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To: John Braid Company: Main Roads Fax/email: john.braid@mainroads.wa.gov.au Date: 4 October 2016 Project No: MRO16249.01 Inquiries: D. Panickar/D. Goundrey

Armadale Road Duplication - Tapper Road to Anstey Road Supplementary vegetation survey, targeted *Drakaea elastica* survey and black cockatoo assessment

Background

Main Roads Western Australia (MRWA) is proposing to duplicate approximately 7 km of Armadale Road, between Tapper Road in Atwell and Anstey Road in Forrestdale (the Project). MRWA proposes to duplicate this section of Armadale Road to increase traffic capacities in the locality within the City of Cockburn (CoC) and City of Armadale (CoA) local government areas.

The Project will involve the upgrade of intersections of Armadale Road between Tapper Road and Anstey Road and associated works including lighting, service relocations and drainage, including the following intersections:

- Tapper Road/Verde Drive, Atwell
- Fraser Road, Banjup
- Liddelow Road, Banjup
- Wright Road, Piara Waters
- Rossiter Avenue, Piara Waters
- Nicholson Road, Forrestdale.

In November 2015 Astron undertook a biological assessment which included a flora and vegetation survey and black cockatoo habitat assessment in relation to the Project (Astron survey area, Figure 1). During this assessment, Astron identified potential habitat for the orchid species *Drakaea elastica* within *Kunzea glabrescens* tall shrublands (Figure 1).

Drakaea elastica is listed as Threatened under section 178 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Threatened under Schedule 1 of the State *Wildlife Conservation Act 1950* (WC Act). No other vegetation associations within the Astron survey area were considered to contain suitable habitat for this species.

MRWA revised the study area in 2016, identifying additional areas that require investigation, which were not surveyed by Astron in 2015 (additional survey area). The additional survey area is indicated in Figure 1 and is predominantly located around the Armadale Road and Liddelow Road, Wright/Taylor Road, Warton Road and Nicholson Road intersections.

Based on the above Strategen was engaged by MRWA to undertake a supplementary broad level flora and vegetation survey to assist MRWA to determine the environmental approvals required to facilitate construction of the Project and to identify further investigations that may be required to support the environmental approvals.



The objectives of this survey were to:

- undertake a supplementary flora and vegetation survey to the Astron survey (2015), to define the flora and vegetation values within the additional survey area as per the vegetation types defined within the Astron survey (2015)
- undertake a targeted survey for *D. elastica* within the Astron mapped *K. glabrescens* tall shrublands. As well as undertake a targeted survey for *D. elastica* in any *K. glabrescens* tall shrublands, identified during the supplementary field survey
- undertake a Black cockatoo habitat assessment to confirm potential black cockatoo foraging, breeding and/or roosting habitat within the additional survey area.

Methodology

Supplementary flora and vegetation survey

Due to the restricted access to private property within the additional survey area, the supplementary flora and vegetation survey for vegetation within private properties focussed on the extrapolation of mapped vegetation type boundaries as provided by Astron (2015) and does not directly align with the standard approaches for Level 1 and Level 2 surveys as outlined in Guidance Statement 51 (EPA 2004). The survey of these private properties was primarily undertaken through visual observations made from the property boundary.

Some areas within the additional survey area were able to be traversed on foot, including Metropolitan Regional Scheme (MRS) Parks and Recreational Reserves and the vegetation along the roadsides. This allowed for more accurate observations regarding the changes in vegetation structure or composition to be recorded. The survey of these areas was undertaken in accordance with the Guidance Statement 51 (EPA 2004) and constitutes a supplementary Level 1 flora and vegetation survey to the original Level 2 Astron flora and vegetation survey. Five 10 x 10 m quadrats were established within the MRS reserves to confirm the vegetation types as per the vegetation types described within the Astron survey (2015).

The supplementary survey was undertaken over the course of two events by Daniel Panickar (Senior Consultant and Lead Ecologist – Strategen) and Dr. Jeffrey Cargill (Senior Botanist – Mattiske Consulting) on 28 July 2016 and by Daniel Panickar and Clare Courtauld (Ecologist - Strategen) on 11 August 2016.

Targeted flora survey

The targeted *D. elastica* field survey was undertaken in accordance with the *Draft survey guidelines for Australia's threatened orchids* (DotE 2013). The survey was undertaken over the course of two events by Daniel Panickar (Senior Consultant and Lead Ecologist – Strategen) and Dr. Jeffrey Cargill (Senior Botanist – Mattiske Consulting) on 28 July 2016 and by Daniel Panickar and Clare Courtauld (Ecologist - Strategen) on 11 August 2016.

The survey included areas of *Kunzea glabrescens* tall shrublands within the Astron Survey area (Figure 1) and areas of *Kunzea glabrescens* that were publically assessable within the additional survey area (Figure 2). These areas were ground-truthed and the vegetation types identified in the Astron survey were reclassified where necessary.

While *D. elastica* typically flowers in spring; individuals flower unreliably (i.e. not every year) and as a result, cannot be surveyed effectively during spring months. The ideal survey time for *D. elastica* is during July and August, when this species produces a distinctive and easily visible leaf. The leaf then dies off prior to spring (DEC 2009). Timing for the *D. elastica* survey was determined through consultation with Dr. Andrew Brown of the Department of Parks and Wildlife (Parks and Wildlife). The targeted surveys for *D. elastica* were undertaken area in accordance with methodologies specified in DotE (2013) via transects at a maximum distance of 10 m apart and recorded by GPS units.

Black cockatoo habitat survey

The additional survey area was inspected for black cockatoo habitat by Strategen personnel with relevant experience as specified by the *EPBC Act Referral guidelines for three threatened black cockatoo species* (DSEWPaC 2012). The inspection included a significant tree assessment to identify any trees with the potential to be utilised by black cockatoos for breeding and an assessment of potential foraging habitat for signs of black cockatoo use.

Significant trees are defined as trees of suitable species with a diameter at breast height (DBH) greater than 500 mm (DSEWPaC [now Department of Environment and Energy [DEE] 2012). Trees with a DBH greater than 500 mm are large enough to potentially contain hollows suitable for nesting black cockatoos, or have the potential to develop suitable hollows over the next 50 years. Trees of this size may also be large enough to provide roosting habitat (i.e. trees which provide a roost or rest area for the birds).

Due to restricted access into private property, the survey was primarily undertaken through visual observations of habitat made from the property boundary. Areas traversed on foot included publically accessible areas and potential habitat along roadsides. Significant trees were only surveyed in areas where access was not restricted.

Results

Flora and vegetation survey

The supplementary flora and vegetation survey identified four vegetation associations (three previously mapped by Astron in 2015 and an additional vegetation association that, following ground-truthing was mapped as *Beaufortia elegans* tall shrublands by Strategen), comprising an area of approximately 64.2 ha, as presented in Table 1 and Figure 1, including:

- 1. Banksia woodland.
- 2. *Melaleuca* damplands.
- 3. *Kunzea glabrescens* tall shrublands.
- 4. Beaufortia elegans tall shrublands (mapped as Kunzea glabrescens tall shrublands in Astron [2015]).

This includes three areas (totally approximately 0.4 ha) that were previously mapped as *Kunzea glabrescens* tall shrublands (Astron 2015) which were re-classified by Strategen as *Melaleuca* damplands after ground-truthing the area (Figure 2).

Native vegetation recorded in the additional survey area ranges from Completely Degraded to Good– Excellent vegetation condition, in accordance with the Keighery (1994) vegetation scale. Table 1 presents vegetation associations, habitat and condition recorded within the survey area, as determined in the Strategen vegetation and flora survey.

The additional survey area was largely degraded with a weed-dominated understorey. The additional survey area also contains large areas of planted and/or cleared vegetation covering approximately 44.9 ha (Table 1).

Targeted flora survey

No *D. elastica* individuals were found during the surveys. A large proportion of the *Kunzea glabrescens* tall shrublands within the Study area was dominated by the invasive species **Ehrharta calycina* (Veldt Grass), **Zantedeschia aethiopica* (Arum Lily), **Fumaria capreolata* (White Flower) and Poaceae spp. in the understorey, which tend to suppress growth of annual herb species and are therefore not considered suitable habitat for *D. elastica*. The *K. glabrescens* opposite Warton Road was particularly degraded and infested with exotic species, thus not comprising habitat for *D. Elastica*. Consequently, this area was not surveyed to the same level of intensity as the remainder of the Survey area (Figure 3).

Black cockatoo habitat survey

No significant trees were recorded within the additional survey area and no black cockatoos were observed during the survey. Based on visual observations from the private property boundaries, potentially significant trees may be present within private property.

The additional survey area contains approximately 6.2 ha *Banksia attenuata* and *Banksia menziesii* woodland, which was assessed as moderate quality foraging habitat for Carnaby's Black Cockatoo (CBC), Forest Red-tailed Black Cockatoo (FRTBC) and Baudin's Black Cockatoo (BCB).

Table 1: Vegetation associations recorded within the Study area

| Vegetation association and code | Habitat | Vegetation condition | Additional survey area including reclassified areas |
|--|---|----------------------|---|
| BaBm: <i>Banksia</i> woodland | Mid to upper | Good | 6.2 |
| Banksia attenuata, B. menziesii and B. ilicifolia low woodland (with Eucalyptus marginata scattered trees) over Xanthorrhoea preissii (Macrozamia riedlei) open shrubland over Dasypogon bromeliifolius and Phlebocarya ciliata or Desmocladus flexuosus open herbland to closed herbland. | slopes on grey sand | | |
| Associated species: Allocasuarina fraseriana, *Avena barbata, Burchardia congesta, *Ehrharta calycina, *Euphorbia terracina, *Fumaria capreolata, Hypocalymma angustifolium, Lepidosperma sp., *Moraea flaccida, Patersonia occidentalis. | | | |
| Mp: Melaleuca preissiana damplands | Seasonally | Good to | 6.3* |
| Melaleuca preissiana low open Forest to low closed forest over Lepidosperma sp. or Lepidosperma longitudinale and Dielsia stenostachya closed sedgeland (over Pteridium esculentum herbland). | wet Damplands with dark loamy sand | Excellent | |
| Associated species: Acacia ?longifolia, Hypocalymma angustifolium, Phlebocarya ciliata, Xanthorrhoea preissii. | | | |
| Kg: Kunzea glabrescens tall shrublands | Flat sandy | Good to Very Good | 2.5 |
| Kunzea glabrescens tall open scrub to closed tall scrub over Dasypogon bromeliifolius or Phlebocarya ciliata low open shrubland. | palusplains | | |
| Associated species: Jacksonia sternbergiana, Macrozamia riedlei, Regelia ciliata, Xanthorrhoea preissii. | | | |
| Be: Beaufortia elegans tall shrublands | Seasonally | Good to | 0.1 |
| Beaufortia elegans tall open scrub to closed tall scrub over Regelia ciliata with occasional Cassytha spp. | wet Damplands with dark loamy sand | Very Good | |
| Planted | | | 4.2 |
| Cleared | | | 44.9 |
| TOTAL | | | 64.2 |

*includes approximately 0.4 ha of vegetation was previously mapped by Astron (2015) as Kg that were reclassified to Mg.

Conclusion

The key outcomes from the survey were:

- four vegetation associations were identified within the additional survey area (including the reclassified Astron vegetation); however the majority of the survey area is cleared or planted with exotic species
- no individuals of the rare orchid species *Drakaea elastica* were located within the *Kunzea glabrescens* tall shrublands targeted as part of this survey
- approximately 6.2 ha of moderate quality foraging habitat for CBC and BBC was identified within the additional survey area. No significant trees for black cockatoos were recorded during the survey, although potentially significant trees may be present within private property.

Limitations

- areas of private property) were not able to be accessed as part of this survey and therefore a cockatoo habitat assessment and flora and vegetation survey is recommended to be undertaken to ground-truth the area if clearing is proposed in these areas
- areas of *Kunzea glabrescens* tall shrublands within private property were unable to be accessed as part of this survey and therefore a targeted *D. elastica* if clearing is proposed in these areas.











Note that positional errors may occur in some areas Date: 30/09/2016 Author: JCrute

Source: Aerial image and design: Client 06/2016. Wetlands: DPAW 2015. Path: Q:\Consult/2016/MROWRO16249\ArcMap_documents\M001\WRO16249_01_M001_F002_RevC.mxd



Source: Aerial image and design: Client 06/2016. Wetlands: DPAW 2015. Path: Q:\Consult2016\MROWRO16249\ArcMap_documents\M001\MRO16249_01_M001_F003_RevC_1.mxd



References

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- Department of Environment and Conservation (DEC) 2009, Glossy-leafed Hammer Orchid (*Drakaea elastica*) Recovery Plan, [Online], Government of Western Australia, Available from http://www.environment.gov.au/system/files/resources/f2fe52ea-343b-4fd2-9806-55e86d9b9d6c/files/drakaea-elastica.pdf [August 2016].
- Keighery B 1994, Bushland Plant Survey: A Guide to Plant Community Survey for the Community, Wildflower Society, Floreat.

Appendix 1 Curriculum vitae



CURRICULUM VITAE

Daniel Panickar BSc (Hons)

Senior Consultant



Daniel Panickar is an senior ecologist with over six years experience in conducting and managing botanical surveys throughout Western Australia, including rehabilitation monitoring and vegetation surveys in the Jarrah Forest, Goldfields, Northern Sandplains, Pilbara, Kimberley, Swan Coastal Plain and South Coast bioregions.

Prior to commencing work at Strategen in January 2013, Daniel worked for Mattiske Consulting as an experienced ecologist. During his time at Mattiske Consulting and Strategen, Daniel has gained invaluable experience in conducting field surveys including Threatened and Priority flora searches (including Threatened orchid species), rehabilitation monitoring, riparian health assessments and vegetation mapping. Daniel's role at Strategen has expanded and seen him take on a coordinator and management role for ecological projects throughout the state.

Daniel has managed several large biological projects throughout Western Australia and has been responsible for leading teams in the field, coordinating data management and analysis, plant identification, managing sub-consultants, client liaison, provision of strategic advice and reporting. Additionally, Daniel has been intimately involved in the review and development of bauxite and coal mining rehabilitation programs in the south-west of Western Australia.

The study of ecological relationships between invertebrates and plants has been a major focus of Daniel's prior sponsored research and employment with the former Department of Environment and Conservation which adds to a broad level of experience in environmental issues.

Daniel's key skills include:

- Level 1 and Level 2 flora and vegetation assessments
- · Vegetation mapping, monitoring and condition assessment
- Targeted flora surveys (including Threatened orchids such as Caladenia huegelii and Drakaea elastica)
- Fauna habitat assessment
- Environmental impact assessment
- EPBC Act referrals
- Bushfire management
- Providing strategic advice.

Since joining Strategen in January 2013, Daniel has been involved in the following projects:

- On-site vegetation surveys, off-site rehabilitation monitoring and project advice for the Fiona Stanley Hospital Project
- Development and preparation of a Vegetation Management Plan for Ibis Place, High Wycombe
- Development and preparation of Environmental Management Plans for Main Roads WA (Malaga Drive-Reid highway intersection)
- Vegetation surveys for Main Roads WA (Reid Highway Duplication, Malaga Drive-Reid highway intersection, Shelley Bridge duplication, Albany Highway widening [SLK 138-140])
- Vegetation and fauna assessments for LandCorp, Satterley Property Group, Peet Limited, Dampier Bunbury Natural Gas Pipeline, Alcoa of Western Australia Limited and CSR Limited
- EP Act and EPBC Act referrals for the Tronox Cooljarloo West development
- Project management (subconsultant management and report review) for the Tronox Cooljarloo West development
- Environmental Impact Assessment (PER level) for the Tronox Cooljarloo West development
- Environmental Impact Assessment (API level) for Iron Ore Holdings Bungaroo development.



Selected project examples

Karnup sand mining project (Threatened orchid survey)

Urban Resources Pty Ltd engaged Strategen to undertake a targeted orchid survey for the Threatened (Declared Rare Flora – Extant) orchid species *Caladenia huegelii, Drakaea elastica* and *Drakaea micrantha* within their proposed mining expansion area for the Karnup Sand Mining Project. The site encompassed approximately 50 ha of vegetated areas and cleared tracks and contained areas of potential habitat for the orchid species which were identified during a flora and vegetation survey undertaken by Strategen in May 2015.

Following this identification of habitat, consultation with Andrew Brown of the Department of Parks and Wildlife was undertaken to determine the appropriate time to undertake a targeted survey for the orchids and identify the appropriate methodology given the site's variable condition. A targeted transect survey in accordance with methodologies specified in *Draft survey guidelines for Australia's Threatened Orchids* (DotE 2013) was undertaken within the site to locate any orchids present.

Murdoch University proposed aquatic centre (Threatened orchid surveys)

Murdoch University engaged Strategen to undertake an environmental and hydrological review of an area within the university's landholdings considered development into a comprehensive sports precinct including aquatic facilities and associated infrastructure. Desktop surveys identified potential habitat for the Threatened (Declared Rare Flora – Extant) (T(DRF)) orchid species *Caladenia huegelii* and *Drakaea elastica* within the campus grounds. Following the identification of potential habitat, Strategen were commissioned to undertake a targeted survey for *C. huegelii* and *D. elastica* within the development area.

Surveys were undertaken for both species over the course of two events in August and September 2015 in accordance with methodologies specified in *Draft survey guidelines for Australia's Threatened Orchids* (DotE 2013) to locate any orchids present.

Referee

Professor Kingsley Dixon Curtin University of Technology 0428 285 565 *Kingsley.Dixon@curtin.edu.au*





CURRICULUM VITAE

Clare Courtauld BSc (Env Sc) (Hons) (Conservation Biology)

Environmental Scientist



Clare Courtauld completed her Bachelor of Science from Murdoch University in 2012 and graduated from the University of Western Australia with first class honours in Conservation Biology in 2013. Prior to Joining Strategen in October 2015, Clare has previously worked as a Research Assistant and Supervisor at the University of Western Australia & Kings Park Biodiversity Conservation Centre. She has also worked for the Department of Environment Regulation in the air quality sector and as a rehabilitation officer and team leader at Men of the Trees and Conservation Volunteers Australia. Clare has also undertaken extensive volunteer work both locally and overseas.

Clare's key skills include:

- Flora and vegetation surveys.
- Plant identification.
- Coordination and interpretation of data.
- Report preparation.
- Management skills.
- Research and technical and problem solving skills.
- Communication skills.

Clare's previous work has involved:

University of Western Australia & Kings Park Biodiversity Conservation Centre

- Working as part of a team and autonomously to deliver research outcomes in order to improve restoration of ecological communities as part of Pilbara and Southwest mine site restoration projects.
- Preparation of reports, scope of research, project methodologies, risk assessment reports and experimental trials within strict deadlines.
- Plant species identification, seed collection and cataloguing of herbarium specimens.
- Designing and conducting laboratory and field trials, soil analyses, environmental monitoring, data collection, statistical analysis and data presentation.
- Supervisory role to several honours and biology students, aiding in experimental designs and proofreading.

Department of Environment Regulation

- Design and develop a user-friendly, updated database of all emissions produced by Australian brickworks companies, analysing the change in emissions produced by different companies over the previous 10 years.
- Presenting the internship outcomes to relevant stakeholders and in a written report.
- Coordinate liaison with industry personnel and responsibly deal with confidential information.
- Undertake site visits to further understand industry processes, company procedures and processes and the ongoing reduction of emission outputs.

Men of the Trees

- Coordinating volunteer days and competently leading large teams.
- Organising rehabilitation, planting native plant species suited to the allocated sites.

Conservation Volunteers Australia

- Coordinating conservation volunteer days and competently leading large teams in conservation activities.
- Organising volunteer program, conducting education programs and presentations.



Since joining Strategen, Clare has been involved in the following projects:

- Lake Clifton flora and vegetation survey (Cape Bouvard).
- Forrestfield North flora, vegetation and black cockatoo habitat assessment (Shire of Kalamunda).
- Viveash Stage 2 development flora and vegetation survey (Pindan).
- Binningup Desalination Plant flora and vegetation monitoring survey and report (Water Corporation).
- Upper Swan Development Biological Report and Environmental Assessment Report (Satterley).
- Lakelands Development Revegetation Plan of Works (Peet).
- Barfield Road targeted orchid survey (Caladenia huegelii) and flora and vegetation survey (Blokk Property Australia).





QUALIFICATIONS

Ph.D. (Environmental Science) (Edith Cowan University)
B.Sc. (First Class Honours) (Edith Cowan University)
B.Sc. (Environmental Management) (Edith Cowan University)

CURRENT COMPANY POSITION 2010 – current:

Senior Ecologist & Project Coordinator Mattiske Consulting Pty Ltd

Key Skills and Experience

| · · | |
|---|--------------|
| Project management and planning | \checkmark |
| Infrastructure projects | \checkmark |
| Mining projects | \checkmark |
| Land development projects | |
| Biological data analysis | |
| Sample design and methodology | ✓ |
| Vegetation and condition mapping | ✓ |
| Threatened and Priority Ecological Communities | √ |
| Multi-layered assessments | |
| Environmental assessment and approvals | ✓ |
| Local and regional scale studies | \checkmark |
| Technical review and reporting | |
| Team development and training | |
| Environmental risk assessments | |
| Mine rehabilitation and closure plans | \checkmark |
| Client and stakeholder liaison | \checkmark |
| | |

Dr Jeff Cargill Senior Ecologist Summary of Skills and Experience

Jeff has extensive experience in botanical and ecological studies throughout Western Australia including baseline vegetation studies (Levels 1 and 2), threatened and priority flora surveys, and rehabilitation and vegetation monitoring programs. Jeff also has significant experience in the development and implementation of mine rehabilitation and closure plans and environmental risk assessments.

Significant experience has been gained in designing projects, managing teams, assessing environmental values, reviewing options and adapting methodology of long-term monitoring projects and producing high level technical reports. In addition, Jeff is responsible for providing technical advice on sample design and methodology and biological data analysis for projects undertaken by Mattiske Consulting.

As a Project Coordinator, Jeff has responsibility for the client management, direction, delivery, and oversight of botanical and ecological studies undertaken by the Mattiske Consulting team.

PERSONAL ATTRIBUTES

Jeff has an extensive skillset developed from experiences working within the academic, mining, public and private environmental sectors. He has the proven ability to lead ecological teams across a wide range of projects and deliver high quality technical reports to the satisfaction of clients.

ADDITIONAL QUALIFICATIONS

- Marcsta Mining General Safety Induction
- WA Mine Driving Permit with Alcoa
- Contractor Responsible Person (Alcoa)
- Apply First Aid Training with St John Ambulance (HLTFA311A)
- 4WD defensive Training with Drive Safe Australia
- "C" class Drivers Licence
- Aveling Fundamentals of Supervision
- Flora Collection Permit (Issued under WC Act 1950)
- Aveling Safety Leadership
- Aveling Fire Training







Client: Sheffield Resources Limited (via MBS Environmental) - Kimberley

Extensive work on baseline flora and vegetation studies (Level 2), and targeted threatened and priority flora surveys in vast areas in the Kimberley region associated with mineral exploration and mine development approvals (Thunderbird Project Area) (2016). Dr Cargill is involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Dampier Bunbury Pipeline (DBP)

Extensive work on baseline flora and vegetation studies on major infrastructure projects across various regions associated with the expansion of the pipeline (Level 1 and 2) (2011 to 2016). Targeted threatened and priority flora, and priority ecological community searches along the course of the pipeline (Dampier to Bunbury). Rehabilitation assessment within various bioregions along the course of the pipeline (Dampier to Bunbury). Development and implementation of Environmental Risk Assessments for the DBNGP (Dampier to Bunbury). Project coordinator and Senior Ecologist for works associated with the CS2-Tubridgi-Wheatstone Gas Pipeline (Onslow), Ashburton North Gas Pipeline (Onslow), and Fortescue Valley Gas Pipeline (Onslow to Solomon Mine – FMG). Dr Cargill is involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Multiple Projects for RPS Group

Extensive work on baseline flora and vegetation studies (Level 1 and 2) and establishment and design of longterm monitoring transects for major infrastructure and land development projects in the Pilbara and South-West Regions (2011 to 2016). Site assessments of Threatened and Priority Ecological Communities on the Swan Coastal Plain. Project coordinator and Senior Ecologist for works associated with the Anketell Strategic Industrial Area (Roebourne), Tumulus Spring Assessment (Serpentine), and Preston Beach land development (Mandurah).

Client: Multiple Projects for Strategen

Extensive work on baseline flora and vegetation studies (Level 1 and 2) for major infrastructure and land development projects in the south-west of Western Australia (2012 to 2016). Project coordinator and senior ecologist for works associated with the Ocean Reef Marina development (Joondalup) and DBNGP corridor widening (Kwinana to Bunbury).

Client: Mamba Resource Management

Baseline flora and vegetation studies (Level 1) for proposed drilling operations near Juna Downs (Karijini NP) (2015 to 2016). Dr Cargill is involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Alcoa of Australia Limited

2010 - Current (multiple tasks and projects as Project Manager and Senior Ecologist)

Extensive work on baseline flora and vegetation studies on multiple projects in the Jarrah Forest region associated with mineral exploration (baseline vegetation studies), mine development approvals, stream-zone monitoring, residue rehabilitation and rehabilitation assessment of current mine operations (2010 – 2016). Extensive work related to flora and vegetation studies (Level 1 and 2) and conservation category wetland assessments within the Alcoa Pinjarra Farmlands. Dr Cargill is involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Perth Airport Pty Ltd

Extensive work on baseline flora and vegetation studies (Level 1 and 2), targeted threatened and priority flora surveys, development and implementation of survey methodologies for federal approval, and assessment of threatened and priority ecological communities (2014 to 2015). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Premier Coal Limited

Extensive work on multiple projects in the Jarrah Forest region associated with the design and establishment of long-term forest control plots, mine development approvals and rehabilitation assessment of current and past mine operations (2011 to 2015). In addition, development and implementation of mine rehabilitation and closure completion criteria(s) for mining operations in the Collie Coal Basin. Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

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Client: Jandakot Airport Pty Ltd

Baseline flora and vegetation studies (Level 1) and targeted threatened and priority flora surveys for infrastructure developments (2014). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Department of Water

Extensive work undertaking spatio-temporal vegetation studies on the Jandakot and Gnangara Mounds, and Samson Brook (2010 to 2016. Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: South32 Worsley Alumina

Extensive work on multiple projects in the Jarrah Forest region associated with the design and establishment of long-term forest control plots, level 1 flora and vegetation surveys, mine development approvals and rehabilitation assessment of current and historic mine and refinery (BRDA) operations (2012 to 2016). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: City of Swan

Planning, design and establishment of permanent vegetation monitoring plots in the northern Jarrah Forest. In addition, conducting Threatened and Priority Flora surveys and weed mapping (2015 to 2016). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: AAH Holdings Pty Ltd

Baseline flora and vegetation studies within the northern Jarrah Forest, in view of clearing applications for private landholders (2015). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting.

Client: WA Limestone Pty Ltd

Baseline flora and vegetation studies (Level 2), and assessment of threatened and priority ecological communities for the Yanchep Ridges development (2013 to 2014). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Griffin Coal Limited

Extensive work on the planning, design and establishment of long-term post-impact stream-zone monitoring transects in the Collie Coal Basin (2011 to 2013). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Regis Resources

Baseline flora and vegetation studies and Threatened and Priority Flora surveys (2012 to 2013). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Macarthur Minerals Pty Ltd

Extensive work on baseline flora and vegetation studies (Level 1 and 2), targeted threatened and priority flora surveys, and targeted priority ecological surveys for the Ularring Hematite Project (Lake Giles) (2011 to 2012). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

Client: Forest Products Commission

Extensive work on the planning, design and completion of spatio-temporal vegetation studies in the 31-Mile Brook Catchment area (2012). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation, reporting and project coordination.

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Client: Atlas Iron Limited

Extensive work on baseline flora and vegetation studies (Level 2) for the Balla to Anketell Point Port Slurry Pipeline Corridor (Roebourne) (2011). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation and reporting.

Client: Water Corporation of Western Australia

Definition Jarrah Forest structure and vegetation values in the Wungong Catchment, including long-term monitoring programs associated with impacts to vegetation associated with water usage (2010 to 2011). Dr Cargill has been involved in all phases of the work including design, planning, field studies, data interpretation and reporting.

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