Arrowsmith Hydrogen Project (AHP)

Referral Supporting Document (RSD)

(Pursuant to Section 40(2)(a) of The EP Act 1986)

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IGE respectfully acknowledges traditional owners of the land and water it manages, and recognises their continuing connection to land, water and community

Table of Contents

1 Executive Summary
1.1 Context 15
1.2 Adaptive Management 16
2 Proposal Content Document
3 Green Hydrogen Project Alternatives
4 Key Values, Environmental Factors and Outcomes
5 Introduction
5.1 The Proponent 41
5.2 Site Selection 42
5.3 Legislative Framework 44
6 Green Hydrogen Project Elements
6.1 GHPF Operational Components 52
6.2 Contribution to Grid Stability 54
6.3 Benefits of Phased Approach 55
6.4 Plant Load mix 55
6.5 Energy Transition 58
6.6 Solar Farm 62
7.1 Site Preparation 67
7.2 Land Clearing and Grading 67
7.3 Foundation Construction 68
7.4 Crane Pad and Assembly Area Construction: 68
7.5 Turbine Component Delivery and Assembly 68
7.6 Turbine Assembly 68
7.7 Electrical Infrastructure and Grid Connection 69
7.8 Substation Construction 69
7.9 Commissioning and Testing 69
7.10 Operational Testing 69
7.11 Environmental and Safety Compliance 70
7.12 Safety Protocols 70
7.13 Final Inspections and Handover 70
7.14 Handover to Operations 70
7.15 Conclusion 76
8 Electrolysis
8.1 Production Water Process 79
8.2 Hydrogen Compression and Storage 82
8.3 Vehicles and Machinery 83
9 Regional Context
9.1 Socio-Economic Setting 85
9.2 Native Title 86
9.3 Land tenure 86
9.4 Land use 86
9.5 Anticipated Air Emissions 86
9.6 Climate 87
9.7 Interim Biogeographic Regionalisation of Australia 87
9.8 Nature Reserves 87
9.9 Soil-Landscape Zones 88

9.10 Karst Formation 88
9.11 Contaminated sites 91
9.12 Conservation Estate 91
9.13 Stakeholder Engagement 94
9.14 Consultation 94
9.15 Consultation: Western Australian Speleological Group (WASG) 95
9.16 Stakeholder Engagement 97
10 Environmental Principles and Factors
10.1 Principles 127
10.2 Identification of Key Environmental Factors 132
11 Key Environmental Factor - Flora and Vegetation
11.1 EPA Objective 137
11.2 Receiving Environment Desktop and Field Assessments 138
11.3 Response to EPA Requirements 138
11.4 Regional Biogeography 138
11.5 Pre-European Vegetation 139
11.6 EPBC Conservation Significant Vegetation 142
11.7 DBCA Conservation Significant Vegetation 142
11.8 EPBC Act Threatened Flora 142
11.9 DBCA Threatened and Priority Flora 145
11.10 Field Reconnaissance and Detailed Survey 145
11.11 Flora Presence 147
11.12 Priority Listed Flora 148
11.13 Introduced Flora 159
11.14 Regional and Local Significance 160
11.15 Local and Regional Impacts 160
11.16 Vegetation Types update 162
11.17 Vegetation Condition 163
11.18 Forests Deaths in Western Australia 164
11.19 Statistical Floristic Analysis 170
11.18 Potential Impacts 171
11.19 Altered Groundwater Tables 172
11.20 Avoidance, Mitigation and Management (Summary) 175
11.21 Residual Impact 177
12 Key Environmental Factor – Terrestrial Fauna
12.1 Environmental Values 180
12.2 Receiving Environment 180
12.3 DBCA Database Search 180
12.4 Protected Matters Search 180
12.5 Terrestrial Fauna Assemblage 181
12.6 Fauna Habitat 182
12.7 Fauna Habitat Condition (Vegetation) 182
12.8 Record Temperatures in W.A. 183
12.9 Dying Forests in Western Australia 183
12.10 Carnaby’s Black Cockatoo (CBC) Habitat 192
12.11 Site Significance 192
12.12 Carnaby’s Cockatoo Foraging Habitat 193
12.13 Presence of Foraging Activity During Surveys 194
12.14 Potential site Roosting Habitat and likely Carnaby's Cockatoo Movements 194
12.15 Carnaby's Black Cockatoo Assessment Summary 195

12.16 Targeted Foraging Area 196
12.17 Potential Impacts 200
12.18 CBC Foraging Disturbance Extents 201
12.19 Lack of Foraging Habitat and Value 204
12.20 Avifauna and Bats Impacts from Wind Turbine Operation 205
12.21 Weed Introduction and Habitat Modification 208
12.22 Other Construction and Operational Impacts 208
12.23 SRE Invertebrates 209
12.24 Subterranean Fauna 209
12.25 Stygofauna and Troglofauna Impacts 209
12.26 Avoidance, Mitigation and Management Summary 210
12.27 Residual Impact 212
12.28 Predicted Outcome and Conclusions 213
13 Key Environmental Factor – Inland Waters
13.1 Environmental Values 215
13.2 Legislation, Policy, and Guidance 215
13.3 Receiving Environment 216
13.4 Surface Water 217
13.5 Hydrology and Hydraulics 218
13.6 Infrastructure Layout Assessment update 220
13.7 Groundwater 224
13.8 The Yarragadee Aquifer 225
13.9 Potential Groundwater Abstraction Impacts 225
13.10 Development Constraints 230
13.11 Groundwater Dependant Ecosystems 231
13.12 Groundwater Monitoring and Management 237
14 Key Environmental Factor – Social Surrounds
Environmental Values 245
14.1 EPA Objective 245
14.2 Legislation, Policy and Guidance 245
14.3 IGE Commitment 246
14.4 Social Surrounds: Aboriginal Heritage and Culture 247
14.5 Aboriginal Heritage 249
14.6 Heritage Survey 249
14.7 Women's Cultural Practice Survey 250
14.8 Natural and European Historical Heritage 251
14.9 Potential Impacts 252
14.10 Social Surrounds Impacts 252
14.11 Visual Impact 255
14.12 Dust 256
14.13 Avoidance, Mitigation and Management Summary 257
14.14 Residual Risk 259
14.15 Predicted Outcome and Conclusions 259
14.16 IGE Commitments 260

15 Environmental Offsets
15.2 Types of offsets 263
15.3 CBC Foraging Habitat Offsets 264
15.4 Environmental Offset Implementation 264
16 Other Environmental Factors
17 Visual Amenity
17.1 Landscape Aesthetics 277
17.2 AHP Landscape 277
18 Bushfire Regimes
18.1 Bushfire Access Points and Service Roads 280
18.2 Changes to Fire Regimes 280
18.3 Bush Fire Emergency Escape Route Plan: Approved by the Shire of Northam DFES 280
18.4 Fire Emergency Access Roads Escape Routes 281
18.5 Fencing and Security 281
19 Storm/Wastewater Management
19.1 Wastewater 283
19.2 Stormwater 283
19.3 Sustainable Wastewater Discharge Options: 285
19.4 Closed-Loop Water Recycling System 285
19.5 Brine Treatment and Reuse 285
19.6 Reverse Osmosis (RO) and Brine Minimisation 286
19.7 Stock dams for Discharge and evaporation 286
19.8 Zero Liquid Discharge (ZLD) System 288
19.9 Soil Infiltration Basins 288
19.10 Advanced Filtration and Treatment to meet discharge standards 288
19.11 Above-Ground Sewage Treatment Plant 289
19.12 Leach Drain System 290
19.13 Hybrid System: Above-Ground Treatment with Leach Drain Discharge 290
19.14 Packaged Sewage Treatment Plant with Effluent Disposal (Surface Irrigation/Other Use) 291
19.15 Groundwater Quality 291
20 Cave Systems
21 Landform Environmental Objective
21.1 Objective 297
21.2 Project AHP Landform Aspects 297
21.3 Landform Subregions 297
21.4 Values 298
21.5 Landforms as described by the EPA 298
22 Cumulative Impacts
22.1 Vegetation 300
22.2 Terrestrial Fauna 300
22.3 Inland Waters 301
22.4 Social Surrounds 301
22.5 Holistic Impact Assessment 308
22.6 Holistic Approach 310

23 Conclusions
23.1 Flora and Vegetation 312
23.2 Terrestrial Fauna 313
23.3 Inland Waters 313
23.4 Social Surrounds 313
24 Matters of National Environmental Significance Referral Decision
24.1 Overview of the EPBC Act 1999 315
24.2 Matters of National Environmental Significance (MNES) 316
24.3 EPBC Act Referral Process 316
24.4 What's protected under the EPBC Act?: 316
24.5 Evaluation of Potential Impacts 316
24.6 Referral Decision (EPBC Act) 317
24.7 Referral Decision and Rationale 317
24.8 Rationale for Non-Referral: 318

25 Self-Assessment Guidelines
1 Justification for Non-Referral 320
2 Environmental Impact Assessment Summary 321
3 Compliance with Legislative Requirements 322
4 Mitigation Measures and Monitoring 324
25.1 Assessment of the AHP Project's Impact upon Carnaby's Black Cockatoos 330
25.2 Adaptive Management and Review of Procedures 333
25.3 Environmental Monitoring and Corrective Actions 333
25.4 Management Review 333
25.5 Environmental Incidents/Non-Compliance 333
26 Summary
26.1 Fauna Protection: 334
26.2 Flora and Vegetation Protection: 334
26.3 Groundwater Impacts: 334
26.4 Wetlands and Sensitive Areas Protection: 334
26.5 Cultural Heritage Protection: 334
26.6 Visual Impact and Noise Management: 335

27 References 336
28 Appendices 341

Figures References

Figure 1: Indicative Development Envelope and Regional Context. 43
Figure 2: Indicative Site Layout 51
Figure 4: Indicative Project Elements (Hydrogen Facility, Turbine Layout, Access Roads and Solar 64
Figure 5: Indicative Anchor Cage Foundation Structure 71
Figure 6: Indicative Turbine Construction Pad design 72
Figure 7: Indicative Turbine Type Vestas V162 7.2 MW 73
Figure 8 Indicative Wind Turbine Designs 75
Figure 9: Indicative Green Hydrogen Process Overview 79
Figure 10:Indicative Storage 81
Figure 11: Long term mean monthly rainfall, minimum and maximum temperatures (BoM, 2023). 87
Figure 12: Proposal Area Soil Landscapes. 89
Figure 13: Indicative Cave Limits 90
Figure 14: Beekeepers Nature Reserve (BKNR) 92
Figure 15: Pre-European Vegetation. 140
Figure 16: Vegetation Types (Ecoscape 2023) 146
Figure 17: Vegetation Condition (2022) 165
Figure 18: Fauna Habitat. 187
Figure 19: Vegetation and Carnaby's Black-Cockatoo foraging records disturbance footprint 196
Figure 20: Vegetation and substrate associations and Carnaby's Black-Cockatoo foraging values 197
Figure 21: Black Cockatoo Foraging Values – Classification 198
Figure 22: Black Cockatoo Foraging Values – Classification 199
Figure 23: Black Cockatoo Foraging Area – Classification showing the indicative vegetation types 202
Figure 24: Development Envelopes Vegetation Types(2020) 203
Figure 25: Avian mortality causes per year in the U.S. (Sovacool, 2012). 207
Figure 26: Surface Water and Local Catchments. 223
Figure 27 Geological profile showing the sub-division units and interpretive groundwater 228
Figure 28: Linear hydrography showing 2 m elevation contours. 232
Figure 29: Test Bore (First Production Bore) proposed construction 235
Figure 30: Groundwater Dependent Vegetation. 236
Figure 31: Cultural Heritage Sites 248
Figure 32: Hierarchy of Impact Mitigation 265
Figure 33: Indicative AHP Site Visualisation 276
Figure 34 Fire Emergency 282
Figure 35 Cave Systems Extents within the Development Envelopes 296
Figure 36: Indicative representation of environmental factors 308

Tables References

Table 1: Key Values Summary and Proposal Environmental Factors 36
Table 2: Other Relevant Legislation and Approvals 46
Table 3 GHPF Indicative Operational Elements (Figure 4 below) 52
Table 4: Proposal CO2 Emissions 86
Table 5: Soil landscape mapping within the Proposal area (Schoknecht et al., 2004). 88
Table 6: Industrial Developments within the Arrowsmith Area 93
Table 7: Stakeholder Engagement Register 97
Table 8: Environmental Management Principles. 127
Table 9: Key Environmental Factors Relevant to The Updated Proposal 133
Table 10:Pre-Vegetation System Associations within Proposal Area 141
Table 11:Likelihood of Occurrence of EPBC Act-listed threatened flora species. 143
Table 12 Project Vegetation Types Plus Mosaics of These 153
Table 13: DBCA: PEC P1 vegetation and Priority Two, P2 vegetation 154
Table 14: CBC Vegetation habitat types within the survey area 157
Table 15: Vegetation Systems Disturbance 161
Table 16: Vegetation Type Equivalents 162
Table 17: Vegetation Condition within the Survey Area (Ecoscape 2022 Survey, 768.96 ha) 163
Table 18: Priority Flora. 166
Table 19 Mapping Units: Extents Showing Vegetation Density Across the DE (Ecoscape 2023) 170
Table 20: Potential Impacts to Flora and Vegetation - Avoidance, Mitigation and Management 175
Table 21: Site Vegetation Condition Ecoscape detailed Survey 2022: (768.96 ha) 186
Table 22: Fauna habitats 188
Table 23: Potential Impacts to Terrestrial Fauna - Avoidance, Mitigation and Management. 210
Table 24: Intensity-Frequency-Duration (IFD) (mm) 216
Table 25 RFFE Calculated Flows Upstream of IGE Landholdings for Arramall Lake 219
Table 26 RFFE Calculated Flows Upstream Catchment 219
Table 27: Hydrogeological Setting. 224
Table 28: Potential Impacts to Inland Waters - Avoidance, Mitigation and Management 240
Table 29: Background Noise Levels, LA90,10 minutes [dB(A)]. 252
Table 30: Noise Criteria based on Background Noise Levels [dB(A)]. 252
Table 31: Predicted Noise Levels at NSP LAeq [dB(A)]. 253
Table 32: Potential Impacts to Social Surrounds - Avoidance, Mitigation and Management. 257
Table 33 Assessment Against Residual Impact Significance Model 266
Table 34 Preliminary Offset Quantification 267
Table 35: Range of typical Pollutant concentrations within Stormwater (Australian Guidelines) 284
Table 36: Proposal impacts upon existing vegetation systems. (Ecoscape 2022) 300
Table 37 Potential cumulative impacts from nearby groundwater abstraction. 301
Table 38: Cumulative Impact Summary within the Mid-West regional area. 302
Table 39: MNES Significance Criteria Assessment 325

Acronyms	
Terms & Abbreviations	Descriptor
3D	Three Dimensional
ABS	Australian Bureau of Statistics
ADA	Arrowsmith Development Area
AHP-1	Arrowsmith Hydrogen Project (Now referred to as AHP)
AHP	Arrowsmith Hydrogen Project (The Proposal)
BESS	Battery Energy Storage System
BKNR	Beekeepers Nature Reserve
BMP	Bushfire Management Plan
BoM	Bureau of Meteorology
CBC	Carnaby's Black Cockatoo
CO2-e	Carbon Dioxide equivalent
DBCA	Department of Biodiversity, Conservation, and Attractions
DBNGP	Dampier to Bunbury Natural Gas Pipeline
DCCEEW	The Department of Climate Change, Energy, the Environment and Water
DC	Direct Current
DE	Development Envelopes
DEWHA	Department of the Environment, Water, Heritage, and the Arts
DFES	Department of Fire and Emergency Services
DGs	Dangerous Goods
DJTSI	Department of Jobs, Tourism, Science, and Innovation
DMIRS	Department of Mines, Industry Regulation, and Safety
DPC	Department of Premier and Cabinet
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Land, Planning, and Heritage
DWER	Department of Water and Environmental Regulation
DSEWP	The Department of Sustainability, Environment, Water, Population
EFG	Environmental Factor Guideline
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EP Act	Environmental Protection Act 1986
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FEED	Front End Engineering Design
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GHPF	Green Hydrogen Production Facility
GL	Gigalitres
HRS	Hydrogen Refuelling Stations
IGE	Infinite Green Energy Pty Ltd
IBRA	Interim Biogeographic Regionalisation of Australia
IUCN	International Union for Conservation of Nature
LCT	Landscape Character Type
Met Mast	Meteorological Mast
MHF	Major Hazard Facility
MLA	Member of the Legislative Assembly
MNES	Matter of National Environmental Significance
MP	Member of Parliament
MRWA	Main Roads of Western Australia
NSP	Noise Sensitive Premises
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
RFSU	Ready for Start-Up
RL	Reference Level
SIMOPS	Simultaneous Operations
SRE	Short Range Endemic
TEC	Threatened Ecological Community
TDS	Total Dissolved Solids
TF	Threatened Flora
WASG	Western Australian Speleological Group
WoNS	Weed of National Significance
YSRC	Yamatji Southern Regional Corporation

Defined Terms

Term	Definitions
The Proposal/Project	The Proposal comprises the construction of a Green Hydrogen Production Facility (GHPF) and Associated infrastructure.
Development Envelopes (DE)	The Development Envelopes represent the area within which development of the Proposal is to occur. The Development Envelopes for this Proposal includes Five key components: - The Solar Farm - Green Hydrogen production Facility (GHPF) and Supporting Infrastructure - Road widening and Site Access - The Windfarm and related access roads - Overall project Surrounds
Flora Types	PEC CBC foraging species Priority Flora Vegetation types Mosaics Vascular flora species
Disturbance Footprint	The location within where the physical proposal elements will occur, includes all areas proposed to be disturbed/cleared within the DE.
Clearing Extents	Proposed clearing area
IGE	Infinite Green Energy Pty Ltd.
Buffer Area	In 2022, Infinite Green Energy (IGE) commissioned Ecoscape to undertake comprehensive flora, vegetation, and terrestrial fauna investigations to satisfy the Environmental Protection Authority (EPA) requirements, with a focus on Carnaby's Cockatoo habitat. The survey, spanning an area of 768.95 hectares within the Shire of Irwin in Western Australia's Midwest region, encompasses the IGE project area. This survey area, termed the 'survey area' in Ecoscape's report, includes both the previous permanent site clearing Footprint of 240.37 hectares of vegetation to be cleared and an additional 50-meter buffer zone surrounding the disturbance footprint. This buffer zone was applied in accordance with EPA guidelines to understand and mitigate potential indirect impacts on surrounding flora and fauna habitats.

Invitation to Make a Submission

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this proposal.

Infinite Green Energy proposes to construct and operate a Green Hydrogen Production Facility (GHPF) and related infrastructure (the Proposal). The Environmental Review Document (ERD) has been prepared in accordance with the EPA's ***Procedures Manual.*** The ERD is the report by the proponent on their environmental review which describes this proposal and its likely effects upon the environment.

The ERD is available for a public review period of two weeks from 24 March 2025, closing on 7 April 2025.
Information on the proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposal to the Minister for the Environment.

Why write a submission?

The EPA seeks information that will inform its consideration of the likely effect of the proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses, and other relevant information.
Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate the names of each participant. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the ERD.
When making comments on specific elements in the ERD:

- Clearly State Your Point Of View And Give Reasons For Your Conclusions
- Reference The Source Of Your Information, Where Applicable
- Suggest Alternatives To Improve Environmental Outcomes.

What to Include In Your Submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your name and address
- Date of your submission
- Whether you want your contact details to be confidential
- A summary of your submission, if it is long
- A list of points so that issues raised are clear, preferably by environmental factor
- Refer each point to the page, section and if possible, paragraph of the ERD
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is: 7 April 2025

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, Joondalup DC WA 6919, or
- delivered to: Environmental Protection Authority, Prime House, 8 Davidson Terrace, Joondalup 6027.

If you have any questions on how to make a submission, please contact EPA Services at the Department of Water and Environmental Regulation on 6364 7000

1 Executive Summary

IGE proposes to develop and operate a Green Hydrogen Production Facility along with its associated infrastructure. The Arrowsmith Hydrogen Project (AHP) will be situated in Arrowsmith, approximately 30 kilometres south of Dongara, within the Shire of Irwin, Western Australia.

The Arrowsmith Hydrogen Project (AHP) will be engineered as a state-of-the-art facility, incorporating advanced energy technologies to enhance environmental efficiency, sustainability, and operational reliability. The facility will harness renewable energy from solar photovoltaic panels and wind turbines to support environmentally sustainable operations and maximise energy efficiency. The facility will be centered around high-efficiency alkaline electrolysers, which play a critical role in the electrolysis process, efficiently splitting water into hydrogen and oxygen to produce green hydrogen..

To enhance storage and transportation efficiency, the facility will integrate hydrogen liquefaction technology, converting hydrogen gas into a denser liquid state for improved handling and distribution. Additionally, a state-of-the-art hydrogen dispensing system, incorporating advanced cryogenic storage solutions, will ensure the safe, efficient, and reliable delivery of hydrogen as a clean energy carrier.

IGE's energy model is distinguished by its holistic approach to green energy production, focusing on sector integration to maximise efficiency and sustainability. As part of this vision, a community and workforce skilling initiative is planned for the Shire of Irwin, designed to equip the local community with the skills, knowledge, and infrastructure needed to prosper as the Arrowsmith Area gains prominence. There are also opportunities to collaborate with Traditional Owner groups, such as the Yamatji People, to foster commercial partnerships, employment, and training programs. These collaborative efforts aim to promote economic growth, drive community development, and ensure the benefits of renewable energy projects are shared equitably among all stakeholders.

At Infinite Green Energy (IGE), sustainability is central to our corporate identity and vision. We are committed to leading the delivery of clean, green hydrogen for future generations while developing resilient, high-quality energy solutions. Sustainability is not just a goal; it is the guiding principle underpinning every aspect of our strategic decision-making process, from research and development to operational execution. We aim to make a positive environmental and societal impact, driven by our dedication to innovation and sustainability.

Our mission is to spearhead the expansion of hydrogen infrastructure across the nation, facilitating the transition from a fossil fuel-dependent economy to an integrated, renewable energy marketplace. Through the adoption of advanced technology and renewable energy sources, we aim to establish ourselves as pioneers in the green hydrogen sector and contribute to a low-carbon future, whilst fostering economic growth and sustainability in the region.

We look forward to collaborating with local stakeholders, Traditional Owners, and communities to bring this vision to life, delivering an innovative energy solution that benefits both the environment and society.

1.1 Context

This Referral Supporting Document (RSD) endeavours to provide clarity and provide further insights into the environmental principles, factors, associated objectives, and beneficial outcomes associated with the construction and operation of the AHP project. By offering comprehensive insights and contextualisation, our aim is to enrich comprehension and promote transparency regarding the environmental considerations embedded within the project.

Through the RSD, we strive to elucidate the fundamental environmental principles guiding our actions, outline the factors influencing our decision-making processes, articulate our objectives in mitigating environmental impacts, and highlight the positive outcomes we anticipate as a result of our efforts.

By fostering a deeper understanding of our project's environmental dimensions, we aim to engage stakeholders in meaningful dialogue, address concerns, and collaboratively work towards sustainable outcomes that benefit both the environment and the communities we serve.

IGE has engaged in extensive preparatory work for the Proposal, commissioning a wide range of environmental surveys, studies, assessments, and technical reports. This comprehensive data collection has enabled IGE to make informed amendments to the Proposal, focusing on enhanced environmental sustainability. By leveraging these insights, IGE has developed robust, targeted impact mitigation measures tailored to address the Proposal's key environmental considerations. These efforts underscore IGE's dedication to responsible environmental stewardship, aligning the project with conservation objectives and regulatory standards while advancing the sustainable production of renewable energy. Through these initiatives, IGE reinforces its commitment to fostering a positive environmental impact alongside renewable energy development.

Key updates to the proposal include comprehensive heritage clarifications and initiatives aimed at creating development opportunities for First Nations communities. This includes the completion of ethnographic and archaeological heritage surveys to ensure the protection and management of culturally significant sites within the project area. The revisions also incorporate targeted environmental mitigation strategies, including reductions in clearing extents to minimise impacts upon critical flora and Black Cockatoo habitat. A habitat assessment has been conducted to determine the extent and distribution of Banksia species, ensuring that foraging resources are identified and preserved where feasible.

Additionally, optimisations in wind and solar infrastructure design, along with targeted mitigation measures during wind turbine operation, aim to enhance efficiency while further reducing the project's environmental footprint. Specific measures to mitigate turbine blade strike risks will be implemented, including the integration of radar technology to detect and respond to avian activity, reducing potential impacts on bird populations, including Black Cockatoos. The proposal also prioritises inland water resource protection by minimising aquifer abstraction volumes and implementing measures to safeguard significant landforms and cave systems within the development area.

Furthermore, consultation with the Department of Biodiversity, Conservation and Attractions (DBCA) has been provided to address potential indirect impacts upon Beekeepers Nature Reserve, ensuring that environmental management strategies align with conservation priorities.

1.2 Adaptive Management

Infinite Green Energy (IGE) has utilised avoidance and adaptive management strategies within the Development Envelopes, accompanied by a series of mitigation measures aimed at managing and preserving key environmental values. IGE recognises that the effectiveness of these measures is contingent upon environmental studies, surveys, and assessments, both desktop-based and field-oriented. Acknowledging the dynamic nature of environmental conditions, IGE emphasises the importance of ongoing adaptive management and real-time monitoring and inspections. This approach ensures continuous compliance with environmental regulations and allows for timely adjustments to mitigate potential emerging environmental concerns.

2 Proposal Content Document

Arrowsmith Domestic Hydrogen Project

Proposal Content Document

Proposal Title	Arrowsmith Hydrogen Project (AHP)
Proponent Name	Infinite Green Energy
Short Description	IGE is proposing to construct and operate a Green Hydrogen Production Facility (GHPF) and associated infrastructure (the Proposal), to be located at Arrowsmith, approximately 30 kilometres south of Dongara in the Shire of Irwin, Western Australia. The Proposal will utilise combined onshore wind and solar energy of approximately 225 (MW) capacity to produce Green Hydrogen which will be compressed and transported to various emerging green energy markets. The Proposal comprises the following major components: - PV Solar Array (Approx Maximum 85 MW) - Wind Farm (18 X 7.2 MW wind turbines) - GHPF (Anticipated Hydrogen Output to a Maximum of 42 tpd) - A multi-layered backup power strategy combining battery storage, hydrogen-powered turbines, and grid connection (Renewable Energy) ensures that the AHP remains operational under all conditions, including extended periods of low renewable energy availability - Associated AHP Infrastructure
Date	**February 2025**

Proposal element	Location / Description	Maximum extent, capacity or range	Current hectares
Physical Elements			hectares
Development Envelopes (IGE Property Extent Lot 703)	Figure 3 & 4 Project Development Envelopes	Maximum Extent	**1904.48 ha**
Development Envelopes (Road verge widening and Site Access)	Figure 4	Maximum Extent	**1.68 ha**
Solar Farm (PV Solar Array)	Figure 2	Maximum Extent	140.70 ha
		Previously Disturbed Area	74.83 ha
		Clearing Required	**65.87 ha**
Green Hydrogen Production Facility (GHPF) - Alkaline Electrolyser units - Water Treatment plant: RO Filtration units, demineralisation units, and water storage tanks - Battery Storage units - Grid Connection - Hydrogen powered Turbine - Energy Storage Systems (e.g., batteries) - Optional Temporary Accommodation facilities - Gas Storage tanks. - Cryogenic Liquid Storage: Cooled Hydrogen - Hydrogen Compression Unit - Cooling Systems - Power Management System - Oxygen Management - Hydrogen Liquefaction System - Control and Monitoring Systems - Hydrogen Dispensing System - Pipelines and Distribution Networks - Safety and Ventilation Systems - Waste Management Systems - Office Control Centre and switch room **Note: Clearing Extents include GHPF Entry Road and proposed Gate Widening**	Figure 3 & 4 Located near the Northern Site Boundary	Maximum Extent	22.19 ha
		Previously Disturbed Area	1.53 ha
		Clearing Required	**20.66 ha**

Property Fire Roads Including Boundary **(Shire of Irwin/Dfes)**	Figure 2	Maximum Extent	28.12 ha
		Previously Disturbed Area	26.46 ha
		Clearing Complete	**0.00**
		Clearing Required	0 ha
Windfarm (Wind Turbines)	Figure 2 & 4	Maximum Extent	15.03 ha
		Previously Disturbed Area	0.25 ha
		Clearing Required	**14.78**
Turbine Blade laydown area revegetated after assembly	Figure 4 Located adjacent to the access road	Maximum Extent	4.21 ha
		Revegetated after use	4.21 ha
		Clearing Required	**4.21ha**
Met Mast and Sodar	Figure 2	Maximum Extent	1.69 ha
		Previously Disturbed Area	**1.69 ha**
		Clearing Complete	**0.00**
Project Roads to Install	Figure 4	Maximum Extent	19.02 ha
		Previously Disturbed Area	0.00 ha
		Clearing Required	**19.02**
Vegetation Disturbance: Gate widening for AHP site access (MRWA Verge Side)	Figure 4	Maximum Extent	0.001
		Previously Disturbed Area	0.00
		Clearing Required	0.001
Road Widening (Brand Highway)	Figure 4	Maximum Extent	1.68 ha
		Previously Disturbed Area	0.78ha
		Clearing Required (Ground Disturbance)	0.9 ha
Proposal Clearing Extent			**127.13**
Proposal Extents			
Proposal Maximum Extent, (Development Envelopes Lot 703)			**1904.48 ha**
Proposal Maximum Extent (Development Envelopes, Road verge widening and Site Access)			**1.68ha**
Combined DE Extents			**1906.16**
Previously Disturbed Vegetation			**105.5 ha**
Post Construction Rehabilitation			**4.21 ha**
Permanent Site Disturbance Footprint			**232.63 ha**

Proposal Element	Location / description	Maximum Extent, Capacity or Range
Construction Elements		
Site Facilities	GHPF	Optional: On-site accommodation facility equipped with the necessary wastewater discharge infrastructure to ensure environmental compliance.
Salt and Brine Emissions	GHPF	Salt solids volumes are dependence on further engineering analysis and infrastructure equipment design, to a maximum of 1100 kg per day Liquid Emission Volumes are based on current Geotechnical investigations and engineering solutions and are subject to change dependent on engineering outputs. Options are being considered to discharge processed brine onsite to: - Leach drain system, - A Zero Liquid Discharge system - Reverse Osmosis (RO) and Brine Minimisation - Advanced Filtration and Treatment to meet discharge to ground standards - Hybrid System: Above-Ground Treatment with Leach Drain Discharge - Stock dams for Discharge and evaporation - Groundwater, or Soil infiltration basins, Discharge options as required will be based on further geotechnical investigations and ongoing engineering solutions. Discharge and engineering options will be included within the Wastewater Management Plan
Road Widening AHP Site Gate Access Widening	Brand Highway Brand Highway	0.9 ha (Ground Disturbance) 0.001 ha (Vegetation Clearing)

Operational Elements		
Wind turbines	Wind Farm	18 Turbines x 7.2 MW, maximum rating of 129.6 MW
Solar farm	PV Solar Array (Adjacent to Brand HWY)	85MW maximum rating
Groundwater Water Abstraction	GHPF	Water Extraction up to a Maximum of 2,340 kL per day
Hydrogen Production Electrolysis	GHPF	Hydrogen Production up to a maximum of 42 tonnes per day.
Stormwater and Wastewater	GHPF/AHP	Stormwater management will align with the impending stormwater and wastewater management plans. Wastewater discharge will accommodate up to 15 operational staff.

Proposal Elements with Greenhouse Gas Emissions	
Construction Elements: Note Scope 3 Not Required.	
Scope 1:	Not expected to be greater than14,364t CO_2-e per annum
Scope 2:	N/A
Operation elements:	
Scope 1:	Not expected to be greater than 632t CO_2-e -per annum
Scope 2:	N/A

Decommissioning and Rehabilitation

The decommissioning plan for the Arrowsmith Hydrogen Project will detail the required actions for safely dismantling and restoring the site at the end of its projected 25-year lifespan. It will also include provisions for asset life extensions or rehabilitation if the project does not proceed beyond this period.

The decommissioning plan includes:

- Removal of all vehicles, machinery, and buildings: All equipment, vehicles, and infrastructure utilised during the project's operation will be dismantled and removed from the site.

- Removal from site and recycling or appropriate disposal of all infrastructure and waste: This step involves the proper disposal or recycling of all infrastructure components and waste generated during the project's lifespan, ensuring minimal environmental impact.

- Decommissioning of water bores: Any water bores or wells drilled for the project's operations will be decommissioned, ensuring they are properly sealed to prevent contamination and pose no hazards.

- Remediation of any contaminated soil: If soil contamination has occurred during the project's operation, remediation measures will be implemented to restore soil quality, following regulatory requirements.

- Rehabilitation and revegetation of disturbed areas: Disturbed areas of the site will undergo rehabilitation, including revegetation efforts using native vegetation consistent with that from the local area to restore natural habitats and ecosystems. This aims to mitigate the environmental impact caused by construction activities.

- Vegetation reinstatement: In the event that the project does not continue beyond its 25-year lifespan and rehabilitation is initiated, vegetation reinstatement will commence. This involves replanting native vegetation to restore the landscape.

- Rehabilitation management procedures: The rehabilitation process will be conducted in accordance with established management procedures, ensuring that activities are carried out efficiently and effectively to achieve restoration goals.

- Monitoring: Monitoring activities will be undertaken annually to assess the progress of rehabilitation efforts. Quantitative completion criteria will be established, and monitoring will continue until these criteria are met, indicating successful rehabilitation.

- Reporting and Compliance:
  - Detailed documentation of all decommissioning activities to ensure compliance with regulatory standards.
  - Regular progress reports submitted to environmental regulators, documenting rehabilitation success and adherence to closure requirements.

By implementing these decommissioning and rehabilitation measures, the Arrowsmith Hydrogen Project (AHP) aims to minimise its environmental disturbance footprint and ensure the responsible management of the project site following the conclusion of operations.

Commissioning

The commissioning process of the AHP will be methodically executed in stages, with systems commissioned incrementally as they reach completion. A comprehensive commissioning plan will be devised to prioritise the commissioning of systems utilising non-hazardous products before transitioning to hydrogen production.

Upon the conclusion of construction activities, the construction contractor will formally hand over the site at 'construction completion' to the commissioning team designated by the Proponent. This commissioning team is envisioned to encompass a blend of contracting engineers, engineers from the Proponent, operational personnel, and specialized commissioning subcontractors.

Given the inherently hazardous properties of hydrogen and oxygen, coupled with the intricate nature of the facility's infrastructure, a robust commissioning and completions management system will be employed. The development of this system will be meticulously undertaken during the detailed engineering phase, ensuring meticulous planning and execution of the commissioning process to guarantee safety, operational efficiency, and regulatory compliance throughout the facility's lifecycle.

Critical Containment Infrastructure Report

A Critical Containment Infrastructure Report (CCIR) may be required for premises that include containment infrastructure (e.g. for the purpose of storage and containment of liquid hydrogen). The purpose of the CCIR is to confirm that the environmental controls regarding containment infrastructure are constructed to the correct engineering specifications before materials are deposited within the containment cell.

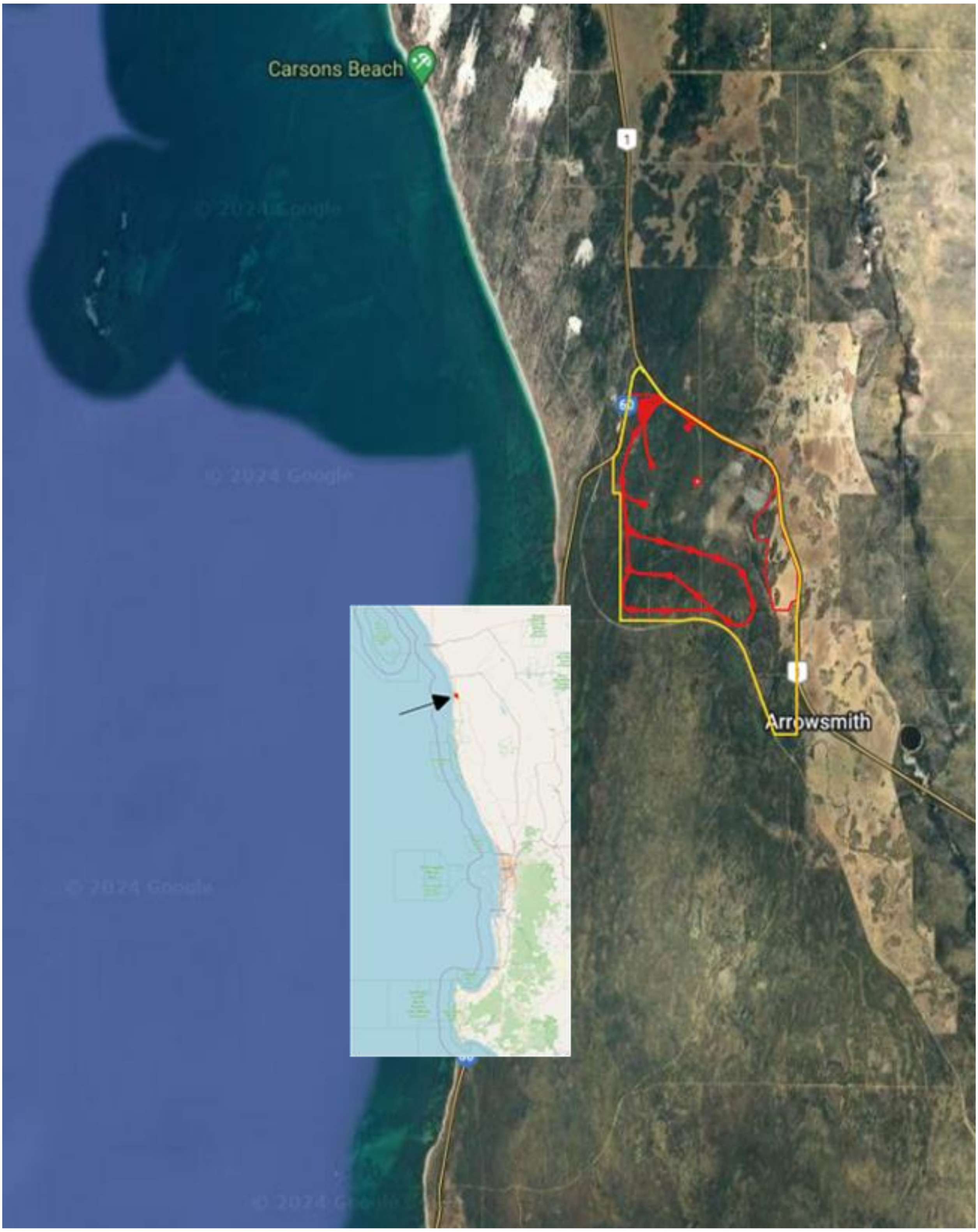
Facility Commissioning and activation will be staged; The anticipated order is as follows (subject to change):

- Power Generation – PV Solar Array, Wind Turbines, Battery Energy Storage System (BESS) and Hydrogen turbines
- Green Hydrogen Production Facility (GHPF) Utilities
- Hydrogen Production
- Hydrogen Liquefaction and Storage
- Liquid Hydrogen Offloading and transporting

Activation will commence when completion assurance is complete, and each area is approved “Ready for Start-Up” (RFSU). The commissioning team will begin with a mark-up of the key deliverables such as Piping and Instrumentation Diagrams to define the system boundaries. IGE will identify the subcontractors and vendors required for commissioning and develop the detailed scopes of work.
This will include:

- Leak Testing
- Testing, Cleaning and Drying Services
- Specialist Package Commissioning Engineers (e.g., Wind turbines, Electrolysers, LH2 and H2 Production)

Other Elements that Impact Extent of Effects on The Environment		
Proposal time*	Maximum project life	Preliminary 25 years Every 25 years asset life extension review and possible extension works to be conducted.
	Construction phase	Approximately 24 months
	Commissioning phase	Approximately 6 months
	Operations phase	25 years
	Decommissioning	Approximately three years



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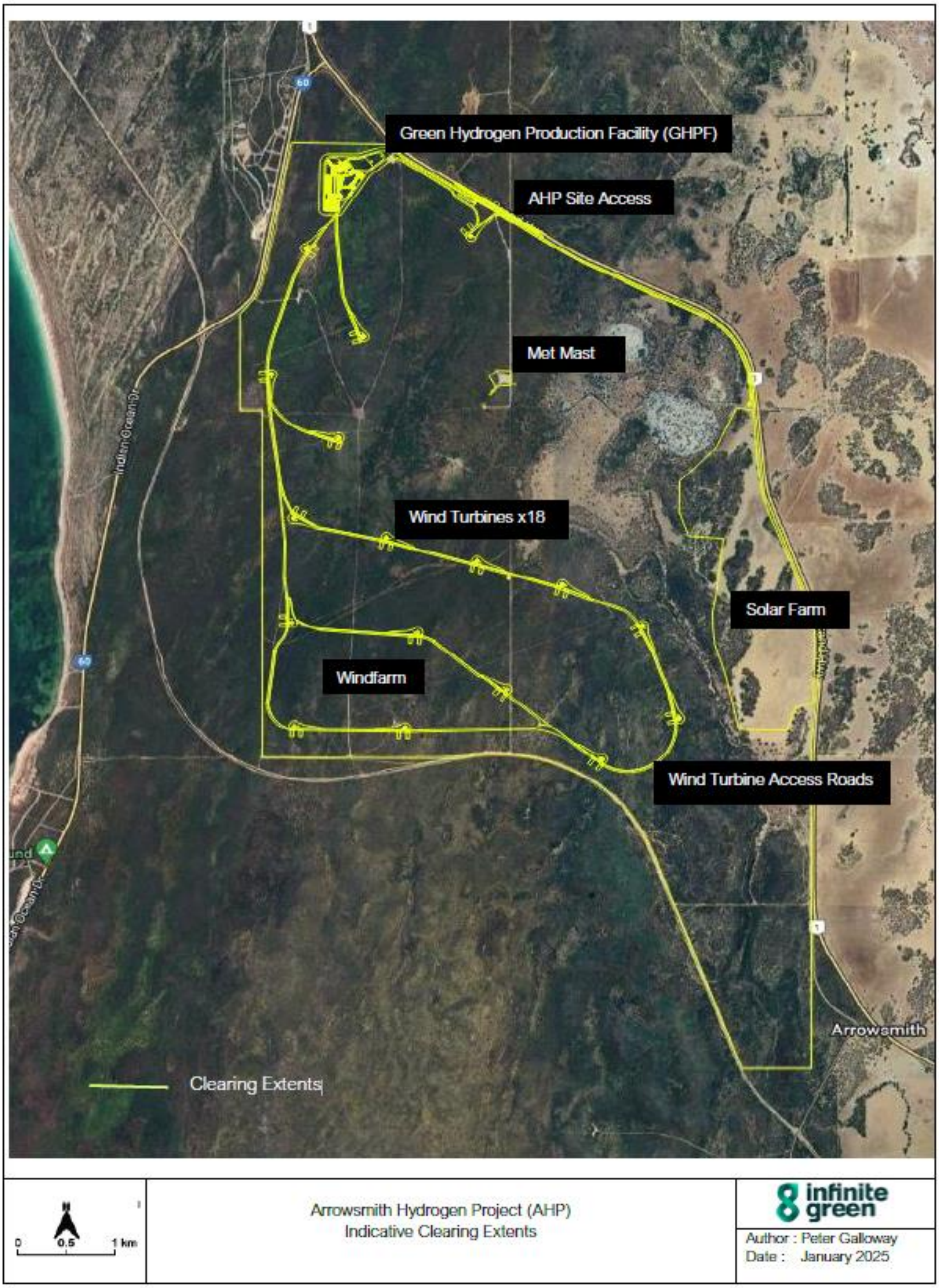
Arrowsmith Hydrogen Project (AHP) Layout and Regional Context

Author : Peter Galloway
Date : January 2025

PCD Figure 1 AHP Indicative layout and Regional Context



PCD Figure 2 Indicative Project Infrastructure Layout

PCD Figure 3 Indicative Project Development Envelope

PCD Figure 4 Indicative Development Envelope Road Widening and Access

PCD Figure 5 Indicative Development Envelope Including and site access

3 Green Hydrogen Project Alternatives

3.1 Comparison of Alternatives and Necessity of the Proposal

The proposed Arrowsmith Hydrogen Project (AHP) is a pivotal initiative in Australia's pathway toward a sustainable, low-carbon energy future. As the world shifts away from fossil fuels, the development of alternative energy sources has become essential, with green hydrogen playing a key role due to its ability to decarbonise challenging sectors such as heavy industry, transportation, and large-scale energy storage.

This project addresses both national and international demand for green hydrogen, supporting Australia's ambition to become a major renewable energy exporter. The AHP facility is well-aligned with critical objectives, including reducing greenhouse gas emissions, enhancing energy security, and driving regional economic growth. By advancing green hydrogen production, the AHP contributes significantly to Australia's environmental and economic goals in the global transition to clean energy.

3.2 Other Technologies or Options

Blue Hydrogen Production

- Description: Blue hydrogen is produced by reforming natural gas (methane) into hydrogen, with carbon capture and storage (CCS) technologies employed to sequester the resulting carbon emissions.

- Environmental Impact: While blue hydrogen is less carbon-intensive than traditional hydrogen production (grey hydrogen), it still relies on fossil fuels and risks methane leakage during production and transport. Additionally, the effectiveness and cost of long-term carbon storage are uncertain.

- Why It Was Not Chosen: Blue hydrogen was not selected as it does not align with the project's vision of producing zero-carbon hydrogen using renewable energy. Green hydrogen production via electrolysis avoids the need for fossil fuels entirely, making it a more sustainable and future-proof solution.

Hydrogen from Biomass

- Description: Hydrogen can also be produced by gasifying biomass, which involves heating organic materials in a controlled environment to produce syngas (hydrogen and carbon monoxide).
- Environmental Impact: While this is a renewable option, the process requires large amounts of biomass, which may lead to deforestation, biodiversity loss, and soil depletion. The emissions from the biomass supply chain can also negate its environmental benefits.

- Why It Was Not Chosen: The availability and sustainability of biomass resources in the project area do not provide a feasible alternative to green hydrogen. Additionally, hydrogen from biomass has a higher lifecycle carbon footprint compared to green hydrogen from electrolysis.

3.3 Location Alternatives

Location A: Inland Alternative

- **Description**: An alternative inland site was considered, located further from the coast, away from potential impacts to coastal ecosystems and wetlands.

- **Environmental Impact**: The inland location represented less impact on coastal wetlands and marine environments. However, this site posed challenges due to lower wind yield and less solar potential, requiring significant infrastructure to transport electricity from renewable sources to site.

- **Why It Was Not Chosen**: The inland site was ruled out because of the increased environmental footprint from the additional infrastructure required. Additionally, the inland site's lower renewable energy potential would result in lower operational efficiency and higher costs. The current proposed site offers a more balanced environmental and logistical approach by taking advantage of existing high yield renewable energy resources and previously cleared land.

Location B: Northern Alternative (100 km from the current site)

- **Description**: This northern site offered similar renewable energy potential and proximity to infrastructure but was closer to sensitive Indigenous heritage sites and cultural areas.

- **Environmental Impact**: Development in this location posed a higher risk to Indigenous heritage, potentially leading to more substantial social and cultural impacts. Additionally, the site required more land clearing, leading to greater disruption to native flora and fauna.

- **Why It Was Not Chosen**: Given the sensitive cultural and ecological landscape, the northern site was deemed unsuitable. The chosen AHP site avoids major heritage and conservation areas while optimising the balance between energy yield and environmental protection.

3.4 Reduced Environmental Impact Alternatives

Smaller-Scale Project

- **Description**: A smaller-scale hydrogen production facility, producing lower quantities of green hydrogen, was considered as a way to minimise land use and environmental disturbance.

- **Environmental Impact**: A smaller project would have reduced the extent of vegetation clearing and infrastructure needs, thus reducing the impact on local biodiversity and water resources.

- **Why It Was Not Chosen**: While a smaller-scale project would mitigate some environmental impacts, it would not meet the projected demand for green hydrogen, particularly for export markets. The facility's smaller capacity would also diminish the economic benefits and regional employment opportunities associated with the project. A balance between environmental considerations and the need for economic scalability led to the rejection of this alternative.

3.5 Hydrogen-Electric Hybrid Facility

- Description: A hybrid facility combining green hydrogen production with battery energy storage was considered to reduce the footprint of hydrogen infrastructure.

- Environmental Impact: The hybrid model would allow for more flexible energy use but would require the development of large-scale batteries, potentially increasing the demand for rare earth metals and contributing to different environmental challenges, such as resource depletion and waste management.

- Why It is optional: A Hydrogen-Electric Hybrid Facility is an optional component that can serve as a reliable backup system. This hybrid setup integrates hydrogen production with battery storage capabilities, providing flexibility to maintain operations during peak demand or when renewable energy supply fluctuates. As a backup, the system enhances energy security for the facility, ensuring continuous operation while supporting grid stability and efficient energy use. This approach aligns with sustainability goals by optimising renewable resources and reducing reliance on conventional backup power sources.

Feasibility of Alternatives

Many of the alternatives explored were deemed infeasible for a variety of reasons:

- Technical limitations: Certain technologies, such as hydrogen from biomass were not scalable or efficient enough to meet the project's energy production goals.

- Environmental and social impacts: Several locations and smaller-scale options were ruled out due to their higher impacts on biodiversity, Indigenous heritage sites, or long-term sustainability.

- Economic Viability: Some alternatives, though environmentally sound, would not have been economically feasible or capable of meeting market demand for green hydrogen, limiting the project's ability to contribute to national decarbonisation goals.

3.6 Comparative Description of Likely Environmental Impacts

Proposed AHP Project

- **Biodiversity**: Some vegetation clearing will be required (approximately 127.13 hectares), though measures are in place to mitigate impacts on fauna, including the endangered Carnaby's Black Cockatoo.

- **Water Usage**: The electrolysis process will require significant amounts of water, but the facility will implement water recycling technologies to minimise extraction.

- **Carbon Emissions**: The project will produce minimal operational emissions, given its reliance on renewable energy sources.

- **Social Impact**: Collaboration with Traditional Owners (Yamatji People) ensures that heritage sites will be protected, and employment opportunities will be created for the local community.

3.7 Inland Location Alternative

- **Biodiversity**: Less impact on coastal wetlands but requires more extensive land clearing, affecting dryland ecosystems and potential fauna habitats

- **Water Usage**: Inland water resources are more sensitive, leading to potentially greater water extraction impacts.

- **Carbon Emissions**: Higher emissions during the construction phase due to the need for additional infrastructure.

Smaller-Scale Facility

- **Biodiversity**: Reduced land clearing but diminished economic output and market impact.

- **Water Usage**: Lower water demand due to reduced production capacity.

- **Carbon Emissions**: Slightly lower carbon footprint but unable to meet demand or significantly contribute to decarbonisation goals.

Conclusion

The Arrowsmith Hydrogen project, as currently proposed, represents the most feasible and balanced approach to achieving Australia's energy and sustainability goals. While alternatives were considered and evaluated, the proposed project offers the best combination of renewable energy production, economic scalability, and minimal environmental impact. The selected site and design allow for optimal integration of renewable energy sources and minimise disruption to sensitive ecosystems and cultural heritage, ensuring that the project aligns with both environmental and social sustainability objectives.

Key Values, Environmental Factors and Outcomes

4 Key Values, Environmental Factors and Outcomes

This management support document delivers a thorough analysis of the potential environmental impacts of the Proposal across its construction, commissioning, and operational phases. It provides a structured framework for integrating environmental considerations at every project stage, ensuring that mitigation strategies are effective, relevant, and sustainable throughout the project lifecycle.

Drawing from detailed studies conducted within the Arrowsmith Hydrogen Project (AHP) Development Envelopes and its surrounding areas, the document identifies, evaluates, and addresses any significant environmental effects associated with the Proposal. Through a comprehensive examination of relevant environmental factors, this document supports informed decision-making, with a focus on sustainable development practices. By carefully considering both short- and long-term environmental implications, it helps balance development goals with ecological preservation, promoting responsible project execution.

As a foundational resource, this document not only informs the development of targeted mitigation strategies but also ensures that these measures are adapted to the unique characteristics and challenges of the AHP site and its surroundings. For stakeholders involved in the planning, approval, and implementation of the Proposal, this document provides essential insights into environmental considerations, enabling the proactive safeguarding of environmental integrity across all project phases. By leveraging in-depth environmental studies and analyses, it facilitates a well-rounded approach to project development, supporting balanced and responsible project outcomes aligned with both regulatory standards and sustainability goals.

The EPA has identified the following key environmental factors to be considered for this Proposal:

Table 1: Key Values Summary and Proposal Environmental Factors

Flora and Vegetation	
EPA Objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Key Values	- (Priority 2,3,4) flora communities within the development area - PEC'S - Identification of significant vegetation (Black Cockatoo foraging vegetation, particularly *Banksia sessilis* and *Banksia prionotes*, present) - Inland water resources (Yarragadee aquifer, Groundwater, surface drainage, wetlands, ephemeral lakes, GDE's) - Native Vegetation - Threatened Fauna: Carnaby's Black Cockatoo - Adjacent Vegetation Representative of The Mid-West Gascoyne Region (Beekeepers Reserve)
Proposal Activities	- Native vegetation within the disturbance footprint to accommodate a Green Hydrogen Production Facility (GHPF) and associated infrastructure elements - Three Groundwater production Bores - Site access and vehicle movement (Vegetation Clearing) - Equipment deployment during construction and operations (Vegetation Clearing) - A Green Hydrogen Production Facility (GHPF) (Vegetation Clearing) - Wind farm/Solar farm construction and operations (Vegetation Clearing)
Potential Impacts	- Potential fragmentation of native vegetation - Impact to Carnaby's Black Cockatoo (CBC) foraging habitat - Potential introduction and spread of environmental weeds and diseases - Potential reduction in vegetation health as a result of clearing, water abstraction and dust deposition - Potential changes to vegetation structure and floristic composition in surrounding/ adjacent areas through altered surface water drainage patterns and flows - Potential aquifer draw down - Potential impact to GDE's from lower groundwater levels - Heritage values - Landforms: cave systems/ landform formations - Alteration to fire regimes - Beekeepers Nature Reserve

Outcomes	- The Proposal will directly impact up to 127.13 ha of native vegetation. - The Proposal is unlikely to cause a significant reduction in the extent or distribution of PEC's, priority species or Impact to Carnaby's Black Cockatoo (CBC) foraging habitat within the Vegetation Representative of The Mid-West Gascoyne Region - It is likely that PEC's or priority species will be minimally impacted in a local context - No introduction of weeds into Development Envelopes are anticipated and Phytophthora Dieback will be managed throughout the proposal lifecycle - Disturbance to Beekeepers nature reserve: Project Disturbance will be confined to the IGE disturbance footprint - DE Indirect impacts affecting BKNR will be monitored and managed - Consultation with DBCA in relation to the monitoring and management of activities within or directly adjacent to Beekeepers Nature Reserve will be instigated
Terrestrial Fauna	
EPA Objective	To protect terrestrial fauna to ensure biological diversity and ecological integrity are maintained.
Key Values	Minor drainage line (high value) and water bodies within habitat areas (high value) - Habitat for Threatened and Priority fauna including Carnaby's Black Cockatoo (Endangered) and conservation significant Mallee Fowl - Inland water resources - Eight fauna habitat types were recorded within the Development Envelopes: heath, Mallee woodland, pastoral, riparian, shrubland, waterbody (seasonal), wetland and woodland. - The majority of the survey area was comprised of Mallee woodland or shrubland habitat. The most significant habitat types were those associated with Carnaby's Black Cockatoo potential foraging habitat (heath and shrubland). - Fifty-seven vertebrate fauna species were identified during the assessment including seven introduced species and three that are conservation-listed: - *Zanda latirostris* (Carnaby's Cockatoo) – Endangered under the BC Act and EPBC Act - *Calidris acuminata* (Sharp-tailed Sandpiper)–Listed Migratory species under the EPBC Act - *Merops ornatus* (Rainbow Bee-eater) – Listed Marine species under the EPBC Act
Proposal Activities	- Clearing of native vegetation - Create the Disturbance Footprint to accommodate the proposal physical elements - Construct access roads and associated infrastructure, to accommodate vehicle movements
Potential Impacts	- Clearing of 127.13 ha resulting in loss of fauna habitat including conservation significant fauna habitat - Fauna habitat fragmentation due to clearing activities - Potential injury and/ or death to fauna as a result of turbine blade strike - Temporary increase in noise and vibration during construction and permanent during operations - Increased light spill

	- Injury and/ or death of fauna as a result of vehicle strike - Native vegetation clearing, loss of habitat
Outcomes	Based on the location minimal disturbance extents and the application of mitigation measures, the Proposal is not anticipated to cause significant direct or indirect impacts to habitat or other conservation significant species.
Social Surroundings	
EPA Objective	To protect social surroundings from significant harm
Key Values	- Yamatji heritage sites (archaeological and ethnographic) - Seven Aboriginal heritage sites of cultural importance - Southern Yamatji Stakeholder Engagement - Heritage values - Landforms: caves systems and possible limestone formations - Native vegetation clearing - Groundwater
Proposal Activities	- 127.13 ha of clearing within the Development Envelopes to accommodate Project infrastructure - Construction and earthworks activities - Operational activities
Potential Impacts	- Potential impacts to heritage sites during construction - Potential impacts to cave systems during construction - Local amenity (visual, noise and dust)
Outcomes	- Comprehensive Cultural Heritage Assessment: Before finalising site locations for the solar farm, wind farm, and Green Hydrogen Production Facility (GHPF), a detailed cultural heritage assessment was conducted in partnership with Aboriginal communities and heritage specialists. This assessment was essential to identifying Aboriginal heritage sites, including sacred sites, burial grounds, and culturally significant areas, ensuring that these are preserved and respected in the project's design. - Infrastructure Layout Optimisation: The positioning of infrastructure, such as solar panels, wind turbines, and hydrogen production facilities, was optimised to prevent any encroachment on identified heritage sites. This involved adjusting the layout, orientation, and footprint of installations to ensure that heritage areas remain untouched, demonstrating a commitment to preserving cultural heritage within the project area. - Access Routes and Construction Footprints: Access routes for construction and maintenance activities were carefully planned to avoid crossing or impacting heritage sites. Where necessary, alternative routes were developed, and

	construction footprints were minimised to limit ground disturbance, thereby protecting culturally significant areas. - Ethnographic and Archaeological Surveys: Extensive ethnographic and archaeological surveys will be conducted within the Proposal Development Envelopes (DE) before any ground disturbance. If additional heritage sites are identified, they will be preserved, and all phases of development will be coordinated with the Yamatji People, facilitated by the Yamatji Marlpa Aboriginal Corporation (YMAC), to ensure respectful management of cultural heritage. - Access for Traditional Owners: Traditional Owners will retain access rights to the DE during both the construction and operational phases, allowing continued use of areas not occupied by Proposal infrastructure. Access around the DE will remain relatively unrestricted, accommodating traditional activities and practices and supporting ongoing cultural connection to country.
Inland Waters	
EPA Objective	Maintain the hydrological regimes and quality of groundwater and surface water to ensure environmental values are protected (EPA, 2018)
Key values	- Groundwater: Yarragadee aquifer - Groundwater Dependent Ecosystems (GDE) - Surface water: Superficial Swan aquifer - Wetlands waterbodies and surface drainage
Proposal Activities	- Groundwater extraction for electrolysis processing (Yarragadee aquifer) - Construction (water abstraction/ production bores) - Earthworks and vegetation clearing for bore construction
Potential Impacts	- Draw down from the Yarragadee aquifer - Altered drainage/ waterlines - Altered wetland hydrology - GDE impacts from decreased groundwater levels - Fragmentation of native vegetation and impacts to GDE - Reduction in vegetation health as a result of water drawdown/ extraction - Changes to vegetation structures and floristic composition in surrounding/ adjacent areas through altered surface water flows - Alteration of aquifer regimes
Outcomes	- Water volume abstraction from the Yarragadee aquifer will be optimised to reduce volume abstraction and mitigate possible impacts to GDE - Water quality parameters (pH, salinity, water temperature and dissolved oxygen concentration) of the Yarragadee Aquifer will be monitored and maintained to pre-disturbance levels - There will be no water abstraction from the Swan Coastal Plain superficial aquifer Aquifer Integrity: The superficial aquifer is a critical natural resource, often serving as a source of water for ecosystems, agriculture, and local communities. By committing to no water abstraction from this aquifer, the project ensures that the aquifer's integrity and the dependent ecosystems remain intact.

	Ecosystem Preservation: Many ecosystems, including wetlands, rivers, and groundwater-dependent vegetation, rely on the superficial aquifer. Avoiding water abstraction helps maintain the natural water table, supporting the health and sustainability of these ecosystems. - A groundwater monitoring program will commence when the three groundwater production bores are constructed and in production to protect environmental values.

5 Introduction

IGE are proposing to develop a Green Hydrogen Production Facility (GHPF) and associated infrastructure. The Arrowsmith Hydrogen Project (AHP) (The Proposal).

This updated supporting document has been prepared to support the Proposal under s 38 of the *Environmental Protection Act 1986* (EP Act). This document has been prepared in accordance with the Environmental Protection Authority (EPA) guidelines.

5.1 The Proponent

IGE are a pioneering renewable energy company proposing to deliver renewable green hydrogen to evolving domestic and international markets.

Proponent	Infinite Green Energy Ltd
ABN	80 628 842 464
Address	Level 13/99 St George Terrace, Perth, 6000 WA, Australia.
Key Contact	Stephen Gauld
Telephone number	08 6268 5000
Email	sjgauld@igeh2.com

5.2 Site Selection

The Arrowsmith Area, situated in the Mid-West region of Western Australia, is strategically positioned to capitalise on the area's exceptional renewable energy resources, particularly its outstanding wind and solar energy potential. The Arrowsmith location already hosts several internationally renowned energy producers, positioning it as a key player in the global energy market. This prime location also fosters opportunities for collaborative workforce development through industry partnerships and resource sharing. With its strong renewable energy foundation, the mid-west is poised to evolve into a globally competitive industrial precinct, capable of producing a diverse range of sustainable energy products and driving innovation within the energy sector.

The selection of the Arrowsmith Hydrogen Project (AHP) site was guided by several key factors, notably accessibility to abundant renewable energy yields, proximity to vital transport infrastructure hubs, availability of water resources, and the imperative to avoid environmentally sensitive areas.

