAWE) have stipulated a number of conditions that must be met as part of the approval process. Those directly relevant to *Prasophyllum* sp. Wybong are shown in Box 1. This *Prasophyllum* Offset Management Plan (POMP) has been specifically prepared to address Condition 10b as it relates to the MO and MgO offset areas: Conditions 10a and 11 are not the subject of this POMP. Full consent conditions are provided in Appendix 1.

This POMP has been prepared by Dr Stephen Bell, who has worked with *Prasophyllum* sp. Wybong every year since 2009, either in the conduct of targeted surveys or in a monitoring capacity of natural and translocated populations. He has also been endorsed by the NSW Department of Planning and Environment as a species expert for *Prasophyllum* sp. Wybong. A Curriculum Vitae is provided in Appendix 2.

Box 1: Commonwealth Consent Conditions, *Prasophyllum* sp. Wybong

10. *For the protection of the Prasophyllum sp Wybong, prior to the commencement of coal extraction in the MCCO Additional Project Area, or other timeframe agreed to by the Minister, the approval holder must provide the Minister with:*

    a. *evidence that 193.1 ha of Prasophyllum sp Wybong offset habitat has been secured under a Biodiversity Stewardship Agreement.*[1]

    b. *a Prasophyllum sp Wybong offset management plan (this can be provided separately or as part of the Biodiversity Management Plan). This plan must be prepared by a suitably qualified Prasophyllum sp Wybong expert and must include, but not be limited to:*

        i. *identification of potential direct and indirect impacts to the Prasophyllum sp Wybong individuals and/or habitat in the offset area;*

        ii. *management actions proposed to minimise impacts to the Prasophyllum sp Wybong individuals and/or habitat in the offset area;*

        iii. *performance indicators and trigger thresholds for the population size and habitat condition. Both short- and long-term performance indicators and trigger thresholds should be included to account for seasonal variations;*

        iv. *a program to monitor and evaluate the population size and habitat condition against the performance indicators and trigger thresholds;*

        v. *an action plan to respond to exceedances and/or failure to meet the performance indicators and thresholds.*

11. *The approval holder must provide the Minister with an annual report outlining the results of the monitoring and management actions required under the Prasophyllum sp Wybong offset management plan, within 60 business days of the end of the calendar year.* [1]

[1] Note that Condition 10a and Condition 11 are addressed in the BOMPS

2.0 Orchid Biology and Management

2.1 Life History

Terrestrial orchids are complex life forms with high dependencies on specific pollinators and mycorrhizal fungi associates for germination and long-term survival (Rasmussen et al. 2015; Shefferson et al. 2020). Many orchid species also occur in habitats favoured highly by human occupation, food production and resource extraction. In Australia, such modification to orchid habitat ranks third for 64% of 184 threatened orchids assessed (Wraith & Pickering 2019), and land clearing associated with coal mining contributes directly to this threat.

Orchids are, however, resilient to high levels of disturbance to their habitats geographically and temporally. Charitonidou and Halley (2020) point out that orchids are typical of other life forms which follow a Type III survival strategy (i.e. high fecundity and high mortality during the early stages of life), whereby high seed production acts as an amplifier of environmental variability. In addition, at high fecundities the extinction probability of orchids and other organisms characterised by this life strategy may be relatively insensitive to initial population size. This means that long-term persistence of an orchid species in any area subject to environmental change is reliant only on the survival of relative few individuals to source re-colonisation of a disturbed landscape. Many orchids have been described as 'time travellers' due to their ability to appear in areas where they have not been detected for many years (Brundrett 2016). This might be true for *Prasophyllum* sp. Wybong, since surveys in and around the MOC during early ecological studies failed to record the species (Abel Ecology 2005; Umwelt 2006), but soon after many hundreds of plants appeared (e.g. Bell & Copeland 2009, 2010).

2.2 Detectability

Detection of orchids during targeted surveys rarely if ever locate all individuals, and juvenile plants too immature to flower are nearly always overlooked. Additionally, as noted by Zhang et al. (2018) most orchids are long-lived and slow growing and may not flower for the first 4-7 years of life. Incomplete detection of all individuals during single- or even multi-season surveys leads to unreliable estimates of baseline population size, and this is particularly the case for the *Prasophyllum* genus. For example, Coates et al. (2006) found that most individuals of *Prasophyllum correctum* are expected to remain dormant and undetectable in any given year, and that altered management regimes (more frequent fire events) increased the number of emerging individuals. This has important implications for any census of population size for this and other *Prasophyllum* species, an issue also raised in Bell (2019) in relation to translocated individuals of *Prasophyllum* sp. Wybong. A further example is given in Medd and Bower (2019), who note the presence of a new and unnamed *Prasophyllum* taxon at Mt Canobolas which appeared only after fire in 1982 and again in 2018, with none observed in the intervening 18 years despite considerable survey effort.

Part of the difficulty of orchid detection experienced particularly during drought years is the added stress placed on emerging orchids by herbivores searching for palatable foods: orchids may well emerge every year in some species but they may be quickly consumed by grazing mammals, birds or invertebrates. For example, Duncan and Moloney (2018) found that for the threatened *Diuris fragrantissima* good rainfall increased the probability of flowers setting seed and decreased the probability that plants would be browsed. For *Prasophyllum* sp. Wybong, Bell (2019) outlines a range of factors that have influenced detection of this taxon during surveys, highlighting that population size on any given day or in any given season will be but a proportion of the total number of individuals present.

2.3 Prasophyllum sp. Wybong (Orchidaceae)

2.3.1 Conservation Status

Prasophyllum sp. Wybong is listed (under the synonym *Prasophyllum petilum*) as endangered in NSW (*Biodiversity Conservation Act 2016*) and the Australian Capital Territory (ACT) (*Nature Conservation Act 2014*), but as critically endangered nationally (*Environment Protection and Biodiversity Conservation Act 1999*). Listing advice prepared by NSW and Commonwealth governments in assessing conservation status document the major threats to *Prasophyllum* sp. Wybong as habitat clearance and fragmentation, infrastructure and agricultural development, weed invasion, vehicle traffic, inappropriate disturbance and grazing regimes, chemical drift from agricultural practices, competition from native and non-native plant species, illegal collection, trampling by people and climate change.

2.3.2 Taxonomy

As reflected in the listing status shown above, there remains some disagreement on the taxonomic position of *Prasophyllum* sp. Wybong within the *Prasophyllum* genus. There are clearly strong affinities with *Prasophyllum petilum*, a species originally described from the ACT, with plants from the Hunter Valley included in this species concept and extending across the inland slopes and ranges of NSW from Delegate to Tenterfield (Backhouse et al. 2019; Copeland & Backhouse 2022). Other authorities (e.g. Jones 2021), while not separately profiling *Prasophyllum* sp. Wybong, include notes suggesting that populations of *Prasophyllum petilum* from central and northern NSW represent different unnamed taxa. Clements and Jones (2019) proposed the separation of *Prasophyllum* into two genera (*Prasophyllum* and *Paraprasophyllum*), but this has not yet been widely adopted; under this system, *Prasophyllum* sp. Wybong would be included in *Paraprasophyllum*. Irrespective of taxonomic ambiguity, and in keeping with DAWE consent conditions, this POMP refers to the taxon in question as *Prasophyllum* sp. Wybong.

2.3.3 Habitat

Habitat for *Prasophyllum* sp. Wybong has been detailed elsewhere (Bell 2020a, 2021), but in summary it predominates in derived grassland and grassy open woodland areas on seasonally moist clay soils. Most frequently supporting habitats include grasslands derived from former Ironbark (*Eucalyptus crebra*) and Dawson's Box (*Eucalyptus dawsonii*) woodlands (unpubl. data). Derived grasslands of *Aristida*/ *Cymbopogon*, *Bothriochloa*/ *Carthamus*/ *Danthonia*, and *Dichanthium*/ *Sporobolus*/ *Chloris* were commonly found to support *Prasophyllum* sp. Wybong (Bell 2021).

2.3.4 Mycorrhizal Fungi

Weston et al. (2005) suggested the genus *Ceratobasidium* (family Ceratobasidiaceae) as the likely mycorrhizal fungi necessary for *Prasophyllum* species, supported partially by work on two threatened species in Victoria by McQualter et al. (2007) where *Ceratobasidium cornigerum* (and a *Rhizoctonia* sp.) were isolated. Within the Hunter Valley, mycorrhizal seed-baiting for *Prasophyllum* sp. Wybong has been attempted but was unsuccessful (Vizer 2013).

2.3.5 Pollination

Prasophyllum species use nectar and scent to entice various insects to pollinate and be rewarded with food. These pollinators are thought to be colletid and halictid bees, ichneumonid, tiphiid, scoliid and sphecid wasps, syrphid flies, and beetles (Weston et al. 2005), but few detailed studies have been completed. For *Prasophyllum odoratum*, Bernhardt & Burns-Balogh (1986) found that polytrophic flies (family Syrphidae)

and opportunistic male bees in the genus *Leioproctus* (family Colletidae) were the principal pollinators. There are no data on which insects are responsible for pollinating *Prasophyllum* sp. Wybong, hence the retention of a variety of vegetated habitats suitable for a range of insects within the local area is essential.

2.3.6 Reproduction and Dispersal

With few exceptions, nearly all species of *Prasophyllum* replace their tubers annually and do not colonise adjacent habitat through daughter tuberoid spread (Jones 2021). As a consequence, most species rely on seed production and dispersal within favoured habitat, and most individuals occur as scattered plants or in loose groups. Within the Hunter Valley, *Prasophyllum* sp. Wybong follows this pattern of population growth, with most plants occurring as individuals or loose groups (pers. obs.).

2.4 Habitat Management

Management of habitat for *Prasophyllum* sp. Wybong is critical to the long-term persistence of this taxon in the region. Historically, habitats which today support large populations of *Prasophyllum* sp. Wybong have been subject to prolonged grazing and agriculture for over 200 years, following extensive vegetation clearing (Perry 1963). It is unknown if *Prasophyllum* sp. Wybong was formerly widespread prior to the introduction of European agricultural practices, or if in fact these actions promoted the spread of a perhaps more restricted species. Irrespective of this, the stock grazing pressures exerted over 200 years have not appeared to be detrimental to the species, and destocking over the last couple of decades has likely permitted further spread. Grasslands and grassy woodlands dominated by native species now provide ample habitat for *Prasophyllum* sp. Wybong and its pollinators (Bell 2021).

Over time, and in the absence of suitable disturbance regimes, grasslands and grassy woodlands may lessen their suitability as orchid habitat due to excessive grass growth over wet seasons, or through progressive thickening of habitat by woody shrub and tree encroachment. This is generally observed in the field by lower densities of a target orchid species during surveys, and rejuvenation of habitat such as through fire may result in greater orchid numbers appearing (e.g. Canackle 2021; Roper 2021). Under natural conditions, habitat rejuvenation (i.e. reductions of biomass) in these grassy landscapes is generally undertaken in one of two ways: consistent yet intermittent grazing pressure exerted by native herbivores such as macropods, or through relatively frequent burning. Historically, both actions would have occurred to maintain habitat in a state suitable for orchids, although this may have varied significantly over time. Evidence for this affect is demonstrated in grazing exclusion plots which have seen the growth of dense swards of grass after a few good seasons, leading to a requirement to reduce biomass through slashing on a yearly basis (Bell 2020a).

Stock grazing and the use of fire in offset areas are contentious issues, as the role of both in areas set aside for nature conservation is not yet fully understood. Historically, grazing by native herbivores would have been sufficient to maintain grass and herb levels for longer periods, with an occasional fire event removing excess grass thatch and woody regrowth. Providing native herbivores remain in an area, there seems little need to maintain stock grazing to perform this role (but see Morgan 2021 for impacts from over-abundant native herbivores). The exception may be during a series of good growing seasons where native fauna cannot adequately maintain grass growth, in which case crash-grazing by stock may be appropriate. The Biodiversity Conservation Trust (BCT) have provided guidelines on the use of stock grazing in offsets (BCT 2021), and stress that the central goal of biodiversity conservation should govern any program of stock grazing, and monitoring of ground cover condition and seasonal conditions should dictate when grazing is allowed.

Similarly, the use of fire as a biodiversity tool in offsets is only now beginning to be recognised, although its role in promoting orchid habitat has been previously documented (e.g. Coates et al. 2006; Dilley 2007; Duncan 2012; Brown & York 2017). Experimental burning of grassy woodlands is currently being undertaken

in several Hunter Valley sites to improve habitat values (including at MOC), but there are no data yet available on the impacts to orchid populations (unpubl. data). Guidelines for the use of fire in offsets have been prepared by the Biodiversity Conservation Trust, highlighting that cultural or ecological burns may be beneficial in certain landscapes and that monitoring of outcomes should be a key objective (BCT 2022).

3.0 Condition 10b Requirements

3.1 Potential Direct and Indirect Impacts in MO and MgO Offsets (Condition 10bi)

Subsection i. in Condition 10b seeks to identify the potential direct and indirect impacts that may occur to *Prasophyllum* sp. Wybong or its habitat associated with the MCCO Project. Some potential impacts may be self-evident while others are more difficult to define. A review of the literature has been undertaken to assist in identifying potential impacts for other *Prasophyllum* species and for orchids in general, and these have been used to structure discussion around management of the MO and MgO offsets.

3.1.1 Direct Impacts

Table 1 summarises agents of direct impacts that may potentially affect individuals or groups of *Prasophyllum* sp. Wybong or their habitat during the MCCO Project. While it is likely that some of these agents will have negligible impact in the MO and MgO offsets, they have been included to allow for unplanned or maintenance activities.

Table 1 Summary of potential direct impacts of the MCCO Project on *Prasophyllum* sp. Wybong and its habitat.

Potential Impact Agent	Potential Effects	Examples
1. Removal of topsoil and orchids	expiration of orchids and/or severing of mycorrhizal fungal networks	Brundrett 2007
2. Excessive dust (particularly during flowering period)	interruption to pollination processes	Farmer 1993
3. Changes to hydrological patterns during construction and extraction	alteration to length and severity of wet-dry climate phases within topsoil affecting mycorrhizal distribution	Jasinge et al 2018
4. Increased fragmentation of orchids and pollinator habitat	decline in genetic fitness	Kotilinek et al. 2020; Ellwanger et al. 2022
5. Stock and feral animal grazing impacts on habitat and orchids	degradation of habitat through soil compaction, erosion; grazing and trampling of orchids	Su & Guo 2007; Alexander et al. 2010; Ba et al. 2012

1. Topsoil removal

Orchids, like nearly all plants, are reliant on the supply of nutrients and water from soil, and specifically from the topsoil (Shefferson et al. 2020). Although unlikely within the MO and MgO offsets, removal of topsoil during planned or unplanned earthworks (such as access trail creation or maintenance, revegetation activities, creation or maintenance of utility corridors) may result in the loss of orchids and their mycorrhizal fungi associates. Consequently, all planned or unplanned soil disturbances involving the removal of topsoil are to be assessed for orchid presence (Section 3.4).

2. Dust generation

Dust generation, although not significant, will likely occur within the MCCO Project area during the construction phase and over the course of coal extraction, and this may affect orchid populations and their habitat in proximate areas including offsets MO and MgO. For most of the year, excessive dust fall will not impact on orchid life processes while they remain in the dormant phase, or during the pre-flowering phase where leaves have emerged (April-August). However, upon flower emergence dust may interrupt critical pollination processes including the release of pheromones necessary to attract pollinators, particularly in the long absence of rain which might otherwise wash dust away. Although not addressing orchids, a comprehensive review by Farmer (1993) outlined a range of potential impacts on vegetation from dust generation, including changes in transpiration, growth and some reproductive elements. There are scant studies reported in the literature on the impacts of dust specifically on orchids. In the few published studies, Adhikari et al. (2012) found that road dust in subtropical forests of Nepal altered the pH of host tree bark and led to declines in epiphytic orchid abundance, while Fekete et al. (2017) examined the ecology of roadside orchids and highlighted the need for further research on how dust deposition may impact on reproductive processes in the European terrestrial orchid genus *Himantoglossum*. Despite the limited research in this area, impacts from dust on terrestrial orchids and particularly on *Prasophyllum* sp. Wybong within the MO and MgO offsets remains a possibility and monitoring for reduced seed output will occur (Section 3.4).

3. Hydrological changes

Extraction of topsoil and subsoil material will alter existing hydrological patterns within and surrounding the MCCO Project area. At the micro-scale, this may impact on specific growth conditions for *Prasophyllum* and its mycorrhizal fungi, and it may also affect orchid habitat as turnover in dominant species changes to suit new soil moisture conditions. The genus of *Ceratobasidium* mycorrhizal fungi likely associated with *Prasophyllum* sp. Wybong is widespread across Australia (Freestone et al. 2021), although there is no data on the preferred habitat conditions for these fungi to persist. Some studies (e.g. Jasinge et al. 2018; Ventre Lespiaucq et al. 2021) have shown how dominant fungi in a landscape change over time in response to varying rainfall conditions, and hence there is a temporal element linked to current environmental conditions that may partially redress changing hydrological conditions. During drought conditions, Jasinge et al. (2018) found *Ceratobasidium* to dominate, but these were replaced by other fungi during wet periods. There is also some evidence that changes in soil phosphorous and other elements can alter the presence and abundance of orchid mycorrhizal fungi (e.g. Nurfadilah et al. 2013; Mujica et al. 2020), which may be influenced by changing hydrology. Although relatively minor, changes in hydrology (natural or due to nearby mining activity) may consequently alter the mycorrhizal fungi community within the soil and result in changing distribution patterns for *Prasophyllum* sp. Wybong, and monitoring of population dynamics may be beneficial (Section 3.4).

4. Fragmentation

Fragmentation of habitat and landscapes is a common by-product of extractive industries, and unless managed correctly can result in declines in biodiversity (Hobbs & Yates 2003; Aguilar et al. 2019). This is particularly relevant for plant species, like terrestrial orchids, which have relatively poor dispersal capabilities due to low seed release heights, and reduced fruit set has been reported in some species due to fragmentation (Murren 2002). Of equal importance, however, is the impact of fragmentation on plant pollinators and their feeding, breeding and roosting sites (Lennartsson 2002; Hobbs & Yates 2003). Changes to orchid pollinator presence following fragmentation can lead to declines in genetic fitness in orchids (e.g. Kotilinek et al. 2020; Ellwanger et al. 2022), which ultimately may lead to local extinction. For *Prasophyllum* sp. Wybong, the likely pollinators include a range of bees, wasps, flys and beetles (Weston et al. 2005), which

are generalists with few specific habitat requirements. Over the course of a decade where progressive fragmentation has been occurring with the existing MOC, successful pollination and fruit production of *Prasophyllum* sp. Wybong has occurred (Bell 2020a; unpubl. data), suggesting that pollinating insects have persisted in the wider landscape. However, further fragmentation and loss of pollinator habitat as part of the MCCO Project, although counterbalanced by the progressive rehabilitation of mined areas and assisted regeneration of offset areas, may potentially impact pollination and seed production across adjacent landscapes including the MO and MgO offsets and will be monitored (Section 3.4).

5. Stock and feral animal grazing

Much of the Hunter Valley, including the MCCO Project area, has been grazed by sheep, cattle and horses for over 200 years (Perry 1963), and increasingly grazing by feral pests (goats, deer) is becoming problematic. Impacts to orchids and their habitats over this period is undocumented; however, in the case of *Prasophyllum* sp. Wybong stock grazing regimes over recent decades appears to have favoured this and other orchid species. Two key factors will influence how detrimental stock grazing can be to orchid populations: overall stocking density and stock presence during the flowering period. High stock density over prolonged periods will result in soil compaction in some areas, and soil erosion in others, and these effects are exacerbated during wet-dry climate cycles. There is some evidence that soil compaction as a result of stock presence can create hostile environments for mycorrhizal fungi, which will lead to a loss in orchid populations (e.g. Su & Guo 2007; Ba et al 2012). Direct grazing and trampling of orchids by stock during their above-ground phase almost certainly occurs in grassy habitats, resulting in loss of flowers prior to and during flowering and fruiting. There are few published studies on this impact (e.g. Smale et al. 2008), although anecdotally the process is widely known. In one American study, Alexander et al. (2010) found that cattle grazing significantly reduced capsule production in the Western Prairie Orchid (*Platanthera praeclara*) by up to 60%. Fortunately, in the MCCO Project area historical stocking rates do not appear to have been detrimental to *Prasophyllum* sp. Wybong and its habitat, including within the MO and MgO offsets where good populations are known. However, monitoring for stock and feral grazing impacts will continue to be monitored, including where unplanned intrusion to offset lands has occurred (Section 3.4).

3.1.2 Indirect Impacts

Indirect impacts on *Prasophyllum* sp. Wybong within the MO and MgO offsets may be long lasting depending on the level of modification and disturbance that has occurred in surrounding areas. In this respect, there is a certain level of context required to determine what further impacts, if any, might be expected during the MCCO Project located as it is in an already highly modified and fragmented landscape. Clearing of woodlands associated with agriculture began in the upper Hunter Valley during the early 1800s (Perry 1963), and until coal extraction began at an increasing scale in the 1980s the running of stock (sheep, cattle, horses) was the primary land use. Identifying indirect impacts of the MCCO Project can consequently only be undertaken within the caveat that pre-existing (pre-MCCO) environmental conditions were already compromised by 200 years of European land management and the existing MOC which commenced operations in 2010. Despite this, *Prasophyllum* sp. Wybong appears to have prospered under the *de facto* land management afforded through stock grazing. The following discussion of potential indirect impacts of the MCCO Project therefore aims to identify theoretical changes that may occur, but these should be monitored against current-day reference sites. Table 2 summarises potential indirect impacts that may occur as a result of the MCCO Project.

Table 2 Summary of potential indirect impacts of the MCCO Project on *Prasophyllum* sp. Wybong and its habitat.

Potential Impact Agent	Potential Effects	Examples
1. Removal of vegetation or habitat adjacent to orchid colonies	interruption to pollination processes; loss of pollinator habitat; increased grazing pressure	Duncan et al. 2005; Swarts & Dixon 2009
2. Introduction of weed species	competition for resources; reduced emergence, flowering and fruiting over time	Duncan & Coates 2010; Nevill 2010; Brundrett 2007
3. Reduced grazing lands for herbivores	increased grazing pressure on nearby orchid populations	Nevill 2010; Shefferson et al. 2020
4. Changes to soil salinity	local extinction due to unsuitable environment	Bastick & Walker 2000; Brundrett 2007
5. *Phytophthora* infection	death of orchids and/or supporting habitat	Duncan et al 2005; McDougall & Liew 2020

1. Vegetation Removal

Clearing of vegetation and habitat has been identified as a key threat to numerous orchid populations within Australia (Wraith & Pickering 2019, 2020; Phillips et al. 2020) and elsewhere. Physical removal of vegetation structure and altered floristic composition can have direct impacts on the orchid flora of a site, but it also has indirect impacts for surrounding habitats and interacting ecological networks. Vegetation clearing associated with the MCCO Project may impact on orchid populations present in adjoining areas, principally through modification or removal of habitat for pollinating insects. Indirect impacts on the pollinators of *Prasophyllum* sp. Wybong are expected to be limited, given the lack of specialisation shown in this group of orchids. Weston et al (2005) note that the likely pollinators in this genus are various flys, wasps, bees and beetles which are generalist foragers, hence there is little prospect for vegetation clearing to remove or destroy specific pollinator habitat and orchid-pollinator networks. Provided there remains a range of broad habitats (grassland, forests, waterways) within the surrounding landscape, there is little reason to expect major change in pollinator communities; however, monitoring of seed-set in *Prasophyllum* sp. Wybong will be a priority (Section 3.4).

2. Weed spread

Conversion from natural forests and woodlands to other land uses almost always leads to invasion by introduced plant species, with many species now naturalised and contemporary landscapes supporting them dramatically shaped by such historical disturbances (Lunt & Spooner 2005; Fensham & Laffineur 2019). This has been seen in the Hunter Valley and many other areas following 200 years of vegetation clearing and agricultural use (Perry 1963; Lunt 2002; Peake 2006), although most weed species are herbs and grasses. Of these, invasive grasses such as Coolatai (*Hyparrhena hirta*), Whisky Grass (*Andropogon virginicus*), Rhodes Grass (*Chloris gayana*), African Love Grass (*Eragrostis curvula*) and Crowsfoot Grass (*Eleusine indica*) are of most concern. As these and other weed species transform grassy woodlands and forests, there is some potential for a reduction in the extent of available orchid habitat through increased shading and reduced inter-tussock space that is typically colonised by orchids. Emergence and survival of individual orchids may also be compromised by high weed loads (Scade et al. 2006), ultimately leading to reduced seed output and population resilience.

Invasive weeds may also drive changes in orchid-insect interactions including pollination, although there is conflicting evidence on the direction of these changes. For example, Stephens et al. (2003) found increased

pollinator activity around *Pterostylis bryophila* in areas with high infestations of *Asparagus asparagoides*, while Taylor (1998) found lower pollination rates in *Pterostylis gibbosa* for populations surrounded by urban and agricultural landscapes. For pollinator interactions, negative impacts from weed invasion will invariably depend on the structural attributes of the habitat and the nature of invasion (dense vs sparse), and on the specificity of orchid pollinators. The MCCO Project area (including the MO and MgO offsets) is former agricultural land and inherits a landscape already supporting numerous herb and grass weed species. The condition of these landscapes should therefore be accepted as 'baseline' habitat (given the existing presence of *Prasophyllum* sp. Wybong), and any significant increase in weed abundance or density because of the MCCO Project will be carefully monitored (Section 3.4).

3. Native grazing pressure

Grazing by native fauna is a natural process that affects all terrestrial orchids and their habitats (Duncan et al. 2005), and often this is a prerequisite to maintaining high population numbers through suppression of co-occurring species (Shefferson et al. 2020). Impacts of grazing tend to be amplified in the first few years following fire (Coates et al. 2006) or during drought (Duncan et al. 2005) when food for herbivores is limited. Many orchid species possess fleshy leaves and succulent flower stems that are highly palatable, particularly during dry times when other food sources are scant. Types of fauna known to feed on orchids include mammals (Duncan et al. 2005; Just & Beardsell 2015; Bell 2020a), birds (Duncan et al. 2005; Faast & Facelli 2009; Bell 2020b; Canackle et al. 2020) and invertebrates (Scade et al. 2006; Light & MacConaill 2011; Just & Beardsell 2015; Yare et al. 2020). Impacts to individual orchids and populations from grazing is variable over time and geographically, and is mostly related to environmental conditions (Duncan et al. 2005) and other factors mediating their presence.

Apart from general observations, there are few studies in the literature that have quantified the extent to which orchid populations are impacted upon by native fauna, although fencing to reduce grazing pressures has been implemented in several studies (e.g. Nevill 2010; Bell 2020b; Bell 2021). One ongoing and unpublished study has found grazing by native fauna to prevent capsule production in up to 34% and 68% of *Diuris tricolor* and *Diuris sulphurea* populations respectively (Bell et al. 2022), which is comparable to cattle grazing reported in some studies (e.g. up to 60% in Alexander et al. 2010). However, low recruitment in high fecundity plants like orchids is expected (Charitonidou & Halley 2020) and grazing by native (or introduced) animals should not be seen as threat unless habitat modification has resulted in increased populations of grazing species, such as may be seen in macropod numbers following the installation of watering points (Morgan 2021). Increased grazing pressure on orchid populations might be expected within the MO and MgO offsets following commencement of the MCCO Project, particularly during drought conditions and as grazing lands are progressively removed. However, this impact will be offset by the creation of new grazing habitats in rehabilitated mined areas. Nevertheless, monitoring of grazing impacts within MO and MgO will be undertaken to ensure that native fauna do not significantly reduce flowering and fruiting in *Prasophyllum* sp. Wybong and its habitat (Section 3.4).

4. Dryland salinity

Increasing salinity in surface soils ('dryland salinity') due to rising water tables is a long-recognised side effect of extensive vegetation clearing in the creation of pastoral grazing lands (Briggs & Taws 2003; Seddon et al. 2007), impacting threatened species and terrestrial orchids (e.g. Zeppel et al. 2003; Brundrett 2007). This outcome is partly explainable by the sensitivity of mycorrhizal fungi to changes in soil chemistry (Bastick & Walker 2000), and in many cases results in the replacement of native species by introduced weeds (Briggs & Taws 2003). There are few documented Australian examples of dryland salinity affecting terrestrial orchids, with the most notable being *Caladenia drakeoides* from Western Australia (Brown et al. 2003) where rising

salinity was identified as a threat at 20 of the 23 populations known at that time. Salinity is not noted as a threat in recovery plans completed for several *Prasophyllum* species in NSW, Victoria and South Australia (Coates et al. 2003; Duncan 2010a, 2010b, 2010c; Kahout & Coates 2010; NSW OEH 2011), including *Prasophyllum petilum* (DECCW 2010). Although parts of the MCCO Project area already show signs of dryland salinity, it is unknown how new mining here will impact other areas of the catchment including the MO and MgO offsets. Monitoring of orchid populations and for evidence of increased salinity will be undertaken (Section 3.4).

5. *Phytophthora* infection

Phytophthora cinnamomi is an introduced water mould that infects a range of plant species across the world and in Australia (Burgess et al. 2017), spreading via root growth from infected plants or through transportation of soils and water and ultimately leading to necrosis of plant tissue. Once present, *Phytophthora* is practically impossible to eradicate (Dunstan et al. 2010) and has impacted many thousands of plant species, including threatened taxa (Reiter et al. 2004; Wan et al. 2019). Few orchid species are known to be susceptible (Duncan et al. 2005), although dramatic changes to habitat supporting orchids have been documented (e.g. Laidlaw & Wilson 2003; Shearer et al. 2004; Wilson et al. 2020), and such broader degradation is arguably more critical. Weste et al. (2004) found three orchid species (*Glossodia major, Corybas incurvus, Pterostylis concinna*) to be resistant to *Phytophthora* and persist in their study area despite being symptomatic. McDougall and Liew (2020) include a single orchid species (*Pterostylis concinna*) in their compilation of NSW plant taxa as being susceptible to *Phytophthora*, contrasting with the findings of Weste et al. (2004) for that species. There remains much to learn on *Phytophthora* susceptibility in individual orchid species, however it is perhaps more important to understand impacts on supporting habitat. In this regard, Umwelt (2008) undertook an extensive sampling program across the original MOC project area to determine if *Phytophthora cinnamomi* was present prior to and during construction activities. No evidence was found of any infection at that time; however, it is unknown if further monitoring for *Phytophthora* presence has been undertaken, and monitoring of dieback due to *Phytophthora* within MO and MgO will be continued (Section 3.4).

3.2 Minimising Impacts (Condition 10bii)

3.2.1 Direct Impacts

1. Topsoil removal

While significant amounts of topsoil are not expected to be disturbed within the MO and MgO offsets, there remains the possibility that orchid habitat may be impacted upon or removed as part of track or utility corridor creation or maintenance within these offsets. *Prasophyllum* sp. Wybong and its associated mycorrhizal fungi occupy the upper layers of topsoil (to c. 10 cm depth), and management of topsoil including its removal and respreading must acknowledge this. No stockpiling of topsoil will occur, and immediate spreading will increase the chances for orchid and fungi survival. If stockpiling does occur, time in storage will be critical to maintain the life of both orchid tubers and fungi, particularly if an absence of host roots is evident due to vegetation scalping (Miller et al. 1985). There are many examples demonstrating that better rehabilitation of disturbed land occurs where topsoil management has retained biological interactions. For example, in restoration of bauxite mine areas in Western Australia it has been recommended that topsoil be stripped and spread immediately onto rehabilitation areas, or if material must be stockpiled it should be done so as shallowly as possible and revegetated to provide protection from exposure (Jasper 2007).

The *Pre-clearance Survey, Land Clearing and Topsoil Stripping* procedure for Mangoola Coal (MANOC-1772150304-4327) provides guidelines for the stripping and storage of topsoil, indicating that topsoil should be stripped and respread directly onto rehabilitated lands wherever possible. Where this is impractical, topsoil should be stored in windrows less than 3 m in height, and if longer than 3 months in storage they should be shaped, deep ripped and sown with a cover crop.

ACTION: To minimise direct impacts of **topsoil removal and storage** on *Prasophyllum* sp. Wybong and its associated mycorrhizal fungi, in areas subject to soil disturbance all topsoil is to be stripped and respread immediately, and stockpiling of soil will be avoided. Should individuals or groups of *Prasophyllum* sp. Wybong be encountered during this process, they will be translocated to more secure lands and monitored for survival for at least five flowering seasons.

2. Dust generation

Minimisation of dust generation during construction and mining is desirable to lessen any potential deleterious impacts on pollinators and pollination of *Prasophyllum* sp. Wybong within the MO and MgO offsets. Although there is scant scientific literature on the impacts of excessive dust settling on orchids, there remains some potential for this to occur. This may particularly be problematic during the flowering period (late-August to late-October) when pheromones are being released and pollinators are active.

As with all mining operations, there are strict protocols around the generation of excessive dust during day-to-day operations at MOC. Dust is managed in accordance with the *MOC Air Quality Management Plan*, which is being updated to include the requirements of SSD 8642. This plan includes the following mitigation measures: a) minimising the area of disturbed land at any one time, in line with the approved MOP; b) development of a mine plan that provides for timely progressive rehabilitation; c) adopting controls for haul road dust emissions; d) review of meteorological conditions prior to blasting; e) consideration of meteorological conditions in planning the loading and unloading of overburden; f) applying water and using dust curtains when drilling overburden; g) minimising fall distance during loading and unloading of overburden; h) utilising water sprays on ROM coal stockpile areas; i) maintaining the existing covered conveyors and belt cleaning; j) maintaining and servicing machinery, exhaust systems and plant equipment in accordance with contemporary maintenance practices; k) using dust cameras to monitor dust; l) enact the TARP process and to investigate dust levels when the TARP process is triggered to identify likely sources of dust from any complaints or potential compliance issues; and m) using temporary rehabilitation and stabilisation measures on disturbed land.

The *Pre-clearance Survey, Land Clearing and Topsoil Stripping* procedure for Mangoola Coal (MANOC-1772150304-4327) also recommends stripping topsoil only when moist to restrict dust generation, and mulching of vegetation only where immediate access to a water cart is available. There is also some guidance on non-operation when winds are >10m/s, and the sowing of topsoil stockpiles that may remain in storage for longer than three months.

ACTION: To minimise any direct impacts of **dust generation** on pollination processes in *Prasophyllum* sp. Wybong, topsoil stripping and transportation and other dust generating activities will follow MOC procedures, particularly during the active flowering period between September and October inclusive.

3. Hydrological changes

Changes in hydrology are of particular importance to orchids and their associated mycorrhizal fungi, as both are sensitive to micro-conditions. There is some evidence to suggest that temporal changes in fungal

ecosystems are driven by rainfall and soil moisture variations (Jasinge et al. 2018; Ventre Lespiaucq et al. 2021), although no research has been completed specifically on *Prasophyllum* sp. Wybong. Hydrological changes will inevitably occur during the mining process, potentially affecting the soil moisture conditions of areas adjacent to or downslope of disturbance areas and including the MO and MgO offsets. However, there are few options to mitigate any impacts that hydrological changes may have on *Prasophyllum* sp. Wybong.

ACTION: There is little that can be done to minimise direct impacts of **hydrological changes** on *Prasophyllum* sp. Wybong within the MO and MgO offset areas, although impacts proximate to mining are likely to be minor.

4. Fragmentation

Fragmentation of habitat for *Prasophyllum* sp. Wybong and its pollinators as a result of mining is inevitable. In this instance, fragmentation operates at two levels; firstly, on the population of *Prasophyllum* sp. Wybong as individuals are removed during the mining process, reducing the broader effective population size available for genetic exchange and for sourcing new colonies; and secondly, changes in the extent and quality of habitat for the necessary pollinators. Partial mitigation of the impacts of mining on known *Prasophyllum* individuals within the planned disturbance areas can be achieved through extraction and translocation into offset lands (demonstrated in Bell 2020a). This action will also maintain genetic diversity within the population by ensuring as great a range of genotypes as possible are made available for future genetic exchange. Translocation need not involve the removal of all known individuals, but a proportion of them taken from across the impact areas. In relation to fragmentation impacts on pollinators, the types of insects involved (bees, wasps, flys and beetles; Weston et al. 2005) for *Prasophyllum* are generalists with few specific habitat requirements, hence they are unlikely to be detrimentally affected through temporary loss of habitat. Additionally, progressive rehabilitation of mined areas lessens the full impact of fragmentation as new habitats are created over the life of planned mine operations. Within offset areas, any ground disturbance works required for revegetation purposes will be subject to appropriate due diligence to ensure *Prasophyllum* sp. Wybong is not present.

ACTION: To minimise direct impacts of **fragmentation** on *Prasophyllum* sp. Wybong individuals, a proportion of the population known to be present within the impact lands will be translocated to more secure lands and monitored for survival for at least five flowering seasons. No specific mitigation is required for the pollinators of *Prasophyllum* sp. Wybong, given their generalist habitat requirements.

5. Stock grazing

Domestic stock are known to detrimentally effect orchid populations through degrading habitat (soil compaction, soil erosion, promotion of weeds) and more directly by grazing and trampling during the flowering period. For these reasons, domestic stock will not be a permanent fixture within MO and MgO offset lands year-round, but (with approval from the BCT) they may have a role in reducing grass biomass in occasional years (crash-grazing) in order to reduce biomass, weeds and fire risk. Crash-grazing will not occur between April and December when *Prasophyllum* sp. Wybong has a presence above ground but pending growing conditions may be introduced at other times. There may be a need to co-ordinate crash-grazing activities with any application of fire that may also be introduced to reduce biomass; both are complimentary mechanisms that will improve orchid habitat.

ACTION: To minimise the direct impacts of **stock grazing** on existing populations of *Prasophyllum* sp. Wybong, if necessary and with approval from the BCT, crash-grazing be considered should monitoring show excessive biomass is impacting on *Prasophyllum* persistence. Crash-grazing will occur only between January and March, and that flexibility be incorporated into the grazing regime to allow for occasional burning of the MO and MgO offsets to reduce biomass. Both activities will perform the same role, and climatic conditions will determine which of these is the most appropriate in any given year.

3.2.2 Indirect Impacts

1. Vegetation Removal

The removal of vegetation as part of the MCCO Project will indirectly impact on habitat for *Prasophyllum* sp. Wybong and its pollinating insects in and around the MO and MgO offsets. However, this impact is likely to be negligible given the already highly modified agricultural landscape in which the MCCO Project is located, and the generalist nature of the relevant pollinators (Weston et al 2005). Past clearing of the original woody vegetation to facilitate agriculture has created seemingly ideal conditions for colonisation by *Prasophyllum* and other orchid species, and further clearing of the regrowth vegetation now present will likewise create optimum habitat. Any removal of vegetation will alter the resources available for pollinating insects, but this can be offset by progressive rehabilitation and revegetation of mined land as soon as possible after mining.

ACTION: To minimise the indirect impacts of **vegetation removal** on existing populations of *Prasophyllum* sp. Wybong within the MO and MgO offsets, rehabilitation of mined land will occur progressively in accordance with the site rehabilitation plan to offset loss of pollinator habitat.

2. Weed spread

Ground disturbance to any landscape will inevitably allow opportunities for weeds to colonise and reduce the value of remnant bushland. In the case of the MCCO Project, the MO and MgO offset lands have already been substantially altered from their pre-1750 condition and support many grassy and herbaceous weeds. Disturbance of topsoil during planned or unplanned earthworks (e.g. track creation and maintenance) may promote localised outbreaks of problem weeds. However, few of these weed species will impact heavily on *Prasophyllum* sp. Wybong, those of most concern being Coolatai Grass (*Hyparrhena hirta*), Whisky Grass (*Andropogon virginicus*), Rhodes Grass (*Chloris gayana*), African Love grass (*Eragrostis curvula*) and Crowsfoot Grass (*Eleusine indica*). To reduce their impact, diligent monitoring and treatment of outbreaks as they occur will be required.

ACTION: To minimise the indirect impacts of **weed invasion** persisting and spreading into the MO and MgO offsets, a rigorous monitoring program in accordance with the BOMPS will be instigated to identify outbreaks of key problem species (Coolatai Grass, Whisky Grass, Rhodes Grass, African Love Grass, Crowfoot Grass) and rapidly treat these using the appropriate methods. Monitoring will be widespread and thorough, and any herbicide application will occur outside of the active growing period for *Prasophyllum* sp. Wybong (April to November).

3. Native grazing pressure

Increased grazing pressure on existing populations of *Prasophyllum* sp. Wybong by native herbivores within the MO and MgO offsets might be expected following commencement of the MCCO Project, particularly during drought conditions and as grazing lands are reduced through mining operations. This will have the effect of focusing grazers onto offset lands, potentially increasing the rate of herbivory (Bell 2020a). Increased

herbivory leads to reduced seed output, but this may be offset by timely rehabilitation and revegetation of mined lands to increase grazing opportunities in rehabilitated woodland areas.

ACTION: To minimise the indirect impacts of **elevated grazing pressure** on *Prasophyllum* sp. Wybong populations within MO and MgO following commencement of mining operations, rehabilitation of mined lands will be undertaken in accordance with the site rehabilitation plan, thus providing new grazing areas for displaced fauna.

4. Dryland Salinity

The MCCO Project area has historically shown indications of dryland salinity, but it is unknown how new mining activity will alter the existing situation, nor is it known how changing salinity might impact on *Prasophyllum* sp. Wybong (but see Brown et al. 2003 for an example from Western Australia). Dryland salinity is not known from the MO and MgO offsets, and these areas are unlikely to be affected as a result of new mining activities. However, regular quarterly monitoring of surface soils to detect salt crusting in depressions is one method of addressing this potential impact, with remediation undertaken where required. Soil testing in and around known populations of *Prasophyllum* sp. Wybong outside of mining areas may also be necessary to mitigate impacts on this species.

ACTION: To minimise the indirect impacts of **dryland salinity** on existing populations of *Prasophyllum* sp. Wybong, regular quarterly inspections will be undertaken throughout the MO and MgO offsets to detect and mediate elevated salt crusting at known *Prasophyllum* populations likely to be at greatest risk. Soil sampling will be undertaken if elevated salt crusting is observed during existing quarterly inspections for salinity.

5. *Phytophthora* infection

Few orchid species are known to be susceptible to *Phytophthora* infection (Duncan et al. 2005), although changes to habitat supporting orchids can occur (e.g. Laidlaw & Wilson 2003; Shearer et al. 2004; Wilson et al. 2020). Umwelt (2008) found no *Phytophthora* to be present across the Mangoola lands after targeted soil sampling, but it is unknown if more recent sampling has been undertaken. Nevertheless, given the potential for ground disturbance to occur within MO and MgO (e.g. during restoration activities, track maintenance etc), infection by *Phytophthora* must be considered a potential indirect threat to *Prasophyllum* sp. Wybong and its habitat. General reconnaissance of vegetated areas to detect characteristic bands of yellowing and dying foliage is currently undertaken on a quarterly basis and will continue, with any soils near to affected plants tested immediately. If *Phytophthora* is detected, the appropriate remediation actions will be implemented. There is some evidence that application of phosphate to an infected site over an extended period is beneficial in the control of *Phytophthora* in native plant communities (Barrett & Rathbone 2018), and this form of remediation might be explored further if required.

ACTION: To minimise the indirect impacts of ***Phytophthora* infection** on existing populations of *Prasophyllum* sp. Wybong and its habitat within the MO and MgO offsets, targeted soil sampling will be undertaken if plant death without obvious cause is observed during monitoring. Additionally, any opportunistic observations of yellowing and dying foliage of any plant species will have proximate soils immediately tested for *Phytophthora* presence.

3.3 Performance Indicators and Trigger Thresholds (Condition 10biii)

Performance indicators as outlined in some orchid recovery plans include over-arching objectives such as '*all populations will remain stable or have increased in size over a five-year periods*' (e.g. DECCW 2010). Aims such as this do not acknowledge the role of seasonal weather changes or fire history in emergence and detection and may never be achieved. Consequently, low emergence rates during dry years or prolonged fire-free periods may be seen to have failed this objective, when in effect orchid biology and environmental conditions have regulated emergence and detection rates over the assessment period. The long-term monitoring of *Prasophyllum* sp. Wybong and *Diuris tricolor* discussed in Bell (2020a) show these variable detection rates relative to rainfall well. More realistic objectives include those which aim to '*minimise the probability of extinction of ……. in the wild and to increase the probability of populations becoming self-sustaining in the long term*' (Duncan 2010b), and '*…the habitat of ….. is conserved and managed so that natural ecological processes continue to operate*' (Frawley 2010). For the monitoring and performance assessments of *Prasophyllum* sp. Wybong, an objective similar to the latter statements is recommended.

For performance indicators and trigger thresholds in population size and habitat to be effective, it is imperative that indicators of perceived poor performance in the MO and MgO offsets be tied to prevailing environmental conditions, particularly winter rainfall and potentially fire history. Emergence and flowering in this species are closely linked to winter rainfall, with above average falls during July-August resulting in the best emergence and detection (Bell 2020a), but there are no data available on whether emergent rates are also regulated by fire history. During dry periods when rainfall is below average, emergence will be low, and it will be difficult to confidently conclude that any observed changes are real. Data on population changes therefore need to be scored against rainfall in the preceding winter and monitored each year. Other factors will also come into play, such as the impact of vertebrate and invertebrate graziers, but it will be difficult to quantify these factors. To counter variables such as these, monitoring of naturally occurring *Prasophyllum* at plots both within and distant (controls) from the MO and MgO offsets is desirable. Existing monitoring plots outside of the MCCO Project area (1 plot) and within the MO offset (2 plots) may be suitable for this purpose, and these have been monitored annually for emergence and flowering over the last 5 years (Bell 2022).

Note that for the purposes of this POMP and the performance indicators discussed hereafter, 'short term' refers to a period of 1-5 years, while 'long term' is >5 years.

3.3.1 Population Size

Short Term Indicators and Triggers

Table 3 summarises short term (1-5 years) performance indicators and triggers relating to the population demographics of *Prasophyllum* sp. Wybong. Triggers identified in the short term principally relate to observed variations in key life stages of individual orchids from one year to the next. These are the elements that surrogate for changes in population size, but careful correlation with winter rainfall is essential in any interpretation.

Long Term Indicators and Triggers

Long term (>5 years) performance indicators and triggers related to population size focus more on elements that might progressively increase over several years (Table 4). Some of these elements may have confounding effects the longer they continue, and others may be additive with one or more related triggers. For example, dry conditions brought about by drought may result in reduced orchid emergence, high grazing pressure and no new recruitment. A long absence of fire or other ground disturbance might result in high levels of grass

abundance and greater shading, resulting in reduced emergence and flowering and subsequently limited opportunities for new recruitment.

Table 3 Short term (1-5 years) performance indicators and triggers for the *Prasophyllum* sp. Wybong populations within MO and MgO.

Trigger (*Prasophyllum*)	Indicator	Potential Explanatory Variables & Actions
low emergence	reduced emergent rates compared to previous years	if above average winter rainfall, assess grazing impacts, salinity, weed abundance; compare with control data
poor flowering	withered or absent flowers	hot, dry spring or high grazing impacts; compare with control data
poor fruiting	withered or absent capsules prior to dehiscence	hot, dry spring or high grazing impacts; compare with control data
heavy grazing	stock or feral animals observed; dung present	remove stock; identify access points and repair

Table 4 Long term (>5 years) performance indicators and triggers for the *Prasophyllum* sp. Wybong populations within MO and MgO.

Trigger (*Prasophyllum*)	Indicator	Potential Explanatory Variables & Actions
new recruitment	increasing number of new plants	natural recruitment and/or maturation of immature plants
low emergence	reduced emergent rates	drought conditions, particularly with below average winter rainfall; review long term trends in emergence data
high weed presence	increasing weed diversity and abundance impacting emergence	inadequate weed detection and control; address during orchid dormant period (Jan-Mar)
pest animal presence	increasing ground disturbance by feral pig, hares, deer etc	inadequate pest detection and control; instigate pest animal control strategies
human disturbance	inadvertent incursion by vehicles or humans	inadequate fencing or signage; install or repair as necessary
orchid absence	decreasing or no emergence due to dense grass/weed thatch	assess role of fire or crash-grazing in improving emergence and flowering
stock or feral animal presence	stock/feral animal or evidence present during flowering period	identify fence breaches and repair; remove stock or ferals immediately

3.3.2 Habitat Condition

Short Term Indicators and Triggers

Short term (1-5 years) performance indicators and triggers relating to habitat condition focus on year-to-year changes in biotic and abiotic features of known orchid habitat (Table 5). These include habitat features necessary both for *Prasophyllum* sp. Wybong and their pollinators.

Table 5 Short term (1-5 years) performance indicators and triggers for *Prasophyllum* sp. Wybong habitat within MO and MgO.

Trigger (Habitat)	Indicator	Potential Explanatory Variables & Actions
plant mortality	high incidence of dead plants	assess for impacts of *Phytophthora*, prolonged drought, dryland salinity
human disturbance	inadvertent incursion by vehicles or humans	inadequate fencing or signage; install or repair as necessary
ground disturbance	loss of topsoil, mortality of plant species, incursion of weeds	inadequate fencing or signage, feral animal presence; install or repair fencing or instigate cull program as necessary
weed invasion	replacement of native species by weeds	unplanned ground disturbance and soil disturbance; remove weeds using appropriate techniques
heavy grazing	stock or feral animals observed; dung present	remove stock or ferals; identify access points and repair

Long Term Indicators and Triggers

Long term (>5 years) performance indicators and triggers for habitat condition focus on cumulative elements that might progressively degrade orchid habitat over longer time periods (Table 6).

Table 6 Long term (>5 years) performance indicators and triggers for *Prasophyllum* sp. Wybong habitat within MO and MgO.

Trigger (Habitat)	Indicator	Potential Explanatory Variables & Actions
orchid absence	no or reduced emergence	assess role of soil compaction, fire absence, weed abundance; rectify as required
low pollinator presence	no or reduced orchid pollination	assess role of increased fragmentation and loss of pollinator habitat; improve regeneration of nearby disturbed lands
pest animal presence	increasing ground disturbance by feral pig, hares, deer etc	inadequate pest detection and control; instigate pest animal control strategies
human disturbance	inadvertent incursion by vehicles or humans	inadequate fencing or signage; install or repair as necessary
dense grass thatch	long absence of ground disturbance (fire or grazing)	assess potential for ecological burning or crash-grazing
woody regrowth	increasing shrub and tree cover shading orchid habitat	assess potential for ecological thinning or burning to reduce regrowth

3.4 Monitoring Program (Condition 10biv)

In a review of threatened plant monitoring programs, Lavery et al. (2021) found that 63% of Australia's monitored vascular plants did not possess adequate tracking of basic life traits in their target species. This meant that insufficient data had been collected to make meaningful observations on the ecology and survival of these species, effectively questioning the role and expense of their monitoring. For *Prasophyllum* sp.

Wybong, monitoring for survival and reproduction within MO and MgO offsets is a condition of consent. Known populations present in these lands will therefore require monitoring of the number of plants emerging year-to-year, including details on flowering and fruiting rates, as well as observations on the condition and quality of habitat. Integral in this monitoring program will be how the MO and MgO offset populations and their habitat compare with control populations elsewhere, and how emergence and flowering data correlate with environmental conditions.

3.4.1 Population Size

Issues around seasonality and detectability of orchids complicate any monitoring program aiming to identify changing population size (Bell 2019). Differing rainfall and/or grazing regimes will result in emergence and persistence data that might vary significantly from one site to another, as has been illustrated for *Prasophyllum* sp. Wybong previously (Bell 2020a). To counter this outcome, it is imperative that any monitoring program established to document changes in population size include control sites well distant from the disturbance area, so that fluctuations can be assessed within a wider environmental context. Fortunately, MOC already have three monitored populations of *Prasophyllum* sp. Wybong that could be used for this purpose (2 in MO, and 1 outside of the MCCO Project area), but more will be established. New monitoring plots might be positioned in known *Prasophyllum* populations elsewhere in the MO and MgO offsets, and emergence, flowering and fruiting data collected concurrently with control plots. All individual *Prasophyllum* detected will be marked and labelled to enable follow-up monitoring, as explained further in Bell (2022). In total, 10 monitoring plots (10 x 10m) are recommended: 5 in the MO and MgO offsets (including the 2 existing plots), and 5 in offsets elsewhere (including the 1 existing plot).

Should translocation of *Prasophyllum* sp. Wybong be undertaken for individuals located within the mined area, tagging and monitoring of all individuals will occur following the protocol outlined in the MOC Translocation Plan (MANOC-1772150304-2867), and as demonstrated in Bell (2020a).

Table 7 provides attributes to monitor in and around the *Prasophyllum* sp. Wybong populations within the MO and MgO offsets.

Table 7 *Prasophyllum* sp. Wybong monitoring attributes and remedial actions.

Attribute	Monitor for	Potential Remedial Actions
population change	number of emergent orchids, flowering and non-flowering, relative to winter rainfall	assess and treat weeds as needed
decreasing fruit production	flower:fruit ratios	assess dust prevalence, available pollinator habitat or other factors impacting on pollination (weeds etc)
grazing of flowering stems	proportion of grazed stems	assess native and exotic herbivore abundance
feral pig rooting	excavated soil consistent with feral pig rooting	trapping program for feral pigs
stock / feral presence	cattle, horse, sheep, deer, or goat dung	locate and remove stock or ferals
increasing soil salinity	visible salt deposits in depressions	assess reasons and remediate as necessary

3.4.2 Habitat Condition

Monitoring of habitat condition can be undertaken concurrently with orchid monitoring. This will entail the recording of flowering in co-occurring herb and forb species that may be developed as potential indicators of habitat quality and peak flowering for *Prasophyllum* sp. Wybong, such as has been done elsewhere (e.g. Lunt et al. 2005). Example taxa here include *Wurmbea dioica, Murdannia graminea*, *Leptorhynchos squamatus* and *Chrysocephalum apiculatum*, which anecdotally seems to flower well concurrently with *Prasophyllum* sp. Wybong.

Other aspects of habitat quality, such as depth of grass thatch and abundance of weed species, will also be monitored. This will be undertaken within representative permanent plots annually (potentially the same plots used for orchid monitoring), in combination with walk-over assessments and guided by the information in Table 8.

Ecological burning of potential *Prasophyllum* sp. Wybong habitat is a research area that is yet to be tested, and experimental burns could be undertaken in areas with heavy grass loads to determine if a reduction in biomass ultimately promotes orchid emergence. If required, burning will occur in autumn, with surveys and monitoring undertaken in the following spring. For other *Prasophyllum*, ecological burns at intervals of <3 years have been suggested to maintain grassy habitat and control native woody species, while at the same time increasing orchid emergence (e.g. Kahout & Coates 2010).

Table 8 Habitat condition monitoring attributes and remedial actions.

Attribute	Monitor for	Potential Remedial Actions
increasing grass thatch	depth of thatch, extent of bare ground	crash-grazing (only with BCT approval, and only Jan-Mar); ecological burn
weed species	% cover of weed species; number of weed species	appropriate weed control; ecological burn; crash-grazing (Jan-Mar only)
soil erosion	extent of alluvial fill or rills	stabilise through use of erosion control batters or planting of locally endemic plant species
increasing woody vegetation	increasing shrub and tree stems and projected foliage cover	ecological thinning of shrub and canopy saplings
feral pig rooting	excavated soil consistent with feral pig rooting	trapping program for feral pigs
stock presence	cattle, horse or sheep dung	locate and remove stock
increasing macropod grazing	grazed orchids; high scat counts	consider culling program
increasing soil salinity	visible salt deposits in depressions	assess reasons and remediate as necessary
co-occurring forbs	flowering intensity and timing in co-occurring forbs	-
fire impacts	grass and forb presence pre-fire, and recovery post-fire	-

3.5 Action Plan for Breaches (Condition 10bv)

In situations where triggers have been breached and performance indicators suggest degradation to *Prasophyllum* populations or their habitat, a series of actions will be implemented to correct and lessen the

impact of breaches. Suggested remedial actions have been included in Tables 3-8 in the previous sections, which aim to identify those elements causing declines in population or habitat quality and how best to rectify them. All remedial actions will be documented and included in annual monitoring reports so that outcomes can be used in future management decisions.

Figure 1 summarises an action plan for four key breaches where exceedances and/or failure to meet the performance indicators and thresholds will require active management. In most situations, field observations undertaken by MOC staff or contractors will trigger the path of response.

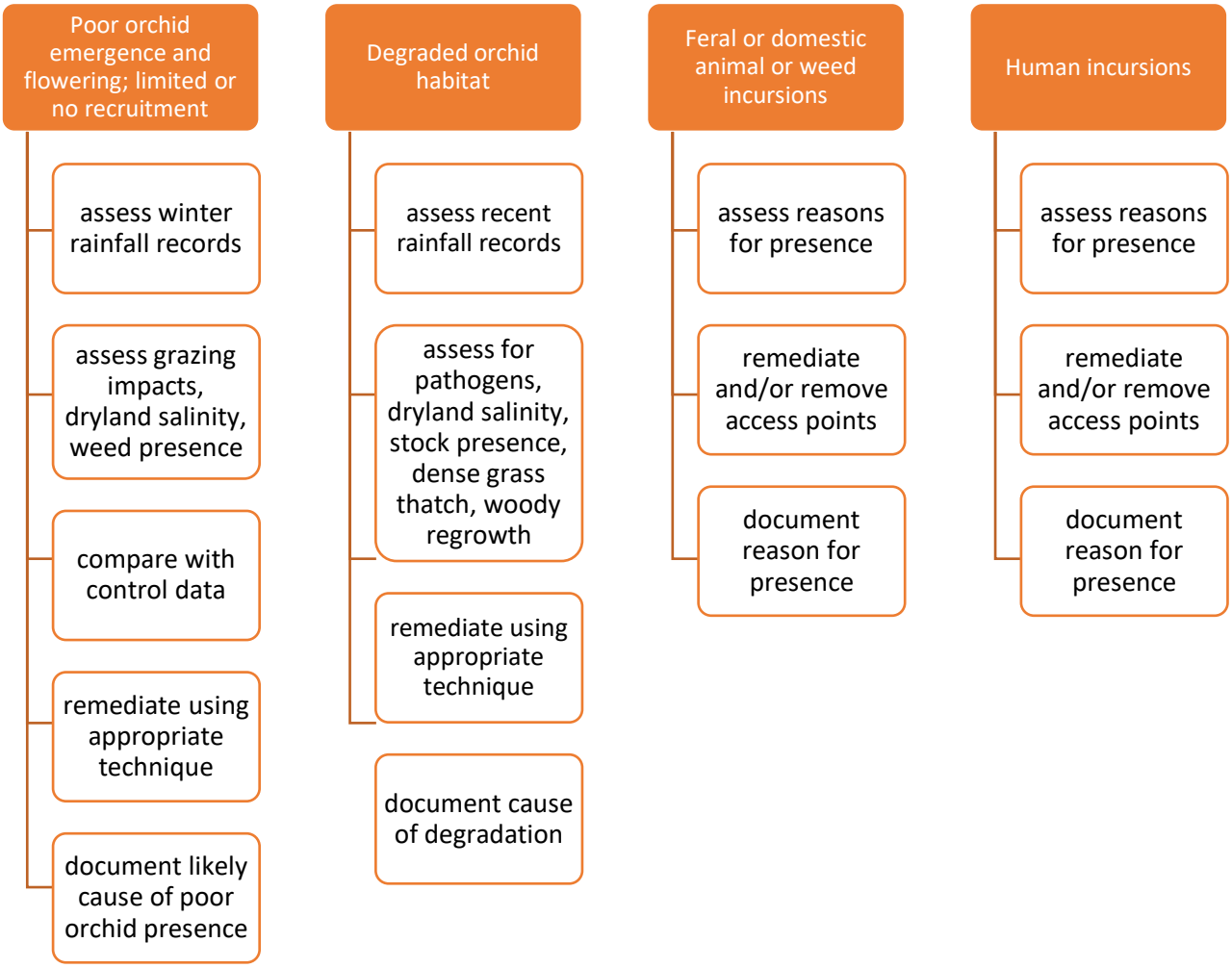

Figure 1 Schematic action plan for breaches of performance indicators and thresholds.

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5.0 Appendices

5.1 MCCO Consent Conditions

5.2 Curriculum Vitae: Dr Stephen Bell

Appendix 5.1 MCCO Consent Conditions

Australian Government
Department of Agriculture, Water and the Environment

APPROVAL

Mangoola Coal Continued Operations (MCCO) Project, Wybong NSW (EPBC 2018/8280)

This decision is made under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)*. Note that section 134(1A) of the **EPBC Act** applies to this approval, which provides in general terms that if the **approval holder** authorises another person to undertake any part of the **action**, the **approval holder** must take all reasonable steps to ensure that the other person is informed of any conditions attached to this approval, and that the other person complies with any such condition.

Details

Person to whom the approval is granted (approval holder)	Mangoola Coal Operations Pty Limited
ACN or ABN of approval holder	ACN: 127 535 755
Action	To establish a new open cut coal pit, as well as associated infrastructure including roads, overburden areas and water management systems within the Mangoola landholdings [See EPBC Act referral 2018/8280 and request for variation of proposal dated 21 May 2021].

Approval decision

My decisions on whether or not to approve the taking of the **action** for the purposes of each controlling provision for the **action** are as follows.

Controlling Provisions

Listed Threatened Species and Communities	
Section 18	Approve
Section 18A	Approve
Coal seam gas or large coal mining development impact on water resources	
Section 24D	Approve
Section 24E	Approve

Period for which the approval has effect

This approval has effect until 31 December 2040.

Decision-maker

Name and position	The Hon Sussan Ley MP Minister for the Environment
Signature	Sussan Ley
Date of decision	1/10/21

1

Conditions of approval

This approval is subject to the conditions under the EPBC Act as set out in ANNEXURE A.

ANNEXURE A – CONDITIONS OF APPROVAL

Part A – Conditions specific to the action

Water Resources

The objective of conditions 1 to 7 is to minimise the impacts of the **action** on **water resources**.

1. The **approval holder** must not extract or process more than **52 million tonnes of run-of mine coal** from the **MCCO Additional Project Area**.
2. The **approval holder** must comply with conditions B36, B37, B38, B39, B40, B41, B42, B43, B44, B45, B46, B47, B48, B49, B50, B51, B52, B85-91 of Part B of the **State development consent.**
3. The **approval holder** must ensure the action has **negligible impacts** to **Groundwater Dependent Ecosystems** (the **GDE Performance Measure**).
    a. The **approval holder** must include in the Groundwater Management **Plan** required by condition B50(v) of the **State development consent:**
        i a program to monitor the **GDE Performance Measure**
        ii A trigger action response plan to respond to any exceedances of the **GDE Performance Measure**
        iii A plan to repair and mitigate any exceedances.
    b. The **approval holder** must notify the **Department** within 5 business days of detecting an exceedance of the **GDE Performance Measure** and the proposed repairs and/or mitigation work to be undertaken. In the event an exceedance of the **GDE Performance Measure** cannot be repaired or mitigated, the approval holder must provide an offset. The offset must be approved by the **Minister**.
4. For the protection of surface water quality, the **approval holder** must:
    a. Ensure the action has **negligible impacts to surface water quality**.
    b. Submit a list of water quality monitoring parameters and **performance criteria** for the Ministers approval. The **approved water quality parameters and performance criteria** are to be included in the Surface water management **plan** (condition B50(iv) of the State development consent). The water quality parameters must include (but not limited to) key metals (total and dissolved) and nutrients. Coal extraction from the **MCCO Additional Project Area** cannot commence until the water quality monitoring parameters and **performance criteria** have been approved by the **Minister** (the **approved water quality parameters and performance criteria).**
        i The **approved water quality parameters and performance criteria** are subject to the same requirements as the **performance measures** listed in Table 6, condition B48 of the **State development consent.**

c. Prepare a Stream Monitoring Program for the Hunter River discharge point which includes:

i a map showing the **water discharge location** on the Hunter River associated with the action. The map must also identify the receiving waters.

ii baseline water quality data of the **approved water quality parameters** for the receiving waters, upstream and downstream of any water discharge locations associated with the action and identified in condition 4c(i)

iii expected water quality, volume, timing (seasonal) and frequency of discharged water and the potential impacts to surface water quality

iv proposed mitigation measures to reduce impacts of the discharged water to the receiving environment

v a program to monitor the **approved water quality parameters** against the **performance criteria** within the receiving waters. The monitoring program must be designed to detect impacts to water quality directly associated with the action and be able to distinguish from natural variability and upstream impacts

vi a program to monitor stream biota within the receiving waters. The program must include site-specific guideline values and mitigation strategies following sampling events.

vii Coal extraction in the **MCCO Additional Project Area** cannot commence until the Stream Monitoring Program has been approved by the **Minister.**

5. The **approval holder** must provide the **Department** with the version of the **Water Management Plan** approved by the **NSW Planning Secretary** as required by condition B50 of the **State development consent** within 5 **business days** of its approval by the **NSW Planning Secretary.**

6. The **approval holder** must notify the **Department** within 5 **business day** of submitting a request to change the approved **Water Management Plan** approved by the **NSW Planning Secretary.** If the revised version of the **Water Management Plan** is approved by the **NSW Planning Secretary,** the **approval holder** must provide the **Department** with the approved revised **Water Management Plan** within 5 **business days** of its approval and outline what changes have been made and any implications for **protected matters.**

7. If, at any time during the period for which this approval has effect, the approval holder detects or predicts an exceedance of any trigger levels which are specified in the approved Groundwater Management **Plan** or Surface Water Management **Plan** required by condition B50 of the **State development consent,** the approval holder must notify the **Department** of the exceedance in writing within 5 **business days** of detecting or predicting the exceedance.

Listed threatened species and ecological communities

The objective of conditions 8 to 12 is to minimise impacts and compensate for residual impacts of the **action** on **EPBC Act listed threatened species and ecological communities.**

8. The **approval holder** must not exceed the **clearing** limits specified below and shown in Annexure 2:

a. 24.3 hectares of the **White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act listed ecological community.**

b. 148 hectares of **Regent Honeyeater (*Anthochaera phrygia*) habitat.**

c. 148 hectares of **Swift Parrot (*Lathamus discolor*) habitat.**

d. 162.7 hectares of **Grey-headed flying fox (*Pteropus poliocephalus*) habitat.**

e. 101.6 hectares of land containing ***Prasophyllum* sp Wybong habitat.**

9. Prior to the **commencement of coal extraction** in the **MCCO Additional Project Area**, or other timeframe agreed to by the Minister, the **approval holder** must retire the biodiversity credits specified in Table 1. The credits must be retired in accordance with **the NSW Biodiversity Offset Scheme** of the **NSW Biodiversity Conservation Act** and to the satisfaction of the **Biodiversity Conservation Trust.**

Table 1 – Credits to be retired

Protected matter	Associated PCT Community	Area (ha)	Credits required
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter	17.8	1,136
	HU821 - Blakely's red Gum - Narrow-leaved Ironbark - Rough-barked apple shrubby woodland of the Hunter	6.46	253
Regent Honeyeater (*Anthochaera phrygia*)/ Swift Parrot (*Lathamus discolor*)	HU816 - Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	6.30	369
	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	135.2	7,821
	HU821 - Blakely's red Gum - Narrow-leaved Ironbark - Rough-barked apple shrubby woodland of the Hunter	6.46	253
Grey-headed flying fox (*Pteropus poliocephalus*)	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter	14.7	1,151
	HU816 - Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	6.3	369
	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	135.2	7,821
	HU821 - Blakely's red Gum - Narrow-leaved Ironbark - Rough-barked apple shrubby woodland of the Hunter	6.46	253

***Note:** The credits in Table 1 were calculated in accordance with the Framework for Biodiversity Assessment of the NSW Biodiversity Offset Policy for Major Projects (OEH, 2014) and will need to be converted to reasonably equivalent 'biodiversity credits', within the meaning of the **NSW Biodiversity Conservation Act 2016**, for the credits are to be retired in accordance with the Biodiversity Offsets Scheme of the **NSW Biodiversity Conservation Act 2016**.*

10. For the protection of the *Prasophyllum* sp Wybong, prior to the **commencement of coal extraction** in the **MCCO Additional Project Area,** or other timeframe agreed to by the **Minister,** the **approval holder** must provide the **Minister** with:

    a. evidence that 193.1 ha of ***Prasophyllum* sp Wybong offset habitat** has been secured under a Biodiversity Stewardship Agreement.

    b. a *Prasophyllum* sp Wybong offset management plan (this can be provided separately or as part of the **Biodiversity Management Plan**). This plan must be prepared by a suitably qualified ***Prasophyllum* sp Wybong expert** and must include, but not be limited to:

        i identification of potential direct and indirect impacts to the *Prasophyllum* sp Wybong individuals and/or habitat in the offset area

        ii management actions proposed to minimise impacts to the *Prasophyllum* sp Wybong individuals and/or habitat in the offset area

        iii performance indicators and trigger thresholds for the population size and habitat condition. Both short and long term performance indicators and trigger thresholds should be included to account for seasonal variations.

        iv a program to monitor and evaluate the population size and habitat condition against the performance indicators and trigger thresholds

        v an action plan to respond to exceedances and/or failure to meet the performance indicators and thresholds.

11. The **approval holder** must provide the **Minister** with an annual report outlining the results of the monitoring and management actions required under the *Prasophyllum* sp Wybong offset management plan, within 60 business days of the end of the calendar year.

12. The **approval holder** must comply with condition B57 of the **State development consent** to prepare and implement the Biodiversity Management **Plan**. The **approval holder** must comply with conditions B54, B55[1], B56, B57, B58 and B59 of Part B of the **State development consent** (to the extent the conditions in Part B relate to **EPBC Act threatened species and ecological communities**).

Part B –Administrative conditions

Notification of date of commencement of the action

13. The **approval holder** must notify the **Department** in writing of the date of **commencement of the action** within 10 **business days** after the date of **commencement of the action**.

14. If the **commencement of the action** does not occur within 5 years from the date of this approval, then the **approval holder** must not commence the **action** without the prior written agreement of the **Minister**.

Compliance records

15. The **approval holder** must maintain accurate and complete **compliance records**.

[1] The Department notes that the 2012 version of the plan referred to in State condition B55 has been updated to version 3 dated 5 November 2018 or latest version as updated from time to time.

16. If the **Department** makes a request in writing, the **approval holder** must provide electronic copies of **compliance records** to the **Department** within the timeframe specified in the request.

Note: Compliance records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, and or used to verify compliance with the conditions. Summaries of the result of an audit may be published on the **Department's website** or through the general media.

Submission and publication of plans

17. The **approval holder** must:

    a. submit **plans** electronically to the **Department;**

    b. unless otherwise agreed to in writing by the **Minister;**

        i publish each **plan** on the **website** within 20 **business days** of the date:

            I. of this approval if the version of the **plan** to be implemented is specified in these conditions or in the **State development consent;**

            II. the **plan** is approved by the **Minister;** or

            the **plan** is approved by the **NSW Planning Secretary** if the **plan** is required under the **State development consent** to be approved by the **NSW Planning Secretary;**

        ii exclude or redact **sensitive ecological data** from **plans** published on the **website** or provided to a member of the public and, if **sensitive ecological data** is redacted from any **plan,** submit an unredacted electronic version of the **plan** to the **Department** explaining what redactions have been made in the published version; and

        iii keep **plans** published on the **website** until the end date of this approval.

Annual compliance reporting

18. The **approval holder** must prepare a **compliance report** addressing compliance with each of the conditions of this approval, including implementation of any management **plans** and strategies from the **State development consent** that are referred to in this approval, every calendar year, or otherwise in accordance with an annual date that has been agreed to in writing by the **Minister**. The **approval holder** must:

    a. publish each **compliance report** on a **website** within 60 **business days** following the relevant 12 month period,

    b. notify the **Department** by email that a **compliance report** has been published on the **website** and provide the **website's** link for the **compliance report** within five **business days** of the date of publication,

    c. keep all **compliance reports** publicly available on the **website** until this approval expires,

    d. exclude or redact **sensitive ecological data** from **compliance reports** published on the **website**, and

    e. where any **sensitive ecological data** has been excluded from the version published, submit the full **compliance report** to the **Department** within 5 **business days** of publication.

Note: Compliance reports may be published on the **Department's website.**

Reporting non-compliance

19. The **approval holder** must notify the **Department** in writing of any: **incident,** or non-compliance with the conditions of this approval. The notification must be given as soon as practicable, and no

later than 5 **business days** after becoming aware of the **incident** or non-compliance. The notification must specify:

a. the condition of this approval or any State condition (if applicable) referred to in this approval which is in breach.

b. a short description of the **incident** and/or non-compliance, and

c. the location (including co-ordinates), date, and time of the **incident** and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.

20. The **approval holder** must provide to the **Department** the details of any **incident** or non-compliance with the conditions of this approval as soon as practicable and no later than 10 **business days** after becoming aware of the **incident** or non-compliance, specifying:

a. any corrective action or investigation which the **approval holder** has already taken or intends to take in the immediate future,

b. the potential impacts of the **incident** or non-compliance, and

c. the method and timing of any remedial action that will be undertaken by the **approval holder**.

Independent audit

21. The **approval holder** must ensure that **independent audits** of compliance with the conditions are conducted as requested in writing by the **Minister**.

22. For each **independent audit**, the **approval holder** must:

a. provide the name and qualifications of the independent auditor and the draft audit criteria to the **Department**,

b. only commence the **independent audit** once the audit criteria have been approved in writing by the **Department**, and

c. submit an audit report to the **Department** within the timeframe specified in the approved audit criteria.

23. The **approval holder** must publish the audit report on the **website** within 10 **business days** of receiving the **Department's** approval of the audit report and keep the audit report published on the **website** until the end date of this approval.

Completion of the action

24. The **approval holder** must comply with condition A5[2] in Schedule 2 of the **State development consent**.

25. Within 20 business days after the **completion of the action**, the **approval holder** must notify the **Department** in writing and provide **completion data**.

Changes to State development consent

26. The **approval holder** must notify the **Department** in writing of any proposed change to the **State development consent** that may relate to **protected matters** within 5 **business days** of formally proposing a change or within 5 **business days** of submitting an application to propose a change.

[2] Condition A5 in the State development consent states that mining operations may be carried out on the site until 31 December 2030

27. The **approval holder** must notify the **Department** in writing of any change to the **State development consent** conditions that may relate to **protected matters**, within 10 **business days** of a change to conditions being approved.

Part C - Definitions

Action means the Mangoola Coal Continued Operations Project, Wybong, NSW (EPBC 2018/8280) as described in the NSW State Assessment Report for SSD 8642 and the referral under the EPBC Act [See EPBC Act referral 2018/8280 and request for variation of proposal dated 21 May 2021]

Approval holder means the person to whom the approval is granted as identified on the approval notice for EPBC 2018/8280, or to whom the approval is transferred under S145B of the **EPBC Act**, or a person who may take the **action** in accordance with section 133(2A) of the **EPBC Act**.

Approved water quality parameters and performance criteria means the parameters and performance criteria that are approved by the Minister in accordance with condition 4(b).

Biodiversity Conservation Trust means the Biodiversity Conservation Trust established under section 10.1 of the NSW *Biodiversity Conservation Act 2016.*

Biodiversity Management Plan means the Biodiversity Management Plan required under the State development consent condition B57.

Business day means a day that is not a Saturday, a Sunday or a public holiday in the state or territory of the **action**.

Clear/clearing means the cutting down, felling, thinning, logging, removing, killing, destroying, poisoning, ringbarking, uprooting or burning of vegetation (but not including weeds – see the *Australian weeds strategy 2017 to 2027* for further guidance).

Commencement of coal extraction means removal of coal and does not include preparatory works such as removal of overburden and removal of vegetation.

Commencement of the action means the first instance of any specified activity associated with the action including **clearing** and construction of any infrastructure. **Commencement of the action** does not include minor physical disturbance necessary to:

i. undertake pre-clearance surveys or monitoring programs;

ii. install signage and /or temporary fencing to prevent unapproved use of the **MCCO Additional Project Area;**

iii. protect environmental and property assets from fire, weeds and pests, including erection of temporary fencing, and use of existing surface access tracks;

iv. install temporary site facilities for persons undertaking pre-commencement activities so long as these are located where they have no impact on the **protected matters**.

Completion data means an environmental report and spatial data clearly detailing how the conditions of this approval have been met. The **Department**'s preferred spatial data format is **shapefile**.

Completion of the action means the time at which all activities associated with the action have ceased.

Compliance records means all documentation or other material in whatever form required to demonstrate compliance with the conditions of approval in the **approval holder's** possession or that are within the **approval holder's** power to obtain lawfully.

Compliance report(s) means written reports:

i. providing accurate and complete details of compliance, **incidents**, and non-compliance with the conditions and the **plans**,

ii. consistent with the **Department's** *Annual Compliance Report Guidelines* (2014),

iii. including a **shapefile** of any clearance of any **protected matters**, or their habitat, undertaken within the relevant 12 month period, and

iv. annexing a schedule of all **plans** prepared and in existence in relation to the conditions during the relevant 12 month period.

Department means the Australian Government agency responsible for administering the **EPBC Act.**

Environmental value means a quality or physical characteristic of the associated user that is conducive to ecological health, public amenity, or safety.

EPBC Act means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

EPBC Act listed threatened species and communities: Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Grey-headed flying fox (*Pteropus poliocephalus*), a Leek Orchid (*Prasophyllum* sp Wybong) and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community and any other matter listed as threatened under the **EPBC Act** at the time of the decision made under section 75 of the **EPBC Act** in relation to this action that may be found to be present where it could be affected by the action.

52 million tonnes of run-of mine coal means the coal mined from the **MCCO Additional Project Area** as approved in the **State development consent**.

Groundwater Dependent Ecosystem(s) (GDE) means ecosystems whose species and ecological processes rely on groundwater, either entirely or intermittently.

GDE Performance Measure means negligible environmental consequences to GDE's beyond those predicted in the EIS and supplementary reports that were considered as part of the assessment documentation. In the event of inconsistencies or ambiguity between documents, the most recent document prevails to the extent of the inconsistency or ambiguity.

Grey-headed flying fox (*Pteropus poliocephalus*) habitat means the area identified in Annexure 2 as potential Grey-headed Flying-fox habitat.

Incident means any event which has the potential to, or does, impact on one or more **protected matter(s)** other than as authorised by this approval.

Independent audit means an audit conducted by an independent and suitably qualified person as detailed in the *Environment Protection and Biodiversity Conservation Act 1999 Independent Audit and Audit Report Guidelines* (2019).

MCCO Additional Project Area means the area shown outlined by the solid red line and labelled as 'MCCO Additional Project Area' in Annexure 1 to this approval.

Minister means the Minister administering the **EPBC Act** and includes any delegate of the Minister.

Negligible impacts means impacts do not exceed what was predicted in the EIS or subsequent documentation that formed part of the assessment documentation. In the event of inconsistencies or ambiguity between documents, the most recent document prevails to the extent of the inconsistency or ambiguity.

Negligible impacts to surface water quality means impacts to surface waters do not (1) exceed what was predicted in the EIS or subsequent documentation that formed part of the assessment documentation. In the event of inconsistencies or ambiguity between documents, the most recent document prevails to the extent of the inconsistency or ambiguity and/or (2) exceed prediction within the Approved Stream Monitoring Program required by condition 4(c).

NSW Planning Secretary means the person designated under the **State development consent** to approve management plans required under the conditions of the **State development consent**.

NSW Biodiversity Conservation Act means the NSW *Biodiversity Conservation Act 2016.*

NSW Biodiversity Offset Scheme means the NSW Biodiversity Offset Scheme established under section 6.2 of the NSW *Biodiversity Conservation Act 2016.*

Performance criteria means a value assigned to water quality parameter(s) by which exceedances require appropriate management actions (repair, mitigate and/or offset).

Performance measures means the water management performance measures specified in Table 6 of the **State development consent**.

Plan(s) means any of the documents required to be prepared, implemented by the **approval holder** and/or published on the **website** in accordance with these conditions (including those plans required by conditions of the **State development consent** that this **EPBC Act** approval requires the **approval holder** to comply with).

***Prasophyllum* sp Wybong expert** means a person with over 7 years' experience in identification and management of orchids who has been approved as an expert by the Minister.

***Prasophyllum* sp Wybong habitat** means habitat identified in Annexure 2 as ***Prasophyllum* sp Wybong habitat**.

***Prasophyllum* sp Wybong habitat offset** means ***Prasophyllum* sp Wybong habitat offset** identified in Annexure 3.

Protected matters means a **water resource** and, the following **EPBC Act listed threatened species and ecological communities**: Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Grey-headed flying fox (*Pteropus poliocephalus*), a Leek Orchid (*Prasophyllum* sp. Wybong) and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community and any other matter listed as threatened under the **EPBC Act** at the time of the decision made under section 75 of the **EPBC Act** in relation to this action that may be found to be present where it could be affected by the action.

Regent Honeyeater (*Anthochaera phrygia*) habitat means the area identified in Annexure 2 as potential Regent Honeyeater/ Swift Parrot Habitat.

Sensitive ecological data means data as defined in the Australian Government Department of the Environment (2016) *Sensitive Ecological Data – Access and Management Policy V1.0.*

Shapefile means location and attribute information of the **action** provided in an Esri shapefile format. Shapefiles must contain '.shp', '.shx', '.dbf' files and a '. prj' file that specifies the projection/geographic coordinate system used. Shapefiles must also include an '.xml' metadata file that describes the shapefile for discovery and identification purposes.

State development consent means the State development consent for application number SSD-8642 approved on 26 April 2021, or any subsequent approved version.

Swift Parrot (*Lathamus discolor*) habitat means the area identified in Annexure 2 as potential Regent Honeyeater/ Swift Parrot Habitat.

Water discharge location means where water associated with the **action** is likely to be released into the Hunter River as a result of planned or unplanned discharge events.

Water Management Plan means the plan required under condition B50 of the **State development consent.**

Water Resource(s) means surface water or groundwater; or a watercourse, lake, wetland, or aquifer (whether or not it currently has water in it); and includes all aspects of the water resource (including water, organisms and other components and ecosystems that contribute to the physical state and **environmental value** of the water resource), as defined in the *Water Act 2007* (Cth).

Website means a set of related web pages located under a single domain name attributed to the **approval holder** and available to the public.

Wetland means land intermittently or permanently inundated with water that is usually slow moving or stationary, shallow, can be fresh, brackish or saline, and where the inundation affects the plant and animal communities present and the type and productivity of soil.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act listed ecological community means the area identified in Annexure 2 as White Box – Yellow Box- Blakely's Red Gum Grassy Woodland and derived native grassland CEEC.

Australian Government
Department of Agriculture, Water and the Environment

Annexure 1

umwelt

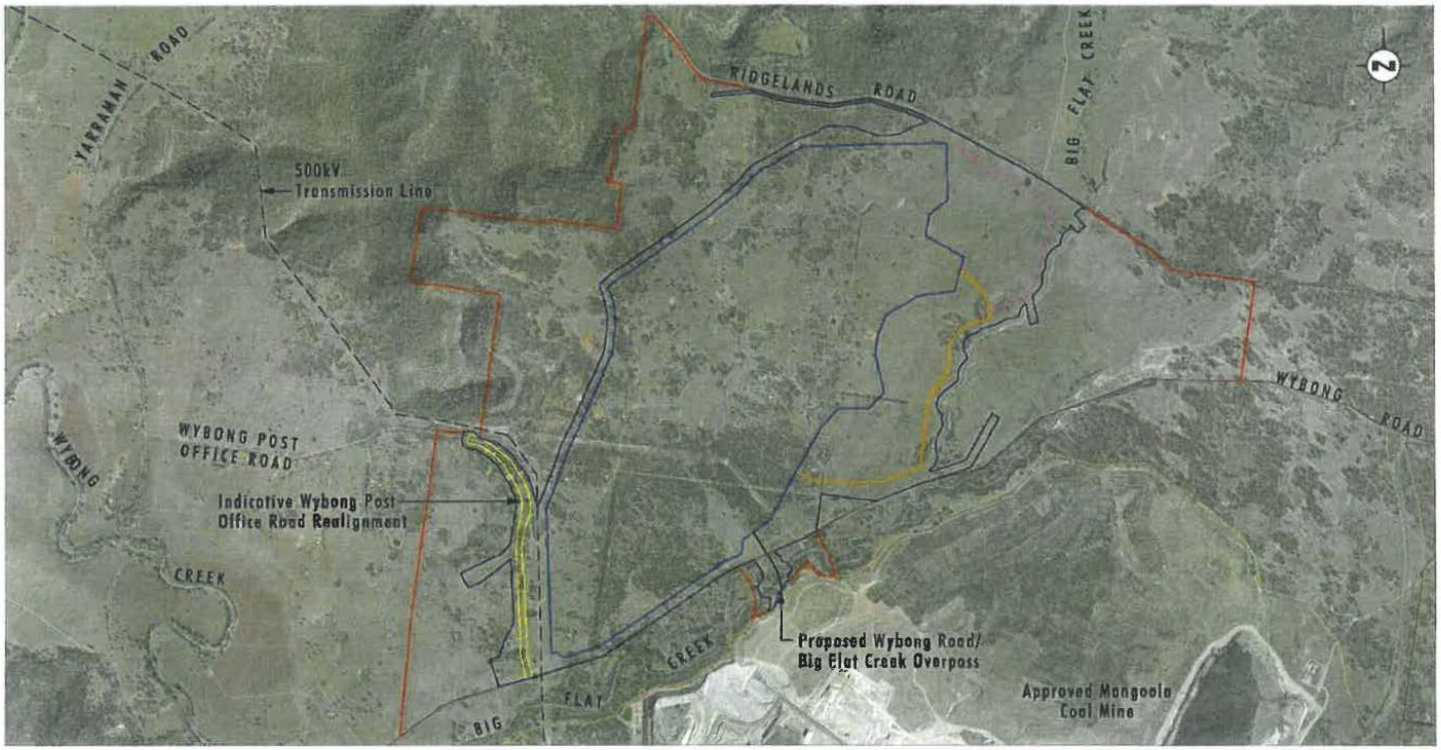


Image Source: Glencore (April 2018)
Data Source: Glencore (2018)

Legend

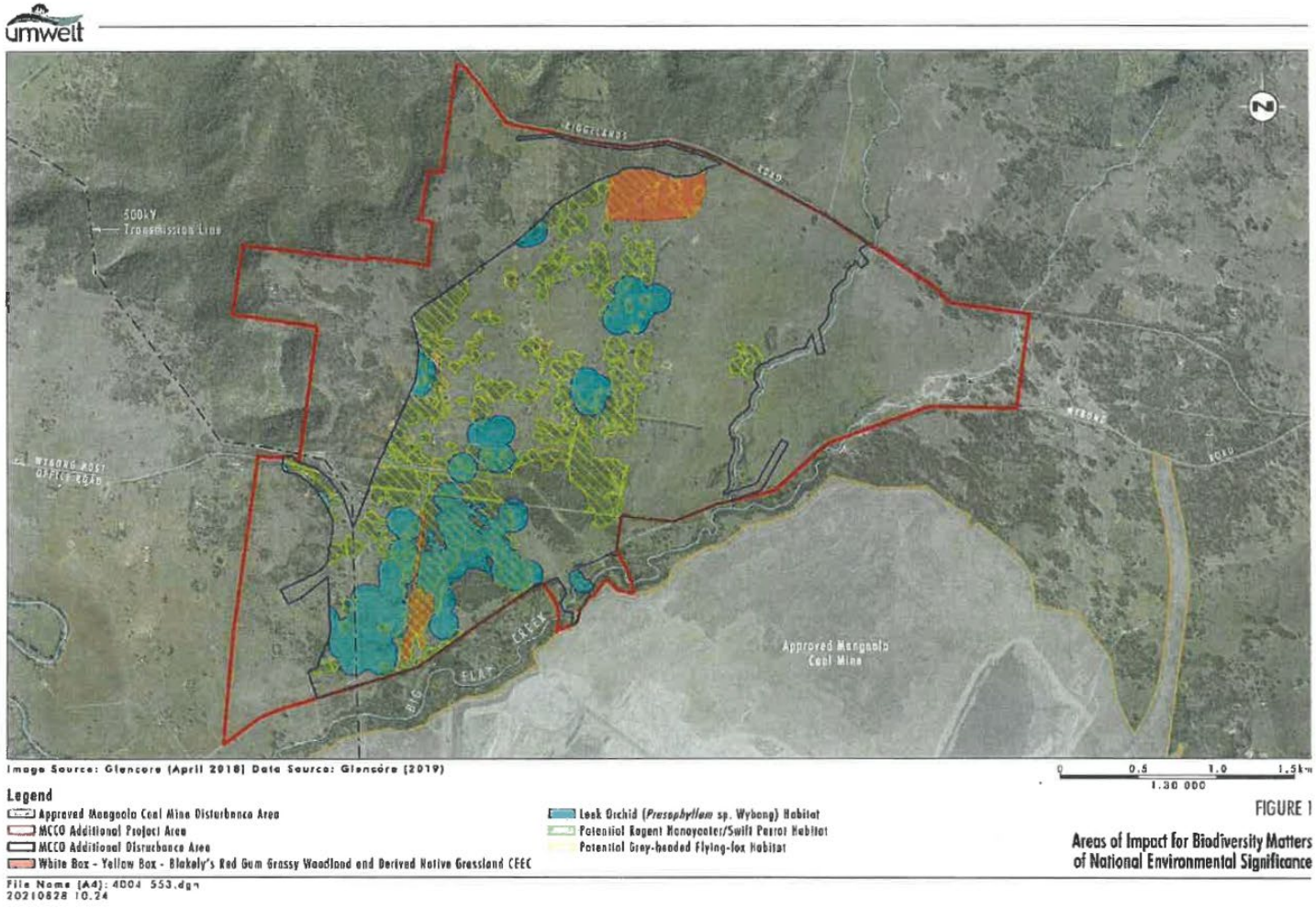
- MCCO Additional Project Area
- Approved Project Area
- Approved Mangoola Coal Mine Disturbance Area
- Development Footprint
- MCCO Proposed Additional Mining Area
- MCCO Proposed Emplacement Area
- MCCO Proposed Topsoil Stockpile Area
- Indicative Wybong Post Office Road Realignment

Mangoola Coal Continued Operations Project
Development Footprint

File Name (A4): 3450_086.dgn
20140214 9.05

12

Annexure 2



13

Australian Government
Department of Agriculture, Water and the Environment

Annexure 3

umwelt

Image Source: Glencore (April 2018)
Data Source: Glencore (2018)
Note: Offset boundaries are based on LPI cadastre

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- Development Footprint
- MCCO Additional Project Area
- Existing Offsets
- Proposed Mangoola Offset Sites
- *Prasophyllum* sp. Wybong Habitat Offset

FIGURE 2

Biodiversity Offsets for *Prasophyllum* sp Wybong

File Name (A4): 4004_552.dgn
20210813 13:16

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Appendix 5.2 Curriculum Vitae: Stephen Bell

Curriculum Vitae: Dr Stephen A.J. Bell

Principal

Eastcoast Flora Survey, PO Box 216 Kotara NSW 2289

Telephone: (02) 4953 6523
Mobile: (0407) 284 240

e-mail: sajbell@bigpond.com

Profile: http://www.stephenbell.com.au/

Adjunct Lecturer

School of Environmental & Life Sciences,
University of Newcastle, Callaghan NSW 2308

e-mail: stephen.bell@newcastle.edu.au

Profiles: http://www.newcastle.edu.au/profile/stephen-bell
https://www.researchgate.net/profile/Stephen_Bell10

PRÉCIS

Stephen has been involved in native vegetation survey, classification and mapping in the Greater Sydney and Hunter Regions since 1990. During this time, he has undertaken comprehensive surveys for the National Parks and Wildlife Service in over 30 conservation reserves and has been contracted to the NSW Department of Planning and Environment (DPE)) as Senior Botanist and Team Leader for several large scale regional projects within the Sydney Basin bioregion. Under contract to local Councils, Stephen has co-ordinated and completed LGA-wide vegetation classification and mapping projects for Wyong, Gosford, Cessnock, Pittwater and Lake Macquarie LGAs, and has assisted in similar mapping projects for Blue Mountains LGA. Stephen has also completed several studies on Threatened Ecological Communities and threatened plant species, and published the results of some of these in the scientific literature.

On behalf of the Ecological Society of Australia, Stephen was the ecological expert on the Hunter Regional Vegetation Committee (2003), and from 2017 represents that organization on the NSW Threatened Species Scientific Committee (administering the *Biodiversity Conservation Act 2016*). Stephen was also a past member of the Hunter Threatened Flora Recovery Team, a founding member of the Hunter Rare Plants Committee (a sub-committee of the Hunter Region Botanic Gardens), and since 2014 has been a member of the DPE Species Technical Group which oversees management and expenditure of threatened species throughout NSW via its *Saving our Species* initiative. He is also often called upon by Government for advice regarding the significance of vegetation communities and plant species within the northern Sydney Basin bioregion, and has sat on numerous expert panels in this regard. Stephen has been called upon as an Expert Witness for several cases heard in the NSW Land and Environment Court, where his knowledge on the vegetation of the Sydney Basin bioregion has been used to argue contentious land-use decisions.

Stephen has published several scientific papers on various aspects of the vegetation of the Sydney Basin, including classifications of vegetation within conservation reserves, threatened and rare plant species, and the description of new plant taxa. Stephen has completed over 4700 standard full floristic sampling plots within the Sydney Basin, which are stored and used in vegetation classification analyses. Other skills include extensive multivariate data analysis experience, and GIS mapping. Stephen's PhD thesis, completed on a part-time basis through the University of Newcastle, presented improvements in the recognition, identification and classification of restricted, significant and threatened vegetation communities.

In October 1996, Stephen established *Eastcoast Flora Survey*, a specialist botanical consultancy providing high quality services to government and the private sector. Since June 2014, Stephen has also been a Conjoint Fellow, Adjunct Associate Lecturer and now Adjunct Lecturer in the School of Environmental & Life Sciences (Conservation Science Research Group) at the University of Newcastle (NSW), seeking to raise the output of ecological research on plants and vegetation within the Hunter region.

ACADEMIC QUALIFICATIONS

Doctor of Philosophy (PhD), 2013	*Defining and mapping rare vegetation communities: Improving techniques to assist land-use planning and conservation* (University of Newcastle)
Bachelor of Science (Honours), 1991	*Effects of the weed Scotch Broom on bird communities in open forests on Barrington Tops* (University of Newcastle)
Bachelor of Science, 1989	*Majors in Geography and Biology* (University of Newcastle)

EMPLOYMENT HISTORY

Eastcoast Flora Survey	Consultant Botanist (Principal)	Oct. 1996 - Present
University of Newcastle	Adjunct Lecturer	2022 - Present
University of Newcastle	Adjunct Associate Lecturer	2021
University of Newcastle	Conjoint Fellow	June 2014 - 2020
Ecotone Ecological Consultants Pty Ltd	Manager - Flora Studies	Jan. 1996 - Oct. 1996
Private Ecological Consultant	Sole trader	Jan. 1991 - Dec. 1995
NSW National Parks and Wildlife Service	Project Officer	Sept. 1993 - Jan. 1994
University of Newcastle, Geography Dept.	Field Tutor (Scientific)	July 1993 - Aug. 1993
NSW National Parks and Wildlife Service	Project Officer	Jan. 1993 - June 1993
University of NSW, School of Biol. Sciences	Research Assistant (Bird ecology)	Sept. 1992 - Jan. 1993
NSW National Parks and Wildlife Service	Technical Officer (Scientific)	Jan. 1992 - June 1992
RZ Mines (Newcastle)	Environmental Research Officer	Oct. 1990 - Dec. 1991
Wayne Perry & Associates P/L	Environmental Officer (Casual)	June 1990 - Oct. 1990

RESEARCH INTERESTS

- Vegetation classification and mapping, at local and regional scales
- Definition and mapping of rare and threatened vegetation communities
- Restoration of threatened grassy woodlands from derived grasslands
- Improving data sampling methods for monitoring and classification
- Re-constructing vegetation distribution using information from historical botanical explorers
- Population ecology and habitat of rare and threatened plants
- Taxonomy and significance of Hunter Region plants

MINISTERIAL APPOINTMENTS

- Committee Member (ESA Rep.), NSW Threatened Species Scientific Committee (July 2017-present)
- Committee Member, NSW Species Technical Group, Flora (*Save Our Species Program*) (2014-present)
- Committee Member (ESA Rep.), Hunter Regional Vegetation Committee (2001-2003)

CONFERENCE & WORKSHOP PRESENTATIONS

- Australian Plant Society (NSW) Annual Conference, August 2019, Newcastle: "*Endemic Plants of the Hunter Region: Trees and Larger Shrubs*".

- Best Practice Mine Rehabilitation Conference, September 2014, Singleton, NSW; The Tom Farrell Institute for the Environment, University of Newcastle: "*Effective Biodiversity Offsets: Improving planning, valuation and monitoring practice*" (with Martin Fallding).
- Plant Identification for Flora of the Hunter Valley, 7th - 8th April 2014, Kurri Kurri, Australian Network for Plant Conservation: "*Introduction to the flora of the Hunter Valley - history, diversity and ecology*".
- HOTSPOTS Fire Project: Awabakal and Worimi Fire Forum, 27th July 2011, Williamtown, Never Never Resources: "*Vegetation of the Worimi Conservation Lands*".
- HOTSPOTS Fire Project: Wanaruah Fire Forum, 17th – 19th August 2010, Sandy Hollow, Upper Hunter Valley, Nature Conservation Council: "*Vegetation of Wanaruah Lands, Sandy Hollow*".
- Coastal Groundwater Dependent Ecosystems Workshop, 3rd – 4th September 2009, South West Rocks, NSW (Geoscience Australia): "*Surveying, classifying and mapping vegetation on the Tomago Sandbeds*".
- Vegetation Management and Biodiversity Conservation in the Hunter Region, May 2000, Singleton, NSW (Hunter Environment Lobby Inc.): "*An evaluation of vegetation survey and threatened plant species listings in the Hunter Region*"

PROFESSIONAL MEMBERSHIPS

- Ecological Society of Australia (ESA)
- Australian Network for Plant Conservation Inc. (ANPC)
- International Association for Vegetation Science (IAVS)
- International Association for Vegetation Science Vegetation Classification Working Group (IAVS VCWG)
- Australasian Systematic Botany Society (ASBS)

PUBLICATION REVIEWER

- *Austral Ecology* (John Wiley & Sons Ltd)
- *Australian Journal of Botany* (CSIRO Publishing)
- *Diversity* (MDPI, Switzerland)
- *Forests* (MDPI, Switzerland)
- *International Journal of Environmental Research and Public Health* (MDPI, Switzerland)
- *Journal of Vegetation Science* (International Association for Vegetation Science)
- *Nordic Journal of Botany* (John Wiley & Sons Ltd)
- *Pacific Conservation Biology* (CSIRO Publishing)
- *Phytocoenologia*
- *Proceedings of the Linnean Society of NSW* (The Linnean Society of NSW)
- *Resources* (MDPI, Switzerland)
- *Sustainability* (MDPI, Switzerland)
- *Telopea* (National Herbarium of New South Wales)
- *Vegetation Classification and Survey* (International Association for Vegetation Science)

BOARD MEMBERSHIPS

- 2019 to present - *Vegetation Classification and Survey* (Editorial Board)
- 2019 to present - *Sustainability* (Review Board)
- 2019 to present – *Don McNair Herbarium, University of Newcastle* (Industry Rep. & Committee Member)
- 2019 to 2021 – *Australian Network for Plant Conservation* (Committee Member)

ACCREDITED BAM SPECIES EXPERT (NSW DPIE)

- *Callistemon linearifolius* (Myrtaceae)
- *Cryptostylis hunteriana* (Orchidaceae)

- *Diuris praecox* (Orchidaceae)
- *Diuris tricolor* (Orchidaceae)
- *Eucalyptus parramattensis* subsp. *parramattensis* (Myrtaceae)
- *Hibbertia procumbens* (Dilleniaceae)
- *Prasophyllum petilum* (Orchidaceae)
- *Prostanthera junonis* (Lamiaceae)
- *Pterostylis chaetophora* (Orchidaceae)
- *Rhodamnia rubescens* (Myrtaceae)
- *Thelymitra adorata* (Orchidaceae)

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Bell, S.A.J. (in prep) A strategy for assessing population size in threatened plant surveys using a classification of detectability based on key life-form traits, seasonality and disturbance response. *Diversity* (in prep)

Bell, S.A.J. & Driscoll, C. (in prep) *Acacia pendula* (Fabaceae: Mimosoideae) in the Hunter Valley of New South Wales: Cunningham's collection from April 1825 and its implications. *Telopea* (in prep)

Bell, S.A.J., Lamrock, P., Haines, H.A., & Turney, C. (in review) Multiple lines of evidence identify century-scale habitat change and resilience in threatened plant species at Mt Dangar, Hunter Valley, New South Wales. *Australian Journal of Botany* (in review)

Bell, S.A.J., Hunter, N., & Steed, A. (in press) Lack of fire rather than pollinator absence may drive population decline in the critically endangered *Banksia conferta* (Proteaceae). *Australian Journal of Botany* (in press).

Bell, S.A.J. (2022) Differing habitat defines two metapopulations of a threatened Hunter Valley eucalypt: *Eucalyptus parramattensis* subsp. *decadens*. *Cunninghamia* 22: 11-25.

Bell, S.A.J., Phillips, G.P., & Nicolle, D. (2022) Resolution of a 35-year taxonomic dilemma: *Eucalyptus* sp. 'Howes Swamp Creek' (Myrtaceae) from eastern Wollemi National Park, NSW. *Telopea* 25: 151-163.

Kellermann, J., Clowes, C. & Bell S.A.J. (2022) A review of the *Spyridium eriocephalum* complex (Rhamnaceae: Pomaderreae). *Swainsona* 36: 75-88.

Doyle, C.A.T., Pellow, B.J., Bell, S.A.J., Reynolds, D.M., Silcock, J.L., Commander, L.E. & Ooi, M.K.J. (2022) Threatened plant translocation for mitigation: Improving data accessibility using existing legislative frameworks. An Australian perspective. *Frontiers in Conservation Science* 2: 789448.

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Bell, S.A.J. & Nicolle, D. (2020) Glen Gallic Mallee (*Eucalyptus dealbata* subsp. *aperticola*, Myrtaceae), a new taxon from the sandstone escarpment of the Hunter Valley, New South Wales. *Telopea* 23:141-150.

Mickaill, L., Bell, S., & Beranek, C. (2020) Dispersal potential in two restricted and five wide-ranging *Senecio* (Asteraceae) taxa from central eastern New South Wales, Australia. *Australian Journal of Botany* 68: 333-344.

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Thackway, R., Keith, D., & Bell, S. (2022) *Review of the NSW State Vegetation Type Map (SVTM) for eastern NSW version 1.1.* Unpublished Peer Review to NSW Department of Planning, Industry and Environment.

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Bell, S.A.J. (2021) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum*): Proposed 'Gilgal' Stewardship Site*. Unpublished Report to Moolarben Coal Operations Pty Ltd. September 2021. Eastcoast Flora Survey.

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