Following detailed site selection analysis, Infinite Green Energy (IGE) commenced stakeholder consultations and initiated the development of baseline studies. These comprehensive studies encompassed various technical environmental assessments, including hazard analysis studies aimed at identifying potential risks associated with the project site. These analytical studies involved thorough evaluations of factors such as geological stability, water availability, soil conditions, wake modelling and potential contamination sources. The goal was to ensure a robust understanding of potential hazards and risks to inform effective risk management strategies throughout the project lifecycle..

By comprehensively evaluating these factors and engaging in rigorous environmental assessments, IGE ensured that the AHP site was chosen with careful consideration of environmental sustainability and the interests of community stakeholders. Following the completion of the preliminary site selection, lot 703 Development Envelopes was then subject to a Multi-Criteria Analysis (MCA), that considered but was not limited to the following:

- The potential of high-quality wind and solar yields;
- The proximity to sensitive receptors, including heritage and social surroundings
- Environmental factors impacted by development activities;
- Land area and flexibility of site for future expansions;
- Access to major port rail and road infrastructure;
- The Suitability of surface and sub-surface geological landforms;
- Proximity to fibre optic communications;
- Proximity to oil and gas infrastructure; and
- Sufficient water resources within the Yarragadee groundwater aquifer.
-

To deepen our understanding of the site's environmental conditions and surroundings, IGE installed a Meteorological Mast (Met Mast) onsite in December 2021. This mast, combined with mobile ground monitoring apparatus, has confirmed that the site boasts potential world-leading wind and solar energy yields.

Through site comparison studies, it was determined that while alternative sites offer opportunities for a Green Hydrogen Production Facility, the timing associated with developing those areas does not offer the same potential for anticipated energy yields or the leveraging of existing and anticipated expansion of common user infrastructure within a timeline that aligns with that of the IGE Proposal.

0 0.5 1 km	Arrowsmith Hydrogen Project Regional Context Indicative DE and Clearing Extents	infinite green Author : Peter Galloway Date : October 2024

Figure 1: Indicative Development Envelope and Regional Context.

5.3 Legislative Framework

5.3.1 The Environmental Protection Act 1986, Part IV Environmental Impact Assessment

The Western Australian EP Act was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- Prevention, Control and Abatement of Pollution and Environmental Harm
- Conservation, Preservation, Protection, Enhancement And Management of The Environment
- Matters Incidental to or Connected With The Above.

The EP Act is the primary legislation governing Environmental Impact Assessment (EIA) in WA. Part IV of the EP Act relates to Environmental Impact Assessment, which is implemented in accordance with the EPA Administrative Procedures (2016). This document has been prepared to support referral of the Proposal under s 38 under Part IV of the EP Act.

In accordance with S3.1.3 of the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016, this Information for Assessment (IFA) has been prepared with the intent to provide the EPA with sufficient information regarding the management of environmental impacts to enable further assessment of the Proposal.

5.3.2 Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The Australian Government's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) oversees the assessment of projects that may significantly impact Matters of National Environmental Significance (MNES). A proposal is designated a 'Controlled Action' under the EPBC Act if it poses potential impacts on MNES.

An initial desktop assessment, conducted in coordination with the Department of Climate Change, Energy, Environment and Water (DCCEEW), evaluated the potential for MNES within the Arrowsmith Hydrogen Project (AHP) Development Envelopes. This assessment included a survey commissioned by Infinite Green Energy (IGE) specifically to evaluate potential impacts on the habitat of Carnaby's Black Cockatoo (CBC), aiming to address regulatory compliance requirements and proactively mitigate environmental impacts on sensitive areas.

Matters of National Environmental Significance (MNES)
Referral to DCCEEW under the EPBC Act is required if a proposed action is likely to have a significant impact on MNES. These are key environmental factors protected under the Act to conserve biodiversity, safeguard World Heritage and National Heritage Places, and uphold Australia's commitments to international treaties.

A comprehensive assessment was conducted to determine the presence and potential impacts on MNES within the AHP Proposal's Development Envelopes (Figure 1). The evaluation concluded that the Proposal is unlikely to significantly impact any MNES, and therefore, referral to DCCEEW under the EPBC Act was deemed unnecessary. The assessment did not identify any MNES within or in close proximity to the Development Envelopes, further supporting the decision.

This thorough review underscores IGE's commitment to environmental stewardship, aiming to ensure that all project activities align with both national conservation priorities and regulatory requirements.

5.3.3 Dangerous Goods Safety Act 2004

The Arrowsmith Hydrogen Domestic facility will be considered a Major Hazard Facility (>50 t Hydrogen present) and is subject to the requirements of the Dangerous Good Safety (Major Hazard Facilities) Regulations 2007 (WA) which includes the approval of a Safety Report and Safety Management System.

A dangerous goods site licence will be obtained under the Dangerous Goods Safety Act 2004. The Department of Mines, Industry Regulation and Safety (DMIRS) is the primary regulatory authority for risks associated with the storage and handling of dangerous goods, including the risk of explosion.

5.3.4 Land Tenure and Zoning

The proposal will be located on freehold land owned by the proponent; Lot 703. This area is currently zoned as 'General Farming.'

Table 2: Other Relevant Legislation and Approvals

Proposal activities	Type of approval	Legislation regulating the activity	Government Department/agency
Groundwater Abstraction Production Bores x3	26D Licence to construct a bore 5C Licence to take water for groundwater abstraction	*Rights in Water and Irrigation Act 1914* (WA)	Department of Water and Environmental Regulation
Construction Land Use	ILUA Agreement	*Aboriginal Heritage Act 1972* (WA)	Department of Planning Lands and Heritage
Native vegetation Clearing	Native vegetation clearing permit	*Environmental Protection Act 1986* by the Department of Environmental Regulation	Department of Water and Environmental Regulation
Construction works including: Electrolysis plant (Hydrogen/Chemical process)	Works approval to construct and licence to operate a prescribed premise Project category 31 under Schedule 1 (Licence) of the Environmental Protection Regulations	EP Act Part V and Environmental Protection Regulations 1987 (WA) Prescribed premises Section 31 manufacturing facility) Requirement for a Part V Works Approval prescribed premises	Department of Water and Environmental Regulation
Renewable Energy/Infrastructure Solar farm Wind farm	EP Act Part IV Approval	EP Act Part IV and Environmental Protection Act 1986(WA)	Environmental Protection Authority
Construction	Development approval and building permit will be required for building Proposal infrastructure	*Planning and Development Act 2005* *Building Act 2011* (WA) *Local Government Act 1995* (WA)	Shire of Irwin/Joint Development Assessment Panel EPA/Planning/DWER
Storage of Dangerous Goods	Dangerous Goods Storage Licence Major Hazard Facility Safety Management System if Schedule 1 materials stored over threshold volume (Hydrogen >50 t)	*Dangerous Goods Safety Act 2004* (WA) Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007 (WA)	Department of Mines, Industry Regulation and Safety
Sewage Treatment Plant	Health Department approval If sewage treatment facility > 3750 L per day	*Health Act 1911* (WA)	Department of Health
Desalination Plant Reverse Osmosis Facility	DWER EP Act Part V approval	EP Act Part V and Environmental Protection Regulations 1987 (WA)	Department of Water and Environmental Regulation

AHP Elements

6 Green Hydrogen Project Elements

Construction activities for AHP project are planned subject to regulatory approvals. However, this timeline is flexible and may be adjusted based on factors such as regulatory clearances, internal funding decisions, and market dynamics. The construction phase will involve a range of tasks and components essential for the successful establishment of the Green Hydrogen Production Facility, including:

Construction activities for the AHP project are scheduled to commence, pending regulatory approvals,. It is important to note that this timeline is subject to change and may be adjusted based on various factors, including regulatory approvals, internal funding decisions, and market dynamics. The construction phase will encompass a diverse array of tasks and components crucial for the successful establishment of the AHP green hydrogen project.

Access Roads and Tracks: The construction of access roads and tracks will entail grading, compacting, and paving to establish stable and durable surfaces capable of supporting heavy vehicular traffic. These roads and tracks will serve as vital conduits, facilitating access to various areas of the construction site for the transportation of materials, equipment, and project personnel.

The Arrowsmith Hydrogen Production (AHP) project is strategically designed to be grid-ready, ensuring future flexibility in energy sourcing and distribution. Infinite Green Energy (IGE) has identified and is considering three optional line routes from previous studies to potentially connect the project to the grid. This readiness enables IGE to explore and evaluate various connection options as the project progresses, providing a pathway for seamless integration if required.

With a grid-ready design, AHP is positioned to incorporate a diverse and geographically dispersed mix of renewable energy resources, including solar, wind, and potentially hydrogen-based turbines, enhancing the overall reliability of its energy supply. This adaptability allows IGE to effectively balance energy inputs from different sources, maintaining operational stability even during fluctuating weather or demand conditions. For example, during times when solar generation is reduced—such as at night or under cloud cover—grid connectivity can provide access to alternative renewable sources, ensuring a steady energy supply that supports the hydrogen production process while maintaining the project’s commitment to green energy.

Civils and Concrete Operations: Civil engineering works will encompass a range of activities, including excavation, earthmoving, and the construction of foundations for various structures, such as wind turbine bases and solar installations. Additionally, a concrete batch plant will be established on-site to mix the various components of concrete, including cement, aggregates, water, and admixtures. The batching plant will be equipped with modern controls to ensure precise mixing ratios and consistent quality.

Sustainability Considerations: Eco-Friendly Mixes: The project will explore the use of eco-friendly concrete mixes that incorporate supplementary cementitious materials (SCMs) such as fly ash or slag, which can reduce the carbon footprint of concrete production. Additionally, recycled aggregates may be used where feasible.

Water Management: Water used in concrete mixing and curing will be managed efficiently, with recycling systems in place to minimise waste. This aligns with the project's commitment to sustainable resource use and environmental protection.

Site Preparation Earthworks: Site preparation will involve clearing native vegetation, leveling terrain, and priming the ground for construction. Earthworks will include excavation, grading, and compaction processes to achieve the necessary site conditions for the installation of the PV solar farm, wind turbines, and other essential infrastructure components. These activities are designed to ensure a stable foundation and optimal layout for all construction elements, facilitating efficient and safe project development.

Electrolysers Installation are essential components in green hydrogen production facilities, such as the proposed Arrowsmith Hydrogen Project (AHP). They operate by splitting water (H_2O) into hydrogen (H_2) and oxygen (O_2) through a process called electrolysis, using electricity as an energy source.

Electrolyser installation for a green hydrogen facility involves a carefully planned infrastructure to ensure efficient and safe hydrogen production. Key components include:

- Electrolyser Units: Installed in modular configurations within climate-controlled enclosures for scalability and protection.
- Water Supply & Pre-Treatment: Pre-treated water is provided to maintain high purity, essential for efficient electrolysis.
- Power Supply: Renewable power sources are converted and managed to ensure a stable power flow.
- Gas Separation & Collection: Systems capture hydrogen and oxygen separately for storage or further processing.
- Cooling Systems: Heat exchangers or cooling towers maintain operational temperatures.
- Compression & Storage: Hydrogen is compressed and stored in high-pressure tanks for transport or use.
- Control & Monitoring: Automated systems track performance and safety, with protocols for immediate shutdown if needed.
- Safety Features: Ventilation, gas detectors, and fire suppression systems ensure safe operation.

Wind Turbine Assembly: The wind turbine assembly process involves the on-site installation of tower sections, nacelles, rotor blades, and ancillary components, requiring meticulous precision and strict adherence to safety protocols. Key steps include the precise alignment and bolting of tower sections, secure installation of nacelles housing the turbine's critical mechanical and electrical systems, accurate mounting and balancing of rotor blades, and integration of control and monitoring systems. Ensuring the structural integrity and optimal performance of the turbines, this assembly process is performed in compliance with industry standards and regulations to guarantee safe and efficient turbine operation.

Green Hydrogen Production Facility (GHPF) Installation: The installation of the Green Hydrogen Production Facility (GGHPF) will involve assembling key components such as electrolyser modules, purification systems, compression equipment, cooling systems, and liquefaction systems. This complex process also includes setting up separators, heat exchangers, circulation pumps, transformers, rectifiers, and metering equipment. Each element will be integrated to ensure maximum efficiency and compliance with environmental and safety standards.

Optional Battery Storage integrated with green hydrogen production plays a vital role in optimising renewable energy usage and enhancing the overall efficiency and sustainability of the Green Hydrogen Production Facility (GHPF).

Green Hydrogen-Powered Turbine is a turbine that generates electricity by using green hydrogen—hydrogen produced through the electrolysis of water powered by renewable energy (such as wind or solar) as fuel. Unlike conventional turbines that run on fossil fuels, a green hydrogen-powered turbine produces zero carbon emissions, making it a key technology for sustainable energy systems.

Solar Farm Installation: The solar farm will be constructed with precision, installing PV modules, mounting structures, foundations, inverters, and batteries according to detailed engineering specifications and design requirements. This methodical approach ensures the system's optimal functionality, aligning with rigorous safety and performance standards throughout the entire installation process.

Storage and Containment Facilities: Hydrogen storage plays a critical role in advancing hydrogen and fuel cell technologies across various applications, including stationary power, portable power, and transportation. Storage and containment facilities will be constructed to safely house water, hydrogen, chemicals, and construction materials. These facilities will feature tanks, vessels, bund walls, and advanced containment systems designed to prevent leaks and spills, ensuring safe and compliant storage.

Hydrogen Refueling Stations (HRS): Hydrogen Refueling Stations (HRS) will be strategically located to provide essential infrastructure for fueling hydrogen-powered vehicles. Each HRS will be equipped with advanced dispensers, high-capacity storage tanks, integrated safety systems, and sophisticated monitoring equipment. These systems will work seamlessly to optimize refueling operations, ensuring precise, efficient, and secure handling of hydrogen fuel while meeting stringent safety standards.

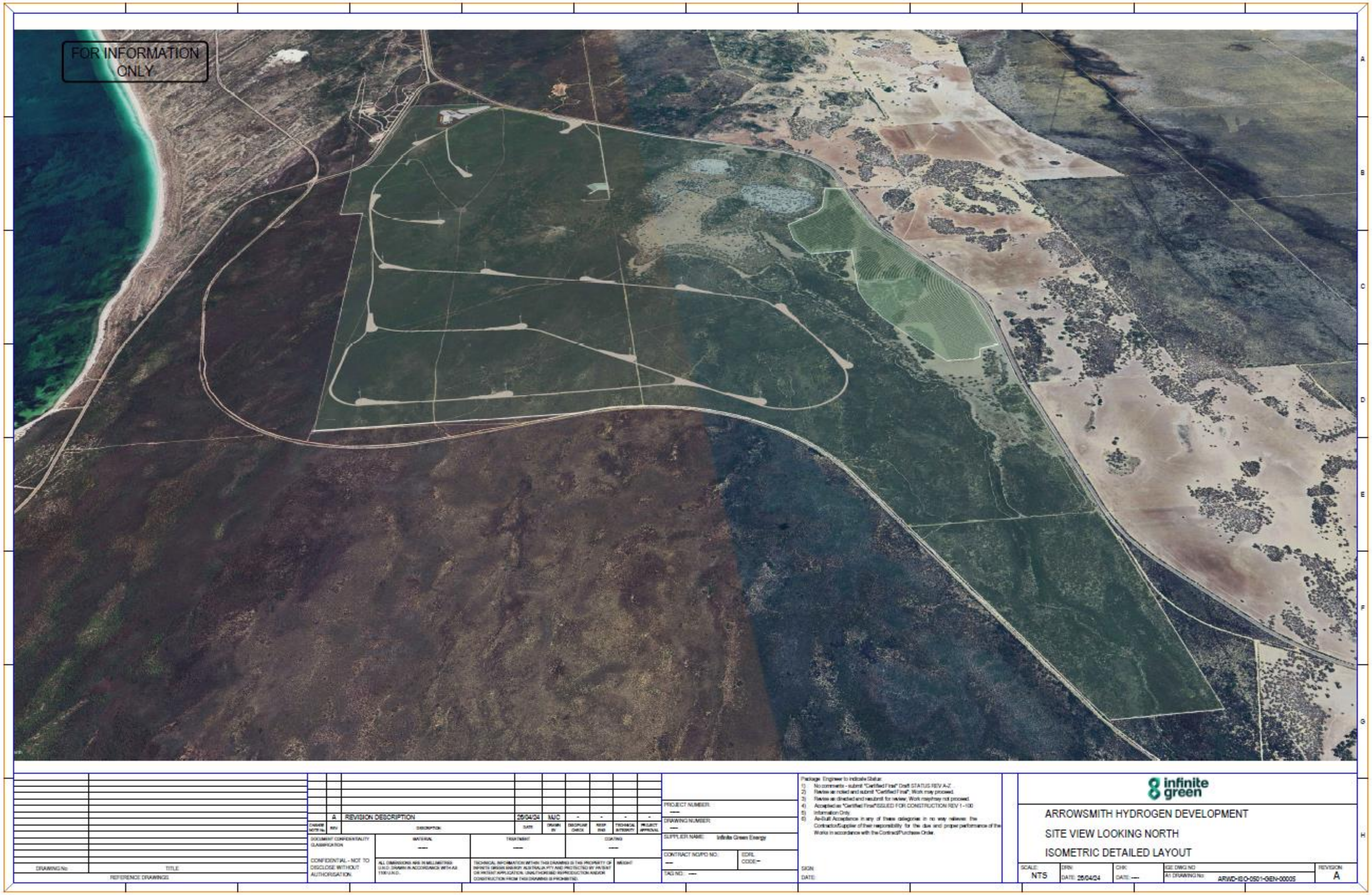


Figure 2: Indicative Site Layout

Each phase of constructing the Green Hydrogen Production Facility (GHPF) and associated infrastructure will be meticulously planned and executed to ensure successful project delivery. This involves leveraging engineering expertise, efficient construction management practices, and strict Adherence to environmental and safety standards throughout the project lifecycle. These efforts are crucial for meeting the project's timeline and budgetary constraints while upholding Environmental and safety standards

6.1 GHPF Operational Components

The Proposal will adopt a phased approach to its operational schedule, initially operating during daylight hours and gradually transitioning to 24-hour operations. This transition will coincide with the deployment of the wind turbine infrastructure and the commissioning of a future grid connection. By implementing this phased approach, the project can optimise its operations based on renewable energy availability, ensuring efficient energy utilisation and grid integration as the project progresses.

Table 3 GHPF Indicative Operational Elements (Figure 3 below)

ITEM		DESCRIPTION
01		ELECTROLYSER BUILDING
02		CONTROL ROOM
03		SITE OFFICE / FIRST AID ROOM
04		KITCHEN AND ABLUTION ROOM
05		STORE AND MAINTENANCE ROOM
06		LIQUEFACTION PLANT 1
07		LIQUEFACTION PLANT 2
08		WATER TREATMENT BUILDING
09		BORE WATER TANK No:1
10		BORE WATER TANK No:2
11		BORE WATER TANK No:3
12		DEMINERALIZED WATER TANK No:1
13		DEMINERALIZED WATER TANK No:2
14		FIRE WATER TANK No:1
15		FIRE WATER TANK No:2
16		FIRE WATER TANK No:3
17		FIRE WATER TANK No:4
18		UTILITY WATER TANK No:1
19		UTILITY WATER TANK No:2
20		CHILLED WATER TANK
21		CHILLED WATER-COOLING SYSTEM
22		BATTERY STORAGE SYSTEM
23		TRANSITIONYARD TRANSITIONROOM
24		AIR COMPRESSOR SYSTEM
25		NITROGEN GENERATION SYSTEM
26		MCC ROOM
27		CRYOGENIC STORAGE
28		LIQUID H2 LOADING FACILITY
29		REED BED No:1
30		REED BED No:2
31		WIND TURBINE No:1
32		BUFFER VESSEL No:1
33		BUFFER VESSEL No:2
34		HYDROGEN REFUELING STATION
35		TRUCK DRIVER FACILITY
36		HYDROGEN FLARE
37		GAS COMPRESSION
38		DIESEL STORAGE
39		GENERATOR
40		SECURITY FENCE
41		SEWAGE TANK / PUMP
42		LEACH AREA
43		TRANSITIONYARD

6.1.1 Initial Operation During Daylight Hours

During the early operational phase, the AHP Proposal will exclusively operate during daylight hours. This strategic decision enables the utilisation of solar energy, leveraging renewable resources to power initial operations. Aligning operations with daylight hours corresponds to the availability of sunlight for optimal solar energy generation, thereby maximising energy efficiency during this phase of the project.

6.1.2 Transition to 24-Hour Operations

As the deployment of wind turbine infrastructure progresses and the grid connection is commissioned, the operational hours will transition to 24 hours per day.

Wind turbines are capable of generating electricity around the clock, utilising wind energy as a continuous renewable resource. Transitioning to 24-hour operations maximises the potential for energy generation and contributes to the overall efficiency of the renewable energy project.

6.2 Contribution to Grid Stability

Balancing Energy Supply: Continuous wind turbine operations contribute to a more stable energy supply by providing a consistent source of electricity. This is particularly important in grids with a high penetration of renewable energy, where variable output from other sources (like solar power) may create challenges. Supporting Base Load Requirements: While wind energy is inherently variable, operating wind turbines around the clock helps to meet base load requirements and reduces reliance on fossil fuels for continuous power supply.

The Arrowsmith Hydrogen Production (AHP) project will tap into green energy from the grid when necessary, made possible by Infinite Green Energy's (IGE) integration of its own renewable energy sources back into the grid. This arrangement enables the AHP project to access a grid-supplied green energy reserve, supplementing on-site renewable generation to maintain a stable and sustainable power supply for hydrogen production. This setup ensures that the AHP project consistently operates with a renewable energy base, enhancing the facility's reliability and alignment with green energy objectives.

Energy Contribution to the Grid:

Solar and wind, power generated from renewable energy installations (such as solar farms, wind farms, battery banks) are fed into the grid.

In many regions, the grid is now increasingly being powered by renewable sources as part of the transition to cleaner energy systems. Western Australia, for instance, is investing in renewable energy infrastructure, which allows companies to draw electricity that is generated from these green sources.

6.2.1 Renewable Energy Certificates (RECs) or Guarantees of Origin (GOs)

The Australian Government's recent introduction of the Future Made in Australia (Guarantee of Origin) Bill 2024 establishes a framework for a Guarantee of Origin (GO) scheme, aimed at verifying the renewable credentials and emissions profiles of products, including green hydrogen

The GO scheme will operate voluntarily, providing renewable electricity certification through the Renewable Electricity Guarantee of Origin (REGO) system. This certification mechanism builds upon the proven Large-scale Generation Certificate (LGC) framework from the Renewable Energy Target (RET) scheme and is expected to continue beyond 2030 when the RET ends. REGO certificates will support a wide range of renewable electricity claims, facilitating corporate emissions reduction commitments, green hydrogen certification, and renewable investment.

For the Arrowsmith Hydrogen Production (AHP) project, this scheme offers a pathway to substantiate its renewable energy sourcing. As energy from diverse sources mixes within the grid, Infinite Green Energy (IGE) can utilise REGO and GO certificates to validate its renewable energy use, ensuring compliance with sustainability commitments and bolstering transparency. By certifying renewable energy use under the GO framework, AHP can maintain its green project status, even while drawing supplementary energy from the grid, aligning with stringent emissions tracking and reporting as established in the scheme.

6.2.2 Direct Contracts with Renewable Energy Providers

The IGE HP project can enter into power purchase agreements (PPAs) with specific renewable energy providers, such as a wind or solar farm or utilise their own excess power that will be produced and sent to the grid. Through these contracts, the hydrogen production facility guarantees that the electricity it consumes is offset by renewable energy generation.

6.2.3 Grid Integration of Green Energy

In some cases, the grid operator actively monitors and reports the proportion of renewable energy in the grid at any given time. This enables projects like the Arrowsmith Hydrogen Production (AHP) facility to strategically schedule energy consumption during periods when renewable energy generation is higher. Depending on the structure of the energy market and grid dynamics, this approach allows AHP to further optimise its sustainability profile by tapping into green energy resources during peak renewable output times, aligning energy use with renewable availability and contributing to overall grid efficiency. This also strengthens AHP’s commitment to carbon-neutral operations, maximising the use of renewable power even when drawing from the grid.

6.2.4 Flexible Demand Management

Hydrogen production facilities, especially those using electrolysers, can adjust their operations to match the availability of renewable energy on the grid. For example, during peak solar or wind generation periods, the facility can ramp up hydrogen production, taking advantage of times when green energy is more abundant.

6.2.5 Supporting Energy Transition

By utilising certified green energy from the grid, the AHP project contributes to the broader energy transition. As more renewable energy enters the grid, the overall carbon footprint of grid-connected industries like hydrogen production will be reduced.

6.2.6 Summary

The HP project can utilise green energy from the grid by drawing power from a grid that is increasingly supplied by renewable energy sources such as wind, solar, and hydro. By purchasing Renewable Energy Certificates (RECs), entering power purchase agreements (PPAs), and utilising grid management practices, the project ensures that the electricity used for hydrogen production is considered "green." This approach aligns the project with sustainability and decarbonisation goals.

6.3 Benefits of Phased Approach

The phased approach to operational hours allows for a smooth transition from initial operations to full-scale 24-hour operations, minimising disruptions and optimising resource utilisation.

By leveraging both solar and wind energy resources, the AHP Proposal enhances its overall sustainability and resilience, diversifying its energy sources and maximising renewable energy generation capacity.

This approach aligns with best practices in renewable energy project management, ensuring efficient utilisation of resources and maximising the project's contribution to addressing climate change and reducing greenhouse gas emissions.

6.4 Plant Load mix

The incorporation of battery storage units and a hydrogen-powered turbine within the IGE Green Hydrogen Production Facility (GHPF) is an optional strategy to balance energy supply, improving plant efficiency, and ensuring the project meets its classification as a green project.

6.4.1 Optional Battery Storage Units

Energy Storage: Battery storage units are crucial for storing excess energy generated from renewable sources, such as solar and wind power. Since renewable energy generation can fluctuate depending on weather conditions, batteries help to store energy when production exceeds demand, making it available when renewable generation dips.

Load Balancing: The batteries provide a stable power supply to the GHPF, helping to smooth out inconsistencies in energy generation. By discharging stored energy during periods of low renewable output or during peak demand, battery storage can offset plant load deficiencies, ensuring a continuous and reliable power supply to the electrolysers in the hydrogen production process.

Optimisation of Renewable Mix: Batteries allow the plant to use as much renewable energy as possible by storing surplus energy during times of high solar or wind production. This maximises the renewable energy mix used in hydrogen production, minimising reliance on the grid's non-renewable power sources and supporting the green classification of the project.

Grid Stabilisation: Batteries also play a key role in providing grid services, such as frequency regulation and voltage support, which stabilises the energy supply for the plant and the wider grid. This ensures that the hydrogen production facility remains functional even during grid disturbances.

Hydrogen-powered turbines are an effective backup power solution for hydrogen production facilities, providing a sustainable and reliable alternative to traditional backup systems that rely on fossil fuels. Here's how hydrogen turbines can enhance the resilience and sustainability of a hydrogen facility:

6.4.2 Optional Hydrogen powered Turbines

Reliable, Carbon-Free Backup Power

- Hydrogen-powered turbines use green hydrogen as fuel, which is produced through electrolysis powered by renewable energy sources, such as solar and wind. This process results in zero-carbon emissions, as the only byproduct of hydrogen combustion is water vapor.
- These turbines ensure a consistent power supply during periods of low renewable energy availability, such as during extended cloudy or calm periods, when wind or solar energy is insufficient.

Energy Storage and Flexibility

- Excess renewable energy generated on-site can be stored as hydrogen when demand is low. This stored hydrogen can then fuel turbines when additional power is needed, effectively serving as long-term energy storage.
- Unlike battery storage, which is better suited for short-term energy needs, hydrogen can be stored over extended periods and used during prolonged renewable energy shortages, making it ideal for handling seasonal variations and lengthy power outages.
- Supporting Grid Stability and Demand Response
- In addition to providing on-site backup power, hydrogen-powered turbines can be designed to integrate with the grid, helping to stabilise grid demand by generating power during peak usage times.
- By running hydrogen turbines to offset grid load or reduce demand during peak times, the hydrogen facility can support grid reliability while maintaining independence from non-renewable grid power during critical operations.

Modularity and Scalability

- Hydrogen turbines can be scaled up or down based on the facility's energy demands, making them adaptable to different operational sizes and backup needs.
- This flexibility allows hydrogen plants to tailor their backup systems, ensuring they meet all requirements without excessive infrastructure or costs.
- Efficiency in Remote or Off-Grid Locations
- Hydrogen-powered turbines are particularly beneficial for facilities in remote or off-grid locations, where grid power may be unreliable or unavailable.
- These turbines provide an on-site, sustainable energy source, reducing dependency on the grid and fossil-fuel-based generators, thus supporting energy security and sustainability in isolated areas.

Economic and Operational Benefits

By using green hydrogen produced on-site, facilities can reduce the costs associated with purchasing and transporting traditional backup fuels.

Energy independence provided by hydrogen-powered turbines can help stabilise operational costs, making the facility less vulnerable to energy price fluctuations and supporting long-term financial stability.

Summary

Hydrogen-powered turbines offer a carbon-neutral, flexible, and reliable solution for backup power at hydrogen production facilities. They enable facilities to:

- Ensure operational continuity with clean backup power,
- Store renewable energy as hydrogen for long-term use,
- Support grid stability, and
- Enhance energy independence, especially in remote settings.

By integrating hydrogen turbines, hydrogen production facilities can maintain efficient, sustainable, and uninterrupted operations, even in the face of fluctuating renewable energy availability.

Clean Energy Backup: A hydrogen-powered turbine acts as a backup power source, providing additional energy to the plant during periods of low renewable energy generation or when the battery storage is depleted. This ensures that the facility can continue hydrogen production without relying on fossil fuels.

Green Energy Generation: The hydrogen used to power the turbine is produced using electrolysis driven by renewable energy. When the hydrogen-powered turbine generates electricity, it produces zero emissions, further supporting the project's green classification.

Supplementing the Renewable Mix: By integrating a hydrogen-powered turbine, the plant is able to tap into another clean energy source. The turbine operates when renewable energy (from wind or solar) is insufficient, thus supplementing the renewable energy mix and maintaining the facility's reliance on carbon-neutral energy sources.

6.4.3 Addressing Plant Load Deficiencies

Intermittent Renewable Energy Supply: Solar and wind power are inherently intermittent, which can cause load deficiencies (periods when energy demand exceeds supply). The battery storage and hydrogen-powered turbine help mitigate these deficiencies by providing a reliable, on-demand power source when renewable energy is insufficient.

Hybrid System: By combining batteries, a hydrogen-powered turbine, and renewable energy generation, the facility creates a hybrid system that is capable of maintaining a consistent energy supply. This ensures the plant can operate smoothly, without interruptions, and achieve maximum efficiency.

6.4.4 Classifying the Project as Green

Renewable Energy Utilisation: The use of battery storage and an optional hydrogen-powered turbine enhances the renewable energy mix and ensures that the majority of energy used in the facility comes from carbon-neutral or renewable sources. This is critical to achieving a green project classification.

Emission-Free Power Generation: The hydrogen-powered turbine generates electricity without any greenhouse gas emissions, further reducing the plant's overall carbon footprint. This ensures that the entire energy ecosystem of the project aligns with sustainability goals.

Minimised Grid Dependency: By incorporating l batteries and a hydrogen turbine, the facility can operate independently of the grid during peak renewable energy production or storage phases, reducing its reliance on external power sources that may not always be 100% green.

Certification: With these technologies in place, the GHPF can qualify for green certifications such as those issued under Renewable Energy Guarantees of Origin (REGO) or similar schemes, reinforcing its status as a green hydrogen production facility.

6.5 Energy Transition

The ability to transition between renewable energy sources such as solar, wind and battery storage, and optimise their usage based on availability, plays a critical role in improving the cost-efficiencies of a project's operations. This flexibility allows the project to minimise energy costs, increase operational efficiency, and maintain a consistent energy supply.

6.5.1 Cost Factors in Transitioning Between Renewable Sources

Energy Price Variability: One of the key cost benefits of transitioning between renewable energy sources is the ability to avoid peak grid electricity prices. For example, during periods of high solar energy availability, the project can rely on solar power, reducing the need to purchase renewable electricity from the grid, which is often more expensive during peak hours.

Operational Efficiency: Transitioning between renewable energy sources reduces the need for energy storage capacity, as the project can tap into different energy sources as they become available, minimising reliance on costly energy storage systems. This means that rather than investing in massive battery storage to handle long periods of no wind or sunlight, the project can use a mix of renewables more efficiently.

Reduced Fuel Costs: By using green hydrogen produced on-site as an energy backup through hydrogen-powered turbines, the project avoids the need for fossil fuel-based backup power sources, reducing fuel costs and further minimising operational expenses. Hydrogen can be produced and stored when renewable energy generation is high and used later when renewable energy availability is low.

6.5.2 Improved Cost-Efficiency through Optimisation

Minimising Energy Waste: Transitioning between solar, wind, and stored hydrogen ensures that the project uses energy in the most efficient manner, reducing waste and lowering overall energy costs. For instance, excess solar energy generated during the day can be stored in batteries or converted into hydrogen for later use, rather than purchasing energy from the grid during periods of low solar availability.

Peak Shaving: By optimising energy use and shifting between renewable sources, the project can perform peak shaving, reducing its demand on the grid during peak pricing hours. This lowers electricity costs, as the project can rely on cheaper, self-generated renewable energy during these times.

Operational Flexibility: Having the flexibility to transition between energy sources allows the project to adapt to changing market conditions, such as fluctuations in green grid energy prices or renewable energy availability. This operational flexibility helps reduce energy procurement costs and improve the long-term financial sustainability of the project.

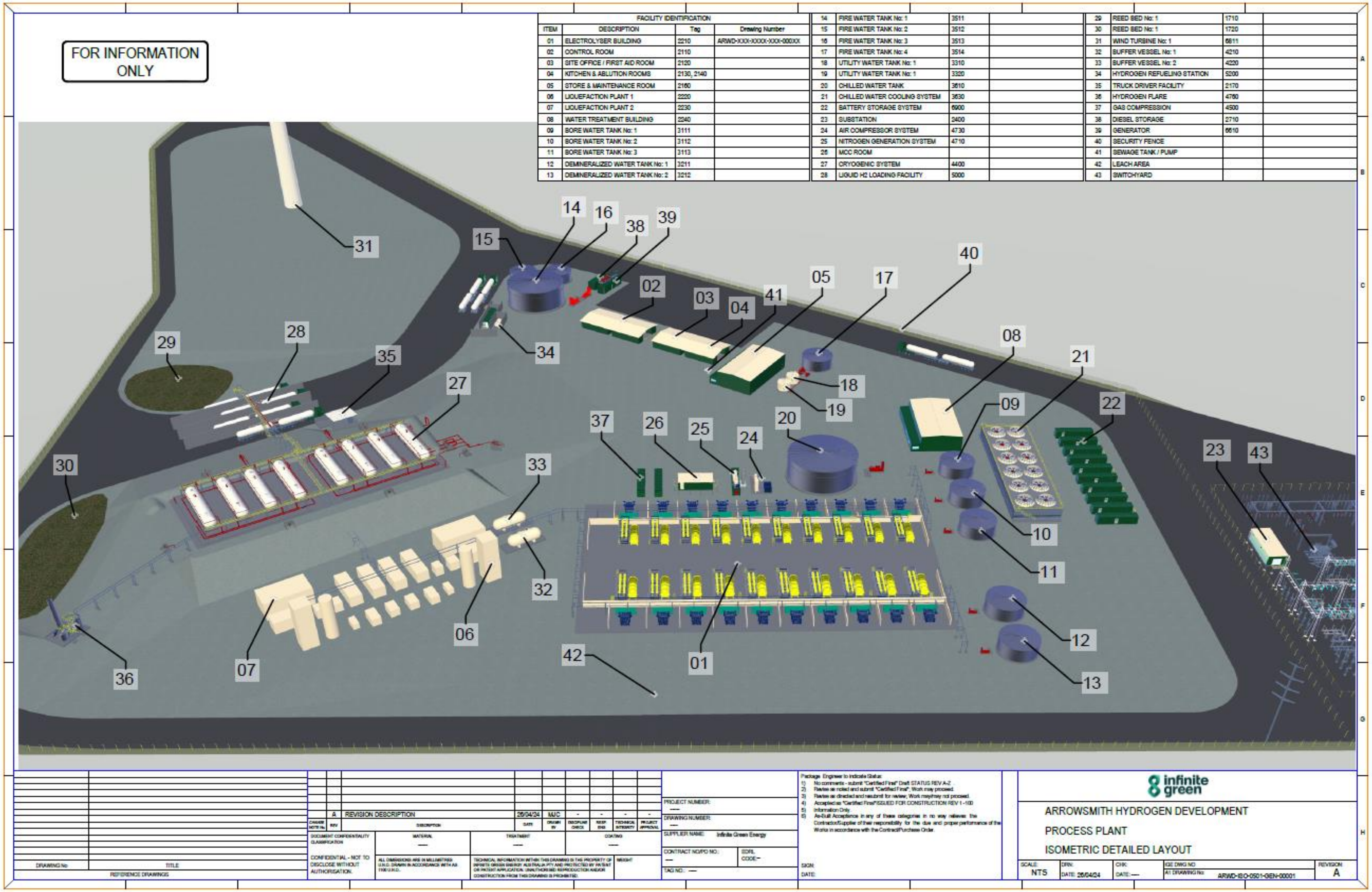
6.5.3 Reduction in Capital Expenditure (CapEx)

Optimised Infrastructure Investment: The ability to transition between energy sources reduces the need for oversizing energy storage or generation capacity. For example, rather than investing heavily in battery storage to handle long periods of low renewable generation, the project can balance its energy needs between wind, solar, and hydrogen power. This optimisation lowers the initial capital expenditure required for energy infrastructure.

Efficient Use of Hydrogen Infrastructure: Hydrogen infrastructure (e.g., electrolysers and hydrogen turbines) can serve dual purposes—both as a backup power source and as a green hydrogen production facility. This dual use increases the value of the investment and helps distribute capital costs across multiple functions.

6.5.4 Environmental and Regulatory Incentives

Carbon Credits and Incentives: Optimising the renewable energy mix and reducing emissions by transitioning between green energy sources can make the project eligible for carbon credits and renewable energy incentives. These can further enhance the financial viability of the project by providing additional revenue streams or reducing costs through tax credits, grants, or subsidies.
Regulatory Compliance: The ability to transition between renewable energy sources ensures that the project meets regulatory standards for emissions and energy efficiency, reducing the risk of non-compliance penalties and demonstrating the project's commitment to sustainability.



FACILITY IDENTIFICATION			
ITEM	DESCRIPTION	Tag	Drawing Number
01	ELECTROLYSER BUILDING	2210	ARWD-XXX-XXXX-XXX-000XX
02	CONTROL ROOM	2110	
03	SITE OFFICE / FIRST AID ROOM	2120	
04	KITCHEN & ABLUTION ROOMS	2130, 2140	
05	STORE & MAINTENANCE ROOM	2160	
06	LIQUEFACTION PLANT 1	2220	
07	LIQUEFACTION PLANT 2	2230	
08	WATER TREATMENT BUILDING	2240	
09	BORE WATER TANK No: 1	3111	
10	BORE WATER TANK No: 2	3112	
11	BORE WATER TANK No: 3	3113	
12	DEMINERALIZED WATER TANK No: 1	3211	
13	DEMINERALIZED WATER TANK No: 2	3212	
14	FIRE WATER TANK No: 1	3511	
15	FIRE WATER TANK No: 2	3512	
16	FIRE WATER TANK No: 3	3513	
17	FIRE WATER TANK No: 4	3514	
18	UTILITY WATER TANK No: 1	3310	
19	UTILITY WATER TANK No: 1	3320	
20	CHILLED WATER TANK	3610	
21	CHILLED WATER COOLING SYSTEM	3630	
22	BATTERY STORAGE SYSTEM	6900	
23	SUBSTATION	2400	
24	AIR COMPRESSOR SYSTEM	4730	
25	NITROGEN GENERATION SYSTEM	4710	
26	MCC ROOM		
27	CRYOGENIC SYSTEM	4400	
28	LIQUID H2 LOADING FACILITY	5000	
29	REED BED No: 1	1710	
30	REED BED No: 1	1720	
31	WIND TURBINE No: 1	6811	
32	BUFFER VESSEL No: 1	4210	
33	BUFFER VESSEL No: 2	4220	
34	HYDROGEN REFUELING STATION	5200	
35	TRUCK DRIVER FACILITY	2170	
36	HYDROGEN FLARE	4760	
37	GAS COMPRESSION	4500	
38	DIESEL STORAGE	2710	
39	GENERATOR	6610	
40	SECURITY FENCE		
41	SEWAGE TANK / PUMP		
42	LEACH AREA		
43	SWITCHYARD		

Figure 3 Indicative GHPF (Process Plant)

Key Construction Activities

6.6 Solar Farm

The proposed development encompasses several key components, including:

Fixed-Tilt Racking Systems: Solar panels are mounted on frames that are tilted at a specific angle, usually optimised for the location's latitude, to maximise sunlight exposure throughout the day. The structures are anchored into the ground using concrete footings, steel poles, or driven piles.

- Tracking Systems: These systems allow the solar panels to follow the sun's movement across the sky.
- Single-Axis Trackers: Panels move on one axis, tilting from east to west to follow the sun's path during the day.
- Dual-Axis Trackers: Panels can tilt on both horizontal and vertical axes, following the sun more precisely throughout the day and seasons, maximising energy capture.
- Installation of low voltage transition gear cabinet and high voltage transformer and substation.
- Construction of boundary fencing, consisting of security fencing mounted on timber posts, around the perimeter of the site, with access gates for entry.
- Establishment of associated access tracks connecting transformer and transition gear substations.
- Implementation of a pole-mounted CCTV system strategically positioned around the site to enhance security.

To maximise the efficiency of solar panels and minimise overshadowing, the design of the solar farm will incorporate a strategic setback of the rows of solar panels from existing and proposed vegetation screening along the site boundaries. This approach not only ensures optimal solar energy production but also offers significant opportunities to enhance biodiversity along the solar farm's perimeters.

Enhancing Biodiversity:

- Vegetation Buffers: The setback area between the solar panels and vegetation screening can be designed as a buffer zone that supports native plant species. This creates habitats for local wildlife, promoting biodiversity and contributing to the ecological value of the site.
- Pollinator Habitats: The area can be planted with flowering plants that attract pollinators such as bees and butterflies, which are crucial for maintaining healthy ecosystems. This enhances the environmental sustainability of the solar farm and supports broader conservation efforts.

Mitigation proposals have been formulated to address landscape and visual impacts, considering identified areas of sensitivity. Additional planting will be undertaken where necessary, with detailed vegetation maintenance strategies provided for both existing and proposed vegetation. Efforts will be made to retain existing vegetation to preserve the local area's character, visual buffers, and biodiversity value.

Landscape mitigation strategies will include:

- Retention, protection, and enhancement of existing flora and vegetation using native species.
- Infilling of new native planting where gaps exist in field boundary vegetation to define site boundaries and enhance visual enclosure.
- Establishment of new native vegetation to demarcate field boundaries were absent or lost over time.
- Planting of native vegetation strategically to break up the perceived massing of the development and filter views from neighbouring areas.
- Management of existing and new planting to a height of 3m or over to enhance visual enclosure.
- Ongoing maintenance of all new planting throughout the solar farm's lifetime.

The selection of the integrated solar farm system's location has been a meticulous process focused on maximising the use of pre-cleared areas within the designated disturbance footprint. The site preparation involves clearing approximately 65.58 hectares of former pastoral land, which will include leveling elevated areas, resulting in a substrate volume of around 30,000 cubic meters.

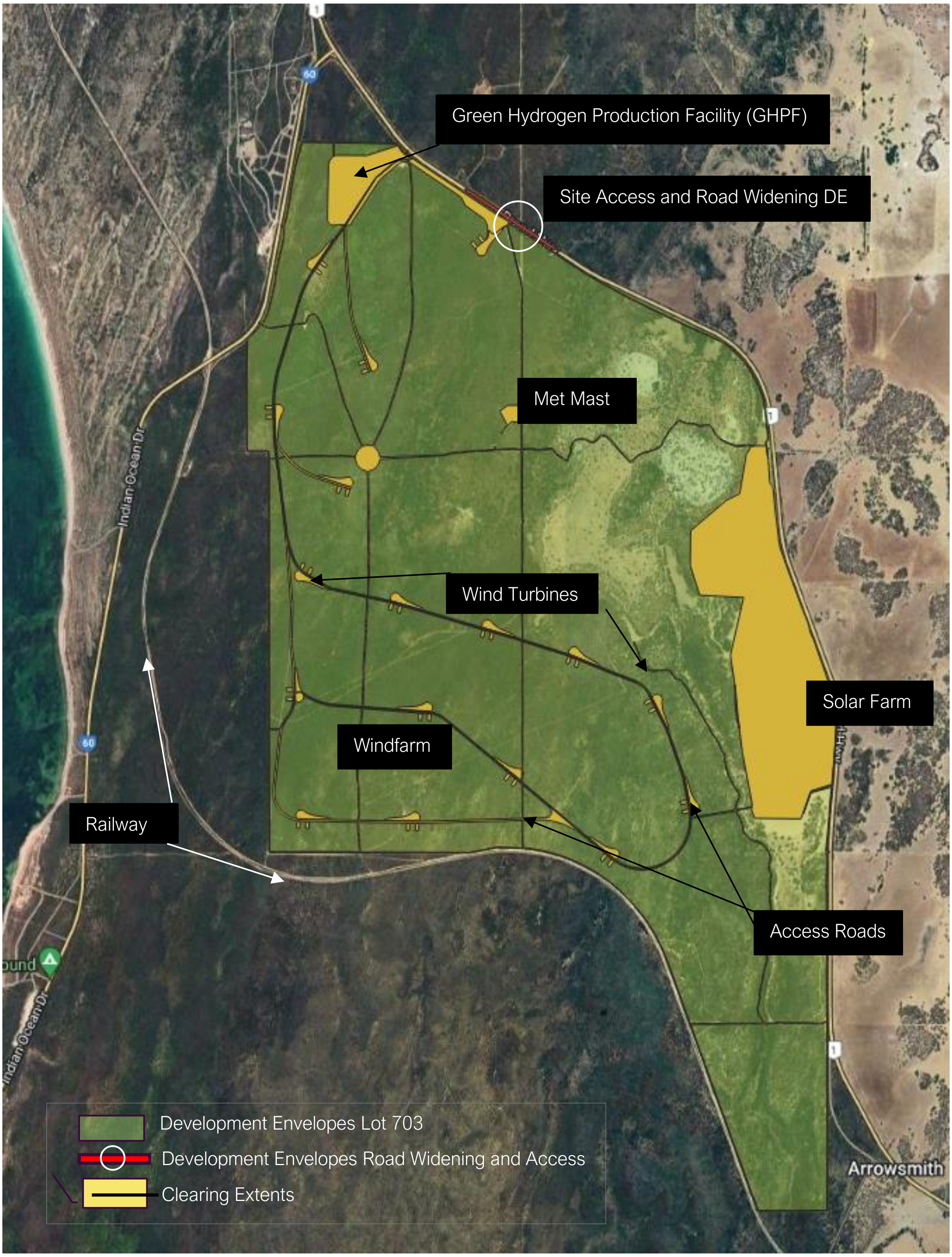
Following site preparation, concrete footings will be strategically installed to support the photovoltaic (PV) panels, each measuring 2.27 meters by 1.06 meters, alongside the necessary power cables and interconnection panels that connect to the solar inverters. To facilitate construction, a temporary 100 meters by 100 meters laydown area will be established. Within this area, a 50-meter by 30-meter section will be designated for demountable office structures, container storage, and the installation of a fauna protection fence to minimize impacts on local wildlife, ensuring that environmental disturbances are kept to a minimum.

6.6.1 Solar PV Panels

The solar farm will have a maximum capacity ranging up to 85 MW, with the photovoltaic (PV) panels installed in uniform rows. These panels will be mounted on concrete footings and connected to inverters via surface cables. Each panel measures 2,256 mm x 1,133 mm x 35 mm and weigh 27.2 kg.

To optimise solar energy capture, the tracking axis will be aligned north to south, enabling the modules to rotate up to a 60° tracking angle. This tracking system ensures the panels follow the sun's movement throughout the day, significantly enhancing energy generation efficiency.

Surface cables will connect the solar panels, creating a direct transmission line from the solar farm to the Green Hydrogen Production Facility (GHPF). This infrastructure is designed to efficiently transmit the generated solar energy, providing sustainable power to the facility and contributing to its renewable energy needs.



N
0 0.5 1 km

Arrowsmith Hydrogen Project (AHP)
Indicative DE's and Clearing Extents

infinite green

Author: Peter Galloway
Date: December 2024

Figure 4: Indicative Project Elements (Hydrogen Facility, Turbine Layout, Access Roads and Solar Farm)

6.6.2 Turbine Loads and Site Layout

To maintain optimal turbine performance and adhere to the manufacturer's design parameters, it is crucial to obtain the minimum acceptable turbine spacing specifications directly from the turbine manufacturer. These specifications are determined by factors such as the rotor diameter, terrain characteristics, and wind patterns specific to the site. The arrangement of turbines is carefully planned to maximise energy production by capturing the highest possible wind yield while minimising interference from obstacles, turbulence, or drag. This approach ensures that turbines operate efficiently and generate maximum output while maintaining operational integrity and longevity as per the manufacturer's guidelines.

Wind Turbines are subject to the influence of adjacent turbines, that may impact their loading, durability and operational parameters. The assessment of the suitability of wind farm positioning at site will recognise the deterministic and turbulent flow characteristics associated with single or multiple wakes from upwind arrays. The effects of turbine layout including, ambient wind speeds and direction relevant to power output. If turbines spacing configuration are designed in closer proximity of less than five rotor diameters (5D) to other turbines, it is likely that unacceptably high wake losses will result from this type of turbine layout.

Areas with predominantly unidirectional or bidirectional wind roses require greater distance between turbine placement, with prevailing wind direction and tighter spacing perpendicular to the prevailing wind proving to be a more productive design configuration. Compressed spacing between modules positioned downstream from other turbines may increase turbulence from upstream turbine wake. This type of layout can create high mechanical loads and may require engineering approval by turbine suppliers if warranty arrangements are to be considered.

The proposed wind turbine layout, spacing, location and positioning will be selected to avoid sensitive environmental receptors, utilising wind data analysis, wake modelling surveys and ground suitability surveys. Additionally, turbine loads are affected by but not limited to ‘natural' turbulence caused by obstructions, topography, surface roughness and thermal effects, including extreme weather conditions.

In summary the turbines will require a combined clearing area of 15.02 ha at completion of installation, the overall area required for construction will be 15.27 ha. The required cleared area for each individual turbine construction pad is outlined in figure 6.

6.6.3 Wind Farm Layout Modifications

Wind turbine technology is constantly evolving, particularly through advanced modularity in design, and an extensive list of design options to create customised solutions to suit the requirements of each unique project, resulting in, increased energy production while utilising fewer turbines.

The proposed AHP wind farm modifications include an updated layout utilising multi-objective optimisation revealing the best design variables, enabling IGE to take advantage of technology changes and provide greater certainty regarding environmental impact mitigation and constructability of the Project.

Turbine siting with respect to environmental values, wake modelling insights and functional expertise have been utilised within the development area to select the optimal placement and turbine array locations, identifying landforms (cave formations and systems), vegetation values and CBC foraging habitat to realign the disturbance footprint and mitigating environmental impacts.

A fully integrated electrolysis plant design will support data acquisition and control hydrogen plant components. The system will be fully scalable and customisable, allowing implementation of a system control concept required to meet local grid/ off grid requirements or site battery storage options.

Economic and environmental parameters are considered the two key objective functions: Wind turbine energy efficiency, and the mitigation of environmental impacts.

7 Wind Turbine Site Construction: Key Steps and Considerations

The construction of the AHP wind turbine site involves a complex sequence of activities, each critical to ensuring the successful installation and operation of wind turbines. This process includes careful planning, civil and electrical works, turbine assembly, and commissioning, while Adhering to safety and environmental standards.

7.1 Site Preparation

Site Selection and Planning

- Wind Resource Assessment: IGE have conducted wind resource assessments to identify the optimal locations for wind turbines. This includes analysing wind speed, direction, and consistency to maximise energy generation.

- Environmental and Geotechnical Surveys: IGE have performed environmental impact assessments (EIA's) and geotechnical surveys to understand the site conditions. These surveys help in designing foundations and planning construction activities with minimal environmental impact.

Land Clearing and Grading

- Vegetation Clearing: Vegetation clearing will be conducted while preserving as much native vegetation and fauna habitat as possible, implementing erosion control measures to protect surrounding areas.

- Grading: Level and grade the land to create stable, accessible areas for turbine foundations, access roads, and crane pads. This is essential for ensuring safe and efficient construction operations.

Access Road Construction

- Road Design and Construction: Access roads will be built that are capable of supporting heavy construction vehicles and the transport of large turbine components. Roads should be designed with proper drainage to prevent erosion and maintain road integrity.

- Dust Control and Maintenance: Dust control measures implemented during road construction, such as water spraying, to minimise air quality impacts. Regularly maintain roads to ensure safe access throughout the construction phase.

7.2 Foundation Construction

Foundation Design:

- Type Selection: The appropriate foundation type will be chosen based on site conditions, such as gravity-based, piled, or rock-anchored foundations. The design will account for soil characteristics, load requirements, and environmental factors.
- Reinforcement: Reinforce the foundation with steel rebar to provide additional strength and stability, especially in areas with challenging ground conditions.

Excavation and Pouring:

- Excavation: Foundation site will be excavated to the required depth, ensuring a level base. Proper shoring may be necessary to prevent soil collapse during excavation.
- Concrete Pouring: Pour the concrete foundation, ensuring that it is evenly distributed and properly compacted to eliminate voids. Use formwork to shape the foundation and allow for accurate placement of anchor bolts.
- Curing: Allow the concrete to cure properly, which is critical for achieving the required strength and durability. This process may take several weeks, depending on environmental conditions.

7.3 Crane Pad and Assembly Area Construction:

- Crane Pad Preparation: Reinforced crane pads will be constructed near the turbine site to support the heavy cranes used for turbine assembly. The pad must be level and capable of bearing the weight of both the crane and turbine components.
- Assembly Area Setup: Establish an assembly area for staging turbine components before installation. This area should be spacious and organised to facilitate the safe and efficient movement of large parts.

7.4 Turbine Component Delivery and Assembly

Component Delivery:

- Transport Logistics: Coordinate the transportation of turbine components, such as blades, nacelles, and tower sections, from the manufacturing facility to the site. This will require careful planning to navigate oversized loads and ensure timely delivery.
- On-Site Storage: turbine components will be stored at the Arrowsmith site in a secure area at the site, ensuring they are protected from damage and weather exposure until assembly.

7.5 Turbine Assembly

- Tower Erection: Tower sections will be assembled on-site, starting with the base and working upward. Each section is lifted into place using cranes and bolted together securely.
- Nacelle Installation: Once the tower is erected, the nacelle will be put into place at the top of the tower. The nacelle houses critical components such as the gearbox, generator, and control systems.
- Blade Installation: turbine blades will be attached to the rotor hub. This is a delicate operation that requires precise alignment and secure fastening. Blades may be installed individually or pre-assembled with the hub before lifting.
- Electrical Connections: Connect the electrical systems within the nacelle, including wiring the generator and control systems, ensuring all connections are secure and weatherproof.

7.6 Electrical Infrastructure and Grid Connection

Cabling and Trenching:

- Underground Cabling will be installed to connect each wind turbine directly to the substation, facilitating a safe and efficient transfer of electricity generated by the turbines. These underground cables are designed to carry high-voltage electricity from each turbine to the substation, where the voltage is transformed and prepared for grid integration.
- Cable Trenching: Excavate trenches for cable laying, ensuring that cables are buried at a sufficient depth to protect them from damage and environmental exposure.

7.7 Substation Construction

- Substation Setup: Build the substation to house transformers and transition gear that convert the medium voltage electricity generated by the turbines to high voltage for grid transmission. The substation must be strategically located to minimise transmission losses.
- Control Systems: Install control and monitoring systems within the substation to manage turbine operations and grid connections. These systems provide real-time data on turbine performance and grid status.

7.8 Commissioning and Testing

System Integration:

- SCADA Integration: Integrate the wind farm into the Supervisory Control and Data Acquisition (SCADA) system, allowing for centralised monitoring and control of all turbines. This system enables operators to monitor performance, detect issues, and optimize energy production.
- Grid Synchronisation (when required): Synchronise the windfarm's output with the grid, ensuring that the electricity generated is compatible with grid specifications. This process involves testing voltage, frequency, and phase alignment.

7.9 Operational Testing

- Performance Testing: Conduct thorough testing of each wind turbine to verify its performance, including power output, mechanical stability, and system responsiveness. Ensure that all components operate as expected under various wind conditions.
- Safety Checks: Perform safety checks on all electrical and mechanical systems, including grounding, lightning protection, and emergency shutdown mechanisms. These checks are essential for ensuring the safe operation of the windfarm.

7.10 Environmental and Safety Compliance

Environmental Protection:

- Erosion Control: Implement erosion control measures throughout the construction process, particularly in areas disturbed by excavation and grading. This includes installing silt fences, re-vegetating disturbed areas, and managing stormwater runoff incorporated within The Stormwater Management plan.(Part V works Approval)
- Habitat Preservation: Take steps to minimise the impact on local wildlife and habitats, such as avoiding construction during sensitive periods for wildlife and implementing buffer zones around protected areas.

7.11 Safety Protocols

- Construction Safety: Enforce strict safety protocols during all phases of construction, including the use of personal protective equipment (PPE), fall protection systems, and safe handling practices for heavy equipment.
- Emergency Preparedness: Establish emergency response plans for potential incidents, such as equipment failure, electrical hazards, or severe weather events. Conduct regular safety drills to ensure all personnel are prepared to respond effectively.

7.12 Final Inspections and Handover

Final Inspections:

- Quality Assurance: Conduct a final inspection of all construction works, including foundations, access roads, electrical systems, and turbine assembly, to ensure they meet the design specifications and quality standards.
- Regulatory Compliance: Verify that the project complies with all relevant regulations and standards, including environmental permits, safety codes, and grid connection requirements.

7.13 Handover to Operations

- Operational Handover: Upon the completion of construction and commissioning, a formal handover of the wind farm will be conducted to transition the site to the Infinite Green Energy (IGE) operations team. This process will involve the transfer of all essential documentation, including maintenance schedules, operational guidelines, technical reports, and compliance certifications
- Training: Provide comprehensive training to the operations team on turbine maintenance, troubleshooting, and emergency procedures to ensure the safe and efficient management of the wind farm.

7.13.1 Turbine Foundations

The turbine concrete foundation zone, measuring 30 m x 35 m, with a required excavation to a depth of approximately 3 metres. The foundation design will carefully consider various load factors that affect selected foundations to ensure structural integrity and stability. The foundation construction comprises a proposed 6 m reinforced concrete diameter base, extending to a height/depth of approximately 4 m, within a 6 m wide steel central anchor cage.

The anchor cage design utilises the finite element method (FEM), allowing for precise simulation of the weight and dynamic loads of a wind turbine. This advanced modelling technique ensures that the foundation can withstand the stresses and forces exerted by the turbine structure.

The foundation incorporates an approximate 25m fire buffer zone, as mandated by the Bushfire Management Plan regulations. This buffer zone is designed to enhance fire safety around critical infrastructure, providing a protective perimeter that aligns with regulatory requirements to mitigate bushfire risks.

The foundation construction for the turbines is engineered with a precise minimum gradient of 2% to facilitate efficient stormwater runoff. This gradient ensures that water drains effectively away from the foundation, reducing the risk of water accumulation and potential damage. Once the foundation is completed, it is backfilled with excavated spoil up to ground level, maintaining a consistent gradient of 0.5% across the area.

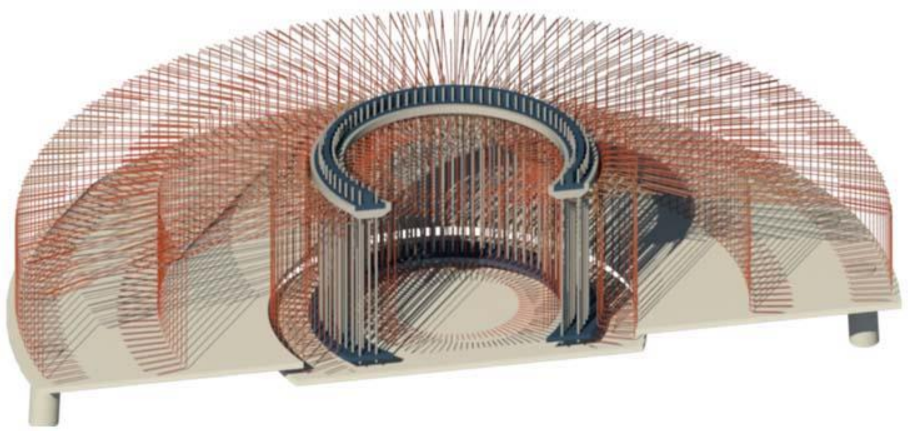


Figure 5: Indicative Anchor Cage Foundation Structure

This meticulous backfilling process not only aids in proper drainage but also serves as a strategic laydown area for the nacelle, a critical component of the wind turbine. The nacelle houses vital machinery such as the gearbox, low- and high-speed shafts, generator, brake system, hub, and various other components essential for turbine operation. Placing the nacelle on the backfilled area optimises space utilisation and facilitates efficient assembly and maintenance procedures for the wind turbine system.

Overall, the foundation construction and design process prioritise structural stability, drainage management, and efficient utilization of space to support the installation and operation of the wind turbine system. (Figure 5).

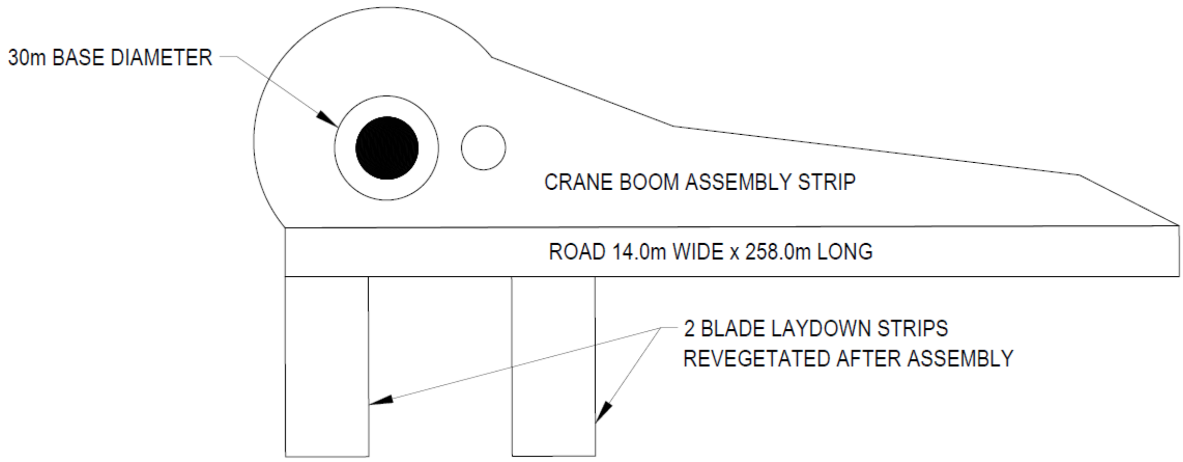


Figure 6: Indicative Turbine Construction Pad design

7.13.2 Wind Turbine Type

The proposed Vestas V162-7.2 MW turbine (7.1g CO_2e/ kWh) features flexible rating, designed to deliver optimised energy production with greater temperature and climate variations. Improved site ability in warmer climates is enabled through the optional larger cooler top and a recyclability rate of 87%

The V162-7.2 MW turbine unit is designed with full value chain strategy, with improved transportability of the nacelle unit, including the flexibility foe the proponent to service and upgrade technology over the operational lifecycle of the turbine.

A proposed 18 x 7.2 MW Vestas V-162 turbines will be generating 132 to 150 MW output of wind power at the AHP turbine facility. The turbine height is 150 m from ground level to hub and the highest blade rotational height is 210 m from ground level.

Individual wind turbine will operate on a 30 m x 35 m (0.1 ha) concrete foundation pad. Overground transmission cabling will connect the wind turbines to the substation via concealed casing running adjacent to project site access tracks.

Figure 7: Indicative Turbine Type Vestas V162 7.2 MW

7.13.3 Green Hydrogen Production Facility (GHPF)

A hydrogen hub that controls facility operations can be divided into three segments: hydrogen production (producing), hydrogen storage (collecting and storing) and hydrogen transportation (transferring), These individual stages are required to be monitored effectively and controlled efficiently to ensure a robust hydrogen production network.

To design a seamless operating system IGE are proposing a hydrogen facility Integration plan that will be developed during early-stage Green Hydrogen Production Facility planning. Systems integrators will take existing network architecture into consideration, in addition to adequately preparing for future expansion as hub development progresses into commissioning stages and continues to expand.

To accurately understand Green Hydrogen Production Facility operations, control room, operators will require visibility into the entire integrated control system, tracking electrolyser systems and production parameters. Associated hydrogen infrastructure details will be analysed including pipeline activity, electrochemical fuel storage interface controls within the power grid, interfacing with safety instrumented systems (SIS).

7.13.4 Wind turbine control and performance

By utilising real-time power facility control, the control hub will control power output of the facility, accurately monitoring and controlling each energy-producing asset.

Allowing the following real-time control:

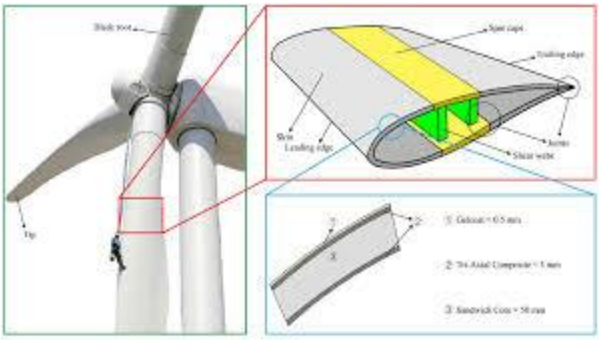
- Voltage, power factor or reactive power control
- Active power closed-loop control, curtailment, derating, ramp-rate limitation
- Frequency control
- Fault ride-through coordination

7.13.5 Wind turbine environmental control options

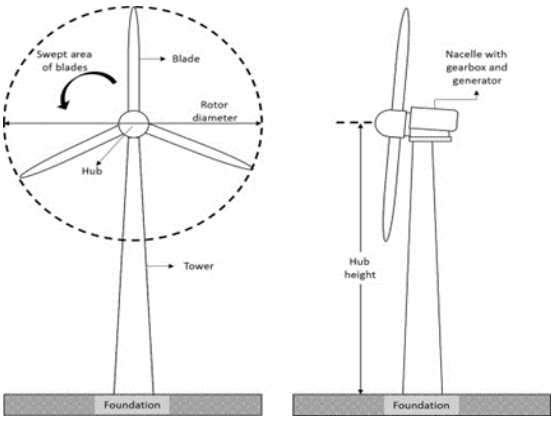
- Shadow flicker control system
- Aviation lights
- Radar installation
- Noise reduction systems
- Anti-Glare
- Aviation markings on blades
- Fire suppression system
- Bat and bird protection system
- Lightning detection system

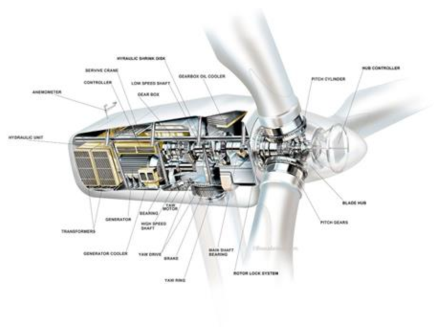
7.13.5.1 Wind turbine Design

Wind turbine design involves several critical elements essential for their efficiency, safety, and environmental compatibility. Firstly, the blade design is paramount, as it's tailored to capture maximum wind energy using aerodynamic shapes and composite materials. This design optimises energy extraction from the wind while maintaining structural integrity.



The rotor, comprising the blades and hub, plays a central role in converting wind's kinetic energy into rotational energy. The hub connects the blades to the main shaft and houses mechanisms for adjusting blade angles, crucial for adapting to varying wind speeds and directions.





tower sits the nacelle, housing the generator, gearbox (if applicable), and other essential components. Its aerodynamic design allows it to face the wind for optimal energy capture. Tower design factors in height, material strength, and foundation stability, ensuring stability and access to stronger winds at greater heights

Figure 8 Indicative Wind Turbine Designs

7.14 Conclusion

The construction of wind turbine sites is a complex, multi-stage process that requires meticulous planning, skilled execution, and strict aderence to safety and environmental standards. From site preparation and foundation construction to turbine assembly and grid connection, each phase plays a critical role in ensuring the long-term success and sustainability of the wind farm. Through careful coordination and quality control, wind turbine site construction can deliver reliable, renewable energy while minimising environmental impacts and ensuring the safety of all involved.

8 Electrolysis

Alkaline water electrolysis is a well-established technology that offers several advantages for hydrogen production. It involves the electrolysis of water in an alkaline medium, typically using a solution of potassium hydroxide (KOH) or sodium hydroxide (NaOH) as the electrolyte. This process is known for its high efficiency, robustness, and scalability, making it suitable for industrial-scale hydrogen production. Alkaline electrolysis systems can operate under a wide range of load conditions, making them flexible and reliable.

This technology uses electricity to split water molecules into oxygen and hydrogen gas, leveraging the fundamental principles of electrolysis.

In an alkaline electrolyser, the setup consists of an anode and a cathode immersed in an alkaline electrolyte solution, typically potassium hydroxide (KOH) or sodium hydroxide (NaOH). The electrolysis process can be broken down into the following steps:

Electrolysis Cell Composition:

- **Anode (Positive Electrode):** Made of materials such as nickel or stainless steel.
- **Cathode (Negative Electrode):** Typically composed of nickel or other suitable materials.
- **Electrolyte Solution:** An aqueous solution of potassium hydroxide (KOH) or sodium hydroxide (NaOH) with a concentration of around 20-30%.

Electrochemical Reactions:

At the Anode (Oxidation Reaction):

- $4OH^- \rightarrow 2H_2O+O_2+4e^-$
- Hydroxide ions (OH-) are oxidised to produce oxygen gas (O2), water (H2O), and electrons (e-).

At the Cathode (Reduction Reaction):

- $2H_2O+2e^- \rightarrow H_2+2OH^-$
- Water molecules (H_2O) are reduced by gaining electrons to produce hydrogen gas (H2) and hydroxide ions (OH-).

Overall Reaction:

The overall balanced reaction for alkaline water electrolysis is:

- $2H_2O \rightarrow 2H_2+O_2$

Water molecules are split into hydrogen gas and oxygen gas, with the hydrogen gas collected at the cathode and the oxygen gas at the anode.

System Components:

- **Power Supply:** Provides the direct current (DC) electricity needed for the electrolysis reaction.
- **Electrolysis Stack:** Contains multiple electrolysis cells stacked together to increase production capacity.
- **Gas Separation Unit:** Separates and purifies the hydrogen and oxygen gases produced.
- **Cooling System:** Maintains optimal operating temperatures and prevents overheating of the electrolysis stack.
- **Control System:** Monitors and controls the electrolysis process, ensuring efficient operation and safety.

Advantages of Alkaline Electrolysis:

- **Efficiency:** High efficiency in converting electrical energy to chemical energy (hydrogen).
- **Mature Technology:** Well-established and commercially available with proven reliability.
- **Scalability:** Suitable for both small-scale and large-scale hydrogen production.
- **Cost-Effectiveness:** Lower capital costs compared to some other electrolysis technologies.

IGE's implementation of alkaline electrolysis at GHPF will enable efficient and sustainable hydrogen production. By carefully designing and optimising the electrolysis system, IGE aims to achieve high purity hydrogen output while minimising energy consumption and environmental impact. This approach supports IGE's commitment to advancing green hydrogen technology and contributing to a sustainable energy future.

During operation, water is decomposed into hydrogen and oxygen gas bubbles through the application of an electric current. This process occurs within the electrolyser's chamber, which contains a porous diaphragm and an alkaline electrolyte. To maintain the separation of the generated gases and prevent their mixing, a specialised membrane, known as an electrolyte, is positioned between the anode and cathode. This membrane serves to balance charges and effectively prevents the gases from combining or becoming contaminated during the electrolysis process.

The generated hydrogen gas will undergo compression, liquefaction, and storage within Cryogenic liquid storage tanks, also referred to as dewars, and are the most common way to store large quantities of hydrogen. Gas storage typically requires the use of high-pressure tanks (350-700 bar or 5000-10,000 psi), while liquid hydrogen storage requires super-insulated low pressure vessels that are needed to store liquid hydrogen at -253°C (-423°F) before being transported offsite to consumers, via road tankers. When renewable energy sources such as wind and solar power are utilised in the electrolysis process, the resulting hydrogen is termed green hydrogen.

Characteristics:

- Inputs: Water, Green Electricity
- By-Products: Oxygen, Water
- Air Emissions: Hydrogen, Oxygen
- Operating Temperature: < 100 °C
- Energy Efficiency: 69 %

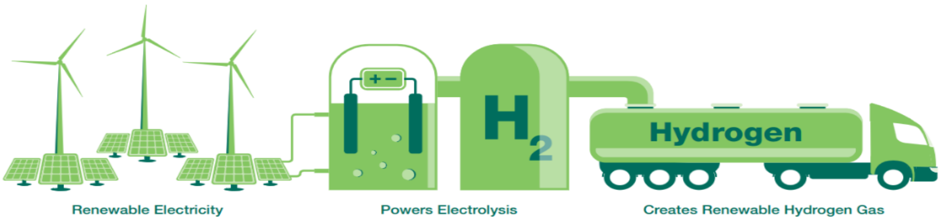


Figure 9: Indicative Green Hydrogen Process Overview

A fully integrated electrolysis facility design will support data acquisition and control the Green Hydrogen Production Facility operational components. The proposed Arrowsmith Domestic (AHP) system will be fully scalable and customisable, allowing implementation of a system control concept required to meet local grid/off grid requirements or site battery storage options.

8.1 Production Water Process

8.1.1 Water

Production water abstraction will require a maximum of approximately 2,340 kL of water per day for hydrogen processing activities.

Groundwater field testing tests have confirmed that the Yarragadee aquifer has sufficient water resource and can be utilised for water abstraction for project operational requirements (Cardno, 2021a) et al.

Three operational groundwater production bores will be strategically installed adjacent to the Green Hydrogen Production Facility to facilitate groundwater extraction during operations. The extracted bore water will undergo a two-stage treatment process including a water filtration system to remove suspended solids, salts and other particulate matter.

8.1.2 Water Treatment

Testing has shown that site groundwater is brackish and typically contains dissolved salts and minerals, resulting in a slightly salty taste, and will require treatment prior to use in the electrolysation process. Raw water will be treated using reverse osmosis and EDI to remove salts and impurities from the groundwater to meet electrolyser water quality specifications.

The filtered water will be directed to a two-stage Electrodeionisation (EDI) system. EDI is a continuous, chemical-free process designed to remove ionised and ionizable species from feedwater, ensuring high purity of the water. This approach ensures the removal and concentration of minerals and impurities from the filtered water, producing a continuous production stream.

This purified water will then be fed into above-ground storage tanks within the Green Hydrogen Production Facility (GHPF). From there, it will be piped directly to the electrolysis units where hydrogen production occurs.

By combining water filtration and EDI technologies, the groundwater used in the hydrogen production process will meet stringent quality standards, supporting efficient and reliable operations of the facility.

The concentrated mineral waste, containing the captured minerals, salts and impurities, will be managed during the Part V approvals submission (EP Act 1986).

This disposal process will Adhere to regulatory guidelines and environmental standards to prevent any adverse impact on the surrounding environment or ecosystem.

8.1.3 Chemical Storage

Hydrogen can exist in both gaseous and liquid states depending on the conditions of temperature and pressure:

Gaseous State: Hydrogen is naturally found in its gaseous form at standard temperature and pressure (STP), which is around 0 degrees Celsius (32 degrees Fahrenheit) and 1 atmosphere (atm) of pressure. In this state, hydrogen molecules move freely and independently, occupying a larger volume.

Liquid State: Hydrogen can be liquefied at extremely low temperatures and high pressures. To liquefy hydrogen, it needs to be cooled below its boiling point of approximately -253 degrees Celsius (-423 degrees Fahrenheit) and maintained at pressures around 1 atmosphere or higher. In its liquid state, hydrogen occupies a much smaller volume compared to its gaseous state, making it more dense and easier to store and transport.

On-site storage of hydrogen often involves specialised storage tanks or vessels designed to maintain the required low temperatures and pressures for keeping hydrogen in its liquid state. This liquid hydrogen can then be used as a fuel source or for various industrial applications where gaseous hydrogen may not be as practical or efficient.

Transporting hydrogen in its liquid state offers advantages in terms of volumetric density, making it more efficient for storage and transport compared to gaseous hydrogen. However, maintaining hydrogen in its liquid state at extremely low temperatures presents challenges due to thermal heat leakage. This heat leakage can cause the temperature of the liquid hydrogen to rise within storage tanks, potentially leading to vaporisation.

To address this challenge, several strategies and technologies will be employed:

Insulation: High-quality insulation materials are used to minimise thermal heat leakage from the surroundings into the storage tanks. These insulation systems help maintain the low temperatures required for keeping hydrogen in its liquid state.

Cryogenic Storage Tanks: Specialised cryogenic storage tanks are designed to store and transport liquid hydrogen safely. These tanks are often double-walled with a vacuum layer between the walls to further reduce heat transfer.

Active Cooling Systems: Some storage systems incorporate active cooling systems that continuously cool the liquid hydrogen to counteract heat leakage. These systems may use cryocoolers or other refrigeration methods to maintain the required low temperatures.

Venting and Pressure Relief : Hydrogen storage facilities will be equipped with venting systems for both normal operating requirements and emergency situations. Vent lines for hydrogen (including pressure relief lines and boil-off from cryogenic systems) will be routed to a safe outside location.
Vent lines are also used to dispose of hydrogen purged from the system for maintenance. The vent will be designed to prevent moisture or ice from accumulating in the line.

Potassium hydroxide: (Potassium hydroxide (KOH) is commonly chosen for alkaline water electrolysis due to its ability to enhance conductivity significantly), sodium hydroxide (used in the water treatment system) and diesel for initial construction purposes will be stored onsite within the Green Hydrogen Production Facility area.

Chemicals will be stored in accordance with Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007) on hardstand areas within secondary containment (Critical Containment Infrastructure).

By employing these technologies and strategies, the challenges associated with maintaining hydrogen in its liquid state during transport can be effectively addressed, ensuring the safe and efficient handling of liquid hydrogen in various applications.

Figure 10: Indicative Storage

8.1.4 Thermal Management System

The heat generated as a by-product during the electrolysis process will be carefully managed and repurposed to optimise system performance and overall efficiency. Through sophisticated thermal management systems, this extracted heat will be redirected to support various functions within the electrolysis process, such as maintaining optimal operating temperatures or powering ancillary processes. By effectively utilising this thermal energy, the electrolysis system can operate more efficiently and achieve higher levels of productivity while minimising energy waste.

To maintain the cooling water system, demineralised water will be employed to replenish the water within the system. Additionally, facility storage tanks will be utilised to contain any excess cooling water, enabling recycled water to flow back into the system.

8.1.5 Flare

An emergency hydrogen flare will be installed to address potential process malfunctions or plant emergency shutdowns. This flare is designed to be positioned at a height of 10 meters above ground level to enhance dispersion and meet safety regulations. Compliance with the necessary exemptions outlined in the Bushfires Act 1984 will be applied when utilising this flare during operational needs.

8.1.6 Vent System

An oxygen venting system will be installed at a height of one meter above ground level to safely manage the discharge of oxygen produced during the electrolysis process. This system is designed to release excess oxygen in a controlled manner, ensuring it disperses into the atmosphere avoiding accumulation at ground level, thereby maintaining equilibrium with surrounding atmospheric pressure. The height and placement of vents are strategically determined based on detailed dispersion modelling, that evaluates gas flow and distribution patterns. Thorough explosion risk assessments to safeguard against potential hazards will be implemented. This design managed and mitigates oxygen build-up within confined spaces, adhering to stringent safety and environmental standards.

By implementing this oxygen venting system, the project prioritises the safe handling and controlled release of oxygen gas, effectively mitigating potential hazards associated with its accumulation. Utilising dispersion modelling and thorough risk assessments, the precise planning of vent locations minimises environmental impact and ensures strict compliance with safety standards.

Hydrogen release and dispersion into ambient air will occur intermittently during venting associated with the electrolysis process and storage phases. The venting of hydrogen creates a combustible cloud, necessitating careful adherence to mandatory separation distances governed by fire codes and standards. A comprehensive understanding of hydrogen dispersion behaviour, combustion properties, and associated thermal effects, both during and after venting, is crucial for meeting environmental and safety mitigation requirements. This approach ensures that the facility's design and operations effectively manage the unique risks associated with hydrogen, maintaining safety and sustainability across all operational phases.

Due to the transient behaviour of calculated variables within hydrogen gas release (pressure, gas density, velocity and hydrogen concentration, the separation distance from the oxygen venting to the hydrogen flare stack is designed to prevent an increased flammable atmosphere. The mandatory separation distance required are governed by international fire codes IFC and operating standards. Clearing distances required when venting hydrogen, construction layout will be based on computational fluid dynamics (CFD), hydrogen dispersion results and thermal effects from burning.

8.1.7 Nitrogen system

The nitrogen system extracts nitrogen from the air for purging of the electrolyser and blanketing of the treated water. This prevents oxygen and carbon dioxide being absorbed into the water supply.

8.1.8 Service Water

Water is pumped from the raw water tank to a service water tank. The water will then be distributed around the facility as required.

8.1.9 Potable Water

Service water will be sent to a freshwater maker and stored within a day storage tank as potable water for site personnel and site safety (eye wash station, safety showers etc.).

8.2 Hydrogen Compression and Storage

Hydrogen will be compressed to 30 bar and sent to a liquefaction unit.

8.2.1 Hydrogen Liquefaction and Storage

The liquefaction system will initially process up to 23 tonnes per day, with a planned install of additional electrolysers and liquefaction units with an output capacity that can achieve up to 42 tonnes per day of hydrogen at below -253 C.

Liquified hydrogen will be stored in cryogenic hydrogen storage tanks with up to 50 tonnes capacity at the GHPF.

8.2.2 Hydrogen Loadout

The hydrogen loadout area is being purposefully designed to accommodate the operational requirements of road trains, ensuring efficient and safe transportation. The facility will comply with all relevant refueling standards, including those governing hydrogen safety and handling. Access to the loadout area will be provided via the Brand Highway, enabling seamless transportation and refueling activities while adhering to applicable regulatory guidelines and ensuring operational safety.

Liquid hydrogen will be conveyed from the Green Hydrogen Production Facility to the load-out area through a complex piping infrastructure. At the load-out area, it will be transferred into tankers utilising liquid loading pumps, a liquid hydrogen metering skid, and specially designed loading arms. Subsequently, hydrogen-fuelled trucks will transport the liquid hydrogen off-site via road using cryogenic liquid tankers. Each truck has the capacity to carry approximately seven tonnes of liquid hydrogen per trip.

8.3 Vehicles and Machinery

During operations, it is anticipated that only light vehicles will be accommodated onsite. Other heavy vehicles and plant equipment would be mobilised if maintenance or repair is required (e.g. cranes and excavators).

Regional Context

9 Regional Context

The Proposal is located within the Arrowsmith region, 30km south of the town of Dongara in Western Australia, approximately 300km north of Perth.

In this section, we delve into the social, economic, and environmental context surrounding the project area. This exploration is crucial for understanding how landscapes are experienced and how the project is perceived, ultimately contributing to the overall 'Experience' aspect.

While the fundamental elements shaping a renewable energy project and its integration with the landscape are rooted in environmental and physical factors, socioeconomics and demographics play a significant role in shaping how landscapes are perceived and experienced by individuals and communities. These factors influence people's interactions with the environment, their attitudes towards renewable energy developments, and the overall societal impact of such projects. Therefore, a comprehensive understanding of the social, economic, and environmental context is essential for effectively assessing the project's overall impact and fostering positive community engagement.

9.1 Socio-Economic Setting

The proposed project area is located within the Shire of Irwin in the Arrowsmith region. It is situated 30 km south of Dongara town (Shire of Irwin) and 41 km north of Eneabba town (Shire of Carnamah) (see Figure 1). The site includes nearby settlements such as Allanooka, Bookara, Port Denison, Springfield, and Yardarino, all falling within the Shire of Irwin.

The Mid-West Region is known for its diverse social and economic development, with sectors like mining, agriculture, tourism, and fishing playing significant roles. Mining is particularly valuable, as the region has abundant minerals and energy deposits such as gold, iron ore, copper, nickel, silver, and natural gas. This has led to substantial employment growth, with new mining and construction projects and job expansion in associated service sectors.

The Shire of Irwin's economy is primarily based on general farming, the oil and gas industry, the rock lobster industry, mineral sands, and olive cultivation and production. According to the Australian Bureau of Statistics (ABS) 2016 Census data, the population of the Shire of Irwin is 3,569, with a nearly equal gender distribution. The main employment sectors for residents in and around Irwin are technicians and trade workers, with additional opportunities in accommodation, supermarkets, and grocery stores. Dongara and Port Denison are the key tourist destinations within the Shire, with the majority of visitors being domestic.

Limited data is available for the Shire of Irwin specifically, but it is estimated that Dongara-Port Denison receives around 138,000 annual visitors from both international and domestic tourists, based on a four-year average from 2016 to 2019.

The consideration of Natural, Built, and Cultural Heritage is crucial, particularly concerning the protection of designated areas. Developments must demonstrate that they do not compromise the natural environment, amenity, and heritage resources of the region. In cases where there may be significant adverse effects, these must be clearly offset by social or economic benefits of regional significance. Moreover, the development should contribute to supporting communities in fragile areas that struggle to retain their population and essential services. This holistic approach ensures that developments not only preserve heritage and environmental values but also contribute positively to the socio-economic fabric of the region, especially in areas facing challenges in sustainability and community resilience.

The city of Geraldton lies approximately 95 km north of the Proposal area, and is a major, regional city within the mid-west region, with a population of 38,634 (ABS, 2016b).

9.2 Native Title

The Proposal is located within a native title application area (Southern Yamatji (Tribunal File No WC2017/002)) and determination area (Tribunal File No WCD2020001). The Proposal is located on freehold land and is within the Surrendered Area under the Yamatji Nation Indigenous Land Use Agreement (ILUA), Registered in October 2020 (DPC, 2020).

9.3 Land tenure

The Proposal was formerly located on four freehold lots and has now been amalgamated in to one single lot (702) owned by IGE. The land has been rezoned from 'General Farming' (DPLH, 2018). The eastern portion has been partially cleared for cropping and grazing and the western area of the DE is predominantly undisturbed and partially grazed.

9.4 Land use

Land use in the surrounding area is dominated by agriculture (cropping and grazing). Several oil and gas production facilities operate within the Arrowsmith Development Area (ADA) including mineral sand mining near Eneabba. (See table 7, Industrial developments)

The coastal towns in the region including Dongara, support a successful crayfishing industry with Beekeepers Nature Reserve (BKNR) situated adjacent to the development area.

9.5 Anticipated Air Emissions

The total Scope 1 and 2 emissions associated with the Proposal construction and operation are shown in Table 5.. This includes emissions associated with the manufacture of equipment and transport to site (including site personnel air travel). There are no Scope 3 emissions from the product.

Table 4: Proposal CO_2 Emissions

Type	**Stage**	
Greenhouse Gas (t CO_2-e)	Construction Total	Operations Total
Period	24 months	25 years
Scope 1	7,182 tpa	316 tpa
Scope 2	0	0
Total	**14,365 (t CO_2-e)**	**7,900 (t CO_2-e)**

9.6 Climate

The Mid-West region of Western Australia has been classified as a Mediterranean climate with dry hot summers and cool wet winters. The closest BoM Weather station for long term rainfall data (1951-2023) is Green Grove (Station Number 8057), located about 2 km to the southeast of the Proposal area. Closest long term temperature data (1940-2023) were taken from Carnamah (Station Number 8025) about 50 km to the east of the proposal. Annual rainfall is 485.3 mm on average with June having the largest monthly mean with 105.3 mm. Mean maximum temperature is recorded for January with 36.2 °C and lowest mean maximum in July with 18.1 °C (Figure 11).

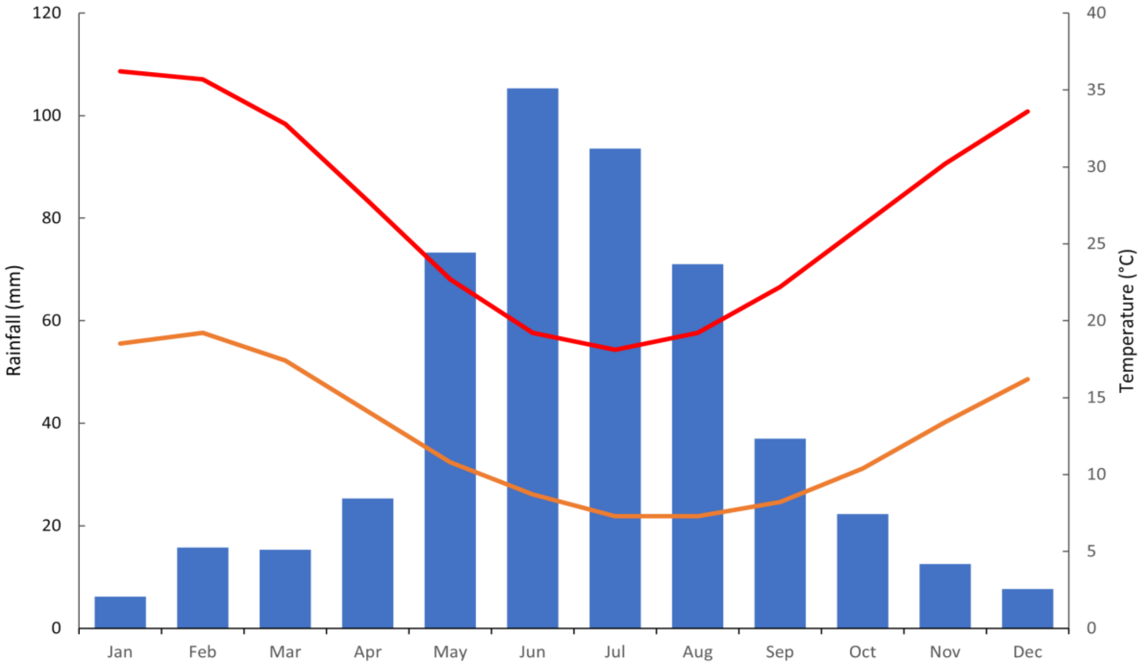


Figure 11: Long term mean monthly rainfall, minimum and maximum temperatures (BoM, 2023).

9.7 Interim Biogeographic Regionalisation of Australia

The Proposal is within the Geraldton Sandplains 3 (Lesueur Sandplain) subregion of the Geraldton Sandplains Interim Biogeographic Regionalisation of Australia (IBRA) bioregion. The subregion contains shrub-heaths rich in endemics occurring on a mosaic of lateritic mesas, sandplains, coastal sands and limestones, with heath on lateralised sandplains occurring along the subregions north-eastern margins (Desmond & Chant, 2001).

9.8 Nature Reserves

There are no nature reserves within the Development Envelopes. Beekeepers Nature Reserve is situated adjacent to the boundary of the existing Arrowsmith Development Envelopes.

9.9 Soil-Landscape Zones

Soil-landscape zones are regional units based on geomorphologic or geological criteria. The Development Envelopes lies within the Geraldton Coastal soil-landscape zone, described as: Low hills of Tamala limestone, recent calcareous and siliceous dunes with alluvial plains and sand sheets. Mainly shallow and deep sands with some loamy and sandy earths (Schoknecht et al., 2004).

There are four mapped soil types within this soil-landscape zone in the Proposal area (Table 6)).

Table 5: Soil landscape mapping within the Proposal area (Schoknecht et al., 2004).

Soil Type	Description
Tamala South 3 (221Ta_3)	Low hills with relict dunes and some limestone outcrop; deep and shallow yellow sand over limestone
Tamala South 4 (221Ta_4)	Low hills with relict dunes and some limestone outcrop; yellow shallow sand with limestone outcrops and yellow deep sand
Tamala South 5 (221Ta_5)	Low hills with relict dunes and some limestone outcrop; calcareous shallow and deep sand
Correy 3 Subsystem (221Cy_3)	Rarely inundated flats and depressions; cracking and non-cracking clays and pale sandy earths

9.10 Karst Formation

The Tamala limestone ridges within the project areas represent relict aeolian calcarenite coastal sand dunes. Where the original calcium carbonate in the dunes has been leached, limestone formed beneath the soil. Caves and other karst features can develop where the limestone underwent dissolution over time, primarily through the action of carbonic acid from rainwater and atmospheric CO2.

The dissolution of limestone is a fundamental process in karstification, that may result in a network of underground voids and conduits. Karst landscapes in limestone are distinguished by the emergence of unique surface and subsurface features, such as sinkholes, caves, underground rivers, and enlarged fractures and conduits. Karst formations and caves typically manifest near groundwater levels.

There are two known caves (Arramall and River caves) in the eastern section of the project area. No information on other caves within the Project Area is available and nor have other significant Karst features been identified during the planning process for the Project.

Site investigations have indicated that the water table is approximately 2 meters above sea level. Due to the landscape elevation any planned infrastructure (e.g. turbine footings) will be at least 6 m above potential karst features.

To mitigate potential risks associated with suspected voids and unsuitable substrate formations, the construction of the Green Hydrogen Production Facility and related infrastructure will avoid cave systems during the construction phase based on further detailed geophysical examination. The cave areas are shown below. Also refer to Section 11.2 for further discussion on the caves.

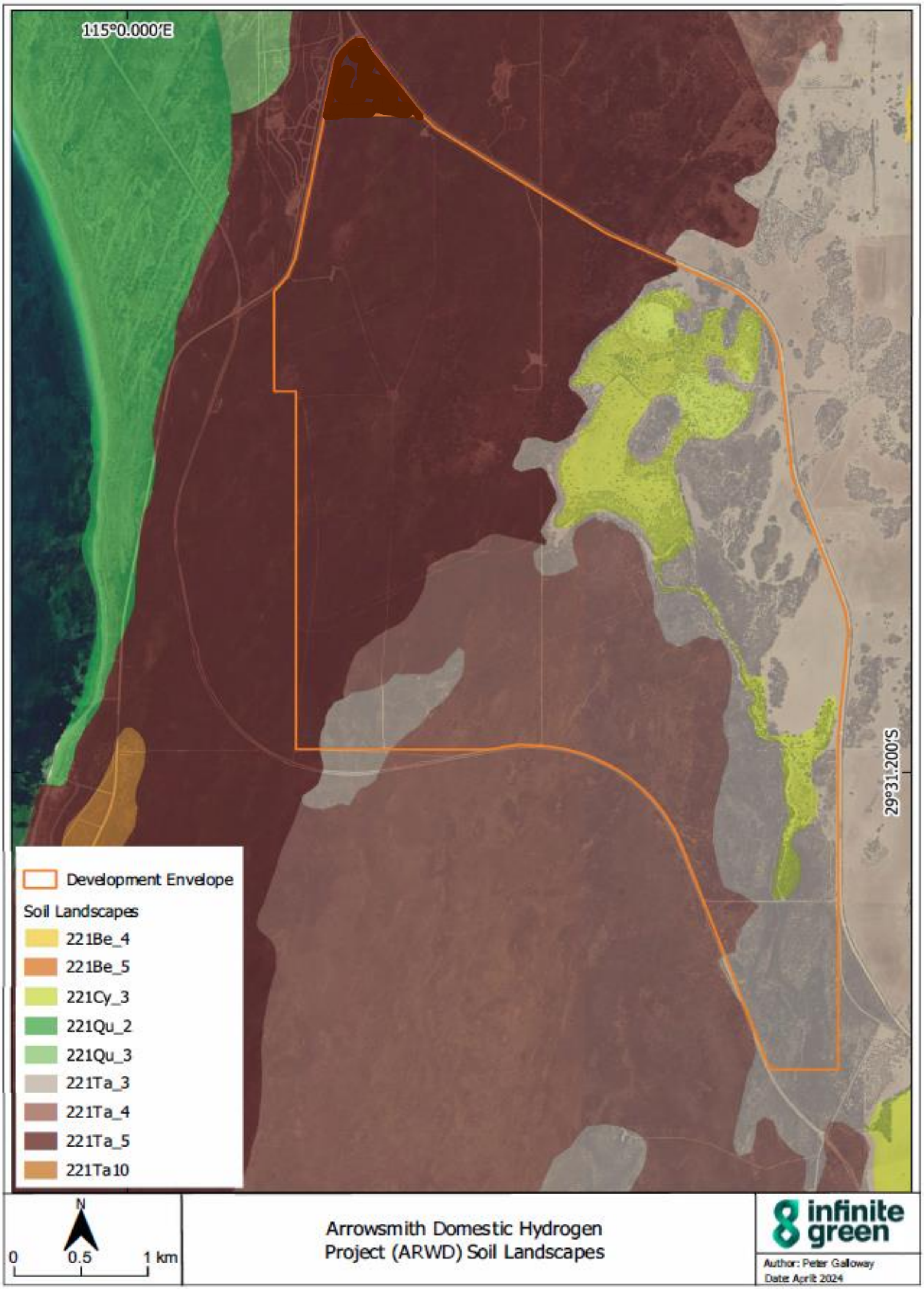


Figure 12: Proposal Area Soil Landscapes.

Figure 13: Indicative Cave Limits

9.11 Contaminated sites

The nearest reported contaminated site is located 10 km to the east of the AHP Development Envelopes comprising groundwater and soil contamination impacted from hydrocarbons, located adjacent to the Beharra Springs Gas Plant (DWER, 2020).

9.12 Conservation Estate

The nearest conservation estate location to the Development Envelopes is Northern Beekeepers Nature Reserve (BKNR) (Crown Reserve 24496) which abuts the western boundary of the Proposal area (Figure 14). BKNR extends from Greenhead, 55 km south of the Proposal area to 6 km south of the town of Dongara.

The Yardanogo Nature Reserve (Crown Reserve 36203) is located 3.3 km to the north-east of the Proposal Development Envelopes (Figure 14)

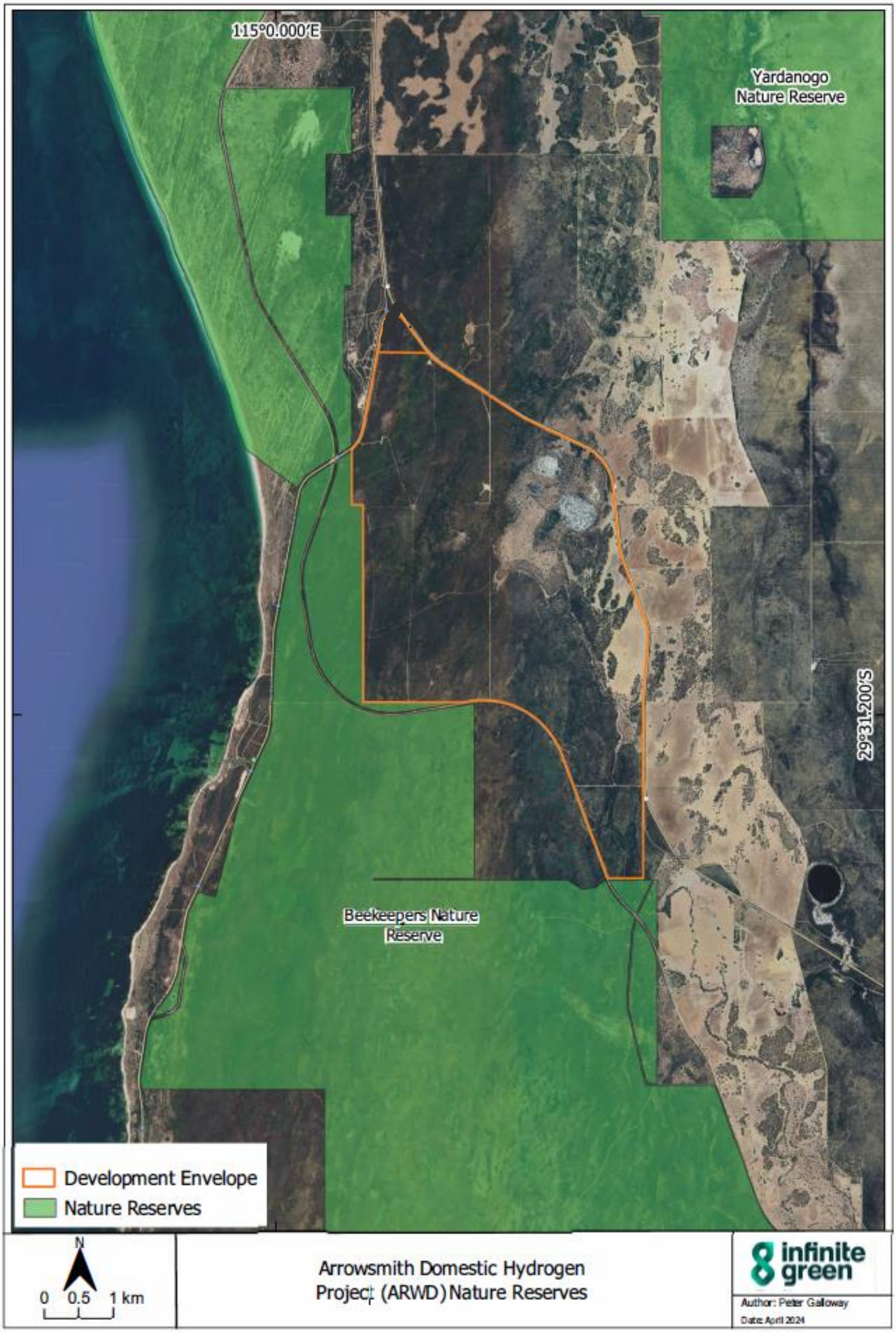


Figure 14: Beekeepers Nature Reserve (BKNR)

9.13 The Arrowsmith Development Area

Table 6: Industrial Developments within the Arrowsmith Area

Variable / Company	*Infinite Green*	Perpetual Resources	VRX Silica	Strike Energy Ltd	Iluka	Beach Energy
Proposal name	*Arrowsmith Hydrogen Project (AHP)*	Arrowsmith West	Arrowsmith North	West Erregulia & Project Haber	Rare Earth Refinery	Waitsia
Type	*Hydrogen & Renewables*	Silica Sands	Silica	Gas	Rare Earth: Mineral Sands	Gas
Location	*Arrowsmith Hub Shire of Irwin*	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Three springs	Arrowsmith Hub Shire of Carnamah	Arrowsmith Hub Shire of Irwin
IBRA Bioregion	*Geraldton Sandplains GES02, Lesueur Sandplain*	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain
Variable / Company	**Cockburn Cement**	**Tronox**	**Triangle Energy**	**Pilot Energy**	**Mitsui E&P**	**MinRes Energy**
Project name	Arrowsmith Hub	Dongara Project	Mt. Homer/Cliff Head	Arrowsmith Cliff Head	Waitsia	Lockyer Deep 1
Type	Lime sand	Mineral Sands	Oil &Gas	Oil	Gas	Gas
Location	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Mt. Homer/Cliff Head Arrowsmith hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Lockyer Shire of Mingenew
IBRA Bioegion	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain

9.14 Stakeholder Engagement

9.15 Consultation

IGE has identified essential stakeholders for the project, including local Traditional Owners, the Western Australian Speleological Group (WASG), relevant Commonwealth, State, and Local Government representatives and departments, as well as community members, regional industry players, and the media. To ensure transparent communication and responsiveness, IGE is committed to ongoing consultation throughout the construction and operational phases, keeping stakeholders informed of project developments and addressing any concerns.

Furthermore, IGE will actively engage with the Indigenous Yamatji people, fostering collaboration with local community groups to create commercial, employment, and training opportunities. This approach reinforces IGE's commitment to building strong, positive relationships with stakeholders and supporting local community development.

IGE has consulted with a number of key stakeholders in relation to the Arrowsmith Hydrogen Proposal Activities, including::

- DWER including the EPA,
- DBCA
- DCCCEW
- DMIRS, Dangerous Goods Safety and Major Hazard Facilities
- The Shire of Irwin
- City of Greater Geraldton
- ARC Infrastructure
- Landowners
- Western Power
- MRWA
- VRX Silica
- Mitsui Exploration and Production Australia
- Beach Energy
- Strike Energy
- Southern Yamatji Regional Corporation
- Region specific WA and Federal Government elected representatives
- Midwest Development Commission
- Department of Jobs, Tourism, Science, and Innovation
- Department of Planning, Lands and Heritage
- Department of the Premier and Cabinet
- Department of Transport
- WA Chamber of Commerce
- Mid-West Ports Authority
- WASG

9.16 Consultation: Western Australian Speleological Group (WASG)

The Western Australian Speleological Group (WASG) raised concerns regarding potential impacts to existing cave systems within the proposed development area and has submitted a catalogue of requests for IGE to address. In response to these concerns, IGE has adjusted its turbine layout and relocated infrastructure within the Development Envelopes to avoid impacts upon cave systems, as well as both terrestrial and subterranean landforms.

IGE has carefully considered WASG's concerns and directions, particularly regarding environmental impacts on surrounding areas, including impacts to fauna and groundwater/surface water systems. In line with these concerns, IGE has implemented a range of mitigation measures to address these issues comprehensively. As part of this approach, no development, disturbance, or construction activities will occur within cave system areas.

The specific IGE response, along with detailed mitigation measures, is outlined in the attached 'Cavers Response Report' and the 'Other Environmental Factors' section within the attached appendices. These documents provide further information on how IGE plans to safeguard the integrity of the cave systems and surrounding environments throughout the development process.

IGE commits to ongoing discussion and future access for the group to engage in speleological activities in the context of site accessibility including aspects of safety during construction and heritage land use values. The cave system (Arramall Caves and River Caves) have been identified as heritage places by the Yamatji people and recommendations were given to avoid these areas (Sticks and Stones Cultural Resources Management, 2021).

Table 7 below summarises the key consultation events, topics raised and responses. IGE will continue to engage with a range of stakeholders throughout the lifecycle of the Proposal.

Stakeholder Engagement Tables

9.17 Stakeholder Engagement

Table 7: Stakeholder Engagement Register

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
Department of Water and Environmental Regulation (DWER)	22/05/2019	Meeting	Stephen Gauld (IGE) Mathew Gannaway (DWER) Jessica Burton (DWER) Peter Knol (DWER) Paul Byrnes (DWER)	A presentation was given by IGE to Clearing Regulation and Industry Regulation officers. IGE asked for clarification in a follow-up email (28/05/2019) on approvals and timeframes for approvals.	DWER (MG) replied on 31/05/2019 with information on assessment times and advised that delays in assessments can only be determined during the assessment process. DWER also advised that the proposed works are located in the Arrowsmith groundwater area and a licence may be required to abstract groundwater. The link to the water licencing page was provided. DWER (PB) replied with information regarding works approvals and licences. DWER stated that

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					definitive timeframes are unable to be provided. DWER advised that the presentation by IGE did not cover the following approvals - Works approval, licencing, groundwater abstraction licencing, referral to the EPA.
Region Specific WA and Federal Government elected representatives	01/05/2020	Letter	Mark McGowan MLA Premier WA Angus Taylor MP Melissa Price MP, Member for Durack Melissa Price MP, Member for Durack Senator Louise Pratt Federal MP Shane Love MLA Member for Moore	Introduction of IGE AHP with elected representatives.	Letters of support received in response.
Region Specific WA and Federal Government elected representatives	01/05/2020	Letter	Mark McGowan MLA Premier WA Angus Taylor MP Melissa Price MP, Member for Durack Melissa Price MP, Member for Durack Senator Louise Pratt Federal MP Shane Love MLA Member for Moore	Introduction of IGE AHP with elected representatives.	Letters of support received in response.
Midwest Development Commission	14/05/2020	Letter	Rebecca Davidson (Energy, Resources and Economics) IGE	Potential impact of AHP on regional economy.	

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
Department of Jobs, Tourism, Science and Innovation	22/05/2020	Meeting	DJTSI Hydrogen Team IGE	Engagement with Hydrogen team.	
Shire of Irwin	28/05/2020	Meeting	Shane Ivers, CEO IGE	Introduction of IGE AHP.	
DWER - EPA services (EPA)	3/09/2020		Hans Jacob (EPA) Leanne Thompson (EPA) Jake Cutler (EPA) IGE	Pre-referral meeting was held to discuss the proposal and referral Groundwater was raised as an issue. Carnaby's cockatoo was raised as an issue - potential foraging habitat in the area.	IGE will make contact again once the results of the flora, vegetation and fauna surveys are received.
Mark McGowan MLA	2/09/2020	Letter	Mark McGowan MLA IGE	Request that JTSI re-engage with IGE to determine potential assistance.	
Department of Jobs, Tourism, Science and Innovation (WA)	6/10/2020	Meeting	DJTSI Hydrogen Team IGE	Engagement with Hydrogen team.	
EPA	4/02/2021	Meeting	Leanne Thompson (EPA) Jake Cutler (EPA) Natalie Lauritsen (DWER) Tim Hodge (IGE) Stephen Gauld (IGE) Clare Hobson (Xodus) Naomi Kerp (Xodus)	Updates to the Project scope, outcome of technical studies (including Flora, Vegetation and Fauna survey report were discussed. DWER provided advice on key factors.	

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
EPA	11/02/2021	Phone	Jake Cutler (EPA) IGE	Phone call from EPA stating that there had been a request that the Proposal is presented to the EPA Board. Date TBC	Meeting organised on 22/02/2021 for the 10/03/2021 to meet with EPA Chairman and DWER assessing officers. Power point sent to EPA prior to meeting (09/03/2021)
EPA	10/03/2021	Meeting	Leanne Thompson (EPA) Jake Cutler (EPA) Matthew Tonts (EPA) IGE	Meeting with EPA Chairman and DWER assessing officers. Issues raised included water management, minimising clearing, visual impact, bird strike. EPA requested clarification on water usage for future expansion.	EPA followed up the meeting with an email outlining some further issues to consider including cumulative impact, altered surface water regimes and using similar language as in the Statement of Environmental Principles.
EPA	9/04/2021	Email	Leanne Thompson (EPA) Jake Cutler (EPA) IGE	IGE query as to the implications of the VRX Silica referral published on the EPA website which impacts IGE's land holding. What does this specifically mean for the IGE referral?	Leanne Thompson spoke with the Mining South Assessment team and said that it is recommended that IGE follow up with VRX regarding the overlapping Development Envelope and please keep her in the loop with outcomes.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
EPA	23/09/2021	Meeting	Leanne Thompson (EPA) Jake Cutler (EPA) Stephen Gauld (IGE) Martyn Anderson (IGE) Andrea Wills (IGE)	Meeting with EPA to present modified proposal and additional environmental factor surveys. Referral to be submitted in late Q4 2021.	
DWER Water Licencing	23/11/2021	Online Enquiry	Natalie Lauritsen (DWER) IGE	Planning advice request via water online.	Reply from Natalie Lauritsen (Water Licencing Midwest Gascoyne) providing advice on groundwater resources in the area and stated that some assessment would be required to determine impact to GDE and to ensure long term sustainable water supply to the Project.
DWER Water Licencing	08/02/2021	Email	Natalie Lauritsen (DWER) Stephen Gauld (IGE)	Received water allocation availability from Natalie Lauritsen.	
DWER Water Licencing	28/04/021	Email	Natalie Lauritsen (DWER) IGE	IGE contacted DWER to discuss the best approach for water licencing and a 5C Licence application submission.	DWER advised submit licence application ASAP to advise on level of investigation Required, and assessment can be undertaken in parallel with the EPA referral process.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
DWER Water Licencing	16/06/2021	Phone	Nick (DWER) Andrea Wills (IGE)	IGE inquiry into groundwater licences on Arramall Property.	DWER advised no historical licenced bores issued on the Development Envelope. Two existing farm bores are located within the Development Envelope, with small volume abstraction for stock watering. No licence required.
DWER Water Licencing	24/06/2021	Email	DWER Automated System Andrea Wills (IGE)	Submission of Groundwater licence applications (5C and 26D) for the superficial aquifer.	Automatic confirmation of receipt email received.
DWER Water Licencing	29/06/2021	Email	Natalie Lauritsen (DWER) Andrea Wills (IGE)	DWER query on licence application and request for construction information on the bores. DWER notified IGE that the maximum construction period would be 12 months.	IGE provided a bore construction diagram and confirmed they would be constructing two bores.
DWER Water Licencing	24/06/2021	Email	midwest@dwer.wa.gov.au Andrea Wills (IGE)	Application for a Licence to Construct and Licence to Take Groundwater from a Superficial Groundwater Bore.	A request for further information was made and responded to on 29/06/2021.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
DWER Water Licencing	17/08/2021	Phone	Natalie Lauritsen (DWER) Andrea Wills (IGE)	IGE query on records of groundwater bores on Arrowsmith Property. The soak identified during the heritage survey is the only record in the DWER database. DWER emailed an image of the location of the Record during the phone conversation.	
DWER Water Licencing	16/09/2021	Email	Clea Latimer (DWER) Andrea Wills (IGE)	Issue of Licence to Construct CAW206272(1) a Superficial Groundwater Licence.	
DWER Water Licencing	10/11/2021	Email	Clea Latimer (DWER) Andrea Wills (IGE)	Request from DWER for additional information before 5C licence can be issued (App 042964).	
DWER Water Licencing	10/11/2021	Phone	Clea Latimer (DWER) Andrea Wills (IGE)	Discussion of IGE's requirement to abstract more groundwater (total of 0.9GL) and advice that Yarragadee would be more suitable for this abstraction. DWER advised they would check allocation available.	DWER followed up with email advising that there was 1.2GL available for licencing in the Yarragadee aquifer and that a new 26D and 5C application would need to be submitted.
DWER Water Licencing	01/12/2021	Email	midwest@dwer.wa.gov.au Andrea Wills (IGE)	Application for a Licence to Construct and Licence to Take Groundwater from two Yarragadee Groundwater Bores.	

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
DWER Business Support Unit	29/06/2021	Email	Tina Taraborrelli (DWER) Andrea Wills (IGE)	DWER requested details of IGE's legal access to Lot 100.	IGE provided the contract of sale.
DWER – Water Management	09/02/2021	Email	IGE Adrian Goodreidfac (DWER)	Request for advice on water management, particularly discharge to the lake and/or aquifer recharge.	A follow up email was sent 22/02/2021.
DWER – Water Management	23/02/2021	Email	Joanne Mannering (DWER) IGE	Adrian Goodried had asked Joanne to assist with IGE's request. Joanne asked for some further information about the site and the proposal. IGE emailed the flora and vegetation report and further information to Joanne on 25/02/2021.	DWER advised on 02/03/2021 that further investigations on the extent of GDE and the impacts on them from groundwater abstraction and discharge of the reject water was recommended. IGE to follow up this recommendation.
Department of Mines, Industry Regulation and Safety (DMIRS MHF and DGs)	21/03/2021	Meeting	Stephen Gauld (IGE) DMIRS	Introduction of IGE AHP. Discussions of MHF and Dangerous Good Requirements.	
DMIRS MHF and DGs	12/05/2021	Meeting	Stephen Gauld (IGE) Lawry Lim (DG) Luke van Baaren (MHF), Nathan Sumner (DG) Steve Williams (IGE) Andrea Wills (IGE) Martyn Anderson (IGE)	IGE presented an update of the AHP1 Project and group discussed approvals approach and requirements. MHF application will take approximately 12 months.	IGE should include DMIRS in workshops and pre-application technical discussions.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
			Izzi Messina (IGE)		
Main Roads Western Australia	02/04/2021	Meeting	Stephen Gauld (IGE) Main Roads	Introduction of IGE AHP. Discussions of interactions with Main Roads jurisdictions.	Main Roads responded with acceptable site entry/exit points. IGE has incorporated the acceptable entry/exit points into plot design.
Main Roads Western Australia (MRWA)	22/06/2021	Email	Patrick Whitehouse (MRWA) Stephen Gauld (IGE)	MRWA advice on signage for the approach and access point signage for Arrowsmith Hydrogen Project.	IGE to prepare application.
Main Roads Western Australia	20/07/2021	Phone	Andrea Wills (IGE) Patrick Whitehouse (MRWA)	Discussion on upcoming submission of application to put signs on Brand Highway. Contractor to be used is Westline who is used regularly by MRWA and is acceptable. MRWA will look out for application.	IGE to submit application.
Shire of Irwin	5/02/2021	Phone	Brendan Jeans (SoI) Tim H Andrea Wills	Discussed the Shire's planning approval requirements, particularly regarding noise. Brendan to send response outlining planning requirements.	Response from Brendan - Development Approval via DPLH Regional Joint Development Assessment Panel as it's over the financial threshold for Development Applications IGE to confirm other planning requirements:

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					Sewage management BAL assessment/bushfire management plan Construction EMP Visual impact assessment IGE to engage Noise and Visual Impact Assessment consultants.
Shire of Irwin (SoI)	09/07/2021	Phone	Shane Ivers (SoI) Andrea Wills (IGE)	Discussion on signage to be placed on Brand Highway. SoI referred IGE on to Westline Contracting to do the work and Patrick Whitehouse at MRWA for approvals.	SoI followed up with an email confirming contact details for Westline Contracting.
YSRC	02/09/2020	Letter	Stephen Gauld (IGE)	Overview of the Project and opportunity to comment emailed to YMAC.	No response.
Yamatji Southern Regional Corporation (YSRC)	16/02/2021	Letter	YSRC IGE	Overview of the Project and opportunity to comment sent.	Response received from Allan Wedderburn from Red Spinifex. Standard Proponent Heritage Agreement attached and note to liaise with Sticks and Stones Cultural Resource Management (SandS CRM) for heritage as they are contracted by

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					YSRC as the heritage service provider
YSRC	24/03/2021	Letter	Paul Case (YSRC)	Letter from YSRC Implementation Officer stating that the YSRC are interested in the Arrowsmith Hydrogen Project and to please arrange a time to give a more detailed presentation/briefing.	Meeting arranged for initial presentation on 22 April.
YSRC	25/05/2021	Email	Allan Wedderburn (YSRC) Andrea Wills (IGE) Daniel Puletama (SandS)	YSRC provided a copy of the Standard Heritage Agreement Template to IGE	IGE marked up the template and returned the document signed by IGE to YSRC on 31/05/2021
YSRC	15/06/2021	Email	Allan Wedderburn (YSRC) Andrea Wills (IGE) Daniel Puletama (SandS) Izzi Messina (IGE) Martyn Anderson (IGE)	YSRC return fully executed copy of Heritage Survey Agreement	IGE then requested a quote for a heritage survey from SandS 18/06/2021.
YSRC	30/06/2021	Email / Survey	Daniel Puletama (SandS) Andrea Wills (IGE) A Heritage Survey was undertaken 27/07/2021 to 05/08/2021 by:	SandS provided a quote for the full heritage survey which was accepted via email 06/07/2021	Correspondence via email in regard to timing of survey to avoid rain before survey timing was

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
			Jai Taylor Noel Taylor Jnr Darren Callow Darren Ryan Doug Comeagain Steve Reynolds Brendon Callow Reginald Brockman Craig Kelly		established for 27/07/2021. Survey was undertaken 27/07/2021 to
Department of Biodiversity, Conservation and Attractions (DBCA)	23/10/2021	Letter	Allison Donovan (DBCA Moora District Manager) IGE	Overview of the Project and opportunity to comment emailed	Steve Buitenhuis replied and stated that DBCA Moora District will make comment during the usual Environmental Impact Assessment process
DBCA	11/02/2021	Letter	Nicholas Woolfry (DBCA) IGE	Letter to the DBCA Environmental Management Branch with an overview of the Project and opportunity to comment.	Phone call received from Cassannya Gray DBCA EMB requesting a briefing on the Project. Briefing arranged for 24/02/2021.
DBCA	24/02/2021	Meeting	Cassyanna Gray (DBCA) Michelle Corbellini (DBCA) IGE	Briefing on IGE AHP. No concerns raised.	DBCA will provide advice to EPA Services as requested
DBCA	01/10/2021	Phone	Andrea Wills (IGE) Stephen Buitenhuis (DBCA)	Stephen Buitenhuis expressed interest in the Arrowsmith Hydrogen	DBCA reiterated his comment he made when

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
				Project during a conversation about other projects. He had had some contact with the Project and he was of the understanding that the Development Envelope was previously cleared land. IGE advised him of the extent of clearing for the Project and answered questions on the sensitivities that would be impacted and avoided.	the proposal was first presented to DBCA that a review would be undertaken in detail when the Project was referred to the EPA.
Arc Infrastructure	14/04/2021	Email	Arc Infrastructure IGE	Email to Arc Infrastructure introducing the Project.	Meeting arranged for 22/04/2021
Arc Infrastructure	23/04/2021	Meeting	Arc Infrastructure IGE	IGE presented proposal to Arc.	No issues with the proposal. Arc to advise on use of access to the access roads / fire breaks to the southern boundary if required.
Western Power	19/02/2021	Meeting	Western Power IGE	Discussion around connection options to State electricity network.	Options to be pursued
A&K Gracie	23/02/2021	Meeting	Alan Gracie Kaye Gracie Stephen Gauld (IGE)	Briefing on IGE AHP and discussion on potential impacts on residence. Alan and Kaye Gracie are the closest residence to the AHP.	Acceptance of the impacts of the AHP was given and documented. Agreement was also reached to purchase the residence at

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					a time of A&K Gracie choosing.
Lake Preston Beef Company	23/02/2021	Meeting	Geoff Pearson Stephen Gauld (IGE)	Introduction of Project to neighbouring property owner and permission sought to place noise monitoring equipment on unused residence (2nd closest neighbour to AHP).	Permission granted for monitoring equipment. Option for access to land extended by Lake Preston Beef. Preliminary discussions held on lease/purchase of land.
VRX	07/04/2021	Meeting	VRX IGE	Meeting between VRX and IGE to discuss overlapping Development Envelopes	Both VRX and IGE amendable to discussions that are in the best interest to both proponents
VRX	23/11/2021	Email	Andrea Wills (IGE) Bruce M (VRX)	IGE request for contact at VRX to discuss details of VRX's groundwater abstraction to determine combined impact of two projects for the purposes of IGE's water licence application and EPA Referral.	
Western Australian Speleological Group (WASG)	20/06/2022	Web enquiry	Andrea Wills (IGE)	IGE web enquiry in regard to information on Arramall and River Caves on IGE's property.	IGE received a letter response by email from the WASG 07/07/2021 expressing interest in sharing of information to limit impacts on cave

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					formations and further exploration of the caves.
WASG	07/07/2022	Email	Andrea Wills (IGE) Daniel Lansom (WASG)	IGE responded to WASG's letter and requested a meeting to discuss a way forward to achieve the mutual objective of sharing information to limit impacts on cave formations and further exploration of the caves	WASG responded by email 14/07/2021, organising a meeting for 21/07/2021 at 5pm.
WASG	21/07/2022	Meeting	Weidi Koh (WASG) Brett Wiltshire (WASG) Greg Thomas (WASG) Ian Collette (WASG) Izzi Messina (IGE) Stephen Gauld (IGE) Andrea Wills (IGE)	Meeting to discuss: IGE's Arrowsmith Project Location of the Arramall and River Cave and associated features on the Development Envelope WASG's interest in the disturbance footprint and a common goal	WASG provided a snapshot of cave features in IGE's Development Envelopes with a request to undertake further investigation and have continuing access to the Development Envelopes.
University of Western Australia (UWA)	06/07/2022	Meeting	Pieter Poot (UWA) Neil Canby (Sunrise Energy) Andrea Wills (IGE)	Discussion of the potential to trial prostrate vegetation under a portion of the solar farm to determine the benefits and if the application will have success. There is a trial site in Gingin which has just been planted however the environment and potential vegetation types are substantially different.	UWA and Sunrise to collaborate and provide a proposal to IGE. UWA provided a proposal 09/09/2021 for a trial.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
DBCA	20/03/2023	Meeting	Cassie Reynolds Dave Harwood Peter Galloway Michael Hutt Tim Walster Murray Baker Beth Chapple Steve Buitenhuis Alanna Chant	Infinite Green Energy to provide a briefing of the Arrowsmith Hydrogen Project,	Beekeepers Impact Clarification Water extraction parameters
EPA	02/2023	Meeting	Dave Harwood Peter Galloway Michael Hutt Tonja Boyd Tim Walster	Arrowsmith Clarifications	EPA noted the importance of consultation with DBCA. EPA noted that the WA Speleological Group is active and will engage with the EPA directly on proposals. EPA clarified that the reference to cumulative impacts in the request for further information is primarily about biodiversity loss. EPA summarised offsets, cumulative impacts, and Indigenous heritage as focus areas.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					Advised environmental review document will need to show changes to the disturbance footprint
EPA	02/2023	Email	Peter Galloway Tonja Boyd	Arrowsmith clarifications	Referred to DWER for Part V approval Advice
DWER	03/2023	Office Meeting	Peter Galloway Michael Hutt Mike Sukudom Michael Greenslade	Water Extraction Clarification/strategy/Part V approvals understanding/Requirements	Yarragadee Extraction Focus Test Bore required: Desalination Plant planned/ Initial aquifer extraction water to be utilised within the hydrogen process. Extraction Report Part V approval: Focus Storage and emissions
Yamatji Marlpa Aboriginal Corporation (YMAC) is the native title representative body for the Traditional Owners of the Pilbara, Midwest,	04/2023	Site visit and further consultation regarding surveys, women's cultural heritage and archaeological deposits	Peter Galloway Daniel Puletama Michael Hutt Vera Saragih (IGE Legal) Yamatji Regional Committee **Group 1** Bobbi-lee Pearce (YSRC) Rickisha Dann (YSRC)Melanie Alone (YSRC) Karen Bonney (YSRC)	Women's Consultation and cultural heritage/Ethnographic site survey Discussion regarding results of the ethnographic survey. In particular, the importance of any identified sites to women's cultural practice. (Stakeholder engagement meeting with the Yamatji people over a 3-day period on the AHP project site)	Update New Heritage Assessment incorporating women's' cultural values. Updated report to address discussion on ethnographic aspects and findings, including ethnographic importance to Traditional Owners and

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
Murchison and Gascoyne regions of Western Australia.			Angelina Dann (YSRC)Michaela Dann (YSRC) Daniel Puletama (SandS) Bianca Waldie (SandS) **Group 2** Karen Whitby (YSRC) Delveen Whitby (YSRC)Wendy Callow Lorelle Callow (YSRC) Gail Eades (YSRC) Bianca Waldie (SandS) Daniel Puletama (SandS)		relevant Knowledge Holders. IGE Update the referral information to address the recommendations set out in the Aboriginal heritage survey report including further research on the caves, mounds (potential archaeological deposits) and stone arrangements referred to in the Aboriginal heritage survey report. (Sands Report Attached)
Midwest Development Commission (MWDC)	22/06/2023	Meeting	Peter Galloway Mike Sukudom Anthony Forbes Jose Silva	Construction Schedule Project Development Current and future needs common use infrastructure	Clarification of future developments Road infrastructure Rail infrastructure Workforce and social inclusion Land Development
Mid-West development Commission	30/08/2023	Meeting	Mike Sukudom Anthony Forbes Jose Silva Stephen Gould Sean Meredith	Arrowsmith AHP Project Development Regional Blueprint vision for the Mid West	Opportunities\ Career development Education Sustained economic growth

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
			Mick Hutt	Regional initiatives	
Western Australia Speleological Group WASG Committee	12/09/2023	IGE Perth Office Meeting	IGE Peter Galloway Oliver Krumholz Stephen Gould Mick Hutt Mike Sukudom WASG Ian Collette(President) Daniel Lansom (WASG) WASG Committee	AHP: landforms and cave System impacts and mitigation Avoidance of Cave and landforms Caves: Bat Impacts and Mitigation Revised map Defined the turbine base locations, area and solar farm location. Geotechnical survey and assessment by accredited engineers to determine turbine base locations. Heritage: Traditional owners, WASG Sites /Cave systems access Monitoring Fauna: Explained Radar technology monitoring to both mitigate fauna strike and data collection	IGE discussed impacts including Cave impact mitigation strategies. Radar technology placement Agreed to mitigate bat impacts. Both parties have collaboratively resolved and agreed upon an updated site wind turbine layout, carefully avoiding both cave systems and water bodies. IGE personnel explained the benefits of Radar technology monitoring to mitigate both bird and bat strike and data collection. Explaining radar technology not only helps mitigate the risk of bird and bat strikes but also

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					provides rich datasets that contribute to our understanding of avian ecology and inform sustainable wind energy development practices. Indigenous heritage impacts and requirements for negotiation with the Yamatji people were resolved. Both parties agreed a common goal to protect cave landforms. IGE have provided clear site map(s) with legends indicated routes of wires, pipework, above or below ground, agreed infrastructure locations. Agreed conditional site access: IGE require notice from WASG before entering a construction site.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
DWER	22/11/2023	Phone: Submission updates	Ray Carvalho	Submission updates	Clarifying information requests. Resubmission information updates.
DWER	4/12/2023	Phone: Submission updates	Ray Carvalho	Submission updates	Clarifying information requests regarding vegetation and PEC Resubmission information updates
DWER	05/12/2023	Office Meeting	Ray Carvalho Hans Jacobs Tonja Harding Oliver Krumholz	Submission updates PEC's Survey Clarification General updates Response to DBCA Document information or undertakes further investigations (i.e. targeted surveys) to clearly identify and describe the full extent and significance (local and regional) of impacts (direct and indirect) from the proposal on Priority flora species. Further investigations to clarify/confirm the presence of the Priority 1 'Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora' Ecological Community (PEC) within the Development Envelopes	Clarifying information requests regarding vegetation and PEC. Additional targeted Survey: Ecoscape encompass targeted survey and reporting on E. foecunda populations within the project area, identification of the overall extent of the vegetation types EobEorEzMOMF, AspBsBIMS, and BpLW

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
				The Significance of Beekeepers Reserve Other Environmental Factors – Landforms	
EPA/DWER	12/01/2024	Phone: Resubmission information updates	Ben Gates	IGE's Arrowsmith Hydrogen Project transferred to the Green Energy team for assessment	Resubmission information updates awaiting IGE to submit the revised additional information for assessment
Green Energy Team	02/3/ 2024	Phone: Resubmission information updates	Ben Gates	Submission updates	Resubmission information updates awaiting IGE to submit the revised additional information for assessment
MRWA Shire of Irwin	March 2024	Office Meeting: Access tracks and site accommodation	Mike Hutt Peter Galloway Sean (mayor)	Agreed site access points: IGE require MRWA clarification Proposed site accommodation locations	One Main Access gate: brand Highway agreed A number of locations are available
Green Energy IGE Shire of Irwin	April 2024	Teams Meeting	Mick Hutt Peter Galloway Ben Gates Mike Sukudom	AHP Fire Access Roads Fire breaks Clearing Regulations	Clearing required: Bush fires act 1954 An Act to make better provision for diminishing

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
			Steven Gauld Shire of Irwin Fire Officer	Site Access Points and Main Roads Western Australia (MRWA) Clarification Overview For the successful implementation of the Arrowsmith Renewable Development (AHP) project, it is essential to establish agreed site access points. These access points are crucial for the transportation of construction materials, equipment, and personnel. Infinite Green Energy (IGE) must coordinate with Main Roads Western Australia (MRWA) to ensure these access points are appropriately located, designed, and approved.	the dangers resulting from bush fires, for the prevention, control and extinguishment of bush fires

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
Shire of Irwin and DFES	21/04/2024	Telephone conversation	Mick Hutt Shannon Stubbs Shane Ibers	Proposed Fire Breaks and Project Compliance with the Bush Fire Act 1954 Overview The Arrowsmith Renewable Development (AHP) project, like any large-scale infrastructure project in Western Australia, must comply with the Bush Fires Act 1954. This legislation mandates specific measures to mitigate fire risks, which are particularly relevant given the project's location in a region prone to bushfires. Compliance with the Act involves implementing fire breaks and other fire management strategies to protect both the development and the surrounding environment. Fire Breaks Implementation Purpose and Design: Purpose: Fire breaks serve to prevent the spread of bushfires by creating barriers that fire cannot easily cross. They provide access routes for firefighting vehicles and personnel and serve as a defensible space to protect assets and infrastructure.	Sign: Documentation procedure regarding Fire roads and breaks Documents signed.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
				Design Considerations: The design of fire breaks will consider the topography, vegetation type, and prevailing wind directions to maximise their effectiveness. The fire breaks will be strategically located around the project site, including the perimeter and internal access routes.	
DWER JETSI	8/2024	Boardroom meeting IGE	Tom Hatton Stephen Gauld Yolanda Gould Belinda Walker Peter Galloway Mike Sukudom Mick Hutt	Strategy to move the submission forward	Confirm all required documentation, assessments, and environmental impact statements are in line with the regulatory expectations. Obtain feedback on the revised project site layout and its alignment with impact mitigation strategies. Discussed turbine relocation and Survey requirements

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					Discussed avoiding sensitive areas such as wetlands and habitats of endangered species.
DWER Green Team	16/09/2024	Boardroom meeting IGE Teams Meeting	Stephen Gauld Yolanda Gould Belinda Walker Peter Galloway Mick Hutt Linda Walker Ben Gates Helen LaFeunte	Alignment on Next Steps and Communication Protocols	**Outcome**: Ensure a clear understanding of the regulatory framework and expectations for the AHP submission. Address any uncertainties related to compliance with **EPA**, **DWER**, or other relevant authorities. **Outcome**: Identify and agree on the main environmental factors (flora, fauna, surveys, timelines etc.) that need prioritisation. This may lead to an adjustment of project plans to mitigate high-risk impacts. Agreement on the next steps, including follow-

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
					up meetings, communication protocols, and points of contact for each stage of the process.
EPA	31 October 2024	Meeting: Rm 66 SGT 8.04 EPA Chair Office; .Rm 66 SGT 8.01 Board Room Kaadatj,	Darren Walsh (Chair Exec EPA) Belinda Walker Yolanda Gauld; Stephen Gauld Peter Galloway	IGE can ensure that the Part IV submission is comprehensive, aligns with environmental protection standards, and fosters community trust in the project's environmental stewardship. Regular updates and close coordination with the EPA will be crucial throughout the process to facilitate a smooth and efficient path forward.	Outcome Structure the ERD to provide a clear analysis of the project's potential impacts, alternatives considered, and proposed mitigation. Include baseline data, potential direct and indirect impacts, and cumulative effects. Agreed Clarifications
Yamatji Southern Regional Corporation YSRC	10-12/12/2024	Email Updated Project Maps Correspondence and telephone	Peter Galloway IGE Michael Hutt IGE Brooke O'Donnell YSRC Daniel Puletama (SandS)	Site Layout infrastructure Layout changes	The Yamatji Southern Regional Corporation (YSRC) has formally acknowledged receipt

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
		communications with stakeholders		Infinite Green Energy (IGE) has communicated the updated site infrastructure layout changes and has confirmed that these modifications will not result in any impacts to identified heritage sites. IGE has undertaken meaningful and proactive consultation with the Yamatji Traditional Owners, ensuring they are fully informed of the proposed changes prior to the commencement of the public consultation period	of the updated information regarding the proposed site infrastructure layout changes. The YSRC have reviewed the details . This acknowledgment reflects their ongoing involvement and awareness of the proposed changes, ensuring alignment with their role as key stakeholders in the heritage assessment process This acknowledgment email: Tuesday 12/12/2024
MRWA	Nov 2024- Jan 2025	Email Updated Project Maps Correspondence and telephone	MWG Region - Coordinator: AMO MWG Region - Network Manager OR Nasima Akter (NA) Network Operations Manager – Patrick Whitehouse (PW)	Support of Items Acceptance of design & approval to work in road reserve:	Wind turbine movements from Geraldton Port to the east, Goldfields area.

Stakeholder	Date	Consultation Type	Participants	Summary of Discussions	Outcomes of Consultation
		communications with stakeholders Office/site visit	MWG Region - Regional Director – Janet Hartley-West (JH-W) MWG REGION Reviewer NM – Louise Adamson (LA) AM - Nasima Akter (NA) AMO – Jerolina Rankin (JR)	Project scope review by Road Planning Branch to verify alignment with future planning requirements. Traffic Impacts traffic volume increase sight distance at both directions at the proposed main access Number of Driveways permitted on to the State Road	Transport route from Geraldton to the south have not been established. HVS and the wind turbines transport company to assess the route and any works required prior to transporting. solar flag lighting to be installed at the intersection. Emergency management plans in design and execution.

Principles and Factors

10 Environmental Principles and Factors

The EPA's Statement of Environmental Principles, Factors and Objectives (EPA 2021) sets out how the EPA considers the objective and principles of the EP Act and uses environmental factors and objectives to organise and systemise environmental impact assessment and reporting.

10.1 Principles

The principles for environmental management as per section 4A of the EP Act that have been considered during the development of this proposal are demonstrated in Table 9. IGE will continue to apply these principles for the life of the Proposal.

Table 8: Environmental Management Principles.

	Principle	Consideration
1	**The precautionary principle** Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decision should be guided by: Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; An assessment of the risk-weighted consequences of various options.	IGE has actively engaged and communicated with stakeholders, including both the local community and corporate entities. Through this collaboration, various design options have been explored to optimise site layout alternatives during the construction planning phase. Our approach to plant infrastructure construction planning prioritises understanding and mitigating potential environmental impacts. This ongoing liaison has facilitated the identification of additional environmental values, enabled informed assessment of Green Hydrogen Production Facility (GHPF) design details, and led to effective mitigation measures to address potential impacts resulting from the Proposal., including: - The purchase of an agricultural area with reliable wind and solar yields - The utilisation of existing cleared areas to reduce native vegetation clearing - Avoidance of Carnaby's Cockatoo (CBC) habitat (foraging or roosting) during site construction and operations - Avoidance of wetlands, surface drainage and water bodies - Avoidance of cave systems formations within the Proposal disturbance footprint While IGE has commissioned numerous ecological and technical assessments to enable design and environmental optimisation, there are still several examples where a precautionary approach has been taken, including: - Continued assessment of environmental factors and impacts and outcomes during construction and operations - The relocation of infrastructure to avoid significant fauna habitats, conservation significant/priority flora and fauna and cave systems - In cases where additional potential adverse impacts have been identified, we will undertake further study and assessment to thoroughly understand and address these concerns. - Potential wind turbine or solar farm impacts including avifauna and bat strike mitigation - Emission assessments resulting from electrolysis and hydrogen processing and production

	Principle	Consideration
		- Communications with the Yamatji people - Vegetation clearing and groundwater abstraction environmental impacts including GDE - Construction environmental management measures, the ongoing rehabilitation of temporary laydown areas and impacts associated with clearing activities - Stakeholder consultation to raise Proposal environmental awareness and opportunities.
2	**The principle of intergenerational equity:** The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	AHP aims to establish a pioneering Green Hydrogen Project, dedicated to spearheading the global transition towards decarbonisation and sustainable energy reliance. Our commitment revolves around adopting a 'Net Zero sustainability philosophy', strategically utilising areas with low ecological sensitivity to deploy green energy infrastructure. We envision powering our operations with renewable energy sources, leveraging their sustainable generation methods. Concurrently, we plan to incrementally integrate hydrogen fuel cell technology into our liquid hydrogen delivery units and site vehicles, enhancing efficiency and reducing emissions.. This holistic approach underscores our dedication to reducing carbon emissions and fostering a greener future. Sustainability at IGE means reducing or eliminating negative environmental and social impacts, including maximising the value that our business and products provide to our customers, employees, shareholders, suppliers, local communities, and the living planet. It also requires upholding social sustainability in governance structures. We believe these efforts will help to elevate the standards of our industry as a whole. The development of the AHP will remove 116,000 kg per day of CO_2-e (total) from the atmosphere (with 23 tpd production, compared to similar fossil fuel powered facilities). IGE commits to minimising and managing environmental impacts of the Proposal to ensure environmental values are maintained or enhanced.
3	**The principle of the conservation of biological diversity and ecological integrity** Conservation of biological diversity and ecological integrity should be a fundamental consideration.	IGE has carefully considered the environmental values of the site, conducting thorough surveys of flora, fauna, vegetation, and water elements to identify key ecological features. Our site layout has been strategically planned to avoid priority ecological communities, fauna habitat and wetlands, with a focus on utilising pre-cleared land wherever possible. Through robust Environmental Management measures, we are committed to safeguarding biological diversity and ecological integrity within the Development Envelopes, ensuring that our proposal does not pose a threat to these vital aspects of the environment.

	Principle	Consideration
		Priority Flora and Priority Ecological Communities (PEC) were identified within the proposed disturbance footprint by Ecoscape consultants during the 2022 detailed site flora and vegetation survey. Disturbance within ecologically significant areas, such as CBC roosting and foraging habitat, will be strictly avoided or minimised. Our priority lies in preserving high-value ecological and biodiversity management areas, ensuring their protection and sustainability.
4	**Principles relating to improved valuation, pricing and incentive mechanism** Environmental factors should be included in the valuation of assets and services. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance, or abatement. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	The Proposal incorporates principles concerning enhanced valuation, cost efficiency, and incentive mechanisms relevant to the activity. Environmental considerations have been integral to every stage of project planning and implementation. These factors have also been integrated into the assessment valuation criteria for assets and services, including infrastructure layout and selection. IGE are committed to environmental management and continual improvement across the full lifecycle of the Proposal. Costs associated with environmental surveys, studies, approvals, and ongoing environmental management have been considered during the planning phase. As a generator of waste, IGE are responsible for the costs to contain, avoid and abate waste impacts. Waste products arising from both construction and operational activities have been methodically identified, with associated costs for waste management carefully considered during the planning phase. IGE fully acknowledges the polluter pays principle and actively embraces closed-loop recycling principles to minimise environmental impacts and promote sustainable resource management throughout the lifecycle of the project. The AHP project stands as a pivotal component of Western Australia's energy transition, representing a groundbreaking case study at the forefront of the decarbonization paradigm. It holds the distinction of being the largest proposed Green Hydrogen Production Facility (GHPF) in Australia. IGE's mission is to pioneer the development of green hydrogen, leveraging our domain expertise in renewable hydrogen projects. Through this mission, we aim to play a leading role in facilitating the transition of the Australian economy towards achieving net-zero emissions.

	Principle	Consideration
5	**The principle of waste minimisation.** All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	The proposal is designed to minimise waste generation, with a focus on reducing general putrescible waste. Any generated waste will be carefully managed and stored within a designated waste management area. Through rigorous evaluation, key waste streams have been identified, and management techniques have been established to minimise environmental impacts. IGE will implement the hierarchy of waste minimisation: - Avoid - Reuse - Recycle - Recovery - Treatment - Containment - Disposal Waste types include: - Oil /hydrocarbons waste (minimal) will be stored in approved receptacles and then removed from site by a specialised waste contractor - Timber, steel, glass and plastics will be separated and removed from site and recycled - Paper and cardboard will be removed from site and recycled - Concrete waste containment area established and then removed from site - Organic waste will be stored in appropriate bins and transported to landfill

	Principle	Consideration
		Environmental Discharge (Part V EP Act 1986) - Oxygen/ hydrogen will be vented (monitored) during the electrolysis process with a view to be recycled - Hydrogen (minimal from operational processes) will be flared/purged or vented to atmosphere, with a view to recycle - Potential hydrogen flaring - Excess brine will be recycled or released to the surrounding environment when treated An option exists to recycle excess water from the electrolysis process and utilised for vegetation watering and or dust suppression if suitable. Volumes and operational engineering details will be incorporated under Part V, Division 3, licence and works approvals submission as part of the approvals process under the Environmental Protection Act 1986.

10.2 Identification of Key Environmental Factors

The environmental factors relevant to the updated document as listed in the EPA's 2018 Statement of Environmental Principles, Factors and Objectives and their applicability to Proposal are outlined below in Table 10. IGE have considered the following when considering which factor is likely to have a potential relevance to the proposal:

- Values, sensitivity and quality of the environment which is likely to be impacted
- Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts
- Consequence of the likely impacts (or change)
- Resilience of the environment to cope with the impacts or change
- Cumulative impact with other existing or reasonably foreseeable activities, developments, and land uses
- Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment
- Level of confidence in the prediction of impacts and the success of proposed mitigation
- Public interest about the likely effect of the proposal or scheme, if implemented, upon the environment, and public information that informs the EPA's assessment

The key environmental factors listed include flora and vegetation, terrestrial fauna, inland waters, and social surrounds. These factors are addressed in Sections, 0,14,15 and 16
Factors that were not deemed key environmental factors but met the above criteria are described in Section 18 and are labelled 'Other Environmental Factors'.

Table 9: Key Environmental Factors Relevant to The Updated Proposal

Factor	Objective	Relevance to Proposal	Key Factor
Sea			
Benthic communities and habitat	To protect benthic communities and habitat to enhance and maintain biological diversity and ecological integrity.	- No impacts to benthic habitats	No
Coastal processes	To maintain the geophysical processes that shape coastal morphology to enhance and protect coastal environmental values	- No impacts to coastal processes.	No
Marine environmental quality	To maintain the quality of water, sediment and to enhance environmental values and protection of marine habitat	- No impacts to marine environmental quality	No
Marine fauna	To protect marine fauna to enhance biological diversity and ecological integrity is maintained.	- No impacts to marine fauna.	No
Land			
Flora and vegetation	To protect flora and vegetation, to enhance biological diversity and ecological integrity are maintained. Focus: Potential impact to significant flora and vegetation species	- Clearing of native vegetation to support infrastructure and access	Yes
Landforms	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	- Cave system/Limestone formations - Stormwater drainage from increased water run-off due to clearing activities	Other
Subterranean fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	- Drawdown from groundwater aquifers - Impact on troglofauna in cave systems	Other
Terrestrial environmental quality	To maintain the quality of land and soils to protect environmental values.	- Soil contamination from a potential hydrocarbon and chemical spills	Other

Factor	Objective	Relevance to Proposal	Key Factor
		- Failure to manage waste satisfactorily - Sedimentation and erosion	
Terrestrial fauna	To protect terrestrial fauna to enhance biological diversity and ecological integrity are maintained, with a focus on endangered or conservation protected species.	- Clearing of fauna habitat	Yes
Water			
Inland waters	To maintain the hydrological regimes and quality of groundwater and surface water to enhance environmental values.	- Abstraction of groundwater - Surface water: Lake Arramall and wetlands - Sedimentation and Erosion	Yes
Air			
Air quality	To maintain air quality and minimise emissions so that environmental values are protected.	- Minimal, temporary impacts not affecting environmental values from: - diesel combustion emissions from the construction vehicles and passenger vehicles. - dust generation from vehicles.	Other
Greenhouse gas emissions	To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change.	- The proposal has the potential to reduce greenhouse gas (GHG) emissions by an estimated 232,000 tonnes @ 42 tpd production CO_2-e per day by providing an alternative fuel source for the transport industry that reduces GHG emissions.	Other

Factor	Objective	Relevance to Proposal	Key Factor
People			
Social surroundings	To protect social surroundings from significant harm.	- The Proposal is located within the Arrowsmith area. - The IGE Development Envelopes (DE) have known heritage values. - An assessment of potential heritage impacts has been undertaken. - An Aboriginal Heritage survey is complete, including an ethnographic and archaeological survey incorporating women's cultural practice.	Yes
Human health	To protect human health from significant harm.	No adverse human health impacts expected.	No

Flora and Vegetation

11 Key Environmental Factor - Flora and Vegetation

Environmental Values

11.1 EPA Objective

To protect flora and vegetation to ensure that biological diversity and ecological integrity are maintained within the AHP Development Envelopes.

Legislation, Policy, and Guidance:

- Environmental Protection Act 1986 (EP Act)
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)
- Biodiversity Conservation Act 2016 (WA)
- Environment Protection and Biodiversity Conservation Act (EPBC Act), Commonwealth
- Biosecurity and Agriculture Management Act 2007 (WA)
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b)
- Environmental Factor Guideline (EFG) - Flora and Vegetation (EPA, 2016)
- Guidance for planning and development: Protection of naturally vegetated areas in urban and peri-urban areas (EPA, 2021)
- Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE, 2013)

11.2 Receiving Environment Desktop and Field Assessments

Detailed Environmental Survey for Arrowsmith Domestic (AHP) Project:

In 2020, Infinite Green Energy (IGE) appointed Ecoscape to conduct a Reconnaissance-level flora and vegetation survey and a Basic-level fauna field survey for the Arrowsmith Renewable Development (AHP) project site. The resulting report was submitted to the Western Australian Environmental Protection Authority (EPA) as part of the environmental review process. However, the EPA identified several constraints, including insufficient information on significant portions of the site due to inaccessible, impenetrable vegetation, and the level of detail reported within the flora and vegetation survey. Consequently, the EPA required further flora and vegetation information.

11.3 Response to EPA Requirements

In 2022, IGE engaged Ecoscape again to carry out additional AHP project site investigations to satisfy the additional EPA information requirements, focusing on Detailed Fora and Vegetation Surveys and endangered terrestrial fauna, particularly the foraging and roosting habitat potentially utilised by the Carnaby's Black Cockatoo (CBC).

11.3.1 Survey Details

Survey Area: The detailed survey covered an area of 768.95 hectares within the Development Envelope Lot 703(DE), including a 50-meter buffer around the proposed disturbance footprint.

Survey Period: The detailed flora and vegetation survey was conducted over five days in October 2022, building on the findings from the 2020 reconnaissance survey.

11.3.2 Key Findings and Considerations

Detailed Survey Methodology: The detailed survey included comprehensive mapping and assessment of vegetation types within the survey area. It addressed the previously identified gaps and provided a thorough understanding of the flora composition.

Significant Vegetation Types: The survey identified and mapped significant vegetation types, including priority species and Priority Ecological Communities. Special attention was given to species such as Banksia sessilis and Banksia prionotes, which are crucial for Carnaby's Black Cockatoo foraging.

Habitat Quality: The survey assessed the quality and extent of foraging habitats, which are critical for the conservation of the CBC.

11.4 Regional Biogeography

The Proposal is located within the Geraldton Sandplains Interim Biogeographic Regionalisation for Australia (IBRA) bioregion. The bioregion is composed mainly of proteaceous scrub-heaths, rich in endemics, on the sandy earths of an extensive, undulating, lateritic sandplain mantling Permian to Cretaceous strata. The bioregional area is 1,358,915 ha (Department of Parks and Wildlife (DPaW) 2013a) and has a Mediterranean climate (hot, dry summers and cool, wet winters).

11.5 Pre-European Vegetation

John Beard and associates conducted a systematic survey of native vegetation in the 1970's, describing the vegetation systems in Western Australia at a scale of 1:250 000 in the south-west and at a scale of 1:1 000 000 in less developed areas.

Beard's vegetation maps attempted to depict the native vegetation as it was presumed to be at the time of settlement and is known as the pre-European vegetation type and extent. Beard's vegetation maps have since been digitised by Shepherd, Beeston & Hopkins (2002) and updated by DPIRD every two years (2019).

The Proposal area intersect four pre-European vegetation units:

- Association Cliff Head 255: Eucalypt shrubland; *Eucalyptus eremophila*, *E. redunca*, *E*. spp.
- Association Illyarrie 377: Mixed heath with scattered tall shrubs *Acacia* spp., Proteaceae and Myrtaceae
- Association Illyarrie 433: Mosaic shrublands; *Acacia rostellifera* & *Melaleuca cardiophylla* thicket/sparse low woodland
- Association Illyarrie 619: Wheatbelt; York gum, salmon gum etc. *Eucalyptus loxophleba*, *E. salmonophloia.* Goldfields; gimlet, redwood etc. *E. salubris*, *E. oleosa*. Riverine; rivergum, *E. camaldulensis*.

The Pre-European vegetation units is shown in Figure 15 in the map below:

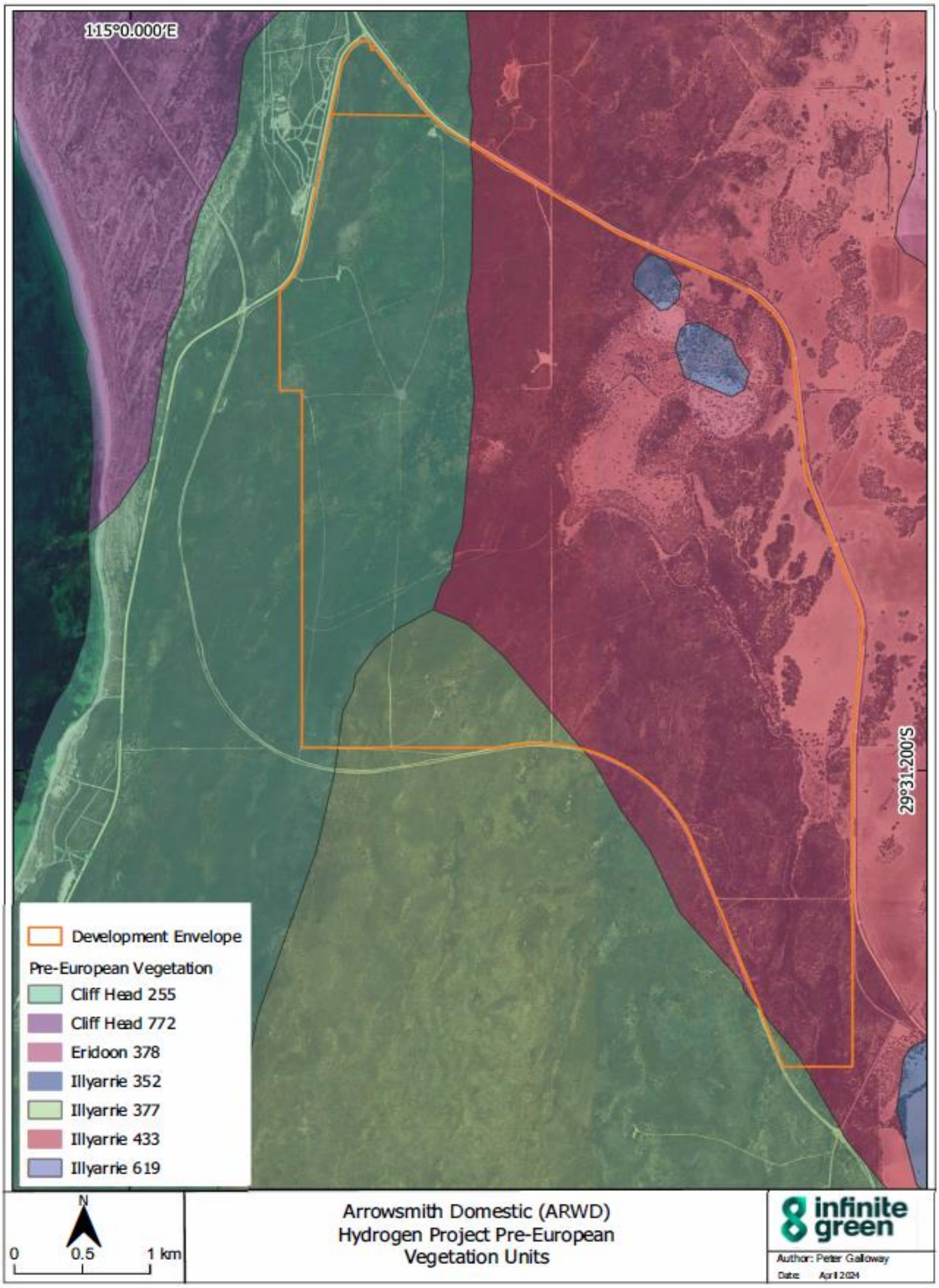


Figure 15: Pre-European Vegetation.

Pre-European vegetation association/s identified from the survey area (DPIRD, 2019) and their Pre-European and current extents are listed in table 11 below.

Table 10: Pre-Vegetation System Associations within Proposal Area

Region	Vegetation Association	Original Extent (ha)	Current Extent (ha)	% Remaining
Western Australia	Cliff Head 255	3,176.54	2,933.27	92.34
	Illyarie 377	63,099.54	62,724.44	99.41
	Illyarie 433	32,460.48	14,746.34	45.43
	Illyarrie 619	119,373.78	118,205.01	99.02
IBRA biogeographic region (Geraldton Sandplains)	Cliff Head 255	3,064.34	2,933.06	95.72
	Illyarie 377	63,099.54	62,724.44	99.41
	Illyarie 433	32,460.48	14,746.34	45.43
	Illyarrie 619	154.54	50.80	32.87
IBRA biogeographic sub-region (LeSueur Sandplain)	Cliff Head 255	3,064.34	2,933.06	95.72
	Illyarie 377	63,099.54	62,724.44	99.41
	Illyarie 433	18,096.74	11,457.68	63.31
	Illyarrie 619	154.54	50.80	32.87
LGA (Shire of Irwin)	Cliff Head 255	3,176.54	2,933.27	92.34
	Illyarie 377	22,618.31	22,395.04	99.01
	Illyarie 433	32,141.03	14,640.90	45.55
	Illyarrie 619	53.96	48.20	89.32

11.6 EPBC Conservation Significant Vegetation

A Protected Matters Search Tool (PMST) search (DAWE, 2020) using a 50km buffer around a point approximating the centre of the survey area identified one EPBC Act listed Threatened Ecological Community (TEC) within the buffer area:

- Subtropical and Temperate Coastal Saltmarsh (vulnerable).
- As the Proposal area is not in a low-lying coastal area or an estuary, this TEC does not occur within the survey area.

11.7 DBCA Conservation Significant Vegetation

A Department of Biodiversity, Conservation and Attractions (DBCA) database search using a 30km buffer around the survey area, identified no TEC's and the following two Priority Ecological Communities (PECs) within the search area buffer:

- Subtropical and Temperate Coastal Saltmarsh (P3) - the equivalent of the TEC listed in the PMST above.(Does not occur within the survey area)

- Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* (Geraldton area) (P1) described as:

Floristically, the *Acacia rostellifera* P1 community is similar to other *A. rostellifera* communities but is differentiated on structure, being dominated by mallee eucalypts. The community occurs on limestone ridges, in some swales in the coastal dunes between Cape Burney and Dongara, on the Greenough Alluvial Flats on limestone soil and near Tarcoola Beach. Some very small occurrences have also been recorded on the limestone scarp north of the Buller River (DBCA, 2021).

11.8 EPBC Act Threatened Flora

The PMST search identified one EPBC Act-listed threatened flora species that is known to occur within the 25km search buffer area (*Paracaleana dixonii*), five as 'species or habitat likely to occur within area' and six 'species or species habitat may occur within the area'. These are presented in table 12.

Blue shading indicates high likelihood; dark blue indicates species is known (recorded) from the survey area.

The updated (since the 2020 survey; Ecoscape (2021)) likelihood takes into consideration IGE's wetland conservation area. As a result, wetland habitat is not present in the current survey area/proposed development footprint and buffer. The PMST database search was updated on 24 January 2023 (DCCEEW 2023b) using a 20 km buffer around IGE's site.

Table 11: Likelihood of Occurrence of EPBC Act-listed threatened flora species.

DBCA*	PMST**	Species name	Habitat from: • *FloraBase* (WAH 1998-2022) • (for *Acacia* species) *World Wide Wattle* (WAH, DBCA & Shire of Dalwallinu 2022)	Flowering	Likelihood of occurrence Desktop (including 2020 results)	Post-survey (2022)
		Threatened Flora***				
	May	*Andersonia gracilis*	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Sep-Nov	Highly unlikely	Highly unlikely
	May	*Caladenia hoffmanii*	Clay, loam, laterite, granite. Rocky outcrops and hillsides, ridges, swamps and gullies.	Aug-Oct	Highly unlikely	Highly unlikely
WAH, TP	Known	*Caleana dixonii* (formerly *Paracaleana dixonii*)	Grey sand over granite.	Oct-Jan	Unlikely	Unlikely
	Likely	*Conostylis dielsii* subsp. *teres*	White, grey or yellow sand, gravel. Low open woodland.	Jul-Aug	Unlikely	Unlikely
	May	*Conostylis micrantha*	White or grey sand. Sandplains.	Jul-Aug	Unlikely	Unlikely
WAH	Likely	*Daviesia speciosa*	Gravelly lateritic soils. Undulating plains, rises.	Apr-May	Highly unlikely	Highly unlikely
TP		*Eleocharis keigheryi*	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Aug-Nov	Highly unlikely	Highly unlikely
WAH		*Eremophila glabra* subsp. *chlorella*	Sandy clay. Winter-wet depressions.	Jul-Nov	Highly unlikely	Highly unlikely
TP	May	*Eucalyptus crispata*	Sand, loam with lateritic gravel. Lateritic breakaways.	Mar-Jun	Unlikely	Unlikely
	May	*Eucalyptus impensa*	Yellow sand. Lateritic hills.	Jun-Jul	Unlikely	Unlikely
WAH, TP	Likely	*Eucalyptus leprophloia*	White or grey sand over laterite. Valley slopes.	Aug-Oct	Unlikely	Unlikely
	May	*Hemiandra gardneri*	Grey or yellow sand, clayey sand. Sandplains.	Aug-Oct	Unlikely	Unlikely
	May	*Styphelia marginata* (known as *Leucopogon marginatus* under the EPBC Act)	Shrublands or low heath. Sand over laterite.	May-Aug	Highly unlikely	Highly unlikely
TP	Likely	*Styphelia obtecta* ***	Grey-white or yellow sand. Gently undulating slope or plain.	Oct-Nov	May occur	May occur
	May	*Tetratheca nephelioides*	White-grey sand, yellow-brown clayey sand, gravel laterite. Outcrops, undulating hills, ridges.	Sep	Unlikely	Unlikely
WAH, TP	Likely	*Thelymitra stellata*	Sand, gravel, lateritic loam.	Oct-Nov	May occur	Unlikely
	May	*Wurmbea tubulosa*	Clay, loam. River-banks, seasonally-wet places.	Jun-Aug	Highly unlikely	Highly unlikely
		DBCA Priority 1				
WAH		*Caladenia denticulata* subsp. *albicans*	Riverbanks, wet flats, depressions. Clay or sandy soil.	Aug	Highly unlikely	Highly unlikely
WAH		*Drosera pedicellaris*	Deep sand.	Oct-Nov	May occur	May occur
WAH		*Korthalsella arthroclada*	White, sandy clay around lake edges.	Dec	Highly unlikely	Highly unlikely
WAH, TP		*Lasiopetalum ogilvieanum*	White/grey or yellow sand, stony loam. Undulating plains, lateritic rises.	Jul-Oct	May occur	Unlikely
WAH, TP		*Micromyrtus rogeri*	Yellow-brown sandy soils, gravel, laterite. Breakaways.	Jul - Oct	Highly unlikely	Highly unlikely
WAH		*Poranthera asybosca*	White sand.	Oct	Unlikely	Unlikely

DBCA*	PMST**	Species name	Habitat from: • *FloraBase* (WAH 1998-2022) • (for *Acacia* species) *World Wide Wattle* (WAH, DBCA & Shire of Dalwallinu 2022)	Flowering	Likelihood of occurrence Desktop (including 2020 results)	Post-survey (2022)
WAH		*Stylidium carnosum* subsp. Narrow leaves (J.A. Wege 490)	Slopes on low hills, low plains. White/grey sand with laterite.	Oct	Unlikely	Unlikely
WAH		*Verticordia dasystylis* subsp. *oestopoia*	Gritty soils over granite. Outcrops.	Oct	Highly unlikely	Highly unlikely
WAH, TP		*Verticordia luteola* var. *rosea*	White sand. Flats.	Dec-Jan	May occur	May occur
		DBCA Priority 2				
WAH, TP		*Acacia vittata*	Grey sand, sandy clay. Margins of seasonal lakes.	Aug	Likely	Unlikely
WAH		*Calectasia palustris*	White or grey sand. Seasonally inundated swamplands.	Jul-Oct	Unlikely	Highly unlikely
WAH		*Comesperma griffinii*	Yellow or grey sand. Plains.	Oct	Likely	May occur
WAH		*Dampiera tephrea*	Sand, gravelly loam.	Jul	May occur	Known
		Eucalyptus foecunda subsp. *aeolica*	White, yellowish or pale brown coastal sands overlying limestone, often on limestony dunes, in mallee shrubland or low open woodland		-	Known
WAH, TP		*Guichenotia quasicalva*	Drainage lines. Sandy clay over laterite.	Sep-Oct	Unlikely	Unlikely
WAH		*Schoenus badius*	Grey sand. Moist areas.	Sep - Oct	Highly unlikely	Highly unlikely
WAH		*Schoenus* sp. Eneabba (F. Obbens & C. Godden I154)	Grey, yellow or white sand. Undulating sandplains, mid slopes, tops of rises.	Dec	Likely	Unlikley
WAH		*Scholtzia calcicola*	Yellow/grey sand, over limestone. Slopes.	Oct	Likely	Known
WAH		*Stylidium pseudocaespitosum*	White, grey or yellow sand over laterite. Breakaways and hillslopes.	Sep-Nov	Unlikely	Unlikely
WAH		*Stylidium* sp. Three Springs (J.A. Wege & C. Wilkins JAW 600)	Upper slopes, ironstone breakaways, flats. Yellow-brown clayey sand over laterite, red rocky soil.	Sep	Unlikely	Unlikely
TP		*Synaphea sparsiflora*	Sandy loam over laterite.	Aug – Sep	Unlikely	Unlikely
WAH		*Tricoryne* sp. Wongan Hills (B.H. Smith 794)	Yellow to grey sand, gravelly clay quartz, laterite, limestone. Mid-slopes and uplands.		May occur	May occur
WAH		*Verticordia argentea*	White, grey or yellow sand. Sand ridges, undulating plains.	Nov-Apr	May occur	May occur
		DBCA Priority 3				
WAH		*Acacia latipes* subsp. *licina*	White sand, granitic soils. Limestone hills, sandplains.	Jun-Sep	May occur	May occur
WAH		*Acacia lanceolata*	Lateritic hills & breakaways.		Unlikely	Unlikely
WAH		*Acacia telmica*	Sand, loam or loamy clay. Low-lying seasonally moist areas.	Jul-Sep	Highly unlikely	Highly unlikely
WAH		*Anthocercis intricata*	Sand or loam over limestone. Consolidated sand dunes.	Jun-Sep	Likely	Likely
WAH		*Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176)	Slopes. Grey clayey or yellow brown sandy soil.		Unlikely	Unlikely
WAH		*Baeckea* sp. Walkaway (A.S. George 11249)	Yellow/brown or white sand. Undulating plains, hillslopes.	Dec-Jan	May occur	May occur
WAH		*Banksia cypholoba*	Sand & gravelly loam.	Aug	Unlikely	Unlikely
WAH		*Banksia fraseri* var. *crebra*	Shallow valley, sandplains, slopes, laterite hills. Yellow-brown sand, gravelly clay loam.	Jul-Aug	May occur	May occur
WAH, TP		*Beyeria cinerea* subsp. *cinerea*	Depressions, limestone ridges, hill tops. Brown or grey sand, sand over limestone.	Jul-Aug	Likely	Known
WAH		*Beyeria gardneri*	Yellow sand.	Aug-Sep	May occur	May occur

11.9 DBCA Threatened and Priority Flora

A comprehensive search of the Department of Biodiversity, Conservation and Attractions (DBCA) database was conducted, utilising a 50km buffer to ensure thorough survey coverage. This search encompassed the Threatened and Priority Flora List (TPFL), compiled from Threatened and Priority Flora Report Forms, as well as the WA Herb database, which includes vouchered specimens from the Western Australian Herbarium. It is important to note that threatened flora species are afforded specific protection under the Biodiversity Conservation Act, while Priority Flora denotes species of conservation significance.

The combined search of the PMST and DBCA databases yielded a total of 89 species, categorised as follows: 14 threatened flora species (eight identified within the database search buffer and six from the PMST where associated habitat is likely to occur), nine Priority 1 species, 13 Priority 2 species, 36 Priority 3 species, and 17 Priority 4 species.

It is worth mentioning that an updated search of the DBCA database was not conducted prior to the 2022 field survey. However, it is noteworthy that Eucalyptus foecunda subsp. aeolica (commonly known as Beekeepers Mallee) was formally described in 2021 by Nicolle & French. This species would have been included in the survey targets if a search had been commissioned earlier. Although an opportunistic observation of the species was recorded during the 2020 survey, it was not described to infrataxon level or listed as a conservation priority at that time.

11.10 Field Reconnaissance and Detailed Survey

In 2020 IGE appointed Ecoscape to undertake a Reconnaissance-Level flora and vegetation survey and a basic fauna survey to identify the significant biological attributes of the site which occupied 1,929.70 ha.

The resulting report was provided to the Western Australian Environmental Protection Authority (EPA) as part of the environmental review process. The EPA identified a number of survey constraints including lack of information on a significant proportion of the site due to inaccessibility as a result of impenetrable vegetation, and the level of detail of the survey, particularly the flora and vegetation component (Reconnaissance rather than Detailed flora and vegetation). As a result, the EPA informed IGE that further survey information was required for the Part IV submission.

In 2022 IGE again appointed Ecoscape to conduct a more detailed investigations to meet the EPA requirements in regard to the detailed flora and vegetation survey and terrestrial fauna, particularly for the Carnaby's Black Cockatoo, component.

The Ecoscape 2022 detailed flora and vegetation survey area occupied 768.95 ha overall, inclusive of a 50 m buffer applied to the proposed Disturbance Footprint. The Ecoscape Detailed flora and vegetation survey was conducted over 5 days during October 2022, incorporating the results of the previous 2020 reconnaissance survey.

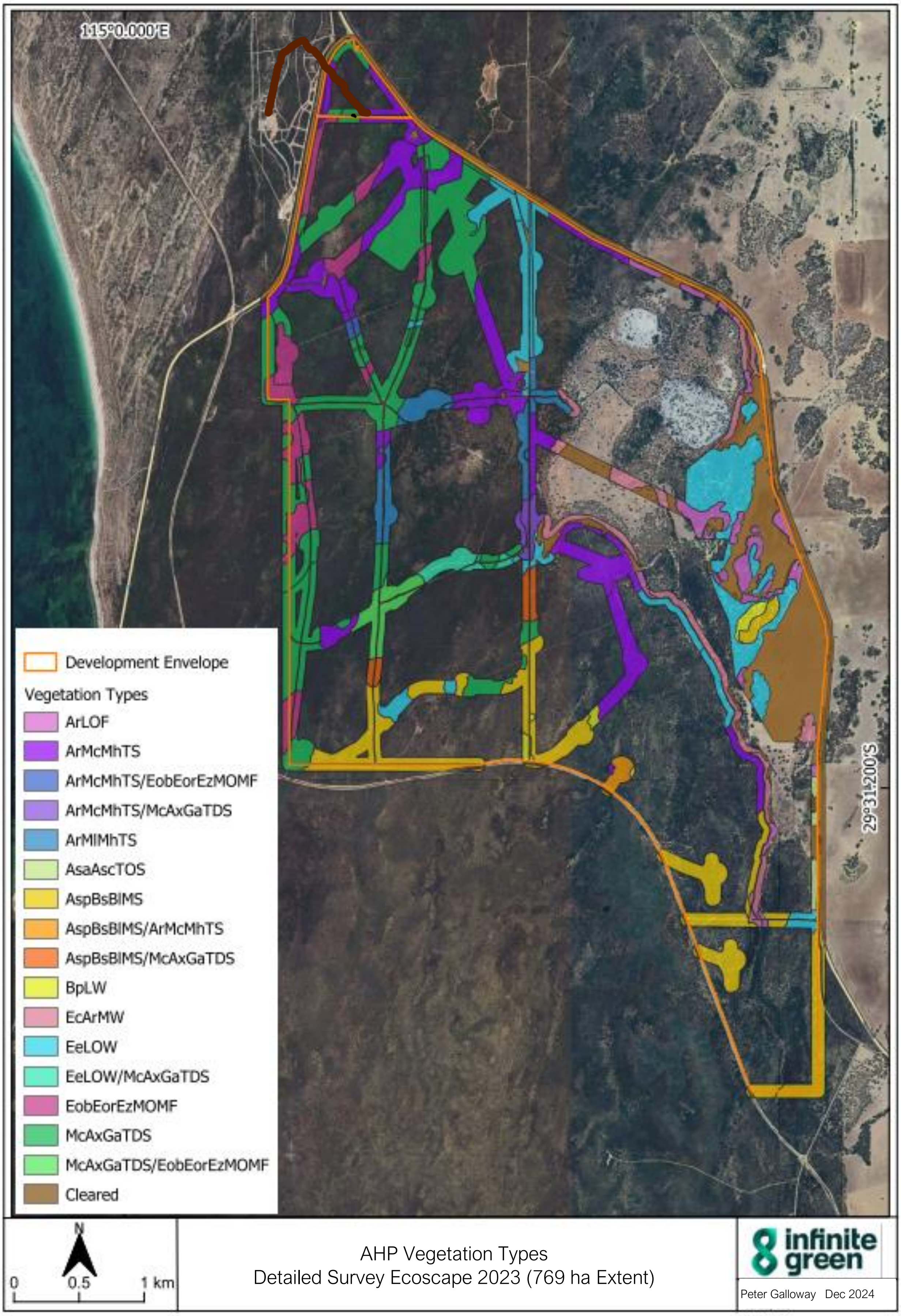


Figure 16: Vegetation Types (Ecoscape 2023)

11.11 Flora Presence

The Ecoscape flora and vegetation field survey was conducted during October 2020 as a Reconnaissance Survey in accordance with the requirements of the Environmental Protection Authority (EPA) 2016 Flora and Vegetation Technical Guidance. This survey identified 191 vascular flora species recorded from five floristic quadrats, 15 detailed relevés and during targeted conservation-listed flora searches and traverses of the site.

The subsequent 2022 Detailed flora and vegetation survey was conducted over 5 days during October and incorporating the results of the Ecoscape 2020 reconnaissance survey. A total of 234 vascular flora were recorded from 157 genera and 63 families from quadrats, relevés, opportunistic observations and searches for conservation-listed flora. Of these, 44 were introduced (18.80 %) and 17 (7.26 %) could not be identified to species level due to insufficient diagnostic reproductive material. Some of these may represent duplicate taxa (nine; 3.84%), however, the others (eight; 3.42 %) are unique taxa not represented elsewhere in the inventory.

The most commonly represented families were Fabaceae (27 taxa), Myrtaceae (23) and Poaceae (22). The most represented genera were *Melaleuca* with eight taxa, *Acacia* (seven) and *Eucalyptus* (six).

No Commonwealth EPBC Act or Western Australian Biodiversity Conservation Act 2016 listed Threatened Flora were recorded during the detailed field survey.

11.12 Priority Listed Flora

During the initial 2020 reconnaissance survey, three Priority-listed flora were recorded: *Anthocercis intricata* (P3), *Beyeria cinerea* subsp. *cinerea* (P3) and *Eucalyptus zopherophloia* (P4). *E. zopherophloia* has previously been recorded from within the survey area, and the others from nearby (within 3.5 km). They were recorded in areas with limestone capping in vegetation type McSrGaTS, with one occurrence of *E. Zopherophloia* in disturbed vegetation type ArLOF adjacent to cleared lands.

During the October 2022 Ecoscape detailed flora and vegetation survey, field researchers identified two additional species that were listed as Priority flora.

These findings were uncovered through thorough field surveys and observations conducted as part of the detailed assessment process.

Five priority Listed Flora:

- Eucalyptus foecunda subsp. aeolica (P2)
- Scholtzia calcicola (P2)
- Beyeria cinerea subsp. cinerea (P3)
- Dampiera tephrea (P3)
- Eucalyptus zopherophloia (P4)

11.12.1 Scholtzia Calcicola (P2)

This species was collected as an opportunistic record without a recorded location or population count, however, based on collecting sequence it is likely that it was recorded in vegetation type AspBsBlMS. It was not recorded in any of the six quadrats and detailed relevés from this vegetation type, or as a dominant species in any of the three descriptive relevés, nor in any other vegetation type including the similar BpLW. It is therefore likely to occur as scattered individuals or small clumps within the Sandplain vegetation types.

Whilst not possible to accurately estimate the number of individuals occurring in the survey area, nor population extent (although presumed to be restricted to these vegetation types), it is likely to be at most 50-100 individuals in the overall survey area with only a small proportion of these within the proposed works footprint due to the 50 m buffer applied (to the works footprint) by the EPA

Due to the likely small number of plants occurring within the development footprint, the potential impact on local and regional populations of the proposed clearing is likely to be negligible at a regional scale and also most likely negligible at a local scale as most of IGE's proposed works area on the western side of the IGE site has already been cleared for tracks and will only require widening for construction, turbine footings and firebreaks.

The area of vegetation types AspBsBlMS and BpLW intersecting the proposed solar farm on the eastern side of the IGE site have been previously grazed, and as such there is a lower likelihood of Scholtzia calcicole occurring.

The likelihood of it impacting the local or regional population is therefore correspondingly lower and would be negligible at worst and more likely to be of no impact (i.e. species not present). (Ecoscape 2022)

11.12.2 Eucalyptus foecunda subsp. aeolica (P2)

Based on the species habitat, particularly in quadrat A2205 in vegetation type **EobEorEzMOMF** where it was the dominant species, and taking into consideration that it was not recorded in quadrats in similar vegetation elsewhere, it is likely to occur patchily in the survey area in mallee vegetation in dune swales and uncommonly in vegetation type **EeLOW** that only infrequently had other Eucalypt species present. It is anticipated to occur rarely in other vegetation types.
The nearest record of this species as shown on *FloraBase* (WAH 2023) is located approximately 7 km to the south of the closest record from this survey.

This WAH record (from two identical entries considered to represent duplicates – PERTH 08839980 and 08840016) is from *Eucalyptus erythrocorys* vegetation in dune swales, which is descriptively the equivalent of vegetation type **EeLOW** although, within the survey area this vegetation type occurred on limestone capping not in swales.

At most it is estimated that there may be 100-200 individuals of this species within the survey area, noting that the EPA requested a survey area that incorporated 50 m buffers beyond the proposed works footprint. Therefore, only a small proportion of these would be within the proposed works footprint and any impact on the species population at local and regional scales is likely to be negligible.

Only fifteen plants are noted in the WAH record, suggesting patchy distribution. (Ecoscape 2022)
There are 25 records of this taxon listed on *FloraBase* (WAH 2023), noting that this is likely to be exaggerated based on duplication of records.

The likelihood of it impacting the local or regional population is therefore correspondingly lower and would be negligible at worst and more likely to be of no impact (i.e. species not present). (Ecoscape 2022)

11.12.3 Other Significant Flora

Pelargonium littorale was found in the survey area with the closest previous records approximately 90km north and south of the survey area. According to the criteria outlined in the Flora and Vegetation Technical Guidance (EPA 2016a), *P. littorale* may be considered as significant as a minor range infill. However, this species has a wide distribution over most of near coastal parts of southern Australia (ALA 2021) thus its significance as a range infill is minor.

Melaleuca strobophylla is a minor range extension of approximately 30km northwards (thus new range edge), and a new record for the local government area. However, taking this species' distribution over much of the southern parts of Western Australia, this range extension is of only minor significance.

11.12.4 Vegetation Types

The 2022 Detailed flora and vegetation survey, conducted over 5 days during October and incorporating the results of the 2020 survey, identified the following significant findings:

234 vascular flora species recorded from 14 floristic quadrats (2022), 13 descriptive relevés (2022) and 20 quadrats and relevés (2020), including:

Five Priority-listed flora (*Eucalyptus foecunda* subsp. *aeolica*, P2; *Scholtzia calcicola*, P2; *Beyeria cinerea* subsp. *cinerea*, P3; *Dampiera tephrea*, P3; *Eucalyptus zopherophloia*, P4)
three range extension or range infill species, although two are introduced.

44 introduced flora including one Declared Pest plant and one WoNS species that were only recorded during the 2020 field survey; neither (**Echium plantagineum* and **Lycium ferocissimum*, respectively) have management requirements.

11.12.5 Priority Ecological Communities

Further Information from additional quadrats recorded during the 2022 Detailed survey identified thar EobEorEzMOMF species was characteristic of the mallee vegetation in dune swales. The other species definitive of the PEC (*Acacia rostellifera*, but not in the upper stratum, and *Eucalyptus oraria*) were also present in vegetation type.

Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora. Floristically, this community is similar to other Acacia rostellifera communities but is differentiated on structure, being **dominated by mallee eucalypts**. The community occurs on limestone ridges, in some swales in the coastal dunes between Cape Burney and Dongara. (DBCA 2023)

It is concluded, therefore, that vegetation type EobEorEzMOMF is likely to be representative of the above-named PEC. Within the survey area it occupied 40.60 ha (5.28% of the total area), and it also occurred in fine-scale mosaics with vegetation types ArMcMhTS (part of 1.41 ha) and McAxGaTDS (part of 1.48 ha).

Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora. Floristically, this community is similar to other Acacia rostellifera communities but is differentiated on structure, being **dominated by mallee eucalypts**. The community occurs on limestone ridges, in some swales in the coastal dunes between Cape Burney and Dongara.

Vegetation type EobEorEzMOMF is likely to be representative of the *Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora (Geraldton area)* P1 PEC.

This PEC has a likely 125 km north-south distribution. It occupied 40.60 ha in the survey area (5.28%) plus representation in mosaics, although only 6.96 ha (2.89%) of the proposed disturbance footprint.

- This vegetation analysis within the submission documents has been updated and concludes that there is PEC's present within the AHP Development Envelopes.

- IGE will further address indirect impacts from the proposal on individuals/populations of Priority flora that are located directly adjacent to areas of proposed disturbance within a further vegetation survey.

Priority 1 Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora (Geraldton area) PEC Occur in the lot 703 Development Envelope.

Extents and distributions of PECs are not publicly available; therefore, it is not possible to adequately discuss how significant a locally occurring PEC is in relation to the PEC as currently understood.

As a bare minimum (based on 'Geraldton area' forming part of the PEC description), this PEC must be assumed to occur from at least Geraldton to the survey area – a distance of approximately 85 km. Limestone ridge plant community 11 in the Geraldton Regional Flora and Vegetation Survey (GRFVS; Department of Planning [DoP] & Ecoscape 2010) includes mallee vegetation characterised by Eucalyptus obtusiflora, E. oraria and on occasion E. zopherophloia (i.e. essentially the same characteristic species composition as vegetation type EobEorEzMOMF), and was recorded as far north as Oakajee, extending the potential northwards distribution by a further 25 km (total 110 km north-south).

No similar vegetation was recorded further north (as far as the Menai Hills near the Hutt River; Ecoscape 2011), although survey further north was not conducted to confirm that Oakajee was the northern limit of this mallee vegetation. Taking into consideration the area where the distribution of the defining species intersect, and given that the distribution of Eucalyptus oraria extends only approximately 20 km south of the survey area (excluding outlier populations; ALA 2023), it must be concluded that the potential north-south range of the PEC is approximately 125 km.

The GRFVS Limestone ridge plant community 11 occupied 0.32% of the GRFVS survey area (DoP & Ecoscape 2010); similar vegetation (community 12; Eucalyptus oraria, E. obtusiflora Mallee (Limestone)) occupied 0.52% of the Dongara to Cape Burney Coastal Vegetation Survey area (DCBCVS; Ecoscape 2010), not including within mosaics. These small extents and overall smaller proportion of native vegetation have justified the listing of these vegetation units as PEC's, that were identified after the previous reconnaissance surveys.(Ecoscape 2023)

11.12.6 CBC Foraging Habitat

The vegetation types AspBsBIMS and BpLW provide crucial foraging resources for Carnaby's Black Cockatoo due to the presence of high-proportion proteaceous species like Banksia prionotes and Banksia sessilis. These species are integral to the cockatoo's diet, supplying essential seeds and nectar. Notably, these vegetation types are minimally affected by the proposed disturbance footprint and IGE's construction activities.

The IGE survey area occupied 768.95 ha overall, inclusive of a 50 m buffer applied to the proposed Disturbance footprint. Within the mapped survey area, AspBsBIMS occupies 93.17 hectares (12.12%) and BpLW occupies 5.59 hectares (0.73%).

Within the previously proposed 242.28 ha Disturbance Footprint, they occupied 11.86 hectares (4.95%) and 2.73 hectares (4.14%), respectively, as recorded in the 2023 Ecoscape detailed survey.

Within the current proposed project clearing extent of 127.13 ha (The disturbance footprint) the above vegetation type will occupy approximately 6 hectares and 1.4 hectares respectively of which 46% is either degraded completely degraded of unvegetated (IGE 2024)

The vegetation ranged from Completely Degraded condition to Excellent condition with 21.93% not having native vegetation (cleared). Overall, 24.03% was in Degraded-Completely Degraded condition and 54.04% in Good to excellent condition.

Eleven vegetation types were recorded from within the overall IGE site series) based on a combination of structural vegetation type as identified in the field, floristic analysis and subsequent desktop review. Ten of these intersected the current survey area.

Ongoing monitoring of these vegetation types will be essential to evaluate any future impacts on foraging habitat. Conservation efforts will focus on management practices aimed at sustaining the minimal existing habitat over the long term. The degree of impact on Carnaby's Black Cockatoo foraging habitat during construction will depend on several factors, including disturbance extent, specific vegetation types affected, and the effectiveness of mitigation measures in place. So far, IGE's mitigation strategies have successfully protected the majority of this habitat (See Figure 23).

It is evident that Carnaby's Black Cockatoo is present in the broader area and may, at a minimum, overfly the Development Envelopes (DE) for purposes such as foraging, roosting, or accessing water. However, their visits to foraging habitats containing Banksia species, particularly the AspBsBIMS and BpLW vegetation types, are likely infrequent.

These specific habitats lie along the DE's southern edge and adjoin a much larger, similar habitat within the Beekeepers Nature Reserve (BKNR), which may offer more suitable resources.

In conclusion, although the Carnaby's Black Cockatoo occasionally visits the IGE project site, observational records from IGE personnel and locals confirm infrequent usage by the species. This targeted observational approach enables responsible management and preservation of essential foraging areas while balancing the project's development objectives.

Table 12 Project Vegetation Types Plus Mosaics of These

Vegetation Type	Locations
ArLOF;	*Acacia rostellifera* low open forest on sandy slopes/disturbed areas
ArMcMhTS;	*Acacia rostellifera*, *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii* tall shrubland on near coastal dunes and swales
ArMlMhTS;	*Acacia rostellifera*, *Melaleuca lanceolata* and *Melaleuca huegelii* subsp. *huegelii* tall shrubland on near coastal dunes and swales
AsaAscTOS;	*Acacia saligna* and *Acacia scirpifolia* tall open shrubland on sandy slopes/disturbed areas
AspBsBlMS;	*Acacia spathulifolia*, *Banksia sessilis* var. *cygnorum* and *Banksia leptophylla* var. *melletica* mid shrubland on sandplain/lower slopes
BpLW;	*Banksia prionotes* low woodland on sandplain/lower slopes
EcArMW;	*Eucalyptus camaldulensis* subsp. *obtusa* and *Acacia rostellifera* mid woodland on riparian and low-lying areas
EeLOW;	*Eucalyptus erythrocorys* low open woodland on exposed limestone/cap
EobEorEzMOMF;	*Eucalyptus obtusiflora*, *Eucalyptus oraria* and *Eucalyptus zopherophloia* mid open mallee forest/mallee shrubland on near coastal dunes and swales
McAxGaTDS;.	*Melaleuca cardiophylla*, *Acacia xanthina* and *Grevillea argyrophylla* tall dense shrubland on near coastal dunes and swales.

Table 13: DBCA: **PEC P1 vegetation** and **Priority Two**, **P2** vegetation identified during the 2020 and 2022 survey (Ecoscape 2022).

Note: The IGE Survey Area occupied 768.95 ha overall, inclusive of a 50 m buffer and the previous proposed Disturbance Footprint Occupied 242.28 ha

<table>
<tr><td colspan="2">EobEorEzMOMF PEC (Priority 1)</td></tr>
<tr><td>Eucalyptus obtusiflora, Eucalyptus oraria and Eucalyptus zopherophloia mid open mallee forest/mallee shrubland over Melaleuca cardiophylla, Acacia rostellifera and Olearia axillaris mid open shrubland over Beyeria cinerea subsp. cinerea, Acanthocarpus canaliculatus and Diplolaena leemaniana low open shrubland

</td><td>Location and habitat

likely to be representative of the Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora (Geraldton area) P1 PEC, noting that this PEC has a likely 125 km north-south distribution.

Identified predominantly within the western area of the Development Envelope, lot 703

Other characteristic species

Acacia idiomorpha
Alyogyne hakeifolia
Austrostipa flavescens Commersonia borealis
Conostylis prolifera
Cryptandra pungens
Dodonaea aptera
Eucalyptus erythrocorys Eucalyptus foecunda subsp. aeolica (P2)
Guichenotia ledifolia
Hibbertia subvaginata Lasiopetalum angustifolium Lysiandra scabra
Rhagodia preissii subsp. obovata Templetonia retusa

Survey Results

40.60 ha
5.28 % within Survey Area

6.96 ha
2.89% within Disturbance Footprint</td></tr>
</table>

Eucalyptus Foecunda Subsp. *Aeolica* (P2) – Recorded During The 2022 Survey	
Description: According to Nicolle & French (2021), *Eucalyptus foecunda* subsp. *aeolica* is a mallee usually to 5 m high with rough bark in the lower part of the trunk becoming ribbony or flaky above, and ultimately smooth grey above. Leaves are glossy. It grows on coastal sands over limestone or on limestone dunes between Cliff Head and Leeman. Within the survey area this species was observed to meet the overall description or, on occasion, to not have the rough bark at the base. 	Habitat: Coastal dunes; lower slope. Vegetation types EobEorEzMOMF and mosaic (intergrade) of EeLOW and AspBsBlMS. Location: Western side of survey area in mallee vegetation and western central area on the edge of sandplain. Survey results: Two records in survey area although more would occur as the taxon wasn't targeted for survey. Populations: The two records are technically from separate populations, however, are likely to be within a single population. Numbers of individual plants were not recorded but is likely to be in low hundreds of plants. Known records and distribution: According to Flora Base (DBCA, 2021b) there are 25 records of this species from the Geraldton Sandplains and Swan Coastal Plain bioregions, with an overall distribution of approximately 80 km (north-south) and up to approximately 15 km from the coast. The survey area at the northern extent of the nominal distribution of this species.

Scholtzia Calcicola (P2) – Recorded During 2022 Survey

Description: According to (Rye (2019)**Description**: According to (Rye (2019) *Scholtzia calcicola* is an erect, dense shrub growing 2 m high with tiny pale pink flowers. Within the survey area this species recorded as an opportunistic observation with vegetation type **AspBsBlMS**.

Habitat: Sandplain.

Location: Not recorded, but near the southern edge of the survey area, towards the western side.

Survey results: One record in survey area.

Populations: Not counted during the survey as the species was identified from an opportunistic collection. Likely sparsely scattered individuals or small clumps but within a single population.

Known records and distribution: According to Atlas of Living Australia (ALA, 2021), there are eight records of this species from the Geraldton Sandplains and Swan Coastal Plain bioregions, with an overall distribution of approximately 115 km (north-south) and up to 20 km inland, from the Irwin river to near Jurien Bay. The survey area is in the northern portion of the species' distribution.

Table 14: **CBC Vegetation habitat types within the survey area**

Bold font indicates site of representative photo; *italic font* indicates recording site is not within current (2022) survey area

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Other characteristic species	Area (ha) and extent (%)
Lower slopes (sand with limestone)	AspBsBlMS	*Acacia spathulifolia*, *Banksia sessilis* var. *cygnorum* and *Banksia leptophylla* var. *melletica* mid shrubland over *Hibbertia hypericoides* subsp. *septentrionalis*, *Scholtzia umbellifera* and *Desmocladus asper* low shrubland/rushland NVIS: M+ ^^*Acacia spathulifolia*,*Banksia sessilis* var. *cygnorum*,*Banksia leptophylla* var. *melletica*\^shrub\3\c;G ^^*Hibbertia hypericoides* subsp. *septentrionalis*,*Desmocladus asper*\^shrub,rush\2\c	A2207 A2210 **A2213** A22O04 A22O09 A22O12 *D20Q03* *D20Q05* *D20R06*		*Acacia scirpifolia* *Acanthocarpus canaliculatus* *Austrostipa flavescens* *Austrostipa macalpinei* *Bossiaea eriocarpa* *Callitris pyramidalis Calothamnus quadrifidus* subsp. *angustifolius* *Conostylis candicans* subsp. *calcicola* *Conostylis prolifera* *Eucalyptus erythrocorys* *Grevillea preissii Guichenotia ledifolia Hibbertia subvaginata Labichea cassioides Melaleuca cardiophylla Melaleuca leuropoma Mesomelaena pseudostygia Scholtzia laxiflora Stenanthemum notiale Styphelia insularis* *Trachymene pilosa* **Vulpia myuros* forma *myuros Waitzia suaveolens* var. *suaveolens*	93.17ha 12.12% In disturbance footprint 11.86 ha 4.93%

Lower slopes (sand)	BpLW	*Banksia prionotes* low woodland over *Banksia leptophylla* var. *melletica*, *Jacksonia calcicola* and *Banksia sessilis* var. *cygnorum* mid open shrubland over *Hibbertia hypericoides* subsp. *septentrionalis*, *Ecdeiocolea monostachya* and *Stenanthemum notiale* low shrubland/rushland NVIS: U+ ^*Banksia prionotes*\^tree\6\i;M ^^*Banksia leptophylla* var. *melletica*,*Jacksonia calcicola*,*Banksia sessilis* var. *cygnorum*\^shrub\3\i;G ^^*Hibbertia hypericoides* subsp. *septentrionalis*,*Ecdeiocolea monostachya*,*Stenanthemum notiale*\^shrub,rush\1\c	A2211 A2214 A22O13 *D20Q04* D20R10		*Acacia saligna* *Acacia scirpifolia* *Acacia spathulifolia* *Callitris pyramidalis* *Calothamnus quadrifidus* subsp. *angustifolius* *Desmocladus asper* *Eucalyptus erythrocorys* *Eucalyptus obtusiflora* *Hakea trifurcata* *Jacksonia hakeoides* *Lepidobolus chaetocephalus* *Melaleuca carrii* *Melaleuca leuropoma* *Mesomelaena pseudostygia* *Scaevola ?sericophylla*	5.59 ha 0.73% In disturbance footprint 2.73 ha 1.14%

11.13 Introduced Flora

During the 2022 detailed survey forty-four introduced flora species (weeds) were recorded during the field survey, representing 18.80 % of the overall flora inventory.

Five of the eight most commonly occurring species were introduced. In particular, these species (**Brassica tournefortii*, Wild Turnip; **Bromus diandrus*, Great Brome; **Ehrharta longiflora*, Annual Veldt Grass; **Lysimachia arvensis*, Pimpernel; and **Vulpia myuros,* Rat's Tail Fescue/ Silver Grass) were significant factors that affected the vegetation condition ratings of quadrats and overall survey area.

**Echium plantagineum* (Patterson's Curse), which is a Declared Pest plant, was recorded from a single location during the 2020 field survey (Ecoscape, 2021a). However, it was not observed at all during 2022 survey and the site of the 2020 survey record is not within the 2022 survey area/proposed Development Envelope. As an annual species it may occur sporadically in different parts of the site, however, even if present it is in the Exempt category and has no management requirements in response to its presence.

**Lycium ferocissimum* (African Boxthorn), which is a WoNS species, was recorded from a single location during the 2020 field survey (Ecoscape 2021) but not observed during 2022. The location of the 2020 record is not within the 2022 survey area/proposed Development Envelope. There are no management requirements regarding the listing of this species as a WoNS (Ecoscape 2022).

11.14 Regional and Local Significance

Five Priority-listed flora were recorded from the survey area; All are considered to have local and regional significance noting that Scholtzia calcicola is perhaps the most significant as it is poorly collected with only seven records listed on Flora Base (WAH 2023) and ALA (ALA 2023). Aside from the recorded PF, none of the recorded flora are considered likely to have any local or regional significance (Ecoscape 2023).

11.15 Local and Regional Impacts

The Proposal Development Envelopes has been strategically placed near the Brand Highway, offering easy access to Western Australia’s primary road network. This location not only supports logistical efficiency but also allows for careful site design that prioritises environmental considerations. The layout has been optimised to make use of previously cleared areas, such as existing fire breaks and tracks, significantly reducing the need for additional clearing of native vegetation. Further, the design avoids interference with sensitive ecological features, including Carnaby's Black Cockatoo (CBC) habitats, wetlands, and known cave systems.

Located within the Geraldton Sandplains IBRA Bioregion and the LeSuer Sandplain Sub-Region, the Proposal area is notable for its floristic diversity and high levels of endemism. However, vegetation mapping undertaken by Ecoscape (2023) confirmed that no vegetation units of high local conservation significance are present within the Development Envelopes. The floristic composition in this area does not support any unique species or assemblages that are not also found elsewhere within the broader region, thus mitigating the ecological impact.

Overall, the proposed clearing for this project is anticipated to have a minimal effect on the biodiversity within the Geraldton Sandplains IBRA Bioregion. Through thoughtful site planning and a commitment to environmental preservation, the Proposal aims to minimise impacts on local flora and fauna while supporting regional development objectives.

The National Objectives and Targets for Biodiversity Conservation 2001 – 2005 (Environment Australia, 2001) aims to:

- Prevent clearing of ecological communities with less than 30 % of the original extent remaining; and
- Recover ecological communities with less than 10 % of the original extent remaining.

These national targets are reflected in state government policy for Western Australia and generally, are used to guide planning and decision-making.

For the implementation of the proposal, a total area of 127.13 hectares of native vegetation will undergo disturbance. This represents approximately 7.21% of the proposal area (DE) that will be impacted by clearing. Additionally, the proposed Disturbance Footprint accounts for less than 1.5% of the current extent of any pre-European vegetation association.. None of the ecological communities have less than 30 % of the original extent remaining and none of the impacted ecological communities have less than 44 % of the original extent remaining.

Table 15: Vegetation Systems Disturbance

Vegetation System Association	Pre-European Vegetation (ha)	Current Regional Extent (ha)	Extent Remaining	Area to be impacted by Proposal (ha)
Cliff Head_255	3,064.34	2,933.06	95.72%	39.49
Illyarie_377	63,099.54	62,724.44	99.41%	3.82
Illyarie_433	32,460.48	14,746.34	45.43%	96.0
Illyarie_619	154.54	50.80	32.87%	0.0
Total	**98,778.90**	**80,454.64**		**240.37 (previous Disturbance Footprint)** (Updated disturbance Footprint: **127.13 ha)**

11.16 Vegetation Types update

The vegetation types were delineated with greater detail during the Ecoscape detailed 2022 survey compared to the 2020 Reconnaissance-level survey (Ecoscape 2021). This enhancement in detail was facilitated by improved access to the survey areas, allowing for increased coverage. Additionally, additional recording sites, including quadrats, relevés, and descriptive relevés, were established, providing a more comprehensive data collection. The availability of more detailed aerial imagery also contributed to a more accurate interpretation of areas that were previously inaccessible or not accessed.

Through meticulous floristic analysis and consideration of the gathered data, several vegetation types were further refined. These refinements are detailed in Table 17 below, which documents the updated classification of vegetation types based on 2022 survey conclusions . Overall, the increased detail and accuracy in vegetation delineation provide a more comprehensive understanding of the ecological landscape within the surveyed area.

Table 16: Vegetation Type Equivalents

Mapping unit	2020 equivalent	Details and Notes
ArLOF	ArLOF	Disturbed sites (previously grazed and/or cleared and naturally regenerated). No change to mapping; no additional quadrats or relevés recorded in 2022.
ArMcMhTS	McArGaTS	Refined from 2020 vegetation type. This is the main equivalent. Occurs in mosaics with AspBsBIMS, McAxGaTDS and EobEorEzMOMF.
ArMlMhTS	McArGaTS	Refined from 2020 vegetation type; generally, occurs on exposed limestone, potentially in association with karst landforms.
AsaAscTOS	As1As2TOS	No change to mapping.
AspBsBlMS	LcBsJhMOS	Refined from 2020 vegetation type. This is the main equivalent.Occurs in mosaics with ArMcMhTS and McAxGaTDS.
BpLW	LcBsJhMOS	Refined from 2020 vegetation type where *Banksia prionotes* is present as an upper stratum.
EcArMW	EcArMW	No change to mapping. No additional quadrats/relevés recorded from this vegetation type in 2022.
EeLOW	EeLW	Refined from 2020 vegetation type. Frequently intergrades with AspBsBIMS and occurs in a mosaic with McAxGaTDS.
EobEorEzMOMF	McArGaTS	Refined from 2020 vegetation type; occurs in a mosaic within ArMcMhTS.
McAxGaTDS	McArGaTS	Refined from 2020 vegetation type where Acacia xanthina is dominant rather than Acacia rostellifera. Tends to be more coastal and have more exposed limestone than ArMcMhTS. Occurs in mosaics with ArMcMhTS, AspBsBIMS and EeLOW.
MsCoMrMOW	MsCoMrMOW	No change to mapping. Does not intercept 2022 survey area.

11.17 Vegetation Condition

The vegetation condition within the survey area exhibited a wide range, from Completely Degraded to Excellent. This diversity in condition reflects various environmental and anthropogenic factors influencing the area.

Approximately one quarter of the survey area was classified as being in Very Good condition, indicating healthy and thriving vegetation with minimal disturbance. These areas support a rich variety of native plant species and provide valuable habitat for local wildlife.

On the other hand, about 20% of the survey area was not vegetated. This lack of vegetation was primarily due to cleared former paddocks located in the eastern portion of the survey area. These paddocks were previously used for agricultural purposes and have not yet undergone significant natural regeneration. Additionally, tracks and localized clearings scattered throughout the site were made for proposed infrastructure projects, contributing to the non-vegetated portions of the survey area.

The main factor affecting vegetation condition in areas of native vegetation was weediness, largely due to long-term grazing by livestock or feral animals that introduced weed seeds to the broader area. This persistent weed invasion has altered the native vegetation composition and structure. Changes to vegetation structure in the eastern portion of the survey area, also a result of long-term grazing, further contributed to the vegetation condition rating within the survey area.

The remaining areas exhibited varying degrees of degradation. Some regions showed signs of partial recovery, while others were significantly disturbed, possibly due to historical land use practices, natural events, or ongoing human activities. This varied condition underscores the need for targeted conservation and restoration efforts to enhance vegetation health and biodiversity within the survey area. The vegetation condition in areas that were not accessed or accessible was attributed with a rating based on the surrounding area and surveyor experience within the wider survey area.(Ecoscape 2023)

Table 17: Vegetation Condition within the Survey Area (Ecoscape 2022 detailed Field Survey, 768.96 ha)

Vegetation Condition	Extent (ha)	Proportion (%)
Pristine	-	-
Excellent	107.39	13.97
Very Good	184.84	24.04
Good	123.35	16.04
Degraded	96.77	12.58
Completely Degraded	88.02	11.45
Not vegetated	168.59	21.93

11.18 Forests Deaths in Western Australia

Widespread forest die-off is occurring across Western Australia, as highlighted by Dr. Joe Fontaine, Lecturer in Environmental and Conservation Science at Murdoch University. Reports from community members, researchers, and authorities indicate the death of shrubs, trees, and other vegetation over an area spanning approximately 1,000 km, from the Zuytdorp Cliffs near Shark Bay to Albany on the southern coast.

The 2024 die-off is particularly severe, impacting a variety of plant species, including acacia, jarrah forests, southern wet forests near granite outcrops, as well as shrublands and woodlands along the northwest coast. The most significant damage has been observed along the west coast, where higher temperatures have resulted in extensive areas of dead or dying vegetation.

Vegetation in shallow soils has been most affected, especially around granite outcrops, limestone, and coastal heath (e.g., within the Arrowsmith Development Envelopes. The February 2024 heatwaves caused immediate die-off in some areas, while the prolonged dry period that followed further compounded the damage, leading to widespread vegetation loss across the state. This combination of extreme heat and drought has left a lasting impact on Western Australia's ecosystems, threatening the long-term viability of many native species.

As a result, 19% of trees and shrubs in affected areas have perished, with approximately 16,000 hectares of forest canopy—equivalent to 1.5% of the southwest's forests—being lost. The ecological impact has been profound, with the endangered Carnaby's Black Cockatoo population suffering a 60% decline, and the Jarrah forest east of Perth being classified as "at risk of collapse" by the Intergovernmental Panel on Climate Change (IPCC). These losses highlight the critical state of the region's biodiversity and underscore the urgent need for conservation efforts.

Given the data outlined above, the IGE project disturbance area of 127.13 hectares represents a significantly reduced environmental impact due to the fact that 46% of the site's vegetation is classified as either degraded, unvegetated or completely degraded. This degradation leaves only approximately 40 hectares of vegetation in good to excellent condition that will be affected by site clearing. As a result, the project's impact on high-quality vegetation is notably diminished, aligning with sustainable development principles while mitigating potential ecological damage. This reduced impact underscores the importance of focusing conservation efforts on the remaining intact ecosystems while ensuring responsible land use within the degraded areas.

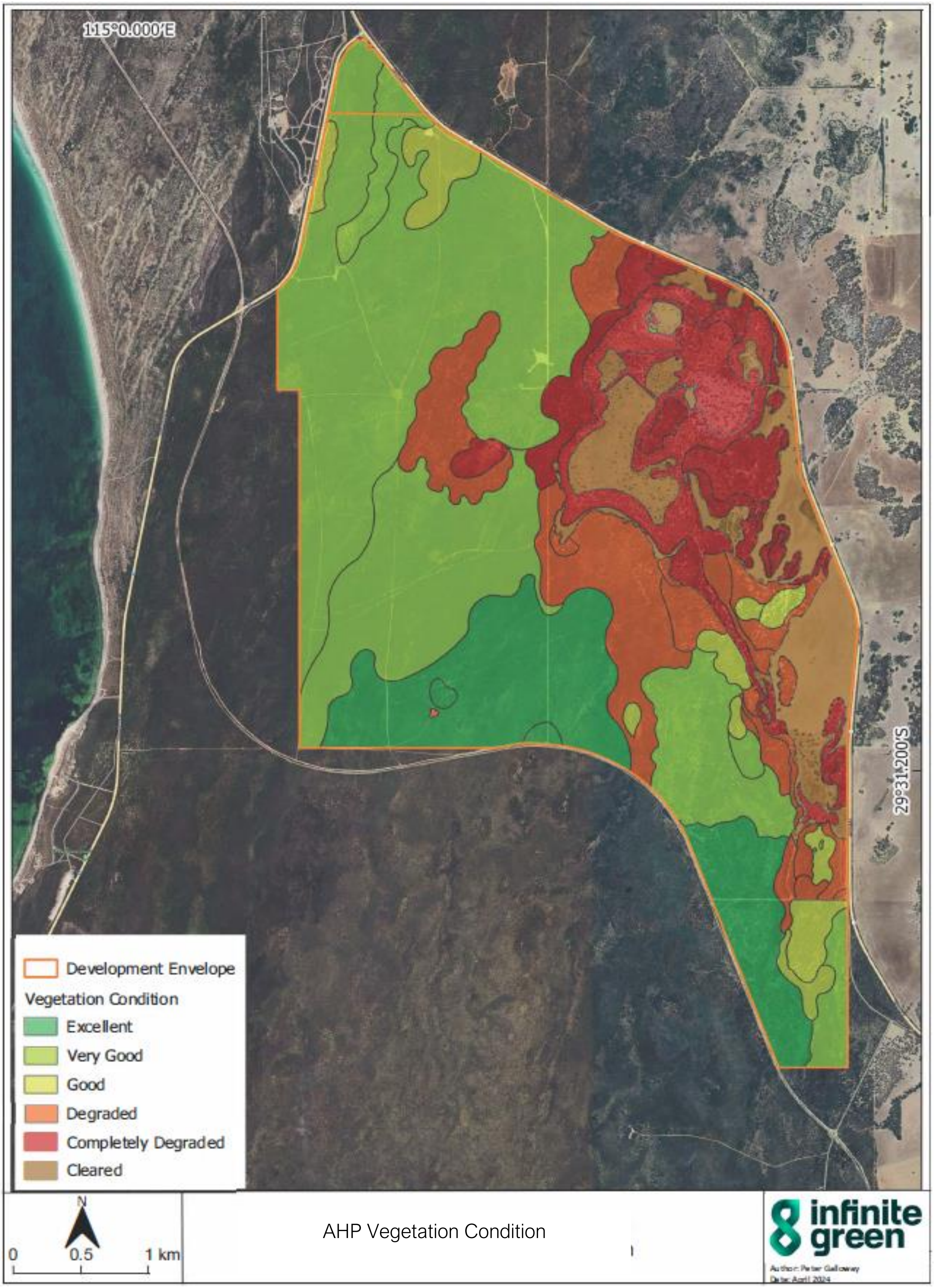


Figure 17: Vegetation Condition (2022)

The Assessment of Impacts Upon the thirteen Identified Priority Flora Species are Listed In Table 19 Below:

Table 18: Priority Flora.

Species	Status	Impact Assessment
Anthocercis intricata (P3)	Observed on site during the 2020 survey	Has been found in low numbers scattered in vegetation type McSrGaTS. 8.1 % of the recorded existing vegetation type area will be affected by the proposal. Furthermore, this taxon is 'relatively widespread and abundant regionally' indicating that loss of individual plants within the disturbance area is unlikely to have a significant impact on the population (Ecoscape, 2021a).
Beyeria cinerea subsp. *cinerea* (P3)	Observed on site during the 2020 and 2022 survey	Has been found in large numbers of individual plants in vegetation type McSrGaTS. during the 2020 and 2022 survey with a total of 2,250 plants recorded. However, it is likely that only a small proportion (10-20%) of the total population in the proposal area has been recorded (Ecoscape 2023). In addition, 8.1% of the recorded existing vegetation type area will be affected by the proposal. With the survey findings and an overall distribution of the taxon with approximately 500 km north south, clearing some of the population within the survey area is unlikely to have a significant impact on the species or population as a whole (Ecoscape, 2021a, 2023).
Eucalyptus zopherophloia (P4)	Observed on site during the 2020 and 2022 survey	Has been found in significant numbers of individual plants in vegetation type McSrGaTS during the 2020 and 2022 survey with a total of 639 plants recorded (Ecoscape, 2023). Potentially occurs sporadically within the entirety of the vegetation type. 8.1 % of the recorded existing vegetation type area will be affected by the proposal. The species occurs from Shark Bay to Jurien Bay with the greatest density of records near the proposal area. Therefore, removal of some individuals of this species would be unlikely to have a significant impact on the species or population as a whole (Ecoscape, 2021a).

Scholtzia calcicola (P2)	Observed on site during the 2022 survey	One record from opportunistic collection with the survey area (Ecoscape, 2023). Likely sparsely scattered or small clumps of individuals. Overall, low numbers of individual records for this species, but the taxon appears to have an overall distribution of approximately 115 km (north south) and up to 20 km inland, from the Irwin River to Jurien Bay. Due to the current information, it is not possible to determine the impact that clearing would have due to the poorly known nature of the species (Ecoscape, 2021a, 2023). Due to the negligible number of plants occurring within the Development Envelopes, the potential impact upon local and regional populations of the proposed clearing is likely to be negligible at a regional scale and also most likely negligible at a local scale as most of IGE's proposed works area on the western side of the IGE site has already been cleared for tracks and will only require widening for construction, turbine footings and firebreaks. The area of vegetation types AspBsBlMS and BpLW intersecting the proposed solar farm on the eastern side of the IGE site have been previously grazed, and as such there is a lower likelihood of *Scholtzia calcicole* occurring. The likelihood of impacting the local or regional population is therefore correspondingly lower and would be negligible at worst and more likely to be of no impact (i.e. species not present).
Damperia tephera (P3)	Observed on site during the 2022 survey	Has been found in significant numbers during the 2022 survey with a total of 197 plants recorded. It has been estimated that the numbers represent 20- 50 % of the potential population with the proposal area, although the majority are unlikely to occur in proposed clearing areas. Taxon has also been described as disturbance opportunist (Ecoscape 2023). Relatively widely distributed with known occurrence records from Geraldton Sandplains and Swan Coastal Plain bioregions. Therefore, removal of some individuals of this species would be unlikely to have a significant impact on the species or population as a whole (Ecoscape, 2023).
Acacia vittata (P2)	Risk Assessment Potential	Has not been recorded with the proposal AHP Development Envelopes. Documented within Beekeepers nature reserve.
Haloragis foliosa (P3)	Risk Assessment Potential	Despite the small number of records, specimen descriptions indicate this species may be a disturbance opportunist and clearing may actually favour its presence (Ecoscape, 2021a).

Thryptomene sp. Lancelin (M.E. Trudgen 14000) (P3)	Risk Assessment Potential	If it occurs, it is unlikely that clearing in the survey area would significantly impact on the population of this species as a whole (Ecoscape, 2021a).
Stawellia dimorphantha (P4)	Risk Assessment Potential	If it occurs, clearing within the survey area is unlikely to have a significant impact on the population of this species as a whole (Ecoscape, 2021a).
Eucalyptus foecunda subsp. Aeolica (P2)	Patchy Distribution	The nearest record of this species as shown on *FloraBase* (WAH 2023) is located approximately 7 km to the south of the closest record from this survey. This WAH record (from two identical entries considered to represent duplicates – PERTH 08839980 and PERTH 08840016) is from *Eucalyptus erythrocorys* vegetation in dune swales, which is descriptively the equivalent of vegetation type EeLOW although, within the survey area this vegetation type occurred on limestone capping not in swales. **Only fifteen plants are noted in the WAH record, suggesting patchy distribution**
Comesperma griffinii (P2) (Negligible)	Likely to be only a few individuals as WAH (2023)	*Comesperma griffinii* has an overall distribution of approximately 850 km north-south by a band of approximately 250 km east-west (*ibid*.) with the survey area located towards the northern end of the species range. Regardless of this species' known local distribution being to the east, due to its small size that may have led to it being overlooked during the Ecoscape surveys and others in the vicinity, and that suitable habitat exists it may occur within the survey area. **If it does occur it is likely to be only a few individuals as WAH (2023) records at most indicate small numbers of plants (maximum 10) per record.**
Anthocercis intricate (P3)	Likely to occur	*Anthocercis intricata* has an overall distribution of approximately 420 km north-south and up to 20 km from the coast for most records (ALA 2023), with the survey area located at the southern end of the specie's known range. Due to the two *Anthocercis* species being so vegetatively similar it must be considered possible that *Anthocercis intricata* individuals could occur and as such it retains its pre-survey (desktop assessment) likelihood (Likely to occur).

Banksia elegans (P4)	May Occur	*Banksia elegans* has an overall distribution of approximately 110 km north-south by 25 km east-west (ALA 2023) with the survey area located near the centre of the species' known range. No similar-looking shrubs have been observed during either the 2020 (Ecoscape 2021) or 2022 surveys, however, isolated plants May occur in vegetation types AspBsBlMS and BpLW.

Note: Shaded green : October 2022 detailed flora and vegetation survey revealed three Priority-listed P2's during field surveys

11.19 Statistical Floristic Analysis

The floristic analysis indicates a clear floristic differentiation (with only one exception) between the vegetation types occurring on sandplain formations (vegetation types AspBsBlMS and BpLW) and other vegetation types. These two vegetation types do not form separate groups within this broader floristic group supporting the field observation that they intergrade between the two types and differentiate based on the presence of *Banksia prionotes* as an upper stratum.

Most other vegetation types cluster together suggesting that the structural vegetation types as identified in the field have a floristic basis. Descriptive relevés not used in this analysis.

Table 19 Mapping Units: Area Extents Showing Vegetation Density Across the DE (Ecoscape 2023)

Mapping unit	Vegetation type (abbreviation)	Survey Area (ha) and extent (%)	Disturbance footprint: area (ha), extent (%)
ArMcMhTS / EobEorEzMOMF	Mosaic of ArMcMhTS and EobEorEzMOMF	1.41 ha, 0.18%	-
ArMcMhTS / McAxGaTDS	Mosaic of ArMcMhTS and McAxGaTDS	5.65 ha, 0.74%	0.68 ha, 0.28%
AspBsBlMS / ArMcMhTS	Mosaic of AspBsBlMS and ArMcMhTS	3.95 ha, 0.51%	0.91 ha, 0.38%
AspBsBlMS / McAxGaTDS	Mosaic of AspBsBlMS and McAxGaTDS	6.03 ha, 0.78%	0.05 ha, 0.02%
EeLOW / McAxGaTDS	Mosaic of EeLOW and McAxGaTDS	7.24 ha, 0.94%	0.93 ha, 0.39%
McAxGaTDS / EobEorEzMOMF	Mosaic of McAxGaTDS and EobEorEzMOMF	11.37 ha, 1.48%	1.09 ha, 0.45%
Not Native Vegetation (Pre-Cleared, Including Tracks)		168.59 ha, 21.93%	103.03 ha, 42.86%
Total Extent		768.95 ha	240.37 ha

11.20 Potential Impacts

11.20.1 Remnant Vegetation

The combined Development Envelopes containing the proposed works (1906.16 ha) contains ~1,700 ha vegetation and adjoins the BKNR (approximately 70,000 ha), an area reserved for the protection of flora and fauna. The area proposed to be cleared is not significant as remnant native vegetation within an area that has been extensively cleared. Overall, it is proposed to clear 127.13 ha (Approx 6%) of the overall native vegetation footprint.

11.20.2 Beekeepers Nature Reserve (BKNR)

The western boundary of the proposed activity aligns with the Beekeepers Nature Reserve (BKNR), with Indian Ocean Drive and the Eneabba Railway Line primarily serving as the demarcation. As such, any indirect impacts on vegetation within this portion of the Development Envelopes are projected to be minor:

- Physical Barriers: Indian Ocean Drive and the Eneabba Railway Line act as significant physical barriers between the proposed activity and the Beekeepers Nature Reserve (BKNR). These existing infrastructure elements serve to separate the two areas and reduce the likelihood of indirect impacts on vegetation.

- Strategic Planning: Clearing and construction activities will be carefully planned and executed to avoid encroachment into the reserve. By implementing precise construction methods and Adhering to designated boundaries and the mitigation hierarchy, we aim to minimise any potential indirect impacts on the surrounding vegetation.

Together, these factors contribute to our expectation of minimal indirect impacts to vegetation within the vicinity of the Beekeepers Nature Reserve.

IGE are committed to implementing rigorous measures to minimise environmental disturbances. Clearing and construction operations will be strategically planned to avoid encroachment into the reserve, ensuring that any potential impacts remain minimal. Additionally, comprehensive monitoring protocols will be established to track sedimentation and topsoil migration, with proactive measures in place to mitigate any unforeseen environmental effects.

11.20.3 Introduction And Spread of Environmental Weeds

The proposal site is located on previously disturbed land including historic domestic grazing, resulting in a significant historic invasion of weeds across all areas including cleared areas, fire breaks and access tracks including vegetated areas. The required management of weeds requires control and prevention of spread rather than eradication. There is the potential for weed numbers to increase within and outside of the proposal Development Envelopes areas by windblown seed dispersion from existing nearby populations, the movement of soil during earthworks or seeds entering the Development Envelopes through contaminated vehicles, earthmoving equipment or construction materials.

For this Proposal, stringent vehicle hygiene, weed control, and ground disturbance protocols will be enforced to protect the site's ecological integrity. Mitigation measures will include restricting vehicle access to designated roads only, significantly reducing the risk of disturbing sensitive vegetation and spreading invasive species. Additionally, a comprehensive weed monitoring program will be implemented to manage and contain existing weed populations effectively, while early detection efforts will be employed to prevent the establishment of new invasive species. Weed hygiene management procedures will strictly adhere to regulatory requirements, ensuring that all operational practices align with environmental compliance standards.

11.21 Altered Groundwater Tables

Modelling of annual groundwater abstraction at a rate of 900 ML per year from the Yarragadee aquifer has demonstrated a maximum drawdown of 0.2. It is important to note that groundwater systems are hydrologically interconnected. However, recent updates to the Proposal indicate that IGE will abstract 2,340 kL of water per day for Green Hydrogen Production Facility operations.

With this water abstraction requirement from the production bores, the anticipated drawdown from the Yarragadee aquifer is highly unlikely to have any discernible impact on Groundwater Dependent Ecosystems (GDEs) or the nearby Arramall Lake and wetland. Should there be any residual impacts on GDEs or the Beekeepers Nature Reserve, IGE has comprehensive mitigation management strategies in place to address them effectively.

Monitoring of project groundwater levels and water quality will be essential to maintain the aquifer's long-term viability and to protect associated ecosystems and water users.

11.21.1 Surface Water Regimes

For ground water dependent ecosystems (GDE’s), the potential impacts primarily revolve around changes in groundwater levels and water quality due to groundwater abstraction activities associated with the GHPF and the development of solar and wind farms.

In the case of the solar farm, while rainwater infiltration is unlikely to be significantly affected by the construction of uncompacted sandy areas, subtle changes in groundwater recharge dynamics may lead to localized variations in the overall groundwater regime.

Windfarm stormwater management design aim to minimise surface runoff and associated impacts on groundwater recharge and quality. However, there may still be minimal localised effects on GDE’s due to changes in surface water flows and potential alterations in soil infiltration rates.

Overall, the key focus for GDE’s is the potential disruption to groundwater hydrology caused by changes in recharge patterns or groundwater abstraction activities associated with the development of solar and wind farms. Comprehensive monitoring and management strategies will be implemented to mitigate potential impacts and ensure the long-term sustainability of GDE’s in the surrounding areas.

The flooded area in the southern portion of the Development Envelopes lot 703 is not associated with vegetation of a watercourse or wetland. The drainage deviation affects vegetation type LcBsJhMOS (shrubland) and EeLW (limestone outcropping woodland).(Ecoscape 2022)

11.21.2 Hydrocarbon and Chemical Spills

Considering the temporal and spatial scale of the construction and operation for the Proposal, large-scale hydrocarbon spills are considered unlikely. Small hydrocarbon spills or other chemical spills are usually associated with failures of machinery and refuelling spills that may occur on occasion within the Development Envelopes. Hydrocarbon spills generally result in a defined area of contaminated soil that can be remediated via passive means such as removal and bioremediation. Control measures will be identified and designed to further minimise the risk of vegetation impacts resulting from hydrocarbon spillage.

11.21.3 Dieback

The Proposal is situated at the northern boundary of the 'vulnerable zone' for the plant disease known as dieback, caused by the pathogen Phytophthora cinnamomi. This zone encompasses all areas of the south-west land division located west and south of the 400 mm rainfall isohyet, including the proposed site.

The risk of dieback occurrence within the disturbance footprint is deemed low due to the presence of limestone and calcareous soils, which are less conducive to the survival and spread of Phytophthora cinnamomi. Additionally, the lack of susceptible vegetation species in the areas to be impacted further reduces the risk.

While there are Banksia species on-site that have the potential to be susceptible to another pathogen, P. multivora, no instances of dieback disease were identified during field surveys. Calcareous sands close to the coast are favourable to *Phytophthora multivora* however the impact of the pathogen has less impact than *P. cinnamomi* and sites do not exhibit increasing impact over time (Glevan, 2021). Furthermore, *P. multivora* being able to establish on drier sites, it has less impact on vegetation than *P. cinnamomi* (Conservation Commission of Western Australia, 2010). Glevan Consulting has assessed thousands of hectares of the Geraldton Sand Plain over many years. During those assessments, *P. multivora* has been recovered from over twenty locations. Most sites have been observed in subsequent years, and those sites do not exhibit increasing impact. Therefore, it would be assumed that the impact of any *P. multivora* infestation within the Proposal Area would be similar.

It is expected that if *Phytophthora* dieback were present in the Proposal area or introduced to the DE, the disease impact would rate as insignificant (Glevan, 2021). Based on DBCA ratings the overall risk at the site is determined to be low and the DBCA manual recommends standard hygiene practices.

The likelihood of the introduction of the pathogen is influenced by:

- Importation of raw material.
- Access
- Complexity of the activity
- Spatial extent of the activity
- Duration of the activity
- Drainage
- Unmanaged access

Hygiene measures will be rigorously implemented during construction to minimise the likelihood of introducing or spreading the dieback pathogen beyond a 'Low' risk level.

11.21.4 Fragmentation of Native Vegetation

During site construction, clearing activities have the potential to impact the habitat of priority flora and Priority Ecological Communities (PEC's), potentially resulting in vegetation fragmentation or altered structural compositions. Fragmentation diminishes the dispersal capacity of flora species within these groups, restricting their ability to spread across larger areas. This can lead to reduced genetic diversity and hinder ecosystem resilience. Furthermore, alterations in community structure may occur due to the disruption of existing ecological dynamics.

To mitigate these impacts, the placement of infrastructure within the Development Envelopes is intended to minimise further vegetation fragmentation. Additionally, the proposal disturbance footprint is not anticipated to result in significant native vegetation fragmentation.

Due to the scale of the disturbance footprint and its strategic placement within areas already affected by previous human activities, the potential for fragmentation of vegetation is expected to be limited.

11.21.5 Dust Emissions

Dust may be generated during the construction phase of the Proposal, resulting from vehicle movement, civil earthworks, and native vegetation clearing.

Dust deposition upon vegetation foliage has the potential to impair a plant's ability to photosynthesis or regulate water loss through transpiration. Dust accumulation on vegetation can follow a cyclical pattern, with increased dust load during dry conditions and decreases occurring after rainfall, with new growth replacing affected leaves (Farmer, 1991).. Dust mitigation measures will be implemented, including ensuring vehicles are limited to designated access routes where dust production can be mitigated.

Further dust suppression measures will be implemented, Including surface watering, restriction of earth moving vehicles during high wind episodes and speed restriction to minimize further dust generation. Additionally, water additives such as a hygroscopic crusting agent will be introduced. This dust control product is highly effective in containing fugitive dust throughout construction sites. The implementation of these mitigation measures is expected to reduce dust emissions to mitigate impacts within or outside of the Development Envelopes.

Following the construction phase, the operation of the Green Hydrogen Production Facility (GHPF) will not involve extensive machinery usage or earthwork activities, and any changes to dust deposition during this phase is expected to be limited to the immediate vicinity of access roads.

11.22 Avoidance, Mitigation and Management (Summary)

The Proposal mitigation process identified suitable measures to avoid and manage potential impacts to flora and vegetation to ensure EPA objective for this key environmental factor is met. The assessment follows a hierarchical approach where avoidance is of highest priority, followed by mitigation and management (Table19).(See appendices, EMRF Mitigation Strategy Document for further details)

Table 20: Potential Impacts to Flora and Vegetation - Avoidance, Mitigation and Management

Potential Consequences	Measures
Loss of vegetation and flora	*Avoid where possible:* - Ensure native vegetation clearing strictly Aderes to demarcated extents. - Protect Carnaby's Black Cockatoo (CBC) foraging habitat from any direct or indirect impacts. - Implement measures to prevent sedimentation and erosion resulting from the localised loss of vegetation and flora. - Avoid disturbance to Priority Ecological Communities (PECs) wherever possible. - Minimise unnecessary clearing to preserve natural habitats. - Prevent erosion and sediment migration through effective management practices. - Mitigate impacts to Beekeepers Nature Reserve and other sensitive areas. - Take proactive steps to avoid direct or indirect impacts on Carnaby's Black Cockatoo habitat during clearing activities. *Mitigation and Management* - Mitigation and Management: - Adhere to ground disturbance procedures to minimise environmental impacts. - Conduct baseline vegetation and flora surveys before commencing development activities to understand the environmental values of the site. - Utilise pre-disturbed areas wherever feasible to reduce new disturbances. - Implement erosion and sediment controls to prevent soil degradation. - Practice progressive clearing and rehabilitation to minimise long-term environmental impacts. - Maintain hygiene protocols to prevent the spread of Phytophthora sp. infection. - Manage groundwater responsibly through Adherence to groundwater licenses. - Store chemicals and hydrocarbons appropriately on-site and be prepared to respond to spills promptly with spill kits. *Rehabilitation* - Mitigation and Management: - Adhere to ground disturbance procedures to minimise environmental impacts. - Conduct baseline vegetation and flora surveys before commencing development activities to understand the environmental values of the site. - Utilise pre-disturbed areas wherever feasible to reduce new disturbances. - Implement erosion and sediment controls to prevent soil degradation. - Practice progressive clearing and rehabilitation to minimise long-term environmental impacts. - Maintain hygiene protocols to prevent the spread of Phytophthora sp. infection. - Manage groundwater responsibly through Adherence to groundwater licenses. - Store chemicals and hydrocarbons appropriately on-site and be prepared to respond to spills promptly with spill kits.

Introduction or spread of invasive species or weeds	*Avoid where possible* - Unauthorised vehicles on site - Unauthorised plant or vegetative material on site. - Direct or indirect weed impacts to site vegetation. - Weed impacts to native vegetation - Direct or indirect weed contamination - Vehicle movement around site where possible *Mitigation and Management* - Weed hygiene procedures – include inspection of all vehicles and machinery entering the site. - Weed inspections completed regularly during construction to inform weed management and detection. - Construction material required for site will be inspected prior entry to site. - No unauthorised plant or vegetative material to be brought to site. - Driving only on approved tracks. - Compliance with ground disturbance and clearing procedures. *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Temporary construction laydown areas will be immediately rehabilitated at end of life - Vegetative material removed in the early stages of clearing for subsequent reuse.
Change to bushfire regime	*Avoid where possible:* - Smoking outside of designated smoking areas - *Naked flames on site* - Parking in vegetated areas (to prevent hot engines causing bush fire). *Mitigation and Management* - Develop Fire Management procedures. - Liaise with local bushfire authorities regarding fire breaks. - Training and inductions include Emergency Response. - Establish and implement hot work procedures. - Regular inspections of generators and other sources of heat/ power. - Fire extinguishers available around site and on all vehicles and machinery. - Vehicles and machinery to be transitioned off when not in use. *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Vegetative material removed in the early stages of clearing for subsequent reuse.
Fragmentation of vegetation	*Avoid where possible* *Disturbing native vegetation clearing outside of demarcated extents* - Clearing outside demarcated clearing limits - Fragmentation of native vegetation where feasible. *Mitigation and Management* - Adherence to ground disturbance procedures. - Implementation of erosion and sediment controls. - Progressive clearing and rehabilitation - Ensure use of disturbed areas where possible. - Proposal infrastructure design to prevent vegetation fragmentation. - Ensure use of disturbed areas where possible. - Proposal infrastructure design to prevent vegetation fragmentation. *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Vegetative material removed in the early stages of clearing for subsequent reuse. - Rehabilitation will be planned to support local ecological linkages. - Rehabilitation activities will be undertaken in accordance with EPA guidelines: Rehabilitate – Repair, Rehabilitate or Restore

11.23 Residual Impact

Following the implementation of detailed environmental mitigation and management strategies, residual impacts affecting vegetation and flora values, including within Beekeepers Nature Reserve, will be significantly minimised.

Clearing activities will be meticulously planned, with the proposed disturbance areas clearly demarcated prior to any work commencing. This ensures strict Adherence to the defined Disturbance Footprint limits, effectively preventing encroachment into protected areas such as the BKNR.

This approach will involve:

- Detailed Planning: Conducting thorough pre-clearing assessments and planning sessions to identify and mark the exact boundaries of the disturbance areas.

- Clear Demarcation: Using visible markers and signage to delineate the Disturbance Footprint, ensuring that all personnel are aware of the boundaries.

- Monitoring and Supervision: Assigning dedicated personnel to monitor clearing activities and ensure compliance with the established boundaries.

- Protective Barriers: Installing temporary barriers or fencing around protected areas to physically prevent access and protect sensitive habitats.

- Regular Audits: Conducting regular audits and inspections to verify that clearing activities remain within the designated boundaries and immediately addressing any deviations.

IGE will implement a robust set of clearing measures to ensure that all vegetation removal is restricted to predetermined boundaries, preventing any unintended encroachment into protected areas like the Beekeepers Nature Reserve (BKNR). These pre-emptive strategies will include clear demarcation of the approved clearing zones, continuous monitoring of clearing activities, and precise site mapping to align with environmental management strategies.

To address invasive species, IGE will apply rigorous weed control protocols aimed at containing and reducing the spread of weeds within and around the project site. These measures, combined with consistent monitoring and adaptive management practices, are designed to minimize the ecological footprint of the project, keeping residual impacts at a low-risk level for both the project area and adjacent sensitive vegetation. To address potential changes in the bushfire regime, stringent hot works guidelines and Fire and Emergency Management protocols will be strictly enforced, providing comprehensive protection for sensitive areas like BKNR.

Minimal habitat fragmentation is anticipated, facilitated by the disturbance mitigation measures within the Development Envelopes and ongoing progressive rehabilitation efforts. Abundant native vegetation within the region, including within the shire of Irwin bio-region will further contribute to mitigating impacts.

11.23.1 Predicted Outcome and Conclusions

The execution of the Proposal involves the clearance of 127.13 hectares of native vegetation, much of which has become degraded due to recent record temperatures and widespread vegetation die-off in Western Australia. To mitigate these environmental impacts, site optimisation management strategies have been implemented, and a revised project site layout has been developed to comply with EPA directives. In response, Infinite Green Energy (IGE) plans to relocate key infrastructure to minimise environmental impacts, particularly in sensitive areas such as wetlands, groundwater-dependent ecosystems (GDEs), priority flora and fauna habitats, and Carnaby's Black Cockatoo foraging areas. These changes aim to reduce disturbance to critical ecological features while maintaining compliance with regulatory requirements. Additionally, IGE is committed to implementing progressive rehabilitation measures where feasible, during construction, aiming to promptly restore vegetation communities and fauna habitat structures.

While potential risks from uncontrolled discharges, weed infestation, and fire hazards may persist throughout both construction and operational phases, the likelihood and severity of these risks are considered to be adequately mitigated through the application of regulatory controls and environmental mitigation measures.

In summary, the established environmental objectives for flora and vegetation, focusing on the preservation of biological diversity and ecological integrity, are anticipated to be upheld (EPA, 2016a). Given the extensive and diverse vegetation present in the surrounding Arrowsmith Development Area, combined with the implementation of flora and vegetation management measures, it is expected that the Proposal will have minimal adverse impacts or long-term ramifications upon native flora and vegetation quality within or adjacent to the AHP Development Envelopes.

Terrestrial Fauna

12 Key Environmental Factor – Terrestrial Fauna

12.1 Environmental Values

EPA Objective

The EPA environmental objective for terrestrial fauna is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained (EPA, 2016b).

Legislation, Policy, and Guidance

- Biodiversity Conservation Act 2016
- EPBC Act
- Statement of Environmental Principles, Factors and Objectives (EPA, 2021b)
- Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016b)
- EPA Technical Guidance –Terrestrial Fauna Surveys, Perth, Environmental Protection Authority (EPA, 2020)
- EPA Technical Guidance – Sampling methods for terrestrial vertebrate fauna, Perth, Environmental Protection Authority (EPA, 2016d)
- Survey Guidelines for Australia's Threatened Bats (DEWHA, 2010)
- Survey Guidelines for Australia's Threatened Mammals (DEWHA, 2011)
- Survey Guidelines for Australia's Threatened Reptiles (DEWHA, 2011b)

12.2 Receiving Environment

A desktop survey was undertaken by Ecoscape in October 2020. The desktop study (Appendix 1) identified 223 terrestrial vertebrate fauna species (PMST and Western Australian Databases) as potentially occurring in the proposed Development Envelope lot 703, including 14 mammals (eight native and six introduced), 163 birds (160 native and three introduced), 39 native reptiles and seven native amphibians. Of these, 35 species are conservation listed either on NatureMap, DBCA database or PMST.

12.3 DBCA Database Search

The search of the DBCA databases was conducted using a 30km buffer around the supplied shapefiles. 20 conservation-listed vertebrate fauna were identified as having previously been recorded from within the search area buffer, consisting of:

- two mammals
- 17 birds
- one reptile

The detailed database search results are presented in Appendix 1 – Table 21 of the Ecoscape report (Ecoscape, 2021a).

12.4 Protected Matters Search

The Protected Matters Search Tool (PMST) search (DAWE, 2020) using a 30km buffer around a point approximating the centre of the survey area, identified:

- four mammals.
- 56 birds.
- two reptiles.

The detailed database results are presented in Appendix 1 – Table 21 of the Ecoscape report (Ecoscape, 2021a).

12.5 Terrestrial Fauna Assemblage

The field fauna survey was conducted by Ecoscape 12-16th October 2020.

Terrestrial vertebrate fauna were the main targets of the field survey that included the following techniques:

- Opportunistic bird observations whilst moving through the survey area
- Turning of surface debris (rocks, logs, vegetation spoil heaps) that reptiles and mammals may shelter beneath
- Raking of litter beds using a three-pronged cultivator rake to locate fossorial reptile species
- Tree hollow inspection to detect arboreal fauna
- Spotlight surveys to detect nocturnal species
- Baited motion cameras to capture evidence of cryptic and nocturnal fauna species not easily observed directly
- Song meter acoustic recorders fitted with both acoustic and ultrasonic microphones to sample birds and bats.

Fauna habitats within the survey area were identified and mapped.

The field survey recorded 57 vertebrate fauna species (42 birds, 12 mammals and three reptiles) including three conservation listed species:

- *Zanda latirostris*(Carnaby's Black Cockatoo) – Endangered under the BC Act and EPBC Act
- *Calidris acuminata* (Sharp-tailed Sandpiper) – Listed Migratory species under the EPBC Act
- *Merops ornatus* (Rainbow Bee-eater) – Listed Marine species under the EPBC Act

The likelihood of the presence of all other potential *Zanda latirostris*icant fauna was assessed and it was determined that the Common Sandpiper (*Actitis hypoleucos*) although not observed during survey, is considered likely to occur based on availability of suitable habitat and known behaviour.

Seven introduced fauna species were recorded:

- *Bos taurus* (European Cattle)
- *Canis lupis* subsp. *familiaris* (Dog)
- *Capra hircus* (Goat)
- *Oryctolagus cuniculus* (Rabbit)
- *Vulpes* (Red Fox)
- *Dacelo novaeguineae* (Laughing Kookaburra) – Introduced to Western Australia

Bat call analysis identified five bat species, none of which are conservation listed. Three of these (*Chalinolobus gouldii, C. morio* and *Nyctophilus geoffroyi*) are commonly known from the region, whilst two species (*Austronomus australis* and *Vespadelus baverstocki*) do not have previous DBCA records from the area and thus represent range extensions. It is not possible to make any population estimations from the occurrence recordings.

12.6 Fauna Habitat

Eight fauna habitat types were recorded within the survey area:

- H: Heath
- Mw: Mallee Woodland
- P: Pastoral
- R: Riparian
- S: Shrubland
- Wb: Waterbody (seasonal)
- Wl: Wetland
- W: Woodland

The majority of the survey area comprises Mallee Woodland or Shrubland habitat, with moderate areas of Woodland or Pastoral habitat in the eastern portion, and Heath in the southern central section. Wetland and Riparian habitats were restricted to the vicinity of the two waterbodies in the northwest of the survey area, and along the Arrowsmith River tributary flowing into these waterbodies from the southeast.
Small areas of Shrubland and Heath in the south of the lot 703 Development Envelope contain patches of Banksia prionotes, which provide low to moderate foraging habitat for CBC's. There will be minimal clearing of CBC habitat, as the majority of the projected disturbance footprint will be outside of these mapped areas. Seed from pasture and cropping grasses in the pastoral habitat, and large paperbark trees within the Wetland habitat, also provide food and roosting habitat for this endangered bird species (Bamford Consulting, 2021). These areas will also be avoided. The Wetland habitat may be additionally important for migratory waders in the locality, seasonally, if inundation occurs.

12.7 Fauna Habitat Condition (Vegetation)

The condition of fauna habitat within the survey area during the 2022 Ecoscape field survey varied significantly, ranging from completely degraded to excellent. Only 54% of the survey area was classified as being in good, very good or excellent condition. In contrast, 46% of the area was rated as degraded, completely degraded, or unvegetated, largely consisting of cleared paddocks in the eastern portion of the survey area. These areas have been historically extensively cleared for pastoral and grazing purposes and have recently been further impacted by herds of feral goats grazing, which has further degraded the overall habitat quality across the proposed project site. This variation in habitat condition underscores the need for targeted management strategies to protect and enhance the remaining high-quality habitats, while taking into account the historical land use and ongoing pressures that have shaped the current landscape.

Factors affecting fauna habitat condition in areas of native vegetation are weeds, due to long-term grazing by livestock or by feral animals that introduced weed seeds to the broader area. Changes to vegetation structure in the eastern portion of the survey area are also a result of long-term domestic livestock grazing, contributing to the fauna habitat condition rating within the survey area.
The vegetation condition in areas that were not accessed or were inaccessible during the survey was initially attributed a rating based on the surrounding area's condition and survey estimates within the wider survey area.

However, since the survey was conducted in 2022, the vegetation condition in these areas has deteriorated due to record temperatures in W.A. resulting in mass plant death further, leading to increased degradation (Murdoch University 2024) resulting in approximately 40% of the DE vegetation being described as being in good, very good or excellent condition, with 40% being degraded, completely degraded with 20% unvegetated (Table 22)

12.8 Record Temperatures in W.A.

Western Australia experienced its hottest summer on record from 2023-2024, with temperatures reaching unprecedented levels. While these records are remarkable in their own right, they are also having significant and tangible consequences upon the environment.

Trees and shrubs, unable to escape the intense heat and aridity, are bearing the full brunt of the changing climate. Previous research has shown that vegetation is far more vulnerable to heatwaves than previously understood. This vulnerability became starkly evident beginning in February 2024, when large areas of vegetation across the state began to turn brown and die off. This mass plant death event is expected to continue, intensify, and expand.

Much like a coral bleaching event, Western Australia's vegetation is reacting to the cumulative stress of an unusually long, hot, and dry summer. And just like coral bleaching, global heating is likely to cause more frequent mass plant deaths. A similar event occurred in 2010-2011, when nearly 20% of trees and shrubs in affected areas perished.

These developments are consistent with climate change models that have identified Western Australia as a warming and drying hotspot. As the state continues to experience extreme temperatures and prolonged dry spells, the impacts on its ecosystems are expected to become more severe and widespread, highlighting the urgent need for climate resilience and adaptation strategies.

12.9 Dying Forests in Western Australia

Patches of forest across Western Australia are dying, as reported by Dr. Joe Fontaine, a lecturer in Environmental and Conservation Science at Murdoch University. Reports from community members, colleagues, and authorities indicate widespread die-off of shrubs and vegetation and tress covering approximately 1,000 km, from the Zuytdorp Cliffs near Shark Bay to Albany on the southern coast.

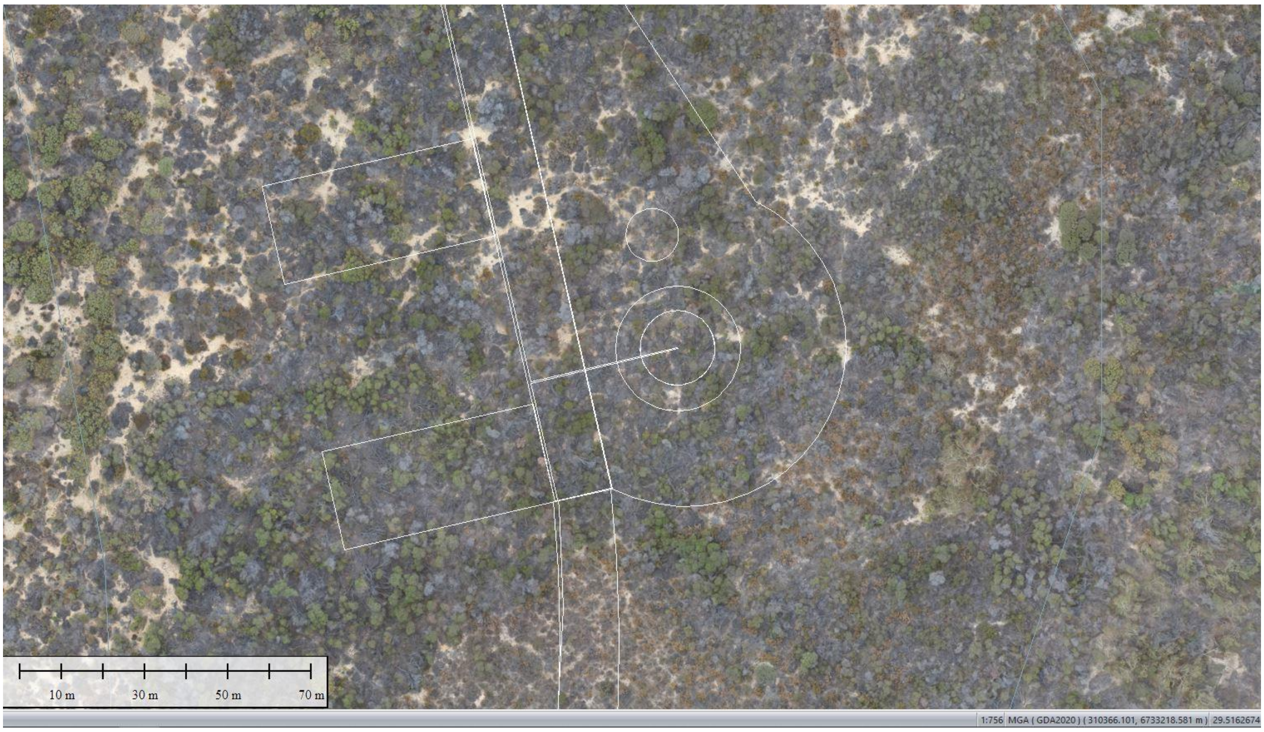
This year's die-off in 2024 is extensive, affecting various plant types, including acacia and jarrah forests, southern wet forests near granite outcrops, shrublands and woodlands along the northwest coast. The most severe damage is seen along the west coast, where hotter temperatures have caused larger patches of dead or dying vegetation.

The vegetation decline has primarily affected plants on shallow soils, such as those near granite outcrops, limestone and coastal heath (Arrowsmith D.E.). The February 2024 heatwaves directly killed some vegetation, while the prolonged dry period that followed exacerbated the situation, leading to widespread plant death across the state.

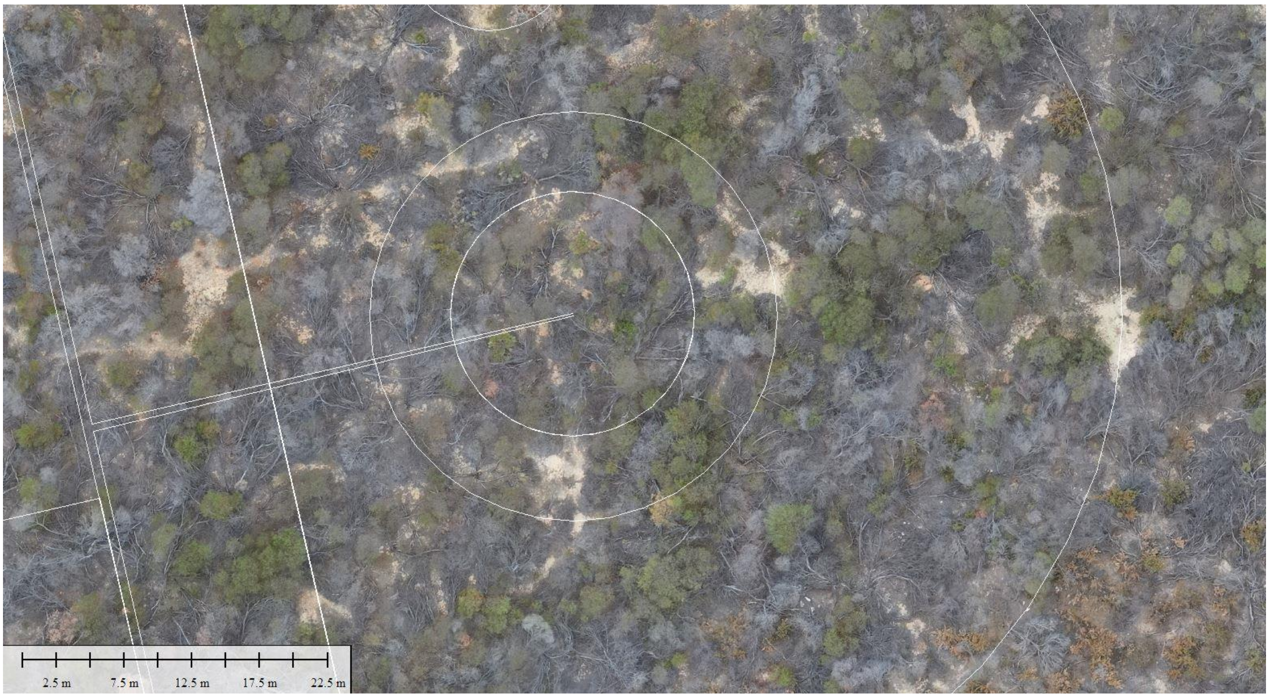
The city of Perth broke temperature records in the summer of 2024, with 13 days recorded over 40°C in 2024 and a 37°C day in April. This follows last year's spring heatwaves, which set new temperature records in September and November. Western Australia experienced significant rainfall deficits, particularly from Shark Bay to Cape Leeuwin.

As a result, 19% of trees and shrubs in impacted areas have died, and approximately 16,000 hectares of forest canopy, or 1.5% of the southwest's forests, have been lost. The ecological impact is severe, with the endangered Carnaby's Black Cockatoo population declining by 60% over the past two years and the Jarrah forest east of Perth being categorised as "at risk of collapse" by the Intergovernmental Panel on Climate Change (IPCC) 2024.

Drone Image 1: AHP Development Envelope lot 703, Site Showing Drone Images of Vegetation Decline (2024)



Drone Image 2: Project site showing Tree Deaths and Vegetation Loss



Drone Image 3: Vegetation Decline and Mass Vegetation Death

Drone Image 4: Tree Mortality: Forest canopy Decline

Table 21: Site Vegetation Condition Ecoscape detailed Survey 2022: (768.96 ha)

Vegetation condition	Extent (ha) 2022	Proportion % (2022)	Update 2024 Extent (ha)	Update 2024 Proportion %
Pristine	-	-		
Excellent	107.39	13.97	38.45	5
Very Good	184.84	24.04	153.8	20
Good	123.35	16.04	115	15
Degraded	96.77	12.58	153.8	20
Completely Degraded	88.02	11.45	153.8	20
Not vegetated	168.59	21.93	153.8	20

Note: Approximately: 40-45.0 Hectares of Good to Excellent native Vegetation Disturbance within the IGE Disturbance Footprint is anticipated.

Habitat Types

Eight fauna habitat types are present in the survey area (Heath, Mallee Woodland, Pastoral, Riparian, Shrubland, Waterbody (seasonal), Wetland and Woodland), of which the Waterbody and Wetland habitats are considered important for Conservation-Listed migratory wading birds

The Pastoral and Wetland habitats are considered important for the Carnaby's Black Cockatoo, noting that Heath and Shrubland may also represent foraging habitat, particularly areas with *Banksia prionotes* trees that are considered as a premium food source.

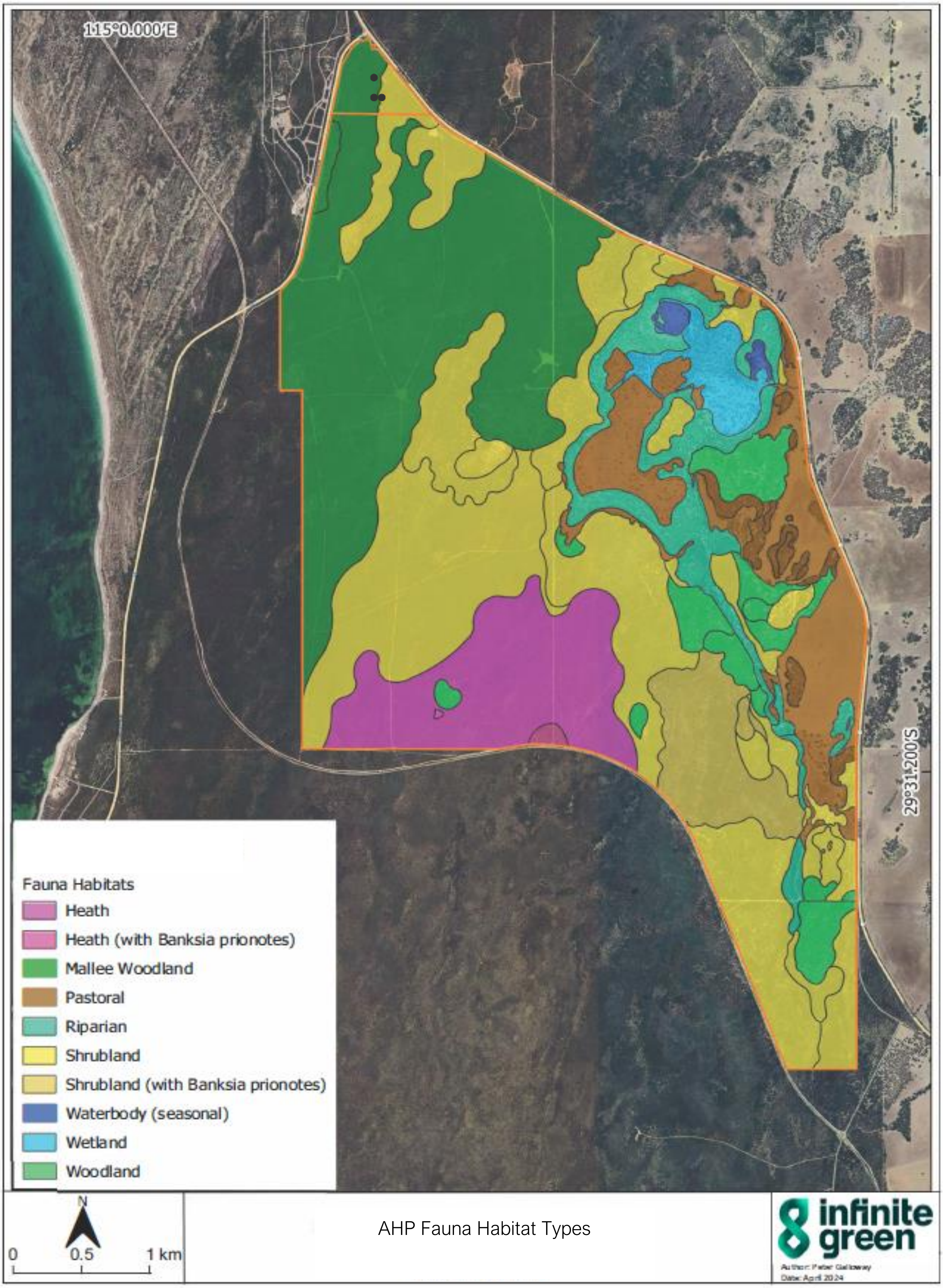


Figure 18: Fauna Habitat.

Table 22: Fauna habitats

Habitat Type and Description	Photograph	Extend within the survey area
Shrubland - Tall shrubland of *Acacia* and/or *Melaleuca* with patches of mallee, on sandplain and limestone . Less degraded areas of this shrubland habitat have dense patches of diverse mid- and understorey, supporting honeyeater and wren bird species. Mammals including kangaroos and wallabies, as well as introduced mammal species, are likely to utilise this habitat. Some proteaceous shrub species (including *Banksia prionotes*), more common in the south-eastern sections, may provide forage **habitat for CBC**. Limestone and outcroppings are present throughout much of the northern extent of this habitat unit, providing breeding habitat for reptiles and microbats.		Extent: 649.17 ha; 33.64%
Mallee Woodland - Low mallee woodland with tall shrubs and stands of low Eucalypts. Dense thickets of understorey shrubs and climbers in some areas, with more open canopy of eucalypts. Habitat is suitable for a range of small to medium sized nectivorous and insectivorous birds, reptiles and small to medium mammals.		Extent: 482.08 ha; 24.98 %

Habitat Type and Description	Photograph	Extend within the survey area
Pastoral - Pastoral plain of farmland pasture and cropped grasses, with scattered small woodland or shrubland remnants. This habitat provides forage habitat for **seed-eating bird species** (including parrot and cockatoo species), as well as insectivorous birds that prefer edge of woodland habitat. Fauna that requires tree hollows for breeding or predate on bird eggs/nestlings (such as monitor lizards or Chuditch) may also utilise treed remnants in this habitat.		Extent: 216.38 ha; 11.21 %
Heath - Tall heath on sandplain, with emergent tall shrubs or isolated mallee. Areas of open sand with occasional small outcroppings exist amongst diverse low or mid-height flowering shrubs. Suitable habitat for nectivorous birds (e.g. honeyeaters), reptiles and predating raptors. Areas with low patches of *Banksia prionotes* present may provide forage for Carnaby's Cockatoo.		Extent: 185.88 ha; 9.63%

Habitat Type and Description	Photograph	Extend within the survey area
Riparian - Mature Eucalypts (primarily *Eucalyptus camaldulensis*) along a seasonal creek line, over grasses or shrubs. Numerous tree hollows exist in mature Eucalypts within this habitat type, providing breeding habitat for multiple bird species such as larger parrots, hollow-nesting ducks and kingfishers, as well as microbat species. Seasonal water flow and pools support Sacred Kingfisher and Rainbow Bee-eaters and are a water source for mammals and reptiles.		Extent: 123.10 ha; 6.37%
Woodland - Low eucalypt woodland, over mixed understorey shrubs or *Acacia/ Melaleuca* scrub. This habitat is suitable as foraging or breeding habitat for numerous woodland bird species. Supportive of a broad range of reptile and mammal species, including microbats.		Extent: 103.49 ha; 5.36%

Habitat Type and Description	Photograph	Extend within the survey area
Wetland - Seasonal wetland of fringing Melaleuca vegetation. Mature *Melaleuca* trees are supportive of Carnaby's Black Cockatoo and other psittacine bird species, with lower shrubs at the edge of the waterbody proper suitable for nesting insectivorous birds.		Extent: 42.89 ha; 2.22%
Waterbody (ephemeral) - Seasonal Lake with clay substrate and fringing vegetation. This aquatic habitat is fed by the Arrowsmith River tributary flowing from the southeast corner of the survey area and run off from the local catchment It supports local bird and mammalian fauna as a water source, and provides forage habitat for insectivorous birds and microbats, and local and migratory waders.		Extent: 8.4 ha; 0.44%

12.10 Carnaby's Black Cockatoo (CBC) Habitat

In December 2020, a field survey of Carnaby's Black Cockatoo (CBC) habitat was conducted by Bamford Consulting, with findings reported in 2021. The survey identified that vegetation previously mapped by Ecoscape (2021) as potential CBC foraging habitat was, in fact, patchy and largely comprised low-quality foraging areas that could not sustain a CBC population. Bamford re-evaluated and mapped portions of the area, identifying a region with low to moderate quality CBC habitat on the eastern side of the Development Envelope lot 703, as presented in Figure 22.

To refine these findings and address EPA requirements, IGE appointed Ecoscape in 2022 to conduct further investigations. Ecoscape's goal was to supplement the CBC habitat assessment results and provide an updated analysis of Banksia sessilis and Banksia prionotes distributions within the proposal's disturbance footprint, essential species for CBC foraging.

Ecoscape's detailed flora and vegetation survey was carried out over five days in October 2022 and included a focused Black Cockatoo habitat assessment. The findings, detailed in the 2023 Ecoscape report, offer a comprehensive evaluation of CBC foraging habitat quality across the project area, ensuring alignment with regulatory expectations and contributing to informed impact mitigation strategies for the protection of CBC habitat within the Development Envelopes.

12.11 Site Significance

The survey area is within the mapped non-breeding range of the Carnaby's Cockatoo. The closest mapped edge of the breeding range is approximately 18 km to the east of the proposal boundary. However, the survey area may be important to Carnaby's Cockatoo as it is within the foraging area of the Koobabbie population (Williams et al., 2017).

Carnaby's Cockatoos are likely to access the proposal site from the east and forage in suitable habitat largely to the southern end of the survey area where the vegetation is more suited to the species, including in Beekeepers Nature Reserve. This species is considered 'scarce and patchily distributed' near Arrowsmith Lake (Johnstone & Johnstone, 2010).

Carnaby's Black Cockatoos were observed near Arramall Lake on October 2020, during the Ecoscape reconnaissance survey, either feeding on or resting in large *Melaleuca* trees, and to the east of the proposal site along Brand Highway, foraging on *Banksia attenuata* shrubs on the (eastern) road reserve on at least three of the10 person days of the 2020 survey. However, none of the observed locations are within the 2022 survey area or proposed Development Envelopes.

The Carnaby's Cockatoo was not sighted or heard during the 2022 survey period (5 person days), noting that this survey concentrated on the western side of the IGE survey area and did not access most of the area of the 2020 observations. No observation or evidence of foraging activity was observed in *Banksia* dominated vegetation types AspBsBlMS and BpLW during the survey (Ecoscape, 2023).

12.12 Carnaby’s Cockatoo Foraging Habitat

Carnaby's Cockatoo forage on native shrubland, kwongan heathland or woodland, dominated by proteaceous plant species such as *Banksia* spp. (including *Dryandra* spp.), *Hakea* spp. and *Grevillea* spp., as well as native eucalypt woodland and forest that contains foraging species (Ecoscape, 2023).

Within the survey area vegetation types AspBsBlMS (*Acacia spathulifolia*, *Banksia sessilis* var. *cygnorum* and *Banksia leptophylla* var. *melletica* mid shrubland) and BpLW (*Banksia prionotes* low woodland) are considered suitable for foraging as they have significant populations of *Banksia* species which are favoured for foraging, and (for AspBsBlMS) a lesser number of other Proteaceous species including small amounts of *Hakea* or *Grevillea* species.

12.13 Presence of Foraging Activity During Surveys

Carnaby's Cockatoo were not observed in these two vegetation types (AspBsBlMS and BpLW, in combination referred to as 'sandplain vegetation types') on either occasion, despite *Banksia sessilis* (being the most common foraging species) having flowers present during both years. The flowering period of *Banksia sessilis* var. *cygnorum* is listed as being between July and October (WAH 1998-2023). The flowering period of *Banksia prionotes* is listed as being between February and August (ibid.). No flowers were observed during either survey periods. *Banksia leptophylla* var. *melletica*, characteristic of vegetation type AspBsBlMS, had largely finished flowering during the 2022 survey. Its flowering period is listed as March-August (ibid.). However, it is listed as having low foraging value for CBC (Groom, 2011). Other proteaceous species, the majority of which were only sparsely distributed had also largely finished flowering by October. The exceptions were *Grevillea argyrophylla* which is characteristic in vegetation type McAxGaTDS on coastal limestone, the foraging value of which is unknown, however, it is not likely to be significant due to the small flower size, and *Grevillea leucopteris* which occurred in patches in AspBsBlMS and has large flowers from July to up to December although as these are on tall, narrow stalks they may be less favourable (Ecoscape, 2023).

In summary, based on available information foraging is likely to occur most commonly during the flowering period of favoured species as the flowers are nectareous and therefore energy-rich, have visiting insects which add to the protein content, and are more visible. However, the main source of sustenance is from the seed, which is present in an immature form during flowering but in a larger and more mature form following flowering, although (for proteaceous species including Banksias) potentially becoming more unpalatable and requiring more time and energy to extract seeds when cones are dry and hard. Therefore, Carnaby's Cockatoo may forage on proteaceous (and other seed and food sources) at any time of year but are more likely during flowering or early fruiting of favoured species (Ecoscape, 2023).

12.14 Potential site Roosting Habitat and likely Carnaby's Cockatoo Movements

Carnaby's Cockatoos require tall trees greater than 8 m high for night roosts (Kabat et al., 2012), located preferably within 6 km radius of a water source (Le Roux, 2017). Trees of this height occur only within vegetation types EcArMW (mainly *Eucalyptus camaldulensis*) and rarely in other vegetation types (primarily *Melaleuca species* e.g. in vegetation type ArMlMhTS). However, there are no tall trees within sandplain vegetation types (AspBsBlMS and BpLW – *Banksia prionotes* is usually less than 8 m high) that would be suitable as night roosts. This suggests that Carnaby's Cockatoo would be moving around the landscape between daytime foraging sites (assumed to be these vegetation types) and night roost sites, the location of which are unknown. They are also likely to move through the landscape to and from water sources that would seasonally include Arramall Lake and some smaller waterbodies to the northeast of the overall Proposal site (that are not within the survey area as this section of the site is being set aside for conservation). Arramall Lake is seasonal and not known to hold water throughout summer and autumn, and thus, only refilling after significant rainfall (Ecoscape, 2023).

Bamford Consulting (2021) confirmed a roost site on the eastern boundary within the Proposal area within large trees close to the wetland and Arramall lake, where birds utilise water sources on paddocks east of the Brand Highway. This site will not be impacted by the Proposal as it is excluded from the disturbance footprint.

12.15 Carnaby's Black Cockatoo Assessment Summary

The survey area is not within the breeding distribution of Carnaby's Cockatoo (DSEWPaC, 2021). Considering the survey information, it would be anticipated that the site would only be visited seasonally for foraging during the non-breeding period. As the site is within the suggested semi-residential population extent (Johnstone & Kirkby, 2019) it could be used for foraging and roosting throughout the year.

This is confirmed with infrequent sightings of Black Cockatoo within the overall Proposal site during October 2020 (Ecoscape, 2021a) and by identification of roosting sites in December 2021 near the eastern boundary by Bamford Consulting (2021) potentially utilising water sources outside of the Proposal disturbance footprint on paddocks at the east of the Brand Highway.

Surveys have shown that suitable foraging habitat exists within the Proposal area and is utilised by birds on infrequent occasions.

However, due to restricted occurrence and condition of relevant vegetation, this area has been classified as low to moderate foraging value for Carnaby's Cockatoo (Ecoscape 2023). These areas are located in the south-eastern section of the Proposal area (Bamford Consulting, 2021; Ecoscape, 2021a, 2023) and are minimally affected by the Development Envelopes (Figure 21)

IGE has proactively revised its initial layout for the wind turbine and solar farm components, strategically relocating turbines and solar panels to avoid potential Carnaby’s Black-Cockatoo (CBC) foraging areas and reduce impacts on critical vegetation and fauna habitats as much as possible. Furthermore, all clearing activities have been restricted to exclude wetland areas, cave systems, Arramall Lake, and identified CBC roosting sites.

With these design optimisations and mitigation measures in place, the potential impacts on the local CBC population are expected to be minimal. The updated turbine layout does, however, intersect an area classified as low to moderate foraging value, primarily comprising Acacia shrubland and heath. To address this, any residual impacts during construction will be managed through stringent monitoring and management protocols, ensuring that habitat disturbance is minimised and environmental commitments are upheld.

12.16 Targeted Foraging Area

Ecoscape has identified limited areas within the project vicinity as moderate foraging habitat for Carnaby's Black Cockatoo. This area extends to the east, outside of the AHP disturbance footprint. The majority of the area identified by Ecoscape, however, is of low foraging value. Ecoscape did not identify any additional potential foraging habitat within the AHP Development Envelopes beyond the areas previously designated.

The mapped area below shown in figure 19 identified foraging area on the basis of the presence of **AspBsBlMS**: *Acacia spathulifolia*, *Banksia sessilis* var. *cygnorum* and *Banksia leptophylla* var. *melletica* mid shrubland on sandplain/lower slopes and **BpLW**: *Banksia prionotes* low woodland on sandplain/lower slopes.

CBC monitoring across the Development Envelopes concluded that the area mapped below is the foraging extents utilised by cockatoos. It is understood that foraging Banksia vegetation types with foraging value do occur within other areas of the disturbance footprint but it is not utilised by the CBC's.

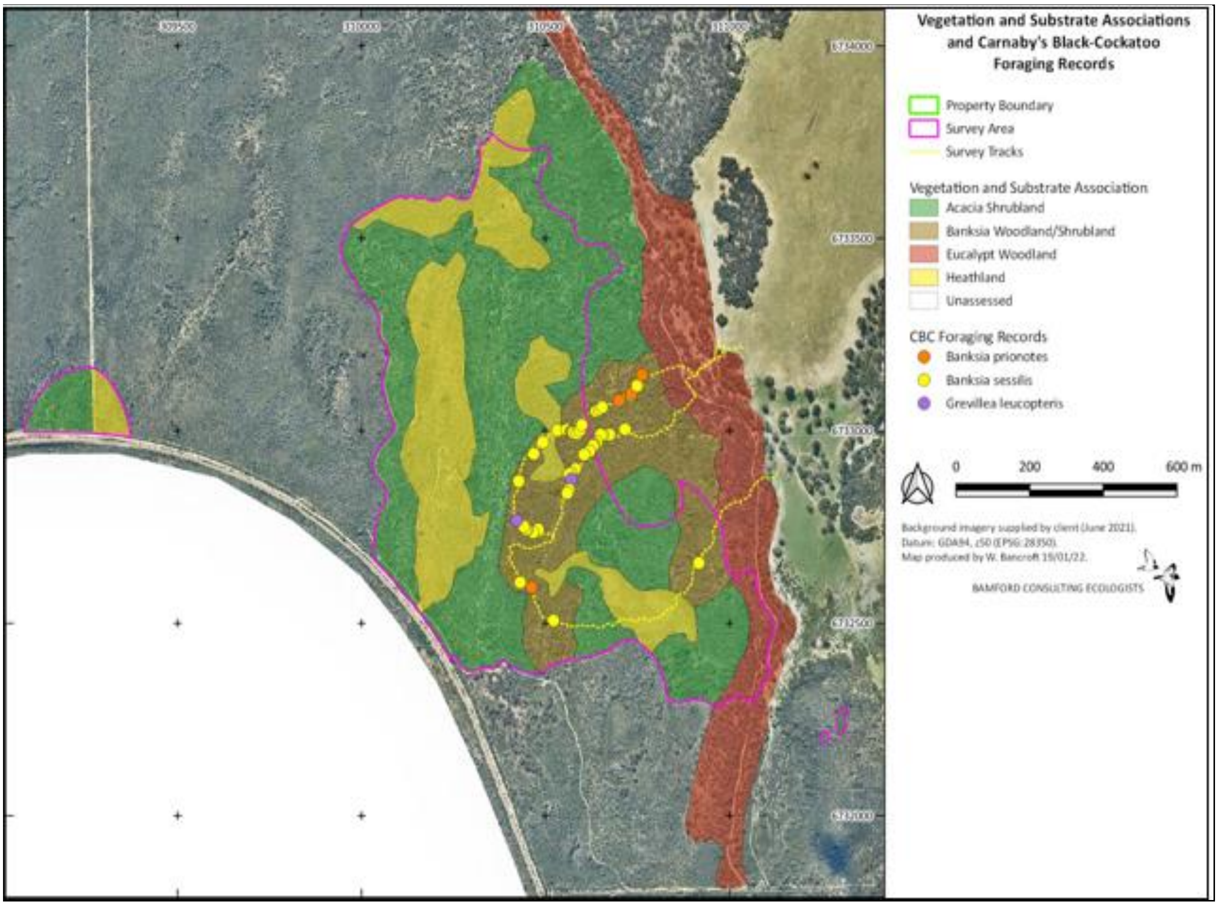


Figure 19: Vegetation and substrate associations and Carnaby's Black-Cockatoo foraging records within the disturbance footprint

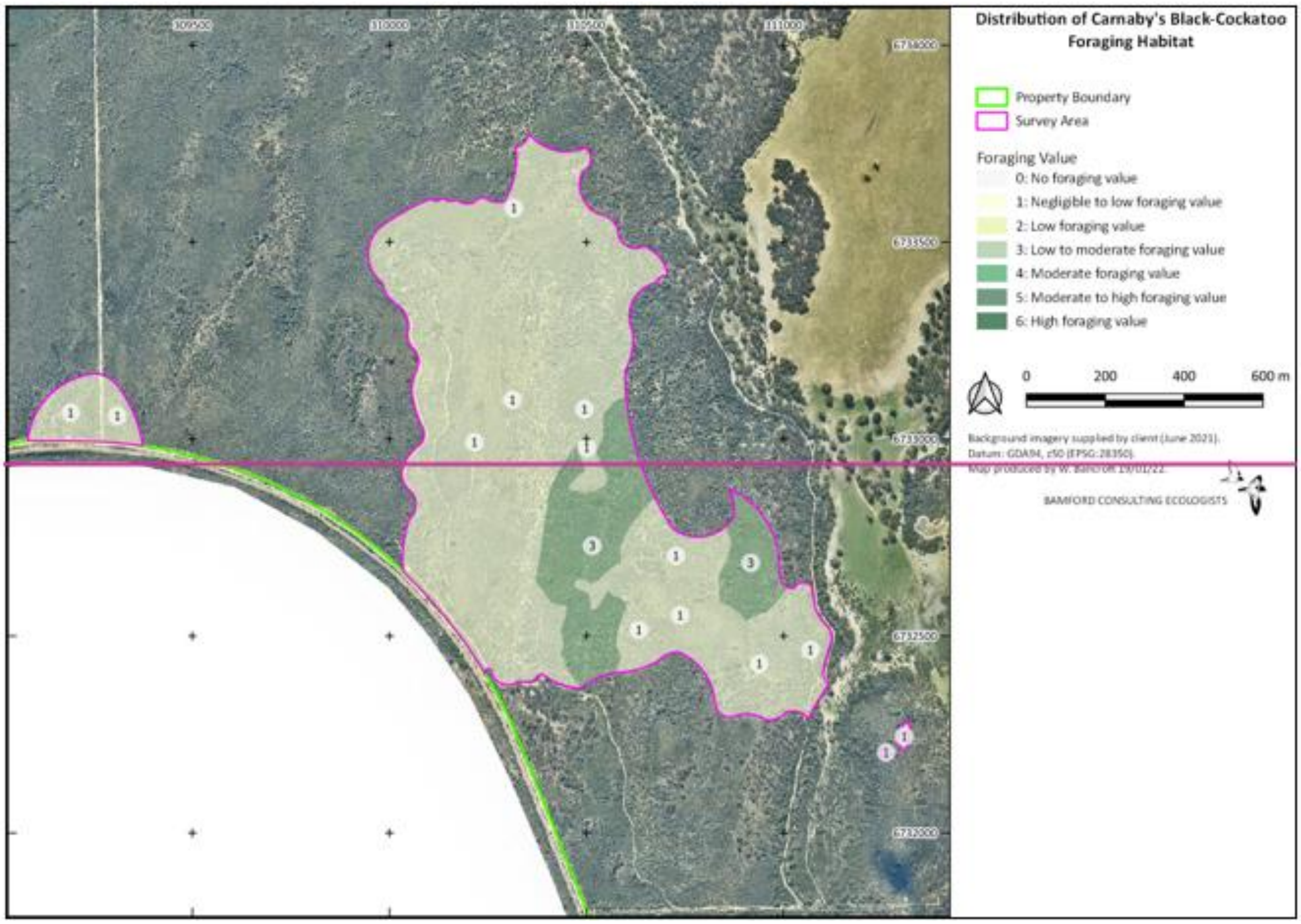


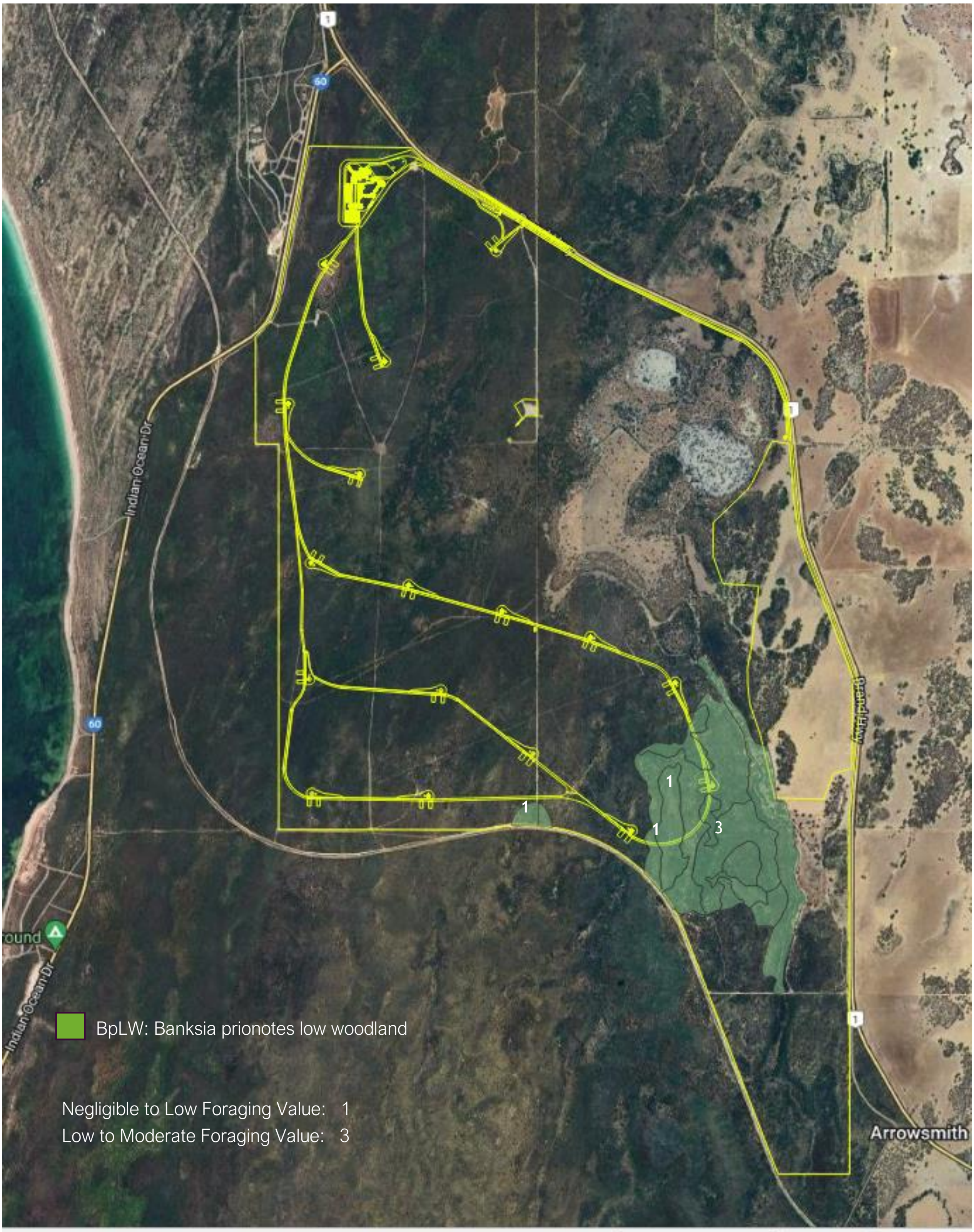
Figure 20: Vegetation and substrate associations and Carnaby's Black-Cockatoo foraging values within the disturbance footprint

The IGE disturbance footprint will encompass vegetation types with low foraging value for Carnaby's Black-Cockatoo (CBC), including acacia shrubland and heathland.

These areas are characterised by:

- Sparse vegetation cover, with limited projected foliage cover of key food plants.
- Dominance of acacia shrubs and other vegetation types that are not preferred foraging habitats for CBC.
- Minimal presence of Banksia species or other plants known to provide essential food sources for CBC.
- Limited habitat complexity and structural diversity, which may reduce foraging opportunities and suitability for CBC.

Overall, these areas are considered to have low foraging value for CBC, indicating limited suitability for their feeding activities and potential impacts on their habitat utilisation within the disturbance footprint.



N 0 0.5 1 km	**CBC Habitat** BpLW: Banksia Prionotes low woodland over *Banksia leptophylla* var. *melletica*, *Jacksonia calcicola* Foraging Values 0 – 6	infinite green Author: Peter Galloway Date: April 2024

Figure 21: Black Cockatoo Foraging Values – Classification

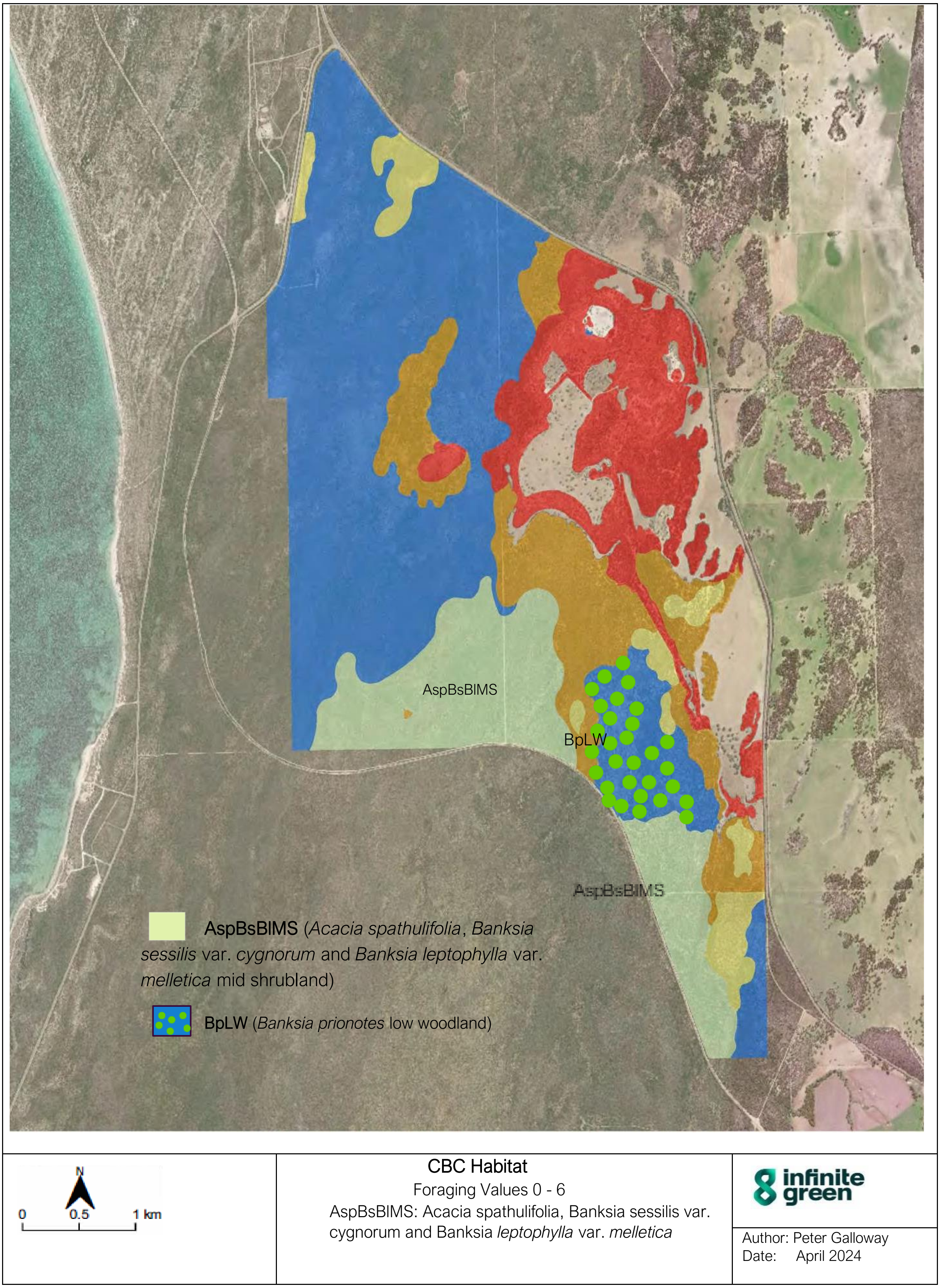


Figure 22: Black Cockatoo Foraging Values – Classification

12.17 Potential Impacts

The proposed project entails the clearance of approximately 127.13 hectares of fauna habitat, primarily composed of Heath, Mallee Woodland, and Acacia Shrubland zones. Among these, 4.49 hectares, designated as turbine laydown areas, are earmarked for post-construction rehabilitation efforts. The Development Envelopes combined extents is 1906.16 hectares, with the solar farm planned for installation predominantly on degraded and previously cleared pastoral land, situated east of the Proposal Development Envelopes along the Brand Highway.

Within the designated development area, the Wind farm, Green Hydrogen Production Facility (GHPF), and associated access roads will be strategically located to minimise environmental impact. These infrastructure components will be situated exclusively within areas classified as Heath, Mallee Woodland, and Shrubland zones, covering approximately 74.4% (1429.2 hectares) of the total disturbance area outlined in the proposal. It is estimated that about 40% of the vegetation habitat within this designated project area is degraded or completely degraded vegetation..

While the Proposal is expected to have minimal impacts on existing fauna habitats, proactive measures have been implemented to steer clear of these areas with the infrastructure layout. Moreover, the impact on Carnaby's Black Cockatoo (CBC) foraging value within delineated areas, illustrated in Figure 22, is relatively minor compared to the overall vegetation disturbance footprint. The proposed disturbance footprint area is rarely frequented, and there has been no evidence of CBC presence in the relevant vegetation types during previous Ecoscape surveys.

The potential roosting area to the eastern side of the Proposal area adjacent to arramall lake will remain unaffected by the project, further minimising impacts to existing CBC habitat. Although no foraging activity was observed in vegetation types AspBsBIMS and BpLW during the detailed survey, it's important to acknowledge that there is no established method to define foraging habitat. These vegetation types are deemed potential foraging habitat for Carnaby's Black Cockatoo due to the proportion of proteaceous species within them, including characteristic Banksia species.

It's notable that Eucalyptus erythrocorys, which is prevalent in the previous Detailed Ecoscape survey area (predominant in vegetation type EeLOW and occasionally in AspBsBIMS), is not listed as a foraging species. This species is extensively planted in the Perth area but is assumed not to be significantly utilised by CBC’s at the AHP project.

12.18 CBC Foraging Disturbance Extents

The anticipated minimal impact on Carnaby's Black Cockatoo (CBC) foraging value will be primarily attributed to layout planning and the selection of areas aimed at minimising disturbances to CBC habitat.

Approach to site selection and planning to mitigate potential impacts:

- Site Selection: The clearing activities are limited to areas identified as having very low-value CBC foraging habitat, as determined by thorough assessments conducted by Bamford Consulting in 2021 and Ecocscape in 2022. These areas are strategically chosen to avoid significant CBC foraging grounds, thus minimising disruptions to their foraging behaviour and habitat utilisation.

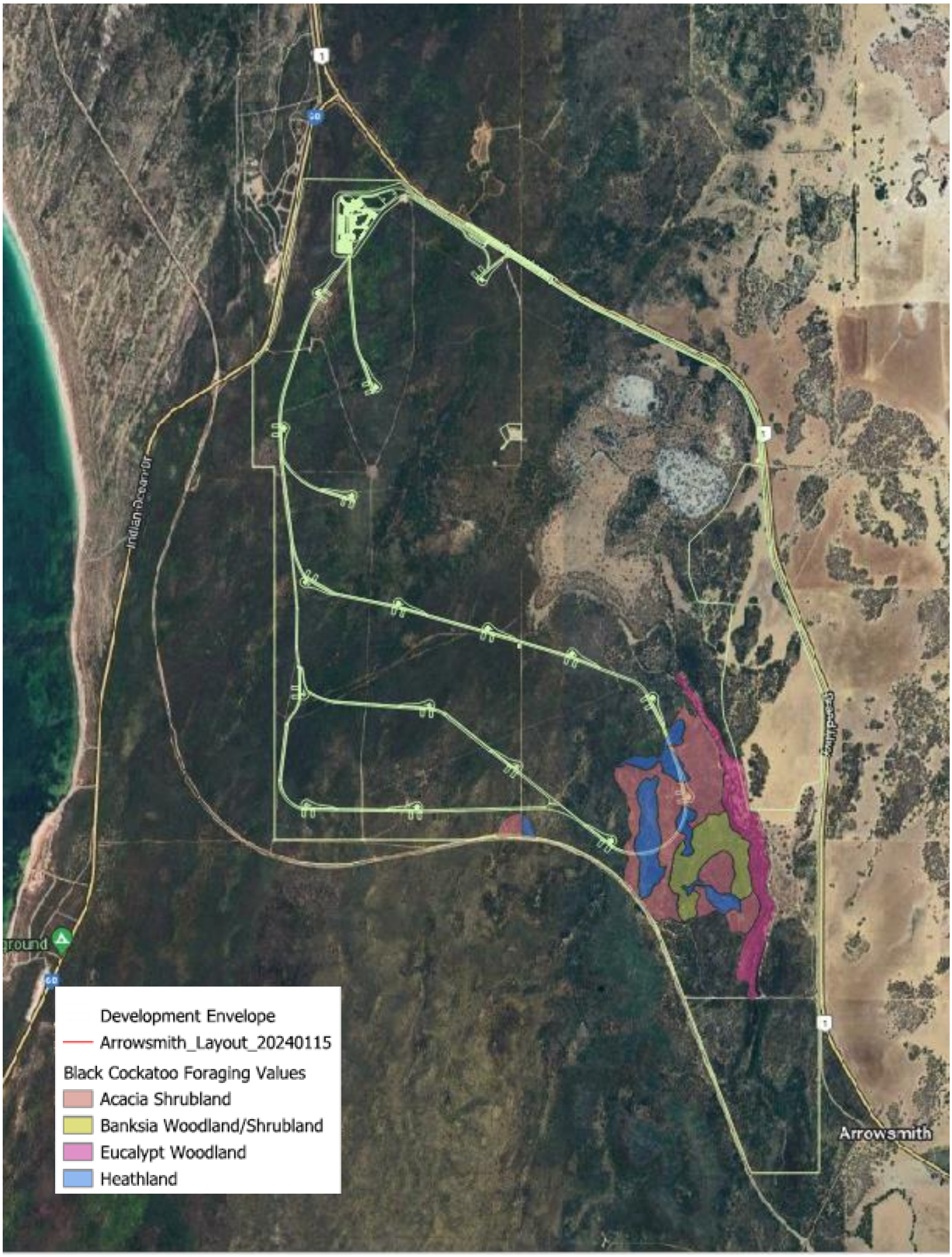
- Restricted Clearing Zones: The identified clearing areas predominantly consist of Heath and Acacia shrubland, covering an estimated area of 2.3 hectares. These zones are carefully selected to limit impacts on CBC foraging habitat while accommodating necessary development activities.

  Lack of CBC Presence: Previous surveys conducted in the region indicated an absence of substantial Carnaby's Black Cockatoo (CBC) presence within the proposed disturbance footprint. This finding reinforces the assessment that the impact on CBC foraging value is expected to be negligible. The absence of significant CBC activity in these areas suggests that the proposed development activities are unlikely to interfere directly with CBC foraging behaviour or habitat use. This supports the conclusion that the project can proceed with a low risk of disrupting critical CBC resources.

- Precision Clearing Practices: Clearing operations are conducted with precision to minimise the extent of vegetation removal and preserve critical habitat elements for CBC's, such as food sources and roosting sites.

- Disturbance Footprint: optimising disturbance to surrounding flora, vegetation and fauna, thereby reducing potential impacts on CBC foraging values.

- Preservation Efforts: In addition to targeted clearing practices, efforts have been made to preserve CBC habitat through initiatives like proposed habitat restoration proposals, revegetation efforts, and the establishment of wildlife corridors to enhance habitat connectivity. These preservation endeavours contribute to the overarching conservation of CBC habitat and support the long-term sustainability of their populations.



N
0 0.5 1 km

Arrowsmith Hydrogen Project (AHP) Hydrogen Project
Foraging Vegetation

infinite green

Author: Peter Galloway
Date: April 2024

Figure 23: Black Cockatoo Foraging Area – Classification showing the indicative vegetation types

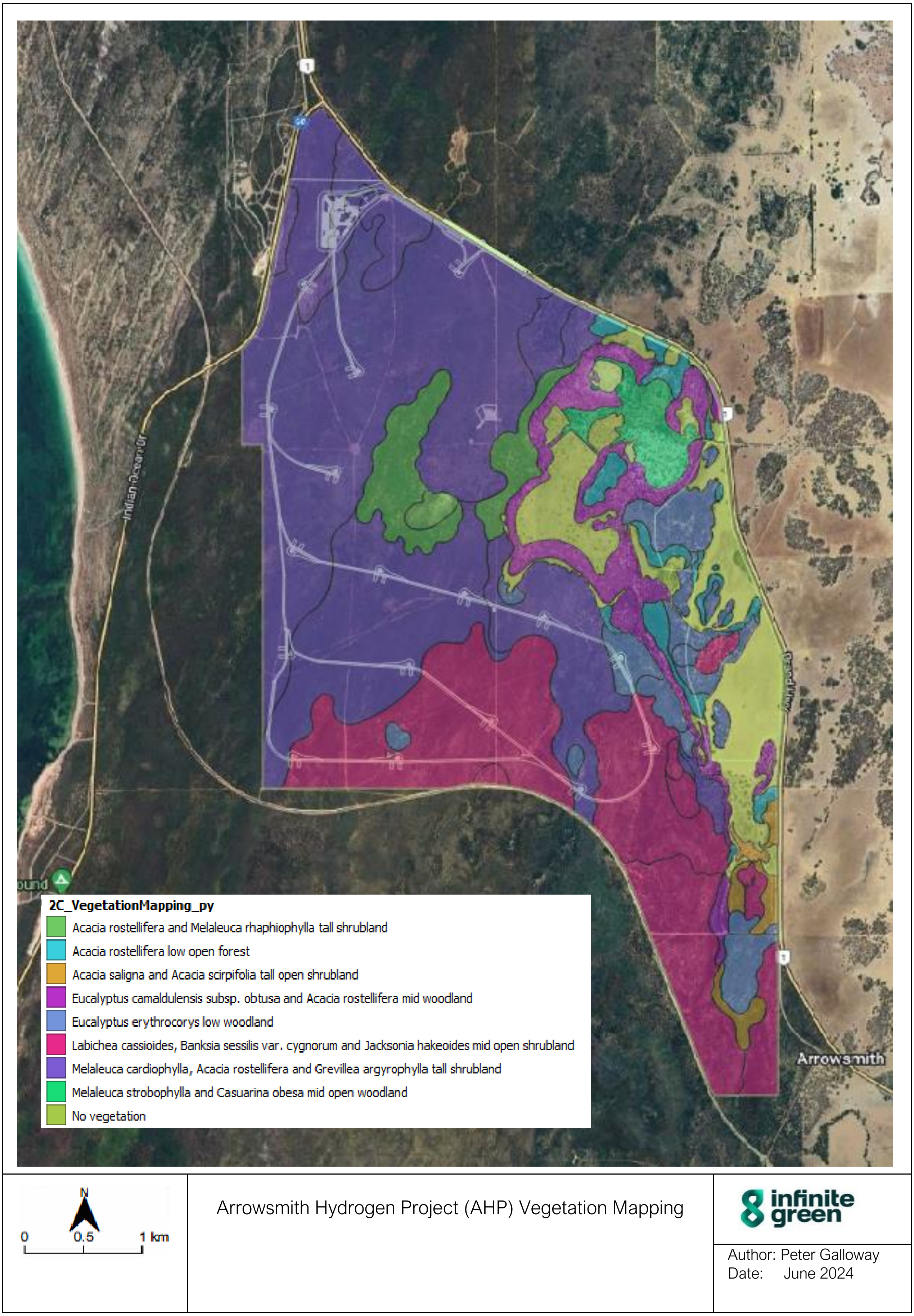


Figure 24: Development Envelopes Vegetation Types(2020)

12.19 Lack of Foraging Habitat and Value

The detailed environmental assessment of the proposed development within the Development Envelopes (DE) confirms that available foraging habitat for Carnaby's Black Cockatoo (CBC) is minimal in both quality and extent. Comprehensive flora and vegetation surveys indicate that the DE offers low-value foraging resources with limited vegetation types essential to the cockatoo's diet, reducing the area's overall suitability for CBC foraging. The proposed disturbance footprint, constituting less than 5.0% of the total DE, further restricts any potential impact on these scarce foraging habitats.

Survey data also show that Carnaby's Black Cockatoo rarely frequents the DE, likely due to the limited foraging value it provides. In addition, the presence of high-quality foraging habitats in surrounding areas, such as Beekeepers Nature Reserve (BKNR), offers more suitable resources, suggesting that the species prefers these alternative habitats. The availability of such resources outside the DE ensures that any minor habitat loss within the DE will not adversely affect CBC populations.

The project incorporates robust mitigation measures to further protect CBC habitats within the DE. These measures include relocating windfarm infrastructure to avoid sensitive areas, implementing monitoring zones, and establishing habitat revegetation initiatives to enhance and protect remaining vegetation. Additionally, advanced avian detection radar and other operational controls will reduce turbine strike risk and mitigate disturbance, maintaining CBC safety throughout the project's operation.

Notably, surveys confirm the absence of critical breeding, nesting, or night roosting sites within the disturbance footprint, ensuring that essential lifecycle activities of the CBC will remain unaffected. The project aligns with all relevant environmental regulations and guidelines, integrating ongoing monitoring and adaptive management strategies to promptly address any unforeseen impacts.

Considering the low-quality and limited extent of foraging habitat within the DE, combined with extensive mitigation strategies and readily available alternative habitats, the proposed development is unlikely to significantly impact Carnaby's Black Cockatoo's habitat. Consequently, the decision not to refer the proposal to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the Environment Protection and Biodiversity Conservation Act (EPBC Act) is well-founded. This approach ensures compliance with conservation objectives and regulatory requirements, underscoring the project's commitment to minimising impact on the species.

12.20 Avifauna and Bats Impacts from Wind Turbine Operation

There is a significant body of literature documenting the potential impacts of a Wind farm developments on avifauna and bats. The types of impacts presented by turbine blades have been extensively characterised (e.g. Dewitt & Langston, 2008; Peste et al., 2015; Powlesland, 2009) and are listed below:

- Loss of, or damage to, habitat resulting from wind turbine and associated infrastructure construction;
- Disturbance leading to displacement or exclusion, including barriers to movement; and
- Collision and/or barotrauma mortality.

The direct loss of bird and bat habitat will result from the clearing of 127.13 hectares of native vegetation required to establish wind turbine infrastructure, including turbine foundations, construction laydown areas, and access tracks. Temporary laydown areas will be fully rehabilitated post-construction, with targeted vegetation restoration efforts aimed at re-establishing habitat quality to the greatest extent possible. The impact on avifauna and bat habitat from turbine facility clearing is anticipated to be minimal due to the implementation of effective mitigation measures designed to limit disturbance, support habitat recovery, and enhance long-term ecological resilience.

Disturbance leading to displacement or exclusion may occur when wind turbines act as barriers to bird and bat flight paths. To prevent this, the manufacturer recommended separation distances between individual wind turbines and arrays will be implemented. For example, spacing greater that 200 m has been recommended to avoid bird movement inhibition within wind facilities (Powlesland, 2009). The proposed distance between individual wind turbines and turbine rows for the AHP project will be a minimum 600 m. Therefore, it is not anticipated that turbine placement will provide barriers for bird and bat movements.

Ecoscape (2021) identified11 migratory species or species habitat likely to occur within the Proposal area resulting from a MNES search. However, there is lack of reliable data to demonstrate flight paths used by migratory birds within Australia. Therefore, only inference on possible routes can be made. For example, distance from beaches and relevant wetlands can be used to assess potential occurrence and interference of migratory birds around Wind Turbine Facilities. The closest wind turbine to the Proposal is approximately 1.5 km from the shoreline.

The closest important wetland is Lake Logue Nature Reserve, located approximately 31 km to the south of the Proposal area. Arramall lake, within the proposal area has limited value as a wetland habitat due to its highly ephemeral character. Furthermore, the lake is outside the proposed disturbance area. Migratory birds in general fly at high altitudes during migration, with flight heights of 1,000 to 5,000 m reported as typical (Geering et al., 2007). It has also been noted that migrating birds fly higher on average at night than during the day (Eastwood & Rider, 1965) when they remain detectable by radar but are unlikely to be detected by visual observation. There is also significant variation within studies, which suggests that shorebirds will use a range of flight heights during migration. This is likely driven by weather, with migratory birds shown to vary their flight heights in response to wind direction and variation in winds at different altitudes, and to keep themselves below the prevailing cloud base (Newton, 2008).

Part of assessing bird and bat collision risk is to consider the likely flying heights of relevant species utilising the Development Envelopes relative to the rotational height range of the turbine blades. The conceptual design for the Proposal is based on turbines that have an approximate nacelle height of 150 m and a rotor length of 85 m from the nacelle to the tip. This equates to an upper most rotor swing of approximately 245 m and a lower swing limit of approximately 75 m above the ground. Birds that regularly fly above the former height, or below the latter, would therefore be at minimal risk of collision with turbine blades.

If birds engage in thermal soaring behaviour (such as raptors and pelicans) directly across the location of a turbine, there is an increased risk of collision. This risk is influenced by factors including the spacing between wind turbine rows, the distance between turbines within rows, rotor size and visibility, and the specific visual acuity and manoeuvrability of the species. The conceptual wind farm design incorporates layout strategies that reduce collision risk, considering these factors to mitigate potential impacts on soaring bird species as they navigate the area.

The terrestrial bird assemblage of the Development Envelopes largely comprises species common in the region. Approximately half of the avifauna species resident in the Development Envelopes (22 species) are passerine songbirds (Ecoscape, 2021a), that would not fly significantly higher than the vegetation layer (<10 m) the majority of the time. These species would be active well below the lower sweep of the wind turbine rotors at 75 m and would not be at rotor collision risk. While passerines represented 22 of the 47 bird species recorded, this group potentially dominates the avifauna abundance in the Proposal area.

Of the non-passerines, the raptors (birds of prey) are the functional group most at risk of collision with turbine blades. Raptors have been found to be at collision risk in past assessments of wind farms, although this has usually only resulted in significant impacts when the overall siting of the wind farm has been poor (e.g. de Lucas et al., 2012). While multiple raptor species were recorded from the Proposal area (*Accipiter fasciatus*, *Falco cenchroides*, *Falco longipennis*, *Haliastur sphenurus*) most were represented by sightings of single individuals during the 2020 survey (Ecoscape, 2021a). Furthermore, there is no information indicating that the Proposal area supports large numbers of raptors. This is consistent with the overall nature of the landscape, which includes little in the way of landforms that can create congregation points for raptors, such as cliffs and steep valleys, which should be avoided in wind farm design (Hötker et al., 2006; Zwart et al., 2016).

In general, there is limited publicly available data on direct strike from wind turbines specifically to CBC's. Impacts on avifauna and CBC from windfarm operations have been monitored and reported for the Badgingarra Wind Farm (Ecoscape, 2021b). The wind farm consists of 37 turbines, is located approximately 100 km to the south of the Proposal area and has been operational since 2019.

Operational monitoring over two years (2019/2020) has shown low mortality numbers and estimated bird strike events (Ecoscape, 2021b). Overall, 8 bird strike carcasses were counted in 2019 and 10 in 2020. None of the bird species were conservation listed and no CBC carcasses were recorded. Overall, the average estimated annual bird strikes per turbine for two years of monitoring was 1.62. Similarly, impact monitoring at Macarthur Wind Farm in NSW had an averaged 3.31 estimated annual bird strike (Wood, 2015). This is approximately a twofold difference to the Badgingarra Wind Farm and is suggesting that wind farms in the area have a low level of impact on avifauna. The wind turbines in the Proposal will be located outside of significant foraging and roosting sites, furthermore it is assumed that the lower sweep of the turbine rotors at 75 m would be well above the normal foraging flight height of the CDC and other passerine birds (Ecoscape, 2021b).

It should be noted that other anthropogenic causes of bird deaths were considerably more important than wind farms. Data from the U.S. is suggesting that estimated annual number of casualties from traffic, building/ windows, electricity infrastructure, and TV and communications towers is about 25,000 times greater than from wind turbines (Hötker et al., 2006).

Sovacool (2012) calculated the avian mortality cost of fossil fuel and nuclear power in the United States: The author estimated that about 46,000 birds were killed by wind turbines in the US annually, whereas 24 million birds were killed by fossil-fuel power plants. Feral cat predation was estimated at 110 million per annum (Figure 25). Furthermore, it was estimated that wind turbine mortality was approximately 0.27 per GWh/ year and mortality from fossil-fuel power plants about 9.4 per GWh/ year (Sovacool, 2012).

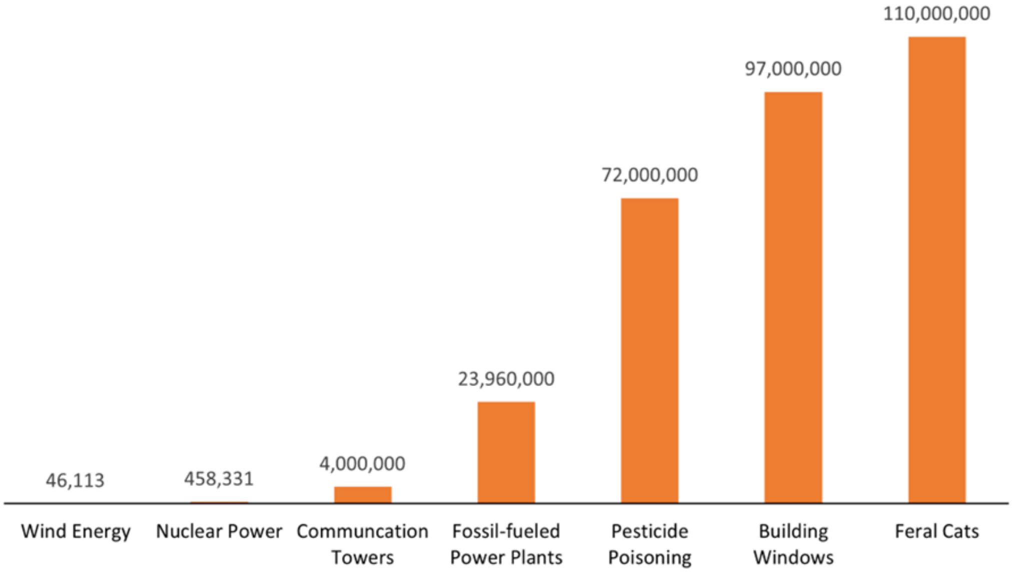


Figure 25: Avian mortality causes per year in the U.S. (Sovacool, 2012).

There is limited information available regarding bat populations within the Proposal area. Ecoscape identified five bat species in the region, but populations numbers remains difficult to quantify from existing records. Notably, all identified bat species are commonly found in the wider region, and none are listed as conservation concerns. It is recognised that bats are at risk of collision with wind turbines, a phenomenon extensively studied worldwide, albeit with limited data from Australia.

AGL Energy Limited engaged Vestas Australian Wind Technology Pty Ltd and Leighton Contractors Pty Ltd to build the Macarthur Wind Farm approximately 15km east of Macarthur in south-west Victoria. Construction of the Wind Farm was completed in late 2012 and was commissioned on 31 January 2013 The Macarthur bat and avifauna monitoring program reported an average bat mortality rate of 3.08 per annum per turbine (Wood, 2015). This finding suggests that, on average, approximately three bats are killed per year by each turbine within the Macarthur wind farm area.

Hötker et al. (2006) compiled data from 12 studies on bat mortality at various wind farms, revealing collision rates ranging from 0 to 50 bats per turbine per year, with a mean of 6.3 and a median of 1.6 across all studies. This wide range reflects the variability in bat mortality rates observed across different wind farm sites and environmental conditions.

Of particular note is a study conducted in Tasmania, which reported a relatively low collision rate of 1.86 bats per turbine per year. This finding indicates that certain factors, such as geographical location, habitat characteristics, and turbine design, may influence the likelihood of bat collisions with wind turbines.

Overall, these studies highlight the importance of monitoring and mitigating the impacts of wind energy development on bat populations. Understanding the factors contributing to bat mortality rates can inform the implementation of effective conservation measures to minimise adverse effects on bat species while promoting the expansion of renewable energy sources. Although data specific to the Proposal area is lacking, available information suggests that wind turbines are likely to have a relatively low impact on local bat populations. IGE's Avifauna and Bat Assessment describes turbine strike mitigation methods in more detail (Appendix 3). IGE intends to utilise a 3D Robin Radar Systems with dedicated Avifauna and bat radar detection systems, integrating both horizontal and vertical radar transmissions with autonomous, stand-alone observation technology. This system is designed and optimised for selective turbine curtailment and as a bird mortality mitigation system for both Wind farm monitoring and a bird migratory mapping tool.

12.21 Weed Introduction and Habitat Modification

As previously indicated, a significant portion of the Proposal area (46% of the Disturbance Footprint)has already been subjected to pre-clearing or is classified as degraded, completely degraded, or unvegetated, as documented by Ecoscape (2022). This classification also accounts for areas affected by weed infestation. The extent of cleared and degraded land reflects prior disturbances to the natural ecosystem, likely resulting from a range of human activities, including agriculture, urban development, climate change, and land clearing for infrastructure projects. Such disturbances contribute to habitat fragmentation, biodiversity loss, and degradation of ecosystem functions, impacting the area's ecological resilience and capacity for recovery.

The risk of weed proliferation within the Development Envelopes during construction and operation poses an indirect threat to native terrestrial fauna by altering habitat conditions. Activities such as earthworks, vegetation disturbance, movement of machinery, and related operations have the potential to introduce or spread weed species within the project area.

To address concerns regarding weed infestation and potential degradation of fauna habitat, a comprehensive management strategy will be implemented throughout the project's construction and operational phases. This strategy will involve the development of detailed weed management protocols, integrating manual removal, mechanical methods, and targeted herbicide application to control invasive species while minimising harm to native vegetation and wildlife. Additionally, habitat restoration and enhancement initiatives will be undertaken, focusing on revegetation with locally appropriate native plant species to restore habitat structure and biodiversity.

12.22 Other Construction and Operational Impacts

A range of lower tier impacts to terrestrial fauna have been identified in association with the Proposal. These include:

- Potential entrapment of ground fauna during temporary trenching works and excavation for transmission cables and turbine foundations;
- Risk of vehicle collision of individual fauna during construction and operation from light and heavy vehicle impact; and
- Direct impacts and behavioural changes resulting from noise, dust or light emissions during construction and operations.

Quantifying these impacts poses a challenge due to their complexity, yet their occurrence is deemed minimal given the confined extent of clearing and the temporary nature of construction activities. Comprehensive mitigation measures addressing these impacts are delineated within the Environmental Management Review Framework (EMRF) document.

12.23 SRE Invertebrates

Bennelongia (2021a) conducted a thorough desktop study encompassing a database search, which revealed records of 21 species categorised as short-range endemics (SRE) within a 100 x 100km radius centered on the AHP Development Envelopes. Among these species were six trapdoor spiders, one harvestman, two pseudoscorpions, one scorpion, one snail, two slaters, six millipedes, and two centipedes. Additionally, the search identified four species listed for conservation, including the Priority 1 trapdoor spider Idiosoma kwongan, the Priority 3 bee Hylaeus globuliferus, the Priority 1 land snail Bothriembryon perobesus, and the land snail B. whitleyi, which is currently categorised as extinct but may potentially still exist based on recent evidence. However, the likelihood of B. whitleyi occurring in the Proposal area is considered negligible.

The survey findings indicate that while the development will lead to the destruction of habitat suitable for SRE species, the impact will be minimal relative to the regional extent of these habitats. (Bennelongia, 2021a)

12.24 Subterranean Fauna

Bennelongia (2021b) conducted a desktop study which revealed the presence of one troglofauna species, the beetle Tripectenopus occultus, exclusively documented in Arramall Cave. However, it is likely that the beetle's distribution is wider than indicated by this single record, with the limited survey effort being a contributing factor to the single known location (Bennelongia, 2021b). Additionally, it was determined that the cave systems within the Proposal area will be avoided, thus avoiding direct impacts from the Development Envelopes.

12.25 Stygofauna and Troglofauna Impacts

Cave formations on site provide suitable habitat for both troglofauna and stygofauna. Bennelongia (2021a) observed that avoiding cave impacts and groundwater drawdown pose a low risk to stygofauna. There will be no construction activities near or upon cave systems resulting in zero impacts to troglofauna including altered ventilation, or additional light (Bennelongia, 2021b). Development will be restricted to surface infrastructure only and the proposed groundwater abstraction will not impact the quality of troglofauna habitat in either potential karst formations or cave systems.

Threats to troglofauna typically involve the removal of habitat through excavation. No excavation including bore construction will occur adjacent to known troglofaunal habitat, nor will most of the other activities known to impact troglofaunal detrimentally (e.g. altered ventilation, additional light, blasting vibration). Thus, it is unlikely that AHP development will reduce troglofauna conservation values irrespective of the richness of troglofaunal present and whether *Tripectenopus occultus* is restricted to Arramall Cave. Development will be restricted to surface infrastructure and minimal groundwater drawdown that are unlikely to affect the quality of troglofauna habitat (especially relative humidity) in caves. (Bennelongia 2021)

12.26 Avoidance, Mitigation and Management Summary

The proposal mitigation process has identified measures aimed at avoiding and managing potential impacts on terrestrial fauna to fulfill EPA objectives concerning this crucial environmental factor. Following a hierarchical approach, avoidance takes precedence as the primary strategy, succeeded by mitigation and management actions (refer to Table 24 for specifics). Any remaining residual risks subsequent to the implementation of mitigation and management measures will be addressed in the accompanying information review document.

Table 23: Potential Impacts to Terrestrial Fauna - Avoidance, Mitigation and Management.

Potential Consequences	Measures
Loss of fauna habitat	*Avoid where possible* - Native Vegetation Clearing outside of demarcated extents - Erosion and sediment migration. - *CBC habitat* - Disturbance of fauna habitat where feasible - Disturbance of native fauna habitat outside Development Envelopes - Direct or indirect Impacts to Impacts to surrounding Beekeepers nature reserve *Mitigation and Management* - Observe ground disturbance procedures. - Implement erosion and sediment controls. - Ensure Progressive clearing and rehabilitation. - Maintain hygiene measures to prevent *Phytophthor*a sp. Infection. - Implement Groundwater management according to licence conditions - Ensure correct storage of chemical and hydrocarbons and spill response - Progressive Rehabilitation will be initiated In areas where construction activities are complete - Rehabilitation activities will follow regulatory rehabilitation procedures. - Vegetative cleared material removed from disturbance footprint will be stockpiled for subsequent reuse. - Rehabilitation will be planned to support local ecological linkages.
Loss of Carnaby's Black Cockatoo Habitat	*Avoid where possible* - Clearing of identified CBC foraging habitat (*Banksia prionotes*) and roosting trees - Native Vegetation Clearing outside of demarcated extents - Erosion and sediment impacts - Wetlands *Mitigation and Management* - Follow ground disturbance procedures. - *Wind Turbine Curtailment: Automatic Radar Shutdown.* - *Light management monitored within the Development Envelopes.* - *3D Radar System installation: Allowing continuous bird monitoring, delivering real-time actionable information and essential insights to enable operational, tactical, and strategic risk mitigation.* Implement of erosion and sediment controls. - Progressive clearing and rehabilitation. - Make use of pre-disturbed areas where possible. - Implement erosion and sediment controls. - Ensure Maintain hygiene to prevent *Phytophthor*a sp. Infection. - Groundwater management through groundwater licence. - Appropriate storage of chemical and hydrocarbons on site and response to spill (e.g. spill kits available).

	Rehabilitation - Progressive rehabilitation will be undertaken on those areas that are no longer required to service the operation of the Proposal. - Rehabilitation activities will be undertaken in accordance with EPA guidelines: Rehabilitate – Repair, Rehabilitate or Restore - Vegetative material removed in the early stages of clearing for subsequent reuse. - Rehabilitation will be planned to support local ecological linkages.
Impacts from wind turbine operation on avifauna and bats	*Avoid where possible* - Avifauna Turbine blade strike - turbine blade bat strike - Fauna Habitat where feasible - CBC Habitat *Mitigation and Management* (*refer also to Avifauna & Bat Assessment*) report. - Assessing the effectiveness of turbine curtailment at low wind speeds. - Assessing potential colouring of blades to prevent fauna strikes. - IGE commits to the installation of bat / bird radar technology that triggers turbine curtailment from approaching avifauna and bats to reduce potential collisions. This methodology has been proven to be effective in preventing bat and avifauna fauna strikes. - Potential Reduction of turbine numbers. - Spacing between turbines and turbine rows at least 750 m. - Inspection at turbine sites to monitor bird/bat mortality rates. - Include monitoring results in annual reporting requirements. *Rehabilitation* - n/a
Weed introduction and habitat modification	*Avoid where possible* - Unauthorised plant or vegetative material brought to site. - Entry to unchecked vehicles *Mitigation and Management* - Weed hygiene procedures – include inspection of all vehicles and machinery entering the site. - Driving only on approved tracks. - Weed inspections completed regularly during construction to inform weed management and detection. - Construction material required for site will be inspected prior entry to site. - No unauthorised plant or vegetative material to be brought to site - Compliance with ground disturbance and clearing procedures. *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Vegetative material removed in the early stages of clearing for subsequent reuse.

Change to bushfire regime	*Avoid where possible* - Vehicles or machinery parked in vegetated areas (to prevent bush fire) - *Smoking outside designated areas* - *Naked flames* *Mitigation and Management* - Develop bush Fire Management Plan. - Liaise with local bushfire authorities regarding fire breaks. - Proposal to establish designated smoking areas - Training and inductions include Emergency Response Plan. - Establish and implement hot work procedures. - Regular inspections of generators and other sources of heat/ power. - Fire extinguishers available around site and on all vehicles and machinery. - Vehicles and machinery to be transitioned off when not in use. *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Vegetative material removed in the early stages of clearing for subsequent reuse.
Other construction and operations impact	*Avoid where possible* - Unauthorised vehicles movements on site - speeding on site. *Mitigation and Management* - Regular inspection of trenches and excavation sites. - Include noise and light management mitigation measures *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal. - Rehabilitation will be planned to support local ecological linkages.

12.27 Residual Impact

The residual impacts on fauna resulting from habitat loss are expected to be minimal, primarily due to the implementation of effective mitigation and management measures. Specifically, efforts have been made to minimise the disturbance footprint of the Solar farm, which will be clearly demarcated before any necessary clearing activities commence. Additionally, measures have been implemented to largely avoid areas known to be Carnaby's Black Cockatoo (CBC) foraging habitats and roosting trees, thus minimising the loss of CBC habitat.

Furthermore, to mitigate avifauna and bat impacts from wind turbine strikes, radar monitoring will be conducted during construction and facility operations, with protocols established to halt turbine operations Curtailment) if significant birds or flocks are detected. Continuous monitoring and refinement of contingency protocols based on radar data will further minimise the residual risk to birds and bats.

Additionally, relevant hot works guidelines and Fire and Emergency Management procedures will be implemented to mitigate any residual impact from changes in the bushfire regime.

12.28 Predicted Outcome and Conclusions

Following the implementation of mitigation measures and the optimisation of clearing activities, the Proposal will involve the direct loss of native vegetation with minimal impact to associated fauna habitat. IGE is committed to conducting progressive rehabilitation during construction to restore vegetation communities and fauna habitat structures as soon as possible.

The selection of the wind farm location and design layout has been carefully considered to mitigate impacts on areas of terrestrial fauna significance. The Proposal's location Aderes to current EPBC Act policies by avoiding areas near wetlands or habitats of listed threatened or migratory species. Additionally, the Project Development Envelopes is not situated within or close to any Ramsar or Nationally Significant Wetlands.

The proposed installation of avifauna radar detection technology represents a significant advancement in monitoring methods. This technology substantially reduces the likelihood and consequences of impacts on bird and bat populations resulting from turbine blade strikes. By providing real-time detection and tracking of avian and bat movements, the radar system enables timely interventions, such as temporary shutdowns of turbines, to prevent collisions. This proactive approach not only enhances the protection of wildlife but also promotes sustainable wind energy development by mitigating one of the key environmental concerns associated with wind farms.

While the risks of weed infestation and fires will persist throughout the construction and operational phases, their likelihood and potential consequences are deemed low due to the application of environmental mitigation measures and Adherence to regulatory frameworks.

The ecological linkages connecting surrounding vegetation, drainage lines, floodplains, and wetlands are expected to maintain a contiguous fauna habitat within the Development Envelopes.

Given the nature and scale of terrestrial fauna impacts associated with this proposal and the identified management measures, significant impacts to biological diversity and ecological integrity are not anticipated. Consequently, the EPA Objective for this factor is expected to be maintained.

Inland Waters

13 Key Environmental Factor – Inland Waters

13.1 Environmental Values

EPA Objective

To maintain the hydrological regimes and quality of groundwater and surface water to ensure environmental values are protected.

13.2 Legislation, Policy, and Guidance

- EP Act 1986
- EPBC Act.
- Rights in Water and Irrigation (RIWI) Act 1914
- Statement of Environmental Principles, Factors and Objectives (EPA, 2021b)
- EIA (Part IV Division 1 and 2) Administrative Procedures (Government of Western Australia, 2021)
- EIA (Part IV Division 1 and 2) Procedures Manual (EPA, 2021a)
- Environmental Factor Guideline - Inland Waters (EPA, 2018)
- Operational Policy 5.12 – Hydrogeological reporting associated with a groundwater well license (Department of Water, 2009)
- Northern Perth Basin: Geology, hydrogeology and groundwater resources (Department of Water, 2017)
- Arrowsmith Groundwater Allocation Plan (Department of Water, 2010)

IGE recognises that water is a crucial component of the electrolysis process and presents environmental challenges due to the required volumes and quality standards. Maintaining water quality is essential for ensuring consistent production output, posing challenges in sourcing the necessary water quantities for hydrogen production.

With drinking water becoming increasingly scarce globally, efforts to develop viable solutions for water electrolysis prioritise the recycling of wastewater and the extraction of groundwater from aquifers where volumes are abundant and the quality is suitable for non-potable use.

Future electrolyser facilities have the potential to contribute to a new water ecosystem by utilising low-quality water from various sources, including wastewater from private enterprises or directly from seawater. While technologies for wastewater treatment and water purification already exist in Western Australia, the water industry is advancing towards innovative solutions to address future challenges.

IGE's objective is to assess groundwater supply for optimal abstraction from the Yarragadee aquifer, ensuring the desired abstraction volumes for hydrogen production through electrolysis while minimising drawdown that could adversely affect Groundwater Dependent Ecosystems (GDEs) within the Development Envelopes.

To achieve this objective, three production bores are proposed to be constructed adjacent to the Green Hydrogen Production Facility (GHPF), strategically located within the northeast area of the Development Envelopes. This assessment primarily focuses on the potential drawdown resulting from groundwater extraction from the Yarragadee aquifer.

13.3 Receiving Environment

The proposed site is situated approximately 300 km north of Perth and 30 km south of the town of Dongara. It is bounded to the south and west by the Beekeepers Nature Reserve (BKNR) and to the northeast and east by Arramall Lake, along with associated wetlands and drainage lines connecting Arramall Lake with Arrowsmith Lake, which lies outside of the proposal area).

Rainfall data, specifically Intensity-Frequency-Depth (IFD) data, is essential for characterising storm rainfall intensities. This information is provided by the Bureau of Meteorology (BOM) and encompasses various Average Exceedance Probabilities (AEPs) and their equivalent Average Recurrence Intervals (ARIs), including up to the 2,000-year ARI.

Intensity-Frequency-Depth (IFD) data is required to characterise storm rainfall intensities and is provided by the Bureau of Meteorology (BOM). Information is provided for various AEPs (Average Exceedance Probability), and the equivalent ARIs (Average Recurrence Interval), up to the 2,000-year ARI.

On this basis, rainfall intensity data for the Arrowsmith area is shown below:

Table 24 Intensity-Frequency-Duration (IFD) (mm)

AEP/ ARI Duration	63% 1y	50% 1.44y	20% 4.5y	10% 9.5y	5% 20y	2% 50y	1% 100y	2,000y	10,000y
1 hour	16	18	24	29	34	41	47	76	94
2 hour	20	22	30	36	43	52	59	96	119
6 hour	28	31	43	53	62	88	97	139	172
12 hour	34	39	62	66	78	96	111	176	218
24 hour	42	47	78	79	94	116	135	217	269
30 hour	44	50	69	83	99	122	146	241	298
72 hour	55	61	83	99	116	141	161	278	344

13.4 Surface Water

The Proposal is situated within the Arrowsmith Hydrological Zone, encompassing three sub-catchments within two hydrographic surface water catchments, namely:

- Arrowsmith River
- Arrowsmith River sub-catchment
- Eneabba Coastal Tributaries sub-catchment
- Irwin River sub-catchment

Arramall Lake is part of the Arrowsmith River catchment, as depicted in Figure 26. Arrowsmith Lake receives discharge from the Arrowsmith River, and when its capacity is exceeded, excess flows are directed towards Arramall Lake. The total catchment area for the Arrowsmith River is approximately 1,604 km2 (Department of Water, 2017).

Originating about 60 km east of nearby Three Springs, the Arrowsmith River flows west-southwest from the Dandaragan Plateau onto sand plains until it reaches Arrowsmith Lake. Beyond the Brand Highway to the west, overflow from the lake proceeds in a northwesterly direction through the coastal plain, ultimately reaching Arramall Lake and discharging into limestone caves. The Arrowsmith River does not reach the ocean; instead, it feeds into groundwater systems, recharging the superficial aquifer along its path. The river's flow is highly ephemeral, typically occurring between April and November, with a mean annual flow of 5 GL/a. The Arrowsmith River is classified as moderately saline, with mean salinity levels averaging around 3,000 mg/L TDS (DoW, 2017).

A minor drainage line originating from the Arrowsmith River traverses the Proposal area, flowing from the south to the northeast where it connects to a seasonal wetland system known as Arramall Lake (refer to Figure 26). This drainage line plays a crucial role in the hydrology of the area, directing surface water flow and influencing local wetland ecosystems.

Technically, the drainage line functions as a conduit for seasonal water movement, supporting both surface runoff and groundwater recharge processes. During periods of significant rainfall, this line may carry increased volumes of water, contributing to the hydrological dynamics of Arramall Lake, which is characterised by its seasonal wetland conditions. The presence of this drainage line highlights the importance of maintaining natural water flow patterns to support wetland health and biodiversity.

Importantly, there are no wetlands within or near the proposal area that are recognised by the Department of Biodiversity, Conservation and Attractions (DBCA) or the Commonwealth as significant. This absence indicates that the proposal area does not intersect with designated RAMSA wetlands or wetlands of national or state significance. Nevertheless, the local hydrological features, including the minor drainage line and seasonal wetland, will warrant careful consideration to ensure that the ecological functions and water quality of these systems are preserved during and after the implementation of the proposal.

There are no major or minor creek lines within the AHP Development Envelopes (DE). The eastern section of the proposal area drains into the low-lying areas nearby Arramall lake that is within the Arrowsmith catchment area. The western section of the proposal area drains through the Eneabba coastal tributaries and Irwin River catchment into the Indian Ocean. Arramall lake is highly ephemeral and hydrologically connected to Arrowsmith lake to the south-east of the Proposal area via a minor tributary (DoW, 2017)

There is only anecdotal evidence of the lake being filled before the early 1970s, mostly after Arrowsmith Lake had filled previously. In addition, hydrological modelling by Cardno (2021b) found that the any inflow into Arramall lake from Arrowsmith Lake would occur in a 1:50 year flood event only. Currently, proposed earthworks within potential inflow pathways would control the flow pathway from a wide flood way in places to a defined channel but will not affect the flow of water into Arramall Lake and associated wetland and GDE from surface runoff or Arrowsmith Lake (Cardno, 2021b).

The Proposal design is unlikely to impact on defined waterways or existing drainage lines nor is it anticipated the proposed disturbance footprint will impact the modelled flood pathway (Figure 27) (Cardno, 2021c).

13.5 Hydrology and Hydraulics

13.5.1 Arramall Lake and Arrowsmith River

Arramall Lake is part of the Arrowsmith River catchment. Arrowsmith Lake takes the discharge from Arrowsmith River. When the capacity of Arrowsmith Lake is exceeded, flows from Arrowsmith River are able to flow toward Arramall Lake. The catchment area for Arrowsmith River upstream of Arramall Lake is 965 km^2. The Arrowsmith River does not reach the ocean and will flow into groundwater systems along its route and at Arrowsmith and Arramall Lakes. When Arrowsmith River does not overflow to Arramall Lake, the approximate catchment area that can drain into the lake is 30 $km.^2$

13.5.2 Flow Estimation

Peak flow estimates were generated using the Australian Rainfall and Runoff Regional Flood Frequency Estimation (RFFE) Model and are presented in Table 26 No specific monitoring data or previous investigations were available for Arramall Lake, Arrowsmith Lake, or the Arrowsmith River in the vicinity of the works area were available to validate the results. (Cardno 2021)

A drawing was acquired of Main Roads Western Australia (MRWA) Bridge 0883 which is located 19 km upstream of Arrowsmith Lake and 26 km upstream of Arramall Lake. The potential flow through the bridge opening was estimated to be in the 300 to 360 m^3/s range.

Table 25 RFFE Calculated Flows Upstream of IGE Landholdings for Arramall Lake Local Catchment

AEP	Discharge	Lower Confidence Limit (5%)	Upper Confidence Limit (95%)
(%)	(m^3/s)	(m^3/s)	(m^3/s)
50	5.87	1.32	26.7
20	16.9	3.76	76.7
10	27.4	6.13	125
5	40	8.92	182
2	58.1	13	265
1	72.5	16.2	330

Table 26 RFFE Calculated Flows Upstream of IGE Landholdings for Arramall Lake Arrowsmith River Catchment

AEP	Discharge	Lower Confidence Limit (5%)	Upper Confidence Limit (95%)
(%)	(m^3/s)	(m^3/s)	(m^3/s)
50	28.6	7.22	116
20	81.9	20.7	331
10	133	33.7	540
5	194	49	786
2	282	71.3	1140
1	352	88.9	1420

13.5.3 Arrowsmith River Flood Extent

The flooding extent at Lake Arramall, which affects the IGE development, is influenced by two primary factors: the lake's top water level and the extent of flow from the Arrowsmith River. To assess this, a TUFLOW two-dimensional hydraulic model was developed, specifically focusing on the flooding dynamics of the Arrowsmith River within the IGE landholdings.

The TUFLOW model was constructed using a high-resolution digital elevation model (DEM) combined with constant inflow rates. The simulation was run until steady-state conditions were achieved within the Arrowsmith River section, ensuring accurate and stable results.

A range of flow scenarios were modeled, with flows reaching up to 360 cubic meters per second (m^3/s). These scenarios were selected to represent both a potential major flow event from the Arrowsmith River into Lake Arramall and flow contributions from the local catchment alone. The results indicate that, due to the presence of deep channels on the site, the flood extent does not significantly increase with higher inflow rates. This suggests that the site's topography, characterized by these channels, plays a key role in mitigating the expansion of flooding under varying flow conditions.

13.5.4 Lake Arramall Flood Extent

Given the limited data available for the river and lake system at the site, a stage-volume relationship was determined to test anecdotal information provided as well as to enable comparisons to estimate runoff volumes. This data is presented in Table 27.

Based on anecdotal information, the local catchment flood level of RL 15 m AHD is possible when considering possible runoff from the catchment. Minor losses as well as runoff coefficients of 0.1 to 0.3 were considered and it is unlikely that local catchment flood levels above RL 16 m AHD would be achievable without sustained rainfall occurring over several storms, or in a 1% AEP long duration event.

Anecdotal information received suggested that when the Arrowsmith River flowed in to the site, the water would reach the River Red Gums. Prior to the upgrade of Brand Highway there would also be water over the road. A flood level in the range of RL 17.0 to RL 17.5 m AHD is supported by these comments. It was noted that the water would flow into limestone chasms at about this level.

The sensitivity of flooding extent to water level in Lake Arramall was considered to determine the impact of conservative flood level estimates within the Development Envelopes. (Cardno 2021)

13.6 Infrastructure Layout Assessment update

Based on the flood level surveys and flood extents, the following areas of the concept layout have been identified and updated to address flood impacts.

13.6.1 Road Alignment

The site modified access road alignment is outside of the flood extent and will achieve the proposed design criteria.

The road alignment was reconsidered against the flooding extent to avoid existing areas of inundation and the RL level of the access road will not be impacted by major flow or flooding.

13.6.2 Solar Farm Layout

The area proposed for the solar farm located at the southeast area of the Development Envelopes has been designed to avoid the flood zone. Additionally, the array will be relocated further north to avoid surface water flows and will have an anticipated RL at 22m above the flood extent.

The revised solar farm layout has reduced the overall Disturbance Footprint, avoiding CBC foraging habitat, and has enabled further impact mitigation, including avoiding impacts to GDE's surface vegetation, drainage/water lines and wetlands.

13.6.3 Surface Water Management - General

On a regional scale, surface water drains west and into the sea, notably around the wetlands and Arramall Lake.

The Development Envelopes site is not impacted by external concentrated flows (i.e. water courses or creeks) due to its elevation in the surrounding terrain

- The proposal site will be continuously rehabilitated with limited exposed disturbed vegetation surfaces, and minimal surface runoff during normal rainfall events,
- No contaminated water runoff impacts, or surface water treatment measures are anticipated
- The post- clearing soil surface profile will be rehabilitated to match the pre-construction topography profiles.
- IGE will ensure continuously draining rehabilitated surfaces, to avoid low / trapped areas that could saturate surrounds and create water pooling.

The Mid-West landscape is often subject to heavy rainfall during the winter months, which can increase the risk of erosion from activities such as vegetation clearing, topsoil removal, and general construction.

The primary objective is to maintain natural surface water regimes to protect local ecosystems. To achieve this, soil and water impacts will be continuously monitored throughout the project lifecycle, ensuring that any adverse impacts on surface water quality and flow are minimized. Implementing erosion control measures and adaptive management strategies will be essential to mitigate these risks and preserve the integrity of the surrounding environment.

13.6.4 Green Hydrogen Production Facility (GHPF)

The production facilities will be located outside of the Arramall Lake and Arrowsmith River area of influence. The production facility is placed within a small local catchment and drainage at the facility should account for this as part of the proposed civil design.

13.6.5 Revised Turbine Facility Layout

The revised turbine array design and reduction in turbine numbers have enabled enhanced impact mitigation, particularly by avoiding impacts on drainage lines, wetlands, Carnaby’s Black Cockatoo (CBC) habitat, and ephemeral waterbodies. This optimised design ensures the preservation of critical environmental features, reducing ecological disturbance and promoting the sustainability of natural habitats within the project area.

Additionally, the wind farm has been relocated to the western portion of the AHP Development Envelopes to avoid potential impacts on Groundwater Dependent Ecosystems (GDEs), including both terrestrial and aquatic GDEs, as identified by Ecoscape. According to Ecoscape's assessment, the majority of the site presents a low potential for GDE impacts, with only the western portion classified as having a moderate potential for impacts on terrestrial GDEs. This relocation serves as a precautionary measure to minimise environmental impacts and protect sensitive ecosystems, ensuring the project's alignment with best environmental practices.

13.6.6 Site Access

The proposed main site access to the north of the site to suit the Green Hydrogen Production Facility is not impacted by the Arramall Lake and Arrowsmith River catchments. A secondary site access from the east (such as the existing northern gate) is recommended to maintain access to areas when the lake is flooded.

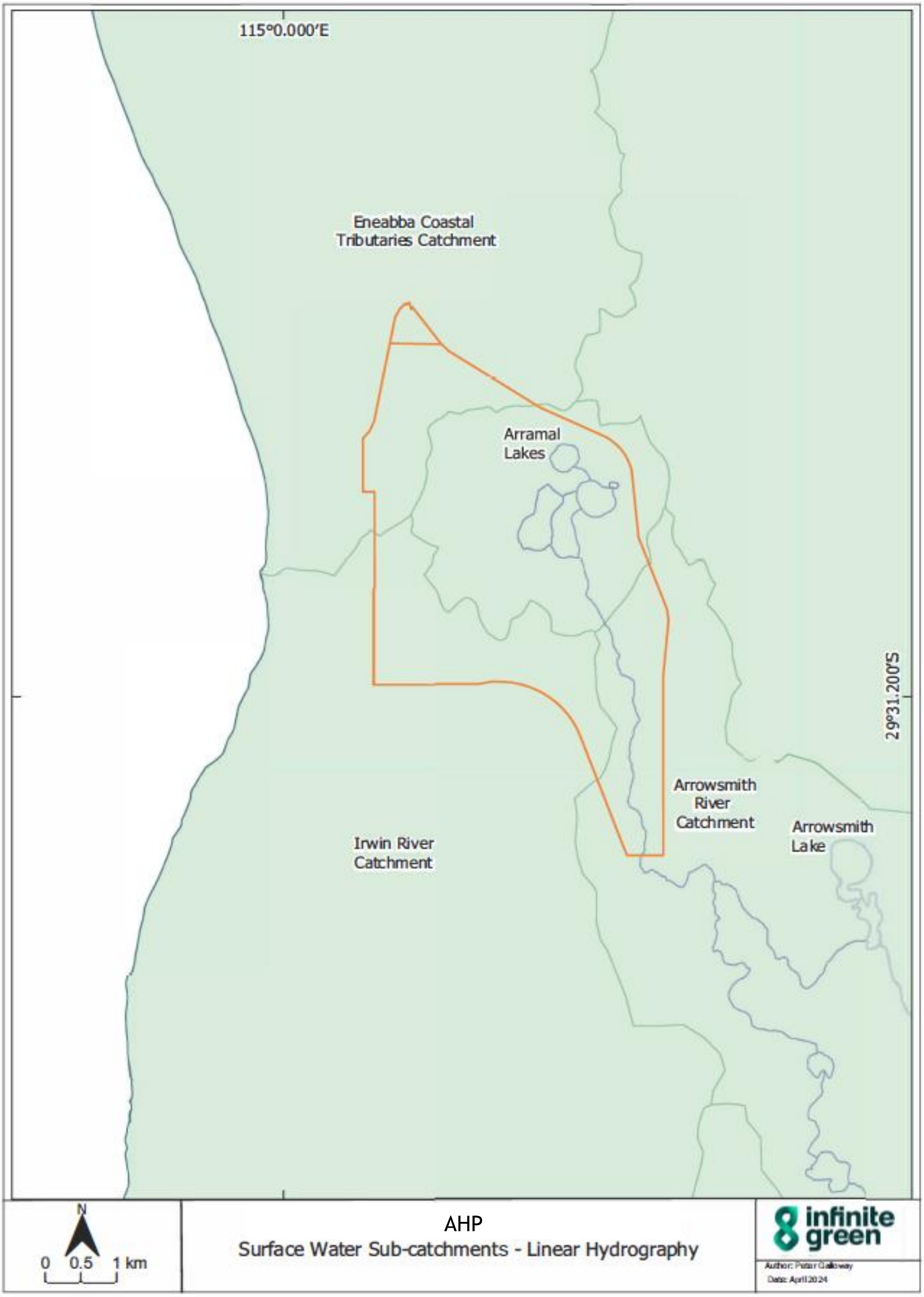


Figure 26: Surface Water and Local Catchments.

13.7 Groundwater

The Proposal area lies within the Dongara sub-area of the Arrowsmith Groundwater Proclamation Area. The groundwater comprises of unconfined superficial systems overlying the Yarragadee aquifer (DoW, 2010). The hydrogeological setting is outlined in figure 25.

Table 27: Hydrogeological Setting.

Physiographic Region	Swan Coastal Plain, Quindalup dunes
Groundwater province	Perth Basin
Groundwater area	Arrowsmith

The Proposal lies within the sedimentary Perth Basin (DoW, 2017). This basin is located onshore and offshore and extends for about 700 km along the southern portion of the west coast of Western Australia and is bounded to the east by the Darling Fault, which extends the full length of the basin. The onshore portion of the basin averages 65 km in width and extends from the southern coast to Geraldton in the north. The northern Perth Basin in the region contains sedimentary rocks of Early Permian to Late Jurassic age and reaches thicknesses greater than 5,000m (DoW, 2017).

The Proposal area is located within the Dongara sub-area of the Arrowsmith Groundwater Proclamation Area and overlies the Superficial Swan aquifer that has the following characteristics in the area (DoW, 2017):

- Predominantly saturated
- Comprise predominantly of Tamala limestone (Calcarenite sand deposit, limestone, clay), with possible surface lenses of Alluvium (in the vicinity of Arramall lakes), Safety Bay sand (calcareous sand) in the north-western extent, Bassendean sand (sand, minor silt, clay) in the eastern extent and lake deposits (mud, silt, sand, limestone, peat) in the south-eastern extent near Arrowsmith lake
- Estimated formation thickness of <10 m
- Based on the surrounding topography, the depth to groundwater estimated to be between 0 mbgs (Arramall lakes) to 50 mbgs (peaks of adjacent dune system)
- Expected salinity 1,500-3,000 mg/L TDS. In the east tending to 3,000-7,000 mg/L TDS (brackish to saline)
- Hydraulic gradient is broadly west toward the Indian Ocean
- Groundwater is recharged predominantly via rainfall, upward groundwater flow from the underlying Yarragadee aquifer expected in the eastern and northern portions, in areas where the aquifers are hydraulically connected with Arrowsmith river in the vicinity of the proposal area (Irwin, 2007; Nidagal, 1994)
- Groundwater from the superficial aquifer discharges predominantly into the ocean at the coast over a seawater interface that may extend up to 1.5 km inland (Moncrieff & Tuckson, 1989)

13.8 The Yarragadee Aquifer

The Yarragadee aquifer (in the north) and the Cattamarra (central and southern areas) are the main formations that sub-crop in the area and underly the superficial aquifer, separated by the Abrolhos Transfer Fault. The Yarragadee's expected salinity in the Proposal area is 1,500 mg/L TDS in the east to 7,000 mg/L TDS in the west (brackish to saline), whereas the Cattamarra aquifer salinity is expected to be as low as 500 mg/L TDS in the eastern extents of the area.

The Cattamarra aquifer comprises the Cattamarra Coal Measures and Cadda formation. The Cadda formation contains predominantly sandstone and siltstone in upper parts and clay/shale in lower parts. The substantial clay and siltstone layers confine water bearing horizons. The Yarragadee aquifer consists of a multilayered sequence of sandstone beds with very fine to very coarse grained and granularised quartz sand with variable amounts of matrix clay and interbedded siltstone, shale and claystone (DoW, 2017).

Rainfall recharge into the aquifer is expected via downward leakage from the Superficial aquifer in the eastern Swan Coastal Plain (Commander, 1981; Kern & Koomberi, 2013; Nidagal, 1994) and from the overlying Yarragadee (DoW, 2017). Where the Cattamarra aquifer is in direct hydraulic connection with the Superficial aquifer, groundwater discharges from the Cattamarra aquifer into the overlying Superficial aquifer (Commander, 1981; Kern & Koomberi, 2013). Groundwater from the Cattamarra aquifer also discharges offshore. Groundwater recharge into the Yarragadee is mostly by direct rainfall (east of the Swan Coastal Plain), as well as downward leakage from overlying aquifers and river recharge.

Groundwater also discharges from the Yarragadee via upward flow into overlying aquifers, such as in the northern portion of the Proposal area, and general groundwater flow offshore into the Indian Ocean (DoW, 2017).

13.9 Potential Groundwater Abstraction Impacts

Groundwater abstraction from the proposed three production bores have the p[potential to impact the discharge of groundwater from the Yarragadee aquifer into overlying superficial aquifers. The Yarragadee aquifer acts as a primary source of groundwater in the region, supplying water to both deeper and shallower aquifers through natural processes such as upward flow.

When groundwater is abstracted from boreholes, it creates a pressure gradient that can potentially alter the natural flow patterns within aquifer systems. Specifically, excessive cumulative abstraction could potentially lead to a lowering of groundwater levels in the Yarragadee aquifer, reducing the hydraulic head or pressure within the aquifer. As a result, the natural upward flow of groundwater from the Yarragadee aquifer into overlying superficial aquifers may be diminished or even reversed.

The Yarragadee aquifer may naturally contribute to the recharge of superficial aquifers, groundwater abstraction can still disrupt this process by altering the hydraulic dynamics within the aquifer system. It's essential IGE consider the potential impacts of groundwater abstraction on the interconnectedness of aquifer systems and manage abstraction practices carefully to avoid unintended consequences.

This reduction in upward flow can have several consequences for the overlying superficial aquifer:

- Decreased Recharge: The reduced flow of groundwater from the Yarragadee aquifer into the superficial aquifer diminishes the natural recharge of the superficial aquifer, impacting its overall water availability and sustainability.
- Changes in Water Quality: The reduced flow of groundwater from the Yarragadee aquifer may alter the composition and quality of water within the overlying superficial aquifer. This could include changes in mineral content, salinity levels, and contaminant concentrations.
- Ecological Impacts: Changes in groundwater flow patterns can disrupt the hydrological balance of ecosystems dependent on groundwater, affecting wetlands, springs, and other surface water features supported by the superficial aquifer.
- Land Subsidence: Excessive groundwater abstraction can lead to land subsidence as the withdrawal of water from the aquifer causes the surrounding land to settle or sink, potentially impacting infrastructure and land use.

Overall, the alteration of groundwater flow patterns and changes in salinity levels resulting from groundwater abstraction can have complex and varied effects on Groundwater Dependent Ecosystems and hydraulic dynamics. Therefore, careful management and monitoring of groundwater abstraction practices will be essential.

IGE intends to construct a groundwater monitoring bore as part of their strategy to monitor and mitigate potential negative impacts from groundwater abstraction, thereby ensuring the long-term sustainability of groundwater-dependent ecosystems.

A monitoring bore will serve as an essential tool for ongoing assessment and management of groundwater levels, flow patterns, and quality within the aquifer system. By regularly monitoring these parameters, IGE can identify any changes or trends indicative of negative impacts resulting from groundwater abstraction activities.

Additionally, the data collected from these monitoring bores will inform adaptive management strategies aimed at mitigating potential negative impacts and promoting the sustainable use of groundwater resources. This may include adjusting abstraction rates, implementing recharge enhancement measures, or modifying operational practices to minimise ecological harm.

Ultimately, the construction of groundwater monitoring bores demonstrates IGE's commitment to responsible environmental stewardship and proactive management of groundwater resources to ensure the long-term health and sustainability of groundwater-dependent ecosystems.

Monitoring and Regulation: IGE will Implement a robust monitoring program to track groundwater levels, flow rates, and quality in both the Yarragadee aquifer and overlying superficial aquifers. Use this data to establish sustainable abstraction limits and regulatory measures to prevent excessive groundwater pumping.

Additionally, adaptive management approaches may be necessary to address unforeseen consequences and adjust management strategies accordingly.

The proposal Development Envelopes is not within a Public Drinking Water Source Area (DWER, 2021).

Water quality in existing superficial bores were tested in January and July 2021. North Bore (500 m south of Arramall lake) exhibited an EC of 3,400 μS/cm and South Bore (3,000 m further south) had an EC of 1,800 μS/cm (Cardno, 2021b). Therefore, the water quality is classified as brackish.

There is no direct measure of groundwater salinity from deeper portions of the Yarragadee aquifer in the Arrowsmith project area, but the salinity has been recorded from the upper portion of the aquifer in nearby Leeman Shallow monitoring bores. The salinity in deeper sections have been estimated from regional mapping.

At Arrowsmith North, LS31B (94 to 100 m) obtained groundwater from the upper portion of Yarragadee aquifer with a salinity of 860 mg/L (Nidagal, 1994). Regional groundwater salinity mapping suggests that the salinity rises to 1 500 mg/L by around 300 m depth, and 3 000 mg/L toward the base of the Yarragadee aquifer.

Near Arrowsmith Central, LS20A (97 to 100 m), located just south-southwest of the project area, yielded groundwater with a salinity from the upper portion of the Yarragadee aquifer of 520 mg/L (Nidagal, 1991a), and at LS24A (96 – 99 m) northeast of the area the salinity was 600 mg/L. Groundwater of salinity less than 1 000 mg/L is projected to extend to about 150 m depth beneath Arrowsmith Central, remaining below 1 500 mg/L to the base of the aquifer.

Evaluation of many pumping tests have found average and median values for hydraulic conductivity of 12 m/day and 5.6 m/day respectively (Department of Water, 2017), although generally lower values are associated with Units D and B. Bore yields are generally large, with pumping rates up to 6000 kL/day obtained from production bores at Eneabba (Johnson and Commander, 2006).

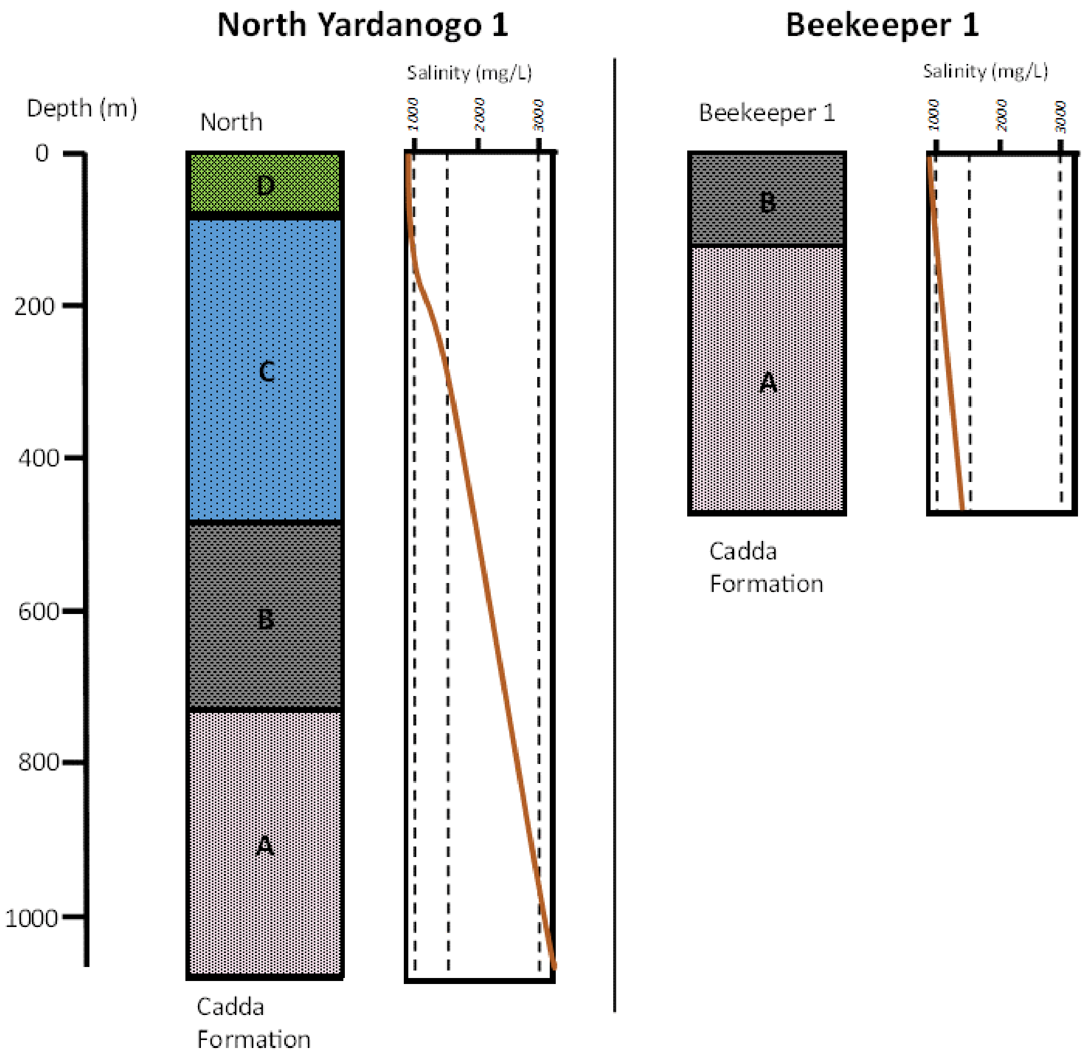


Figure 27 Geological profile showing the sub-division units (A-D) and interpretive groundwater salinity through the Yarragadee Formation within North Yardanogo 1 and Beekeeper 1

Referring to figure 27, Unit C is the sandiest portion in the Yarragadee Formation with only minor interbedded siltstone and shale is present over about 94 to 486 m depth. Downhole gamma-ray logging shows around 50% of clayey strata through Unit B over 486 m to 733 m depth. Unit A was intersected over 733 m to 1 085 m depth where the profile is dominantly sand with approximately 20% clayey intervals. Exploratory petroleum well South Yardanogo 1, located in the central portion of Arrowsmith North intersected 1020 m of the Yarragadee Formation (below about 40 m of Superficial Formations). The base of Unit C is at about 373 m depth, while Unit D appears to be absent.

Arrowsmith is Centrally located south of the Abrolhos Transfer Fault and has a thinner interval of the Yarragadee Formation present, which is projected to thicken beneath Arrowsmith Central from around 400 m in the western portion to 800 m in the east. Only Units A and B of the Yarragadee Formation are present. Unit B extends to about 250 m deep around the eastern portion of the area but pinches out toward the western margin where only the lower-most Unit A is present. (Refer figure 27)

Beekeeper 1 (Australian Aquitaine Petroleum, 1982) drilled just south of the area intersected the Yarragadee Formation to 477 m depth. Unit B extends to 127.13 m depth in the well, and while the lithology over this unit was not logged the equivalent section in the adjacent 12

Monitoring bore LS20 (Nidagal, 1991a) comprises dominantly coarse-grained sandstone with abundant intervals of fine-grained sandstone, siltstone and shale. The underlying Unit A extends to 470 m depth, with a gamma-ray log showing that it is dominantly sandstone with some finer-grained intervals making no more than about 20% of the unit.

The Yarragadee Formation contains the Yarragadee aquifer which is the largest regional aquifer within the northern and central Perth Basin, forming a thick, permeable aquifer. Hydraulic properties are dependent on the portions of sand versus silt and clay, and the degree of cementation. Overall, the transmissivity of Unit C and A would be greater, however, good sand intervals within Units D and B can also be of high permeability. Siltstone and shale layers within Units D and B can form local aquitards.

Evaluation of many pumping tests have found average and median values for hydraulic conductivity of 12 m/day and 5.6 m/day respectively (Department of Water, 2017), although generally lower values are associated with Units D and B. Bore yields are generally large, with pumping rates up to 6000 kL/day obtained from production bores at Eneabba (Johnson and Commander, 2006).

Groundwater within the Yarragadee aquifer is recharged by downward rainfall infiltration over the dissected plateau region inland of the coastal plain referred to as the Arrowsmith Region. From the Arrowsmith Region groundwater flow is westward, discharging around the western margin of the Yarragadee Formation approximately coincident with the central portion of the coastal plain by upward leakage into the Superficial aquifer. (Nidagal, V., 1991b)

13.10 Development Constraints

The most significant constraint to groundwater abstraction in the Arrowsmith Project area is the potential impact on Groundwater Dependent Ecosystems due to a decline in water levels, particularly in areas of shallow water table including wetlands and damp lands.

Areas of shallow water table are found about (east, north and west) and within Arrowsmith North, where a series of wetlands are present along the eastern margin that may have some dependency on groundwater within the Bassendean Sand. Another group of wetlands/damp lands is located west of the area where the water table is within the Tamala Limestone.

Potential wetlands or Groundwater Dependent Ecosystems (GDE's) are present within several kilometres south of Arrowsmith Central. However, this area does not appear to be associated with a shallow water table within the Superficial aquifer, where the water table is projected to be at least 10 m depth. These wetlands may represent areas of perched groundwater developed upon clay in the Guildford Clay.

At LS20, several metres of clay (6.9 to 9.0m) is present within the Guildford Clay (Nidagal, 1991a) which could potentially support a local overlying perched groundwater system. A significant wetland situated from about 3 km south of the project area has a white lake floor, possibly due to salt deposits, which is characteristic of perched groundwater discharging upon a claypan.

The Arrowsmith River will not be impacted by groundwater abstraction from the project development area as the river bed is well above the potentiometric head of the Yarragadee aquifer and water table in the Superficial aquifer, and there is no groundwater discharge to the river. Over the Arrowsmith Region plateau area further east, there may potentially be some seepage to the river from perched groundwater higher within the Yarragadee Formation, most likely associated with Unit D, but this would not be influenced by groundwater abstraction from the Arrowsmith tenements area. (Nidagal, V., 1991a)

13.11 Groundwater Dependant Ecosystems

A database search of the Bureau of Meteorology's (BoM, 2021) Groundwater Dependent Ecosystems Atlas found both terrestrial and aquatic GDE's onsite and surrounds. The majority of the site has a low potential for GDE impact, with the western portion classified as moderate potential for terrestrial GDE's. One small area, located in the north-east section of the site, is classified as a high potential terrestrial GDE (IGE will avoid construction activities within this area). A watercourse located within the project, to the south and east corner is classified as a moderate potential aquatic GDE.

The reconnaissance flora and vegetation survey (Ecoscape, 2021a) identified three vegetation types indicative of Groundwater Dependent Ecosystems within the Development Envelopes:

- *Acacia rostellifera* and *Melaleuca lanceolata (GDV)* tall shrubland on karst limestone (Degraded condition)
- *Eucalyptus camaldulensis* subsp. *obtusa* and *A. rostellifera* mid-woodland in riparian areas and floodplains (Completely degraded condition)
- *Melaleuca strobophylla*, *Casuarina obesa* mid-open woodland associated with ephemeral lakes and floodplain areas (Completely degraded condition)
- Melaleuca lanceolata associated with tall shrublands on near coastal dunes and swale (Completely degraded condition)

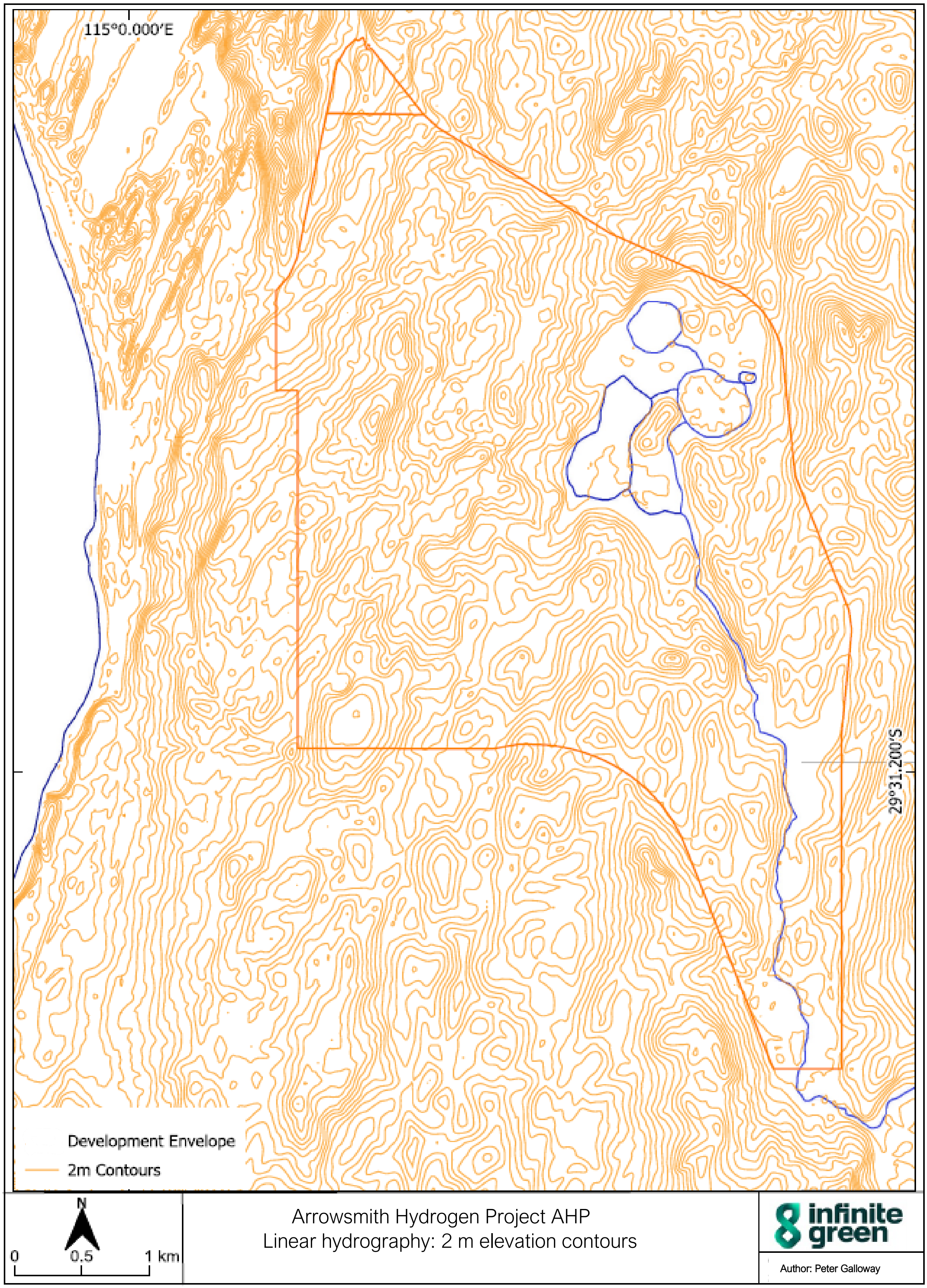


Figure 28: Linear hydrography showing 2 m elevation contours.

13.11.1 Groundwater Abstraction Optimisation Assessment

Following feedback from regulatory agencies (DWER, EPA), IGE has implemented modifications to its groundwater extraction strategy. These adjustments entail the relocation of production bore site locations, positioned at a greater distance from the proposal wetlands. The current Groundwater Dependent Ecosystems (GDE's) are located within the eastern area of the site Development Envelopes and have been described by Ecoscape environmental consultants as being either degraded or completely degraded.

The revised turbine facility layout has resulted in an optimised distribution of water extraction across the three proposed production bores, each separated by 100 metre intervals as advised by Australian Bore Consultants Pty. Ltd. Hydrogeological Division

The targeted Yarragadee aquifer, with a groundwater depth of approximately 100 meters and a thickness exceeding 100 meters (Department of Water, 2017), will serve as the primary and only source of water extraction for hydrogen facility processing. The Hydraulic properties of the Yarragadee formation indicate a throughflow rate of 10 meters per day (Nidagal, 1994).

The annual maximum water extraction of a maximum of 2,340 kL per day will result in a maximum pumping rate of 15 litres per second from the Yarragadee aquifer or 5 litres per second for each of the three production bores. Bore slotting will extend a minimum of 50 meters to sustain the necessary yield and mitigate drawdown. Definitive bore development plans will be established before construction, with careful consideration of local hydrogeological conditions, test results, and compliance with DWER bore licensing requirements.

Considerations have been given to potential cumulative impacts from additional groundwater users nearby, the proposal area under different scenarios (Cardno 2021c). provides a summary of the modelled potential flow estimation within the proposal area.

Collectively, with the proposed reduction in annual water extraction, the revised production bore placement (1 km east of Beekeepers nature reserve and 2km to west of the wetlands)), bore spacing parameters, modified bore development and the optimised operational strategy, it's anticipated groundwater abstraction impacts within the proposal area will be minimal.

13.11.2 Production Bores

Infinite Green Energy are proposing three production bores to be constructed at the Green Hydrogen Production Facility (GHPF) AHP, to supply water for manufacturing hydrogen while utilising the alkaline electrolysis process. The three bores will be constructed in accordance with the DWER Licence 26D of the Rights in Water and Irrigation Act 1914 requirements.

Under Regulation 33(2)(b) of the Rights in Water and Irrigation Regulations, IGE will submit the proposed construction details of the wells (Production Bores).

IGE have engaged Global Groundwater, Australian Bore Consultants Pty Ltd to specify the intended purpose of the wells and will ensure the driller understands the design requirements of the wells within the context of a Green Hydrogen Production Facility and ensure that the bore construction requirements are designed to abstract from the Yarragadee aquifer only.

A geophysical log will be used to determine parameters in the pilot hole to a nominal depth of 400m, before the bore is abandoned by pressure grouting to the surface. Following drilling the consultant will generate a report to present the geophysical and geological data and submit to DWER for assessment of impacts. The consultant geologist will not be present for the entire drilling program but will be available important stages during the program.

Following the construction and commissioning of the initial production bore, comprehensive production data will be analysed to ascertain the drawdown extent and to establish precise well spacing parameters. This analysis will enable accurate quantification of groundwater withdrawal volumes and the associated aquifer drawdown. The insights gained will be applied to evaluate and optimise abstraction rates for the remaining production bores, facilitating the development of strategies to minimise aquifer drawdown and ensure sustainable groundwater management.

Following the construction and commissioning of the three proposed production bores, an alternating bore pumping strategy will be implemented. This strategy will distribute the 'water take' across all three bores, with no more than two bores operating simultaneously at any given time. This approach is designed to optimise water abstraction, ensuring efficient resource use, while minimising aquifer impacts.

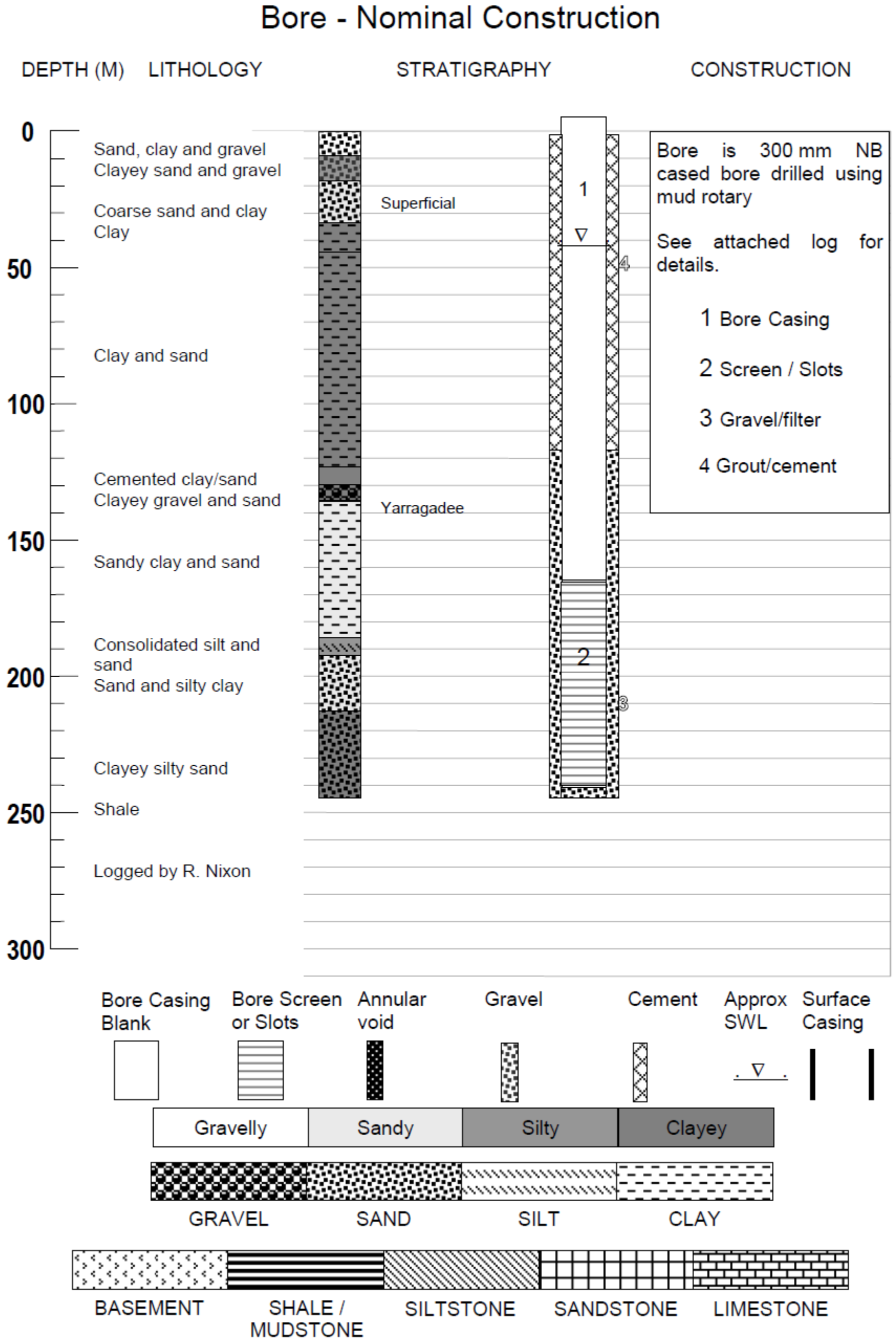
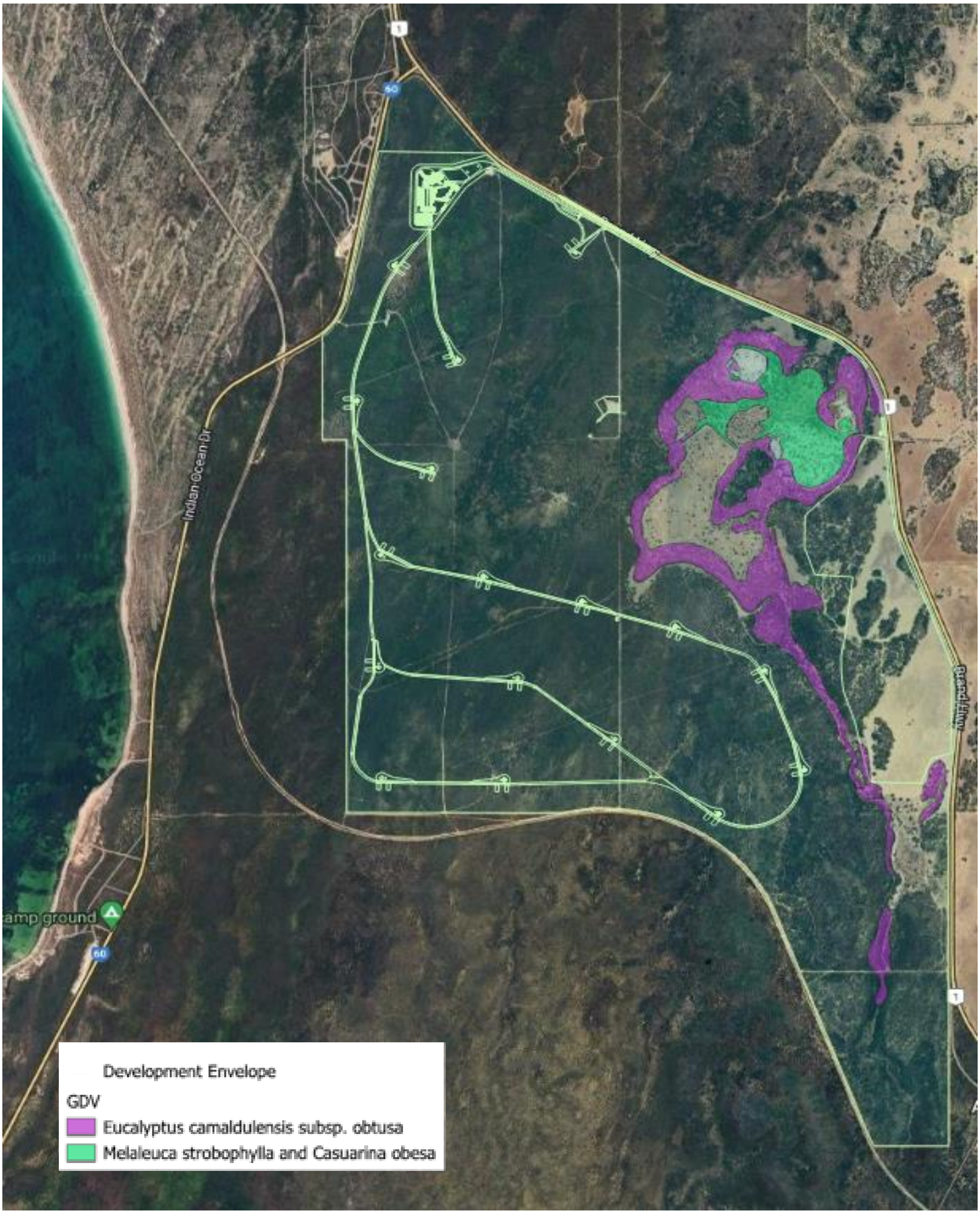
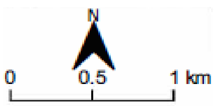


Figure 29: Test Bore (First Production Bore) proposed construction (Global Groundwater, Australian Bore Consultants Pty Ltd.)

Production Bore construction details including depth of screens to ensuring bore is accessing the Arrowsmith Dongara - Perth - Yarragadee North aquifer and avoiding the superficial aquifer.

The three production bore will be constructed into the confined Yarragadee aquifer and will not be connected to the superficial aquifer as required by EPA required conditions.





Arrowsmith Hydrogen Project (AHP) Hydrogen project
Groundwater Dependent vegetation

Author: Peter Galloway
Date: April 2024

Figure 30: Groundwater Dependent Vegetation.

13.12 Groundwater Monitoring and Management

The environmental risks associated with groundwater management and abstraction at the AHP project include:

- Groundwater abstraction for Hydrogen Manufacturing and Electrolysis water supply;
- Groundwater abstraction drawdown resulting in impacts to Groundwater Dependent Ecosystems (GDE's);
- Groundwater drawdown and alteration of hydrological processes as a result of production bore water abstraction; and
- Altered hydrogeology and water balance associated with the creation of void water bodies.

The groundwater monitoring program is designed to manage the three proposed production bores and existing stock bores within the project Development Envelopes, establishing site-specific water quality parameters and baseline water drawdown data from the Yarragadee aquifer, a critical initiative for ensuring sustainable water management and adherence to environmental regulations. It also seeks to assess potential groundwater quality impacts within the superficial aquifer resulting from production bore construction or abstraction.

The program will monitor water quality and drawdown data, comparing the results with baseline data collected by VRX Silica (operating adjacent to the project site) and guidelines from ANZECC and ARMCANZ (2000). This comparative analysis will help determine if adjustments to water abstraction volumes is required from the production bores supplying the electrolysers are necessary.

The monitoring program will commence when the three groundwater production bores are installed and operational, allowing for the collection of groundwater volume information prior to water abstraction and the establishment of site-specific baseline data.

Continuous monitoring of water quality and drawdown in both the Yarragadee and superficial aquifers will be implemented to ensure sustainable resource management. IGE will develop a comprehensive Groundwater Monitoring and Management Plan, detailing procedures for monitoring water abstraction from the Yarragadee aquifer and strategies for managing water quality data from existing stock bores. This plan will also include protocols for monitoring the superficial aquifer to detect any contamination early.

By adhering to the ANZECC and ARMCANZ guidelines and utilising VRX Silica's project data as a comparative baseline, the program aims to mitigate potential impacts upon groundwater quality and ensure sustainable water abstraction practices. Regular reviews of monitoring results against baseline data will allow for necessary adjustments to water abstraction volumes, contributing to the overall sustainability and environmental responsibility of the project.

13.12.1 Inland Waters

The Yarragadee aquifer is the most accessible groundwater resource for water abstraction to supply production groundwater to the AHP project.

There have been previous investigations that provide confidence that aquifer volumes are present within the Yarragadee Formation(See attached VRX report, Appendix 12). It is anticipated that the groundwater aquifer is capable of providing the water volumes required to supply the three IGE production bores proposed.

There are other groundwater users in close proximity as highlighted in the cumulative impact table; and it will be necessary to demonstrate that water abstraction will not impact Groundwater Dependent Ecosystems. (GDE's) across the Arrowsmith industrial hub.

There are options within the Superficial aquifer; however, this resource is under stress from declining rainfall and there will no abstraction from this aquifer as directed by DWER. Production water will be abstracted from the deeper Yarragadee aquifer. This water abstraction alternative is preferred to minimise impacts on Groundwater Dependent Ecosystems (GDEs), which rely on consistent and sustainable groundwater levels for their health and survival. By carefully managing water extraction and Adherering to regulatory standards, the project aims to reduce potential disruptions to these ecosystems.

The Groundwater exploration strategy would be initiated to confirm the water demand and quality requirements for the project, Adhere to DWER for groundwater licenses. Groundwater investigations are likely to require the drilling of a test production bore to facilitate aquifer testing. There may be a need for numerical groundwater flow modelling to understand the impacts on the environment under different abstraction regimes.

Global Groundwater (IGE Subcontractor) will be commissioned to deliver a sustainable groundwater strategy for AHP production requirements. Concurrently, IGE will maintain ongoing consultations with DWER to ensure that groundwater licensing conditions are met and that bore construction Adheres to all regulatory standards..

13.12.2 Surface water discharge

Spill contamination will be mitigated by the implementation of standard construction and operational management measures, including drainage and stormwater control measures, relevant Australian Standards and Major Hazard Facility/Dangerous Goods site licence requirements.

13.12.3

Saline brine residuals generated from the electrolysis process are also being evaluated, with options including off-site transportation by a certified, licensed contractor or potential in-situ recycling. These strategies aim to minimise environmental impact while ensuring compliance with water quality and waste management regulations. Volumes and operational engineering details will be incorporated under Part V, Division 3, licence and works approvals submission as part of the approvals process under the Environmental Protection Act 1986).

13.12.4 Sedimentation and Erosion

Vegetation clearing and soil disturbances associated with construction activities, such as site laydown clearing, access track construction, turbine civil works, and solar farm installation, can disrupt natural surface water drainage patterns. These alterations may lead to erosion, sedimentation, and changes in vegetation structure and floristic composition in adjacent areas, potentially impacting environmental values. Sedimentation and erosion along drainage lines can further compromise the integrity of surrounding ecosystems.

To mitigate these impacts, the project will incorporate industry-standard erosion and sediment control measures throughout construction and operation phases. These include bunding, where appropriate, to stabilise soil and direct water flow, helping to preserve natural hydrological patterns. Additionally, the project's disturbance footprint has been strategically planned to avoid mapped waterways and drainage lines, minimising any potential alteration of water flow regimes. Through these proactive measures, the project aims to protect the surrounding environment and maintain ecosystem stability.

13.12.5 Avoidance, Mitigation and Management Summary

The Proposal risk process identified suitable measures to avoid, mitigate and manage potential impacts to inland waters so that the EPA objective for this key environmental factor is met. The assessment followed a hierarchical approach where avoidance is of highest priority, followed by mitigation and management measures.

Table 28: Potential Impacts to Inland Waters - Avoidance, Mitigation and Management

Potential Consequences	Measures
surface water impacts	*Avoid* - Drainage lines, creek lines, wetlands, and ephemeral lakes. - Avoid the limestone Superficial Aquifer - Direct or indirect Impacts to impacts to groundwater resources. - Direct or indirect Impacts to Impacts to surface water, including impact to drainage/water lines and wetlands, including the ephemeral waterbody. *Mitigation and Management* - Minimise disturbance - Adherence to ground disturbance procedures to avoid interruption of water flow - Use of previously disturbed areas where possible. - Implementation of erosion and sediment controls. - Progressive clearing and rehabilitation. - Appropriate storage of chemical and hydrocarbons on site and response to spill (e.g. spill kits available). *Rehabilitation* - Progressive rehabilitation will be undertaken in those areas that are not required to service the operation of the Proposal. - Rehabilitation activities will be undertaken in accordance EPA rehabilitation procedures.
Groundwater drawdown	Avoid - Direct or indirect Impacts to water abstraction from the superficial aquifer - Excess water abstraction - GDE impacts *Mitigation and Management* - Implement Groundwater monitoring - Implement a Groundwater Operating Strategy - Impacts from groundwater take will be managed through DWER water licences. - Optimisation of groundwater abstraction for hydrogen processing to a maximum of 2,340 kL per day. - Production bores are located at a distance to mitigate impacts to Beekeepers nature reserve and are located to avoid GDE's *Rehabilitation* - n/a

Contamination of surface and groundwater	*Avoid* - Erosion and sedimentation - Hydrocarbon spills - Infiltered discharge to ground *Mitigation and Management* - Appropriate storage of chemical and hydrocarbons on site and response to spills (e.g. spill kits available). - Discharge management of waste and excess water - Implementation of groundwater contamination mitigation management measures *Rehabilitation* - If incident occurs, contaminated area will be rehabilitated
Sedimentation and Erosion	*Avoid* - Construction within creek lines, wetlands, and ephemeral lakes. - Disturbance outside of demarcated clearing extents - Implementation of erosion and sediment controls. - Ensure use of pre-disturbed areas where possible. *Mitigation and Management* - Follow ground disturbance procedures. - Implementation of erosion and sediment controls. - Progressive clearing and rehabilitation. - Implementation of Mitigation Measures. *Rehabilitation* - Rehabilitation will be implemented progressively in areas no longer essential for the Proposal's operation. This approach ensures that disturbed areas are restored as soon as they are no longer required, promoting early ecosystem recovery, reducing erosion, and helping to re-establish native vegetation and habitat over time. Progressive rehabilitation minimises long-term environmental impacts and supports the project's commitment to sustainable land management practices.. - Rehabilitation activities will be undertaken in accordance with progressive rehabilitation procedures. - Temporary construction laydown areas will be immediately rehabilitated at end of life

13.12.6 Optimisation

IGE have optimised the wind turbine layout design to further mitigate potential impacts to Arramall Lake, surrounding groundwater resources and associated GDE's. Wetlands and GDE's areas will be actively avoided and excluded from construction activities.

No changes will be initiated to existing Main Roads drainage located at the eastern boundary of the proposal area. Road drainage will continue to drain into low-lying areas associated with Arramall Lake and wetland.

Groundwater abstraction and bore construction will be managed under a 5C (pending) and 26D licence (pending) issued by DWER under the RIWI Act. This will ensure that the water abstracted from the Yarragadee aquifer will not pose a risk to the water resource and environmental values.

Initial groundwater modelling for the project indicated that annual abstraction could result in a 0.2-meter drawdown in areas containing potential Groundwater Dependent Ecosystems (GDEs), including the Arramall Lake wetlands (Cardno, 2022). This drawdown was assessed as being within acceptable limits for maintaining ecological function, based on standards from the NSW Department of Primary Industries (2012), Queensland Government (2000), and South Australian Arid Lands Natural Resources Management Board (2009).

The model parameters assumed an annual abstraction rate of 900 megalitres (ML) with bore locations approximately 900 meters from the GDEs. However, to further reduce potential impacts, IGE has revised the plan by relocating the three proposed production bores roughly 2 kilometres west of the GDE's while anticipating 2,340 kL water abstraction per day. This adjustment decreases the potential for ecological disturbance, resulting in a minimal anticipated residual risk to groundwater resources.

To prevent hydrocarbon contamination risks, IGE will maintain minimal on-site diesel storage, adhering to Australian Standards and meeting Major Hazard Facility and Dangerous Goods site license requirements. These measures ensure compliance with regulatory standards and further minimize environmental impacts on groundwater quality and dependent ecosystems.

Hydrocarbon and chemical compounds on-site will be managed in strict compliance with relevant legislation and IGE's spill management procedures. This includes secure storage of hazardous chemicals within bunded areas or using self-bunded tanks to prevent any unintentional release. In the event of a spill, immediate containment and remediation actions will be implemented, with impacted soil removed or treated as soon as practicable to prevent contamination spread.

Spill kits will be strategically placed throughout the disturbance footprint, particularly near workshops, fuel storage areas, and hydrocarbon transfer points to facilitate quick response. Any hydrocarbon spill incidents will be recorded and thoroughly investigated under IGE's Environmental Spill Contingency Management process, ensuring proper documentation and analysis to prevent recurrence and support continuous environmental protection efforts.

13.12.7 Residual Impact

Residual impacts on inland waters are anticipated to be negligible due to the application of robust mitigation and management measures. Clearing and earthworks will be minimised as far as practicable and will be clearly demarcated prior to disturbance activities. There are no significant drainage lines within the proposed clearing area extents, while creeks and other surface water features will be actively avoided. Consequently, potential residual impacts from sedimentation and soil erosion, including surface water impacts are anticipated to be minimal.

13.12.8 Predicted Outcome and Conclusions

The modifications to the Arrowsmith Hydrogen Production (AHP) project disturbance footprint have included strategic adjustments to the turbine layout, specifically relocating turbines to avoid water bodies and surface water values. Additionally, enhanced management practices for both surface and groundwater bodies have been implemented. These layout adjustments and improved management strategies have effectively mitigated potential impacts on inland waters, supporting the project's commitment to preserving sensitive hydrological features within the development area.

The relocation of production bores, combined with an increased logistical distance from Arramall Lake, provides an added layer of protection to the lake's ecosystem. This strategic adjustment reduces the risk of potential groundwater impacts on sensitive wetland areas and groundwater-dependent ecosystems (GDEs) associated with Arramall Lake. By situating the bores further from these critical habitats, the project aims to minimise drawdown effects and maintain the ecological integrity of the lake system, thereby reinforcing the commitment to sustainable groundwater management and conservation of regional water resources.

Optimisation of hydrogen processing management and groundwater abstraction to a maximum of 2,340 kL per day, from the revised groundwater aquifer extraction source (Yarragadee), further avoids groundwater drawdown and minimises impacts to surrounding GDE's and wetlands.

Based upon demonstrated management mitigation measures it is anticipated that the proposal meets the EPA's environmental objective for the factor Inland Waters to "maintain hydrological regimes, and the quality of groundwater and surface water to ensure environmental values are protected" (EPA, 2018).

Social Surrounds

14 Key Environmental Factor – Social Surrounds

Environmental Values

14.1 EPA Objective

To protect social surroundings from significant harm.

14.2 Legislation, Policy and Guidance

- EP Act 1986
- Aboriginal Heritage Act 1972
- Heritage of Western Australia Act 1990
- State Register of Heritage Places, the National Heritage List and the World Heritage List
- Statement of Environmental Principles, Factors and Objectives (EPA, 2021b)
- EIA (Part IV Division 1 and 2) Administrative Procedures (Government of Western Australia, 2021)
- EIA (Part IV Division 1 and 2) Procedures Manual (EPA, 2021a)
- Environmental Factor Guideline: Social surroundings (EPA, 2016b)
- Interim Technical Guidance Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage (EPA, 2023)
- Wind farm environmental noise guidelines (Song & Yorke, 2021)

Legislation and heritage agreement Under section 17 (s17) of the Act, it is an offence to disturb an Aboriginal site without prior written Ministerial consent to do so under s16 or s18 of the Act. This applies regardless of whether an Aboriginal site is registered.

Heritage assessments of proposed development areas are conducted to identify the location and extent of sites, to understand appropriately management conditions in accordance with the legislative requirements of the Act.

A full copy of the Act can be accessed online. Yamatji Nation ILUA An ILUA between Yamatji Nation and the State of Western Australia was registered on 26 October 2020.

This ILUA provides for the recognition, protection, and preservation of the heritage and culture of Yamatji Nation peoples within the Agreement Area. It also outlines the conditions around Aboriginal Heritage Agreements, both for the State and Proponents.

14.3 IGE Commitment

IGE is fully committed to honouring the recommendations of the Traditional Owners. Additional information has been provided to clarify the scope and findings of the Aboriginal heritage survey, including detailed discussions on potential impacts to ethnographic values.

We confirm that all recommendations set out in the survey report will be thoroughly addressed and integrated into the project's planning and management processes, ensuring respectful and responsible stewardship of Aboriginal heritage throughout the project lifecycle.

Access for the Yamatji people to continue using and enjoying the area will be maintained, subject to relevant health and safety conditions. Identified heritage sites will be avoided, and access to sensitive areas, such as cave locations, will be controlled through the installation of protective fencing, safeguarding both cultural heritage and the project construction environment.

14.4 Social Surrounds: Aboriginal Heritage and Culture

A public search of the AHIS (DPLH, 2020) produced no registered sites intersecting the proposed works. Sections of the works area have been subject to heritage surveys including:

- 1977 Maynard, L., Summary of Burial Sites Investigations 1976-77
- 1999 O'Connor, R., Report on a survey for Aboriginal ethnographic sites at the Beharra Springs
- 1999 Harris, J., Report of an archaeological study of proposed seismic programme, Beharra Springs
- 1992 Quartermaine, G., Report on a Survey for Archaeological Sites of the Proposed Yanchep to Geraldton and Geraldton to Nabawa Sections of the Telecom Optic Fibre Cable Route
- N.D. O'Connor, R., report on an ethnographic survey of the proposed Telcom Australia optic fibre cable route

IGE has established a heritage survey agreement with the Yamatji Southern Regional Corporation, as referenced in the Yamatji Nation Indigenous Land Use Agreement WI2020/002 (dated 30/07/2020). This agreement facilitated a heritage survey conducted from July 27th to August 5th, 2021, covering the entirety of IGE's property. Importantly, no cultural heritage sites were identified within the areas earmarked for clearing as part of the proposal. However, seven heritage sites were observed outside of the Disturbance Footprint, as documented by Sticks and Stones Cultural Resources Management in 2021.

- Two rock shelters
- One water source
- Two stone arrangements
- Two potential archaeological deposits

During ground-disturbing activities, heritage monitors will be invited to the site to oversee operations and ensure that no heritage sites are inadvertently disturbed during clearing activities. This proactive measure aims to uphold the integrity of cultural heritage while facilitating the necessary development works.

Figure 31: Cultural Heritage Sites

14.5 Aboriginal Heritage

Within the Midwest region there are various localised Aboriginal language groups which are collectively known as Yamatji and include the Amangu people, Naaguja people, Wadjarri people, Nanda people, and the Badimia people, additionally the region includes the Western Desert people known as the Martu people.

The land specific to the Southern Yamatji Native Title Claim (WC2017/002) encompasses an area of approximately 28,000 km2 within the Yamatji Nation Native Title Determination and covers the land along the coast from Coronation Beach Area (DPLH OHP ID 15859) south to the Mid-West town of Leeman, extending east as far as the Wangara Creek & Salt Lakes site (DPLH OHP ID 18906).

The Yamatji people have a strong presence in the region and a major focus for the AHP project is to engage and consult with Aboriginal community groups on all key aspects pertaining to culture during construction and operations and to foster a unified approach towards building a positive and sustainable project.

14.6 Heritage Survey

The initial cultural heritage field survey for the Arrowsmith Hydrogen Production (AHP) project was conducted by a multidisciplinary team, comprising two archaeologists, one anthropologist, and ten Traditional Owners from the Yamatji community, the Indigenous group connected to the project area. This collaborative approach ensured a thorough and culturally sensitive assessment of heritage sites within the project's Development Envelopes.

The ten-day survey involved systematic exploration of the designated area, with the team meticulously identifying, documenting, and mapping cultural heritage sites and artifacts. Each discovery was carefully mapped and delineated, providing an accurate record of the locations and cultural significance of these materials. This process underscores the project's commitment to respecting and preserving Indigenous heritage through active consultation and collaboration with the Yamatji people.

Adherence to heritage protocols concerning earthworks and vegetation clearing were closely monitored and overseen through relevant Heritage Cultural agreements specific to the AHP development project. These agreements outline the procedures and protocols to be followed to ensure protection and preservation of cultural heritage sites and artifacts throughout the project lifecycle.

Engaging with traditional owners and integrating their knowledge and expertise not only respects cultural heritage values but also enriches the overall project by incorporating diverse perspectives and insights.

The AHP project demonstrates a commitment to respecting and preserving cultural heritage values. This collaborative approach helps to ensure that cultural heritage considerations are integrated into project planning and implementation, contributing to sustainable development practices and fostering positive relationships with Indigenous communities. During the survey, seven previously unrecorded Aboriginal sites were identified. These newly discovered sites include two stone arrangements, one water source, two rock shelters, and two potential archaeological deposits (PADs). Detailed mapping of these sites has been conducted to ensure that site personnel are informed and respectful of their presence.

The archaeological findings within the Proposal areas are indicative of past human activity, with evidence of material exploitation and persistence of sites where suitable conditions allow. The strategic targeting of viable stone sources for activities within an area relatively scarce in stone resources reflects a population's deep understanding and utilisation of their environment (Sticks and Stones Cultural Resources Management, 2021).

Based on the results of the survey and consultation with the Traditional Owners, the following recommendations are made:

- The Yamatji Nation Traditional Owners requested that IGE engage heritage monitors be present during initial ground disturbance works, both prior to digging and when digging

- The Yamatji Nation Traditional Owners requested that IGE engage cultural monitors to be present during initial ground disturbance works, both prior to ground disturbance and during disturbance activities

- For the AHP project, it was recommended that IGE engage cultural monitors for all initial ground disturbance activities, such as road construction, track development, and proposed clearing areas within the project's footprint.

- All employees and contractors working within the AHP Development Envelopes will be instructed to restrict access and construction activities to areas that are located adjacent to heritage exclusion zones.

14.7 Women's Cultural Practice Survey

in response to the EPA's request for further information regarding women's cultural practices and ethnographic aspects for assessment, IGE has undertaken an additional survey conducted by Sticks and Stones Cultural Resources Management in 2023. The comprehensive report detailing the findings of this survey is provided in Appendix 4.

Sticks and Stones Pty Ltd. consultants were tasked with conducting a cultural and ethnographic heritage survey specifically focusing on areas earmarked for development within the Yamatji Nation Indigenous Land Use Agreement (ILUA). The consultation process involved engaging with Yamatji women over a two-day period, ensuring the participation of appropriate knowledge holders for the survey area who provided informed consent.

During the consultation period, discussions centred around the significance of previously identified sites pertaining to women's cultural practices. While no distinct sites directly associated with women's cultural practices were identified, it was acknowledged that the Aboriginal sites located within the Proposal area hold immense importance to the Yamatji people, as they serve to preserve the ancestral connections and origins of the traditional owners.

The ethnographic record reflects a diverse range of perspectives regarding the traditional organisation of social and linguistic boundaries within the Mid-West region. These boundaries, historically delineated along circumcision and subincision lines, have traditionally separated the Geraldton Coastal Region from Aboriginal groups further inland (Tindale 1974).

The site holds paramount importance and significance to the Yamatji people, particularly those with connections to the Dongara area. Based on tradition and historical associations, the site may offer valuable insights into the coastal region's dynamics, including resource utilization, population movements, and trade activities. In broader terms, all Aboriginal sites within Yamatji lands are cherished by the community, gaining increased significance amid rising industrial activity, as their scarcity elevates their cultural and heritage value (Sticks and Stones Cultural Resources Management, 2023).

14.8 Natural and European Historical Heritage

No World Heritage Sites or Commonwealth Heritage Sites occur within 10km of the Proposal area (DAWE, 2021).

A search on the Inherit Western Australia database did not identify any European heritage places within the Development Envelopes (DPLH, 2021). The closest listed sites are:

- Arrowsmith lake ~3km away (Heritage Place No. 18127.13).
- Green Grove Farmhouse Ruins ~2km away (Heritage Place No. 12314).
- Arrowsmith and Government wells (not specified location or distance away from Arramall Property) (Heritage Place No. 18112), however there is a well located on the Arramall Property outside of the disturbance footprint.

14.9 Potential Impacts

Potential impacts to social surroundings include:

- Aboriginal heritage sites – accidental damage to undiscovered heritage material during construction.
- Wind turbine noise and plant operational noise.
- Visual amenities change to Indian Ocean Drive, Brand Highway and nearby landowners.
- Increased vehicle movements off and onto Brand Highway and associated road safety.
- temporary increase in noise, vibration and dust during construction activities that generate dust, including earth moving, transport, stockpiling or loading of materials.
- Industrial activities that generate dust or odour.
- Infrastructure that may impact aesthetic values, such as developments adjacent to the tourist driving route Indian Ocean Drive.
- Cumulative impacts as a result of other proposals in the region.
- Interference with services such as mobile phone signals, radio broadcasting and television broadcasting.

14.10 Social Surrounds Impacts

14.10.1 Noise

Background noise monitoring was conducted by Herring Storer (2021) at the two neighbouring noise sensitive premises (NSP) and an onsite wind monitoring station to enable the result to be used in noise impact assessment. There are no dwellings or NSP on the IGE property.

The background noise observed for each NSP is shown below

Table 29: Background Noise Levels, LA90,10 minutes [dB(A)].

Location	Wind Speed at 125m Above Ground Level (m/s)						
	3	4	5	6	7	8	9
1	35	31	32	30	32	36	35
2	38	39	42	40	41	41	40

The noise monitoring determined the criteria for each NSP). These resulted in excessively conservative estimates as the measured noise level is higher at 125m than what is being encountered at the microphone height (1.5m).

Table 30: Noise Criteria based on Background Noise Levels [dB(A)].

Location	Wind Speed at 125m Above Ground Level (m/s)						
	3	4	5	6	7	8	9
1	40	35	35	35	35	41	40
2	43	44	47	45	46	46	45

14.10.2 Noise – Wind Turbines

A Noise impact assessment was undertaken by Herring Storer (2021b) at the nearest NSP and found that they comply with background noise criteria under all wind conditions. The predicted equivalent noise level (LAeq,10 minutes), adjusted for tonality in accordance with the Wind Farm Environmental Noise Guidelines (Song & Yorke, 2021), do not exceed:

- 35 dB(A), or
- 40 dB(A) in a primary production / rural industry zone, or
- the “Alternative Minimum Criteria” (Varying with Wind Speed), or
- the background noise (LA90,10 minutes) by more than 5 dB(A).

The worst case predicted noise level at each NSP is indicated in Table 31. Noise level are below the criteria set in Table 31 under all wind conditions. Increased wind speeds increase the trend of compliance.

Table 31: Predicted Noise Levels at NSP LAeq [dB(A)].

Location	Wind Speed (m/s)						
	3	4	5	6	7	8	9
1	25	25	25	27	30	33	35
2	32	32	32	34	37	40	42

14.10.3 Noise – Plant

Modules for noise generating equipment at the plant (compressors, backup generator etc.) have been designed to ensure that the plant does not generate noise levels above Environmental Protection (Noise) Regulations 1997 (WA) thresholds at all times.

14.10.4 Visual Amenity

The installation of the wind and solar infrastructure within the Development Envelopes will result in a change in the visual landscape of the area. The turbines will be an addition to natural landscape features within a rural setting and will be visible for many kilometres around the site. However, the general scale of the impact and its significance are predicted to be minimal.

The overall determination of visual impacts resulting from the construction and operation of the AHP project Wind farm will result primarily from a combination of receiver sensitivity and the magnitude of visual effects.

The proposed installation of turbines will impact surrounding natural views but will not interact with coastal views due to optimised layout design. Potential views toward the wind farm facility will also tend to be disrupted by discrete placement of vegetation both within and beyond rural dwellings and local roads. Ultimately the level of impact would depend on the type of activities engaged in as well as the location of the activities together with the degree of screening provided by local vegetation within individual properties road boundaries.

14.10.5 Visual Amenity: Brand Highway and Indian Ocean Drive

The road infrastructure surrounding the AHP Development Envelopes includes significant highways such as the Brand Highway and Indian Ocean Drive. These roadways serve as essential transportation routes in the region, facilitating travel and connectivity between various destinations.

As part of the project planning process, IGE will conduct additional visual impact assessments to evaluate the potential visual effects of the AHP Wind Farm on the surrounding landscape. This evaluation will include views from sections of the adjacent highways.

Key Points to Consider:

Visibility of Wind Turbines:

- Topography: The local terrain will play a significant role in determining the visibility of the wind turbines. Areas with higher elevation or fewer obstructions will have a clearer view of the turbines.
- Distance: The further the distance from the turbines, the less prominent they will appear, although they may still be noticeable depending on their size and the landscape visual buffers.
- Line of Sight: Direct lines of sight from highways or other viewpoints will affect visibility. Areas with tree screening, buildings, or other obstructions will have reduced visibility.

Impact Assessment:

- Aesthetic Considerations: Assessments will consider how the presence of wind turbines might alter the visual character of the landscape, potentially affecting its aesthetic value.
- Community Feedback: Engaging with the local community to understand their views and concerns about the visual impact of the wind turbines.
- Mitigation Strategies: Developing strategies to minimise visual impacts, such as careful placement of turbines, use of natural screening, or design modifications.

Alignment with Local Policies:

- Green Values Strategy: The project aligns with the Shire’s commitment to sustainable development and renewable energy.
- Local Planning Policies: Compliance with existing policies that promote environmental sustainability and support for renewable energy projects.
- Existing Developments: Consistency with other renewable energy projects in the region, enhancing the overall green infrastructure and reinforcing the region's commitment to renewable energy.

By addressing these factors, the visual impact assessments will provide a comprehensive understanding of how the AHP Wind Farm will affect the surrounding landscape and help develop strategies to mitigate any negative impacts, ensuring that the project aligns with the Shire's environmental and planning goals.

Views of the wind farm from the roads will be influenced by the remaining landscape elements and characteristics. These include factors such as form, scale, and mass of the wind turbines, including their line height, color, and texture. Additionally, surrounding vegetation, landforms, and land uses will also play a role in shaping the visual experience for commuters traveling alongside sections of the road corridors.

By conducting thorough visual impact assessments and considering the visual context of the surrounding landscape, IGE aims to minimise any potential visual impacts of the AHP Wind Farm on the scenic quality of the road corridors. This approach ensures that the project is sensitively designed and integrated into the existing environment, preserving the aesthetic values of the landscape while promoting sustainable renewable energy development.

14.10.6 Local Values

The installation of wind turbines, a Green Hydrogen Production Facility, and related infrastructure aligns with the Shire's green values strategy and Local Planning Policies. This initiative supports the area's commitment to sustainable development and renewable energy. Furthermore, these developments are consistent with existing renewable projects to the north and south of the Arrowsmith development area, enhancing the region's overall green infrastructure and promoting environmental sustainability. This alignment underscores the Shire's dedication to reducing carbon emissions and fostering a sustainable energy future.

14.11 Visual Impact

At the regional scale, three primary Landscape Character Types (LCT) can be described:

- The predominantly natural coastal LCT
- The rural and farming LCT along Brand Hwy
- The rural/farming LCT, within which the site lies

At a local scale, the distinctive natural character of the Arrowsmith landscape area and the value placed on it by the community and government is evidenced by the multiple camping spots along the State Route 60 – Indian Ocean Drive; a caravan park on Brand Highway and the Yardanogo Natural Reserve further north-east of the proposal area.

The nearest residents are two single dwellings located approximately 600m to the east and 1 km northwest of the Proposal. There is another rural dwelling located within 10km of the Proposal. The nearest towns are Dongara and Port Denison, located approximately 30km from the Proposal Development Envelopes.

Relevant locations were identified to evaluate visual impact from the Proposal; using criteria described in the visual impact assessment conducted August 2021 (360 Environmental, 2021).

14.12 Dust

Dust emissions are anticipated during various phases of the AHP project, including earthworks, vegetation clearing, and the movement of vehicles and plant equipment. These activities have the potential to generate dust, particularly in dry and windy conditions.

To address this, standard operational dust management mitigation measures will be implemented to minim ise dust emissions and their potential impacts. These measures may include:

- Watering: Spraying water on surfaces prone to dust generation can help suppress dust by binding particles together and preventing them from becoming airborne.

- Dust Control Products: Applying dust suppressants or chemical stabilisers to surfaces can help reduce dust by creating a crust or seal that prevents particles from becoming airborne.

- Vegetation Preservation: Retaining existing vegetation where possible can help reduce soil erosion and dust generation by providing natural ground cover and stabilising soil surfaces.

- Traffic Control: Implementing speed limits and traffic management measures for vehicles and plant equipment can help minimise dust generation by reducing vehicle-induced turbulence.

- Site Stabilization: Implementing erosion control measures such as mulching, revegetation, and the use of erosion control blankets can help stabilise exposed soil surfaces and reduce dust emissions.

Dust deposition on foliage has the potential to affect the ability of vegetation to photosynthesise, or control water loss through transpiration. Dust accumulation on vegetation can be cyclical with increases in dust load during dry conditions and decreases occurring as a result of rainfall and replacement of affected leaves by new growth. Dust mitigation measures will be outlined in the revised supporting-document, including ensuring vehicles are limited to designated access routes where dust production can be mitigated.

Generation of dust from driving on unsealed road and farming activities in the local area are anticipated to generate similar levels of dust as expected during the operational phase of this proposal.

Following the construction phase, earthworks and traffic flow will decrease during the operational phase of the Proposal. Changes to dust deposition during this phase is expected to be limited to the immediate vicinity of the access roads. The Proposal is not anticipated to result in any significant or residual impacts from dust generation.

By implementing these dust management measures, the potential for dust emissions during project activities will be minimised. It is important to note that any dust generated is expected to be of short duration and will not result in permanent impacts to vegetation or social surroundings. Regular monitoring and maintenance of dust control measures will be conducted to ensure their effectiveness throughout the project duration.

14.13 Avoidance, Mitigation and Management Summary

The Proposal management outcomes process identified suitable measures to avoid, mitigate and manage potential impacts to social surrounds to enable the EPA objective for this key environmental factor to be met. The assessment followed a hierarchical approach where avoidance is of highest priority, followed by mitigation and management). The relevant residual risk post mitigation and management is addressed in Section 13.

Table 32: Potential Impacts to Social Surrounds - Avoidance, Mitigation and Management.

Potential Consequences	Measures
Damage or loss to Aboriginal Heritage	*Avoid* - Clearing outside of footprint parameters - Disturbing Heritage sires or places - Driving in unmapped areas *Mitigation and Management* - Follow ground disturbance procedures. - Consultation has been undertaken with traditional owner representatives - Clearly mark limits of clearing Extents - Ongoing stakeholder consultation with Traditional Owners. - Heritage monitors utilised during clearing to prevent disturbance of heritage site - Make use of pre-disturbed areas where possible. - Avoid identified Aboriginal heritage sites - Heritage Site Discovery Procedures will be implemented during construction action; enabling immediate actions in the event heritage material is discovered - Consultation has been undertaken with traditional owner representatives, nearby landowners and residents of Dongara townsite. This consultation will be ongoing and registered within the stakeholder engagement register; - Stakeholder engagement prior to commencement of activity – appropriate engagement method identified Initiated and ongoing - *Rehabilitation* - n/a
Social surrounds – Noise emissions	*Avoid* - Excess Noise From Plant and Machinery. - Vehicle Noise Where Possible *Mitigation and Management* - Adherence to ground disturbance procedures. - Adherence to noise limits as described in the Environmental Protection (Noise) Regulations 1997 and the relevant Implementation of Mitigation Measures. - Ensure reuse of disturbed areas where possible. - Enforce vehicle Speed limits. - Mitigate noise by maintaining all equipment in accordance with manufacturers specifications. - Undertake noise monitoring at areas at high-risk hubs. - Noise modelling will be ongoing to demonstrate compliance with the Environmental Protection (Noise) Regulations 1997 (WA); *Rehabilitation* - Native Vegetation Screening

Social surrounds – Visual impacts	*Avoid* - Construction of wind turbines outside surveyed area. *Mitigation and Management* - Consult landscape view sheds that have been assessed on a regional scale to understand visual impacts of wind turbines. - Retain vegetation along the Brand Highway and Indian Ocean drive as a visual barrier. - Visual amenity assessment has been undertaken to identify the extent of visual impact from various locations - Create facility vegetation screening areas - Revegetate areas of visual prominence *Rehabilitation* - Progressive vegetation rehabilitation will be undertaken in those areas that are no longer required to service the operation of the Proposal.
Social surrounds – Dust Emissions	*Avoid* - clearing outside demarcation parameters - Unauthorised clearing. *Mitigation and Management* - Vehicle restricted to designated asceses route. - Dust suppression on site during construction in accordance with industry standards. - Enforce Speed limits for vehicles. - Visual and data monitoring of emissions. - Ensure Compliance with ground disturbance and clearing procedures. - Adherence to Implementation of Mitigation Measures. - Screening vegetation planted at locations in accordance with survey recommendations; - Retain vegetation along the Brand Highway and Indian Ocean drive as a visual buffer; *Rehabilitation* - Progressive vegetation rehabilitation will be undertaken on those areas that are no longer required to service the operation of the Proposal.
General Amenity	*Avoid* - *Driving outside specified proposal areas* *Mitigation and Management* - Consultation has been undertaken with Main Roads and the Shire of Irwin regarding increased traffic flow and potential entry points to site from the Brand Highway; - Ensure visible and clear signage and direction to site.

14.14 Residual Risk

The Proposal area has been extensively surveyed to identify sites of Aboriginal Heritage relevance. Seven heritage sites were identified within the proposed disturbance footprint but located outside of proposed construction areas. IGE is committed to actively avoiding other sites identified during the construction of the Proposal. Furthermore, heritage monitors will be active on site during clearing and construction activities to prevent disturbance of heritage sites. Therefore, the residual risk of damage or loss of Aboriginal Heritage is considered to be minimal.

- Impacts from dust and noise during construction and operation will be mitigated through relevant legislation and Implementation of Mitigation Measures; and

- The residual risk to the social surrounding from noise or dust emissions will be minimal.

Visual impacts from the wind turbines have been assessed on a regional scale. Due to low population density and distance of turbines to publicly accessible areas the residual risk to social surroundings from visual impacts is anticipated to be low.

14.15 Predicted Outcome and Conclusions

Noise and aesthetic impacts are anticipated to be negligible when considering the remote location, duration of activity and distance to nearest sensitive receptors during construction and operations. (Nearest residents (500 m and 2.3 km) will be unaffected by noise or light emissions)

The current strategy prioritises avoiding heritage areas and actively engaging with Traditional Owners during both the construction and operational phases of the Proposal. This approach ensures that heritage sites are respected, and cultural significance is preserved, aligning with the values of Traditional Owners. By fostering open communication and collaboration, the project aims to maintain the environmental and cultural values integral to the Social Surroundings factor, supporting both sustainable development and cultural heritage preservation.

The Yamatji Nation survey representatives provided consistent messaging during the site stakeholder consultation meetings.

Specifically, the representatives stated:

- The area is a place of desirable plant resources for the Yamatji people such as foods, medicines, and decorative features. Women’s cultural practice was considered during the survey and there were no further ethnographic findings within the Development Envelopes. Women’s cultural practices were discussed and considered in a cultural context

- The previously identified heritage features are of importance to the Yamatji people and access to these areas should be restricted by physical and administrative tools.

- The works area retains general importance to the Yamatji people as a place where their ancestors camped, travelled, and gathered resources. Access is afforded for Yamatji people to continue to use and enjoy the area conditional of relevant health and safety conditions.

- The opportunity for collaborative decorative turbine design will be continued to be pursued by both parties.

As the implementation of the Proposal is not anticipated to have a significant direct or residual impacts to Social Surroundings, it is considered that the Proposal meets the EPA objective for this factor ensuring cultural, heritage and amenity values will be maintained.

14.16 IGE Commitments

Through discussion between the Yamatji heritage survey participants and IGE personnel, the following requests were agreed upon:

- Access is afforded for Yamatji people to continue to use and enjoy the AHP area conditional of relevant health and safety conditions; and
- The identified heritage sites will be avoided during project construction and operational activities and access to the cave locations will be restricted through fencing.

Potential Environmental Offsets

15 Environmental Offsets

The EPA's objective for Offsets is to counterbalance any significant residual environmental impacts or uncertainty through the application of offsets (EPA, 2014).

As described in Sections 11, 12, 13, and 0, there are no anticipated significant residual impacts for the environmental factors Flora and Vegetation, Terrestrial Fauna, Inland Waters, and Social Surrounds.

15.1 Offset Policy and Guidance

The WA Environmental Offsets Policy, issued by the Government of Western Australia in 2011, provides a framework for managing environmental offsets to mitigate the impacts of development activities on biodiversity and ecosystem services. This policy aims to ensure that development projects contribute to the overall conservation and enhancement of Western Australia's natural environment.
Key components of the WA

The following EPBC Act policy sets the framework for offsets that relate to Matters of National Environmental Significance:

- EPBC Act Environmental Offsets Policy (DSWEPAC, 2012)

The following EPA policy and guidance statements set the frameworks for the offsets:

- WA Environmental Offsets Policy (Government of Western Australia, 2011)
- WA Environmental Offsets Guidelines, August 2014 (Government of Western Australia, 2014)

These policies and guidelines require environmental offsets be applied to counterbalance significant residual environmental impacts (if considered to be significant) of a proposal, after mitigation has been applied.

For determination of offset requirements, potential environmental impacts, after the application of relevant mitigation measures, where reviewed, with a focus on the application of the mitigation hierarchy:

- Avoidance;
- Minimisation;
- Rehabilitation; and
- Offsets.

IGE anticipates that, after applying the mitigation hierarchy, there will be no significant residual environmental impacts from this Proposal. Consequently, the company expects that the objectives set by the Environmental Protection Authority (EPA) for each of the preliminary key environmental factors and other environmental considerations will be fully met.

This assertion suggests that IGE has conducted a thorough assessment of potential environmental impacts associated with the proposal and has implemented mitigation measures to address any adverse effects. As a result, they anticipate that the residual impacts will be negligible or non-significant, aligning with the EPA's objectives for environmental protection and conservation.

It's important to note that this anticipation relies on the effectiveness of the mitigation measures implemented by IGE and the accuracy of their assessment of potential impacts. Ongoing monitoring and compliance with regulatory requirements will be necessary to ensure that the proposal meets environmental objectives and minimises its impact on the surrounding environment.

15.2 Types of offsets

There are generally three types of environmental offsets – land acquisition, on ground management and research.

The type of offset depends on the:

- Impact predicted (e.g., temporary or permanent, broad scale clearing or effect on an individual species);
- Options for offsets in the vicinity of the project (such as the availability of land for purchase and protection); and
- Understanding the significance of the environmental values being impacted.

15.3 CBC Foraging Habitat Offsets

IGE understands that DWER considers that the impact to 5 ha of low to moderate habitat or more than 1 hectare of significant foraging habitat is likely to constitute a significant residual impact. Currently IGE anticipate that the foraging habitat disturbance footprint will be less than the 5 hectares of low to moderate and less than 1 ha of significant foraging habitat and have determined the proposed disturbance will not result in any significant residual impacts.

In accordance with the Government of Western Australia's Environmental Offsets Policy and Environmental Offsets Guidelines, IGE have determined that the land acquisition and rehabilitation offsets could potentially be required to address moderate residual impacts.

Based on the information provided and considering the contingency measures outlined in the table below, IGE has determined that the proposed clearing is unlikely to pose an unacceptable risk to the CBC environmental values.

However, in the event that offsets are required to counterbalance any moderate residual impacts, the project will prioritise implementing offset measures to minimise adverse effects on Priority Ecological Communities (PECs), priority species, CBC foraging habitat and other sensitive habitats.

15.4 Environmental Offset Implementation

15.4.1 Land Acquisition Offsets

The strategies for protecting environmental values include improving land security and restricting land use through actions like ceding freehold land for conservation or establishing perpetual covenants. When considering land acquisition offsets, IGE will account for upfront and ongoing management costs. Generally, if land is transferred to the government, the Department of Parks and Wildlife handles perpetual maintenance. While IGE isn't expected to fund ongoing management indefinitely, contributing to initial management costs is necessary for ensuring the reserve's integrity from the start of the offset.

15.4.2 On-Ground Management

The environmental management strategies encompass revegetation, which involves restoring native vegetation in degraded areas, and rehabilitation, which focuses on repairing ecosystem processes and managing issues like weeds, disease, or feral animals. The goal of these on-ground management actions is to achieve tangible improvements in environmental values within the offset area.

15.4.3 Research Projects

Research initiatives may encompass a multi-faceted approach involving field surveys and advanced radar technologies tailored to address critical knowledge gaps. These efforts are geared towards enhancing environmental management practices and refining the assessment of future projects' environmental impacts.

In the realm of radar technology, specialised techniques can be developed to detect and track the distinct behavioural patterns of avian species and bats. These techniques leverage sophisticated radar systems equipped with computer algorithms designed to analyse and interpret radar data in real-time. By focusing on the unique flight characteristics, such as wingbeat frequency and flight trajectory, these radar systems can accurately identify and track birds and bats within the vicinity of proposed wind turbine project sites.

The overarching research objective would be to establish a cost-effective and scientifically robust methodology for collecting comprehensive data on bird and bat movements. This data collection process would extend to both on-shore and off-shore wind turbine installations, ensuring a thorough understanding of wildlife interactions in diverse environmental settings.

The data obtained from these radar and computer-based techniques are an invaluable resource for environmental research and assessments. They provide detailed insights into the spatial and temporal patterns of bird and bat activities, allowing project developers and environmental practitioners to assess potential risks accurately and implement targeted mitigation strategies. This approach not only facilitates the responsible development of wind energy projects but also contributes critical information to broader environmental research initiatives.

IGE's commitment to implementing offsets, if required by the EPA, exemplifies a proactive approach to environmental management. This ensures that any potential impacts are effectively mitigated and balanced with conservation measures. By thoroughly considering potential risks and applying appropriate mitigation strategies, the project underscores its dedication to environmental stewardship and the protection of vital ecological values.

Moving forward, IGE will continue to monitor and assess the project's environmental performance, making adjustments as necessary to ensure compliance with regulatory requirements and best practices in environmental management. This commitment to ongoing monitoring and adaptive management will help minimise environmental risks and promote the long-term sustainability of the project.

The hierarchy of impact mitigation is described in the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014). The management and mitigation of the potential impacts of the proposal have been designed to take this hierarchy into consideration. (Figure 32)

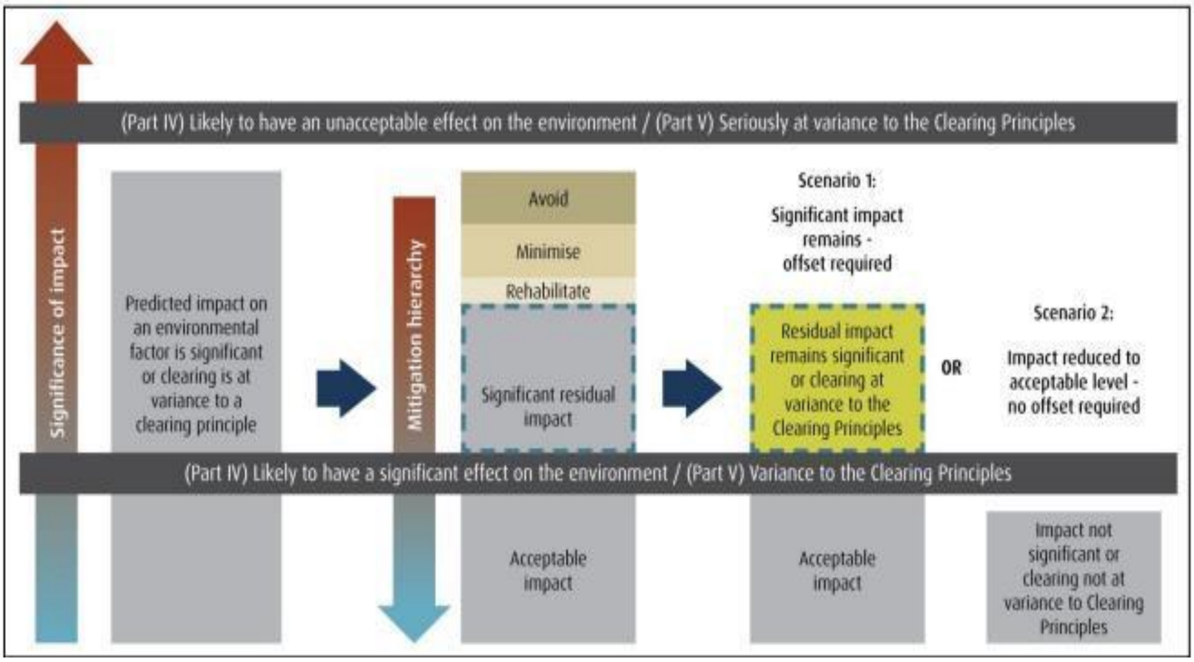


Figure 32: Hierarchy of Impact Mitigation

Table 33 Assessment Against Residual Impact Significance Model

Relevant Part IV Environmental Factors	Vegetation and Flora						
				Terrestrial Fauna			
Part V Clearing Principles	c - Rare flora	d – Threatened Ecological communities TECs	e - Remnant vegetation	f - Wetlands and waterways	h - Conservation areas	a - High biological diversity	b - Habitat for fauna
Residual impact that is environmentally unacceptable and cannot be offset	No residual impacts are considered to meet this criteria						
Protected Matters (Examples)	Impact or removal of buffers or other areas necessary to maintain ecological processes and function for species declared as Rare flora declared under the EPBC act or under the WA act	Impact or removal of habitat necessary to maintain ecological communities declared as environmental sensitive areas under EP Act or listed as TEC's Listed threatened species and ecological communities	Impacts Where vegetation is extensively cleared Such as vegetation complexes at <30% of pre-clearing extents remaining in bioregion	Impact or removal of habitat necessary to maintain conservation significant wetland	Impacts to areas reserved under the statute or managed for conservation areas i.e., Beekeepers Nature Reserve	Impacts to areas recognised as having high biological values High Biodiversity area Habitat supported listed migratory species	Impacts to or removal of habitat necessary to maintain species declared as specially protected under WC act or listed as threatened species under the EPBC act
Significant residual impacts that will require an offset – *all significant residual impacts to species and ecosystems are protected by statute or where the cumulative impact is already at a critical level*	No residual impacts are considered to meet this criteria: - No Threatened Flora records are located within the survey areas - Anticipated Impacts to Priority Flora are not considered significant	No residual impacts are considered to meet this criteria - no TECs were recorded within the Development Envelopes	No residual impacts are considered to meet this criteria All remaining vegetation have 45% or more of their Pre-European extent remaining and impacts will be less than 0.45% of any vegetation association	No residual impacts are considered to meet this criteria as no wetlands or waterways that are protected by statute lie within the Development Envelopes or would be indirectly impacted by the Proposal	No residual impacts are considered to meet this criteria As BKNR is located outside of the Development Envelopes or would be indirectly impacted by the Proposal	No residual impacts are considered to meet this criteria, the Kwongan Heath vegetation is known to have high diversity However, the residual impacts on these areas are not considered significant given the area of intact habitat and natural barriers that remain outside of the Development Envelopes.	Although IGE foraging habitat disturbance extents are minimal. Residual Cumulative impacts to Carnaby's Black Cockatoo foraging habitat has the potential to meet this criteria due to surrounding industrial impacts.
Significant residual impacts that may require an offset Any significant residual impacts to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed	No residual impacts are considered to meet this criteria – refer above	No residual impacts are considered to meet this criteria – refer above	No residual impacts are considered to meet this criteria – refer above	No residual impacts are considered to meet this criteria – refer above	No residual impacts are considered to meet this criteria – refer above	No residual impacts are considered to meet this criteria – refer above	No other residual impacts are considered to meet this criteria – refer above

Table 34 Preliminary Offset Quantification

Existing Environment Impact and Risks	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid/Minimise	Rehabilitation Type	Rehabilitation Success Factor		Type	Risk	Likely Offset Success	Time Lag	Offset Quantification
Flora and Vegetation									
Beekeepers Nature Reserve The potential loss or disturbance of vegetation in the Beekeepers Nature Reserve is a factor that will be carefully addressed and mitigated. The reserve likely contains valuable ecosystems, native plant species, and wildlife habitats that need to be protected from adverse impacts. Potential loss or disturbance of vegetation in the Beekeepers Nature Reserve: The introduction and spread of *Phytophthora* dieback and weeds	Apply mitigations management techniques to minimise vegetation clearing and construction activities in close proximity to the BKNR. Placement of infrastructure (e.g. roads and tracks) associated with the proposal are situated as far as possible from the reserve boundary, to avoid/limit the potential of indirect impacts on the nature reserve and its associated values. Ongoing adaptive management will be implemented as part of the proposal to ensure the management of *Phytophthora* dieback is updated to reflect any new survey findings over the life of the proposal (i.e. construction, operation and closure). In accordance with rehab guidance as per EPA Guidelines, the AHP project will implement measures to mitigate any adverse environmental impacts resulting from its development. This includes adhering to recommendations outlined by the Environmental Protection Agency (EPA) regarding rehabilitation activities to compensate for any ecological disturbances caused by the project.	Replanting PEC or priority species vegetation if required. As part of the Rehabilitation strategy and in accordance with EPA guidelines, IGE will undertake replanting of Priority Ecological Communities (PEC's) or Priority species if residually impacted.	Specifically, the project will incorporate rehabilitation measures to address potential impacts on biodiversity, habitat loss, or other environmental concerns. This may involve habitat restoration, biodiversity enhancement, or other conservation efforts aimed at offsetting any negative effects on the surrounding ecosystem	No					.
Priority 1 'Coastal sands dominated by Acacia rostellifera, Eucalyptus oraria and Eucalyptus obtusiflora' Ecological Community (PEC) within the Development Envelopes	Avoid installation of infrastructure on P1 Coastal Sands where possible Avoidance: Wherever possible, the project will avoid disturbing	The vegetation surrounding turbine facility infrastructure will be allowed to naturally regenerate as part of the environmental management plan for the AHP project. This	The potential loss of Priority Ecological Communities (PECs) in any condition is a concern that requires careful consideration and proactive mitigation measures. PECs are designated	No					

PEC's within the Development Envelopes is a critical ecological community that requires special attention and conservation measures. This ecological community likely consists of unique plant species and habitats that are adapted to coastal sandy environments.	or encroaching upon areas designated as Priority 1 Coastal Sands. This includes careful planning of infrastructure placement and construction activities to minimise impacts on these sensitive habitats.	approach supports the restoration and recovery of native vegetation in the area, promoting biodiversity and ecosystem health. Rehabilitate turbine laydown areas area where practicable	as priority habitats due to their ecological significance, unique characteristics, and the presence of threatened or sensitive species. These communities contribute to biodiversity and ecosystem health, and their protection is crucial for maintaining ecological balance. Mitigation measures may include habitat restoration, protective legislation, and ongoing monitoring to ensure the conservation of these critical habitats.						
Disturbance footprint areas impacting P1/ P2 PEC's	Apply mitigations strategy to minimise vegetation clearing.	Rehabilitation of disturbed area adjacent to PEC population will occur within a short period <(5 years) after disturbance		No					
Disturbance Footprint: Loss of potential habitat *Eucalyptus foecunda* subsp. *aeolica* (Priority 2); - *Scholtzia calcicola* (Priority 2); - *Beyeria cinerea* subsp. *cinerea* (Priority 3) - *Dampiera tephrea* (Priority 3); and - *Eucalyptus zopherophloia* (Priority 4).	Apply mitigations management- Outlined In EMRF	Vegetation surrounding infrastructure will naturally regenerate and will only be managed where it poses a risk to infrastructure.	Replanting PEC's vegetation if required	No					
The introduction and spread of *Phytophthora* dieback and weeds, Potential introduction and spread of weeds.(dieback)	During construction and operations, weed treatment and hygiene management practices will be employed to prevent the spread of invasive species. This includes regular monitoring and control measures. Post-construction, a three-year weed monitoring program will be implemented to ensure the long-term success of the restoration efforts and to maintain the integrity of the habitats.	Weed management to be implemented		No					
Solar PV Disturbance footprint	Visual amenity enhancements, such as tree planting, are planned for areas adjacent to the Brand Highway and within the solar farm disturbance footprint. Specifically, 3.2 hectares of tree planting is designated for screening along the Brand Highway, aimed at improving the visual landscape and integrating the project with its surroundings.	To restore areas to mirror the structure and function of PEC's and Carnaby's Black Cockatoo (CBC) habitat, the project should focus on selecting native species that are characteristic of these habitats. This involves identifying and planting species that support local wildlife, particularly those that are threatened or sensitive	Vegetation Reinstatement adjacent Solar Farm infrastructure	N0					

	Additionally, the rehabilitation efforts will be focused on an area adjacent to the solar farm on the east side (Brand Highway) of the Solar disturbance footprint. This rehabilitation area will likely involve revegetation and habitat restoration measures to mitigate visual impacts and enhance the aesthetic appeal of the project site. By implementing these measures, the project aims to not only minimise visual disturbances but also contribute to the overall enhancement of the surrounding environment. The tree planting and rehabilitation efforts align with the project's commitment to responsible development and community integration, fostering a harmonious relationship between the solar farm and its surroundings.								
Outcome: No impacts to Priority Ecological Communities, Priority Flora Species, conservation significant wetlands, conservation areas or cave systems									
Existing Environment / Impact	Mitigation				Offset Calculation Methodology (If required)				
	Avoid and Minimise	Rehabilitation Type	Rehabilitation Success Factor	Significant Residual Impact	Type	Risk	Likely offset Succes	Time Lag	Offset Quantification

Terrestrial Fauna									
Loss of vegetation habitat potentially used on a seasonal, opportunistic basis by migratory bird species (MNES),	Site location selection of infrastructure to avoid and minimise clearing of CBC habitats or migratory birds, where practicable.	Rehabilitation of temporary construction areas where practicable.	Vegetation cover and structure apparent	No				-	In accordance with offset guidance as per EPA Guidelines
Carnaby's Black Cockatoo Foraging Habitat Vegetation types AspBsBlMS and BpLW are considered key foraging habitat for the Carnaby's Black Cockatoo due to the high proportion of proteaceous species within them, including the characteristic *Banksia* species. The Mosaics occupied 93.17 ha (12.12%) and 5.59 ha (0.73%) of the detailed survey area (769 ha) respectively, plus representation in mosaics, Or 11.86 ha (4.95%) and 2.73 ha (4.14%) within the proposed development footprint (220 ha) plus mosaics (Ecoscape 2023) Note, Current Clearing Extents:127.13 ha AspBsBlMS; *Acacia spathulifolia*, *Banksia sessilis* var. *cygnorum* and *Banksia leptophylla* var. *melletica* mid-shrubland on sandplain/lower slopes BpLW; *Banksia prionotes* low woodland on sandplain/lower slopes	The Proposal maximises the use of previously cleared areas, such as siting the solar farm entirely on already cleared land and utilising existing tracks for the Eastern access corridor option. Efforts will be made to minimise impacts on terrestrial fauna by implementing industry-leading management measures. Additionally, the Rehabilitation Strategy will be fully implemented to restore and enhance affected areas. - Develop and execute a comprehensive FHMP (Fire Hazard Management Plan(DFEs)) to address fire risks and ensure proactive fire management. - Implement preventive measures to reduce the likelihood and mitigate the impact of hydrocarbon spills, focusing on containment, spill response protocols, and regular inspections. - Adhere strictly to Water Quality Protection Guidelines and relevant guidance notes to safeguard water resources and prevent contamination or degradation.	Footprint disturbance and progressive rehabilitation – Beginning with turbine laydown area clearing with backfilling and rehabilitation progressively The project will focus on restoring areas to replicate the structure and function of PEC habitats and CBC foraging habitat. This involves selecting native species that are characteristic of these habitats and support local wildlife, particularly threatened and sensitive species. Vegetation surrounding infrastructure will be allowed to naturally regenerate and will only be managed when it poses a risk to infrastructure.	Target: Restore full ecosystem function Can environmental values be rehabilitated / Evidence? Yes, the foraging habitat values are predicted to be rehabilitated by direct seeding / planting within VDT rehabilitation areas Operator experience in undertaking rehabilitation? IGE will engage experienced operators to carry out rehabilitation works. With a focus on progressive rehabilitation, the expertise gained by these operators will continue to grow throughout the project's lifespan, enhancing the effectiveness and efficiency of rehabilitation efforts over time. What is the type of vegetation being rehabilitated? Predominantly Kwongan heathland defined by Beard (1976) as: Shrublands; scrub-heath with scattered *Banksia* spp., *Eucalyptus todtiana* and *Xylomelum angustifolium* on deep sandy flats in the Geraldton Sandplain Region Credibility of the rehabilitation proposed (evidence of demonstrated success) Some limitations have been noted with Banksia revegetation a n d conducted rehabilitation to date.	Yes	The potential offset type proposed involves acquiring adjoining freehold land and covering management costs to safeguard at least moderate to high-value foraging habitat. This protection may include designating the land as a conservation estate or employing other suitable land tenure protection measures. vegetation to reinstate foraging values to an average value of 4/10 within 10 years	The offset risk refers to the potential variation in the success rates of revegetation efforts for Banksia prionotes and Banksia sessilis across different sites within the bioregion. Revegetation involves planting or restoring vegetation in an area to replace or compensate for habitat loss or environmental impacts caused by a development project. In this context, Banksia prionotes and Banksia sessilis are likely key species that need to be reintroduced or protected as part of the offset strategy.	As recommended by the Department of Water and Environmental Regulation (DWER) investing in strategic biodiversity conservation The values of the foraging habitat can indeed be defined and measured. This includes factors such as habitat quality, biodiversity richness, presence of key species like Carnaby's Black Cockatoo (CBC), vegetation structure, and ecosystem services provided. These values can be quantified through ecological assessments, habitat surveys, species monitoring, and analysis of ecosystem functions. In terms of operator experience and evidence, the Department of Biodiversity, Conservation, and Attractions (DBCA) will oversee the management of the acquired land. Additionally, IGE will collaborate with experienced land management contractors who	IGE can secure critical habitat suitable for Carnaby's Black Cockatoo (CBC) foraging upon agreement, ensuring there is no delay in the implementation of habitat protection measures. This proactive approach allows for swift action to safeguard important CBC habitats without compromising on conservation timelines. The proposed revegetation plan is scheduled to start five years after the commencement of Proposal operations. It is anticipated that it will take up to 10 years for foraging species to become established, meaning this will occur 15 years after the Proposal operations commence. Therefore, the time lag between the start of revegetation and the establishment of foraging	In accordance with offset guidance as per EPA Guidelines The Offset strategy ensures the preservation of moderate to high-value foraging habitats, as assessed by the Commonwealth calculator This approach is deemed suitable for offsetting the foraging habitat if required This meets the minimum 90% offset criteria outlined in DSEWPaC (2012a).

							have a proven track record in implementing habitat protection measures and conservation strategies. This collaboration ensures that the offset activities are conducted effectively and observe conservation objectives. Replanting actions will be guided by ecological assessments and monitoring, ensuring that the chosen species are appropriate for the local environment and contribute to the conservation of Priority Ecological Communities. Careful consideration will be given to factors such as soil conditions, hydrology, and habitat requirements to maximise the success of the replanting efforts.	species is five years, with the offset being triggered at the 10-year mark of the Proposal. Guideline: 7-10 years for Carnaby's species to become productive for foraging; 1-5 years for other management actions	
Potential fauna mortality during clearing and earthworks. Main construction works for Solar PV and Turbine facility in the vicinity of moderate value foraging habitats for threatened and migratory fauna species.	- Pre-clearing surveys and relocation. - Minimising and monitoring excavations. - To mitigate potential fauna mortality during clearing and earthworks, the project will implement specific measures. - Pre-construction surveys will identify the presence of threatened and migratory species.									

Potential fauna mortality due to road kill or turbine strike. Construction and operational traffic generally limited to daylight hours. However, some night time works may be required during the construction period.	- Construction activities will be undertaken during daylight hours. - Low vehicle movement numbers anticipated during operations. - Bird Radar - Turbine Blade painting Main construction works for Solar PV Farm and turbine relocated to avoid high value habitats for threatened and migratory fauna species.								
Potential attraction of feral and native animals resulting in increased predation and road kill. Main construction works for Solar farm and wind farm avoiding high value habitats for threatened and migratory fauna species.	To ensure effective management of food waste and to protect local fauna, strict food waste management practices will be implemented during the construction and operational phases. This includes proper disposal and containment of food waste to prevent attracting wildlife to the site. Additionally, a strict prohibition on feeding fauna will be enforced.								

Inland Waters									
The AHP Wetlands are expected to experience minimal impact on Groundwater Dependent Ecosystems (GDEs) due to aquifer groundwater drawdown. This minimal impact is attributed to the depth of the Yarragadee aquifer, which ensures that the drawdown effects do not significantly affect surface wetlands. Furthermore, the Swan superficial aquifer is not being utilised for production water, further reducing the risk of impact on surface water systems and associated ecosystems. This strategic approach ensures the protection of the wetland habitats and their ecological functions. The decision to avoid using the Swan Superficial Aquifer for production water is primarily due to its proximity to the surface, which increases the risk of impacting Groundwater Dependent Ecosystems (GDEs). This precautionary measure aims to minimise potential environmental impacts upon sensitive ecosystems.	Groundwater Modelling predicted minimal impact (Cardno 2021) Continuous monitoring of groundwater levels and quality will enable adaptive management to address any potential impacts promptly, ensuring the protection of vital wetland habitats and maintaining ecological balance	N/A		No					

Other Environmental Factors

16 Other Environmental Factors

In addition to the primary environmental considerations outlined by the EPA Western Australia guidelines, the sustainability and compliance of the project may be influenced by a range of additional environmental factors. These factors necessitate targeted management strategies to mitigate potential impacts and ensure alignment with environmental objectives. Key considerations include for the AHP project Cave systems and Landforms. By addressing these supplementary factors, the project can achieve a holistic approach to environmental stewardship while maintaining regulatory compliance and fostering positive stakeholder relationships.

17 Visual Amenity

IGE has developed an indicative visualisation of the proposed AHP project infrastructure to provide a clearer understanding of the project's vision and design. This visualization illustrates the site layout, emphasizing key components such as wind turbines and associated facilities. By offering a spatial representation of the proposed design, it enables stakeholders and the public to better grasp the physical layout and potential environmental impacts. This tool bridges the gap between technical planning and practical implementation, showcasing how infrastructure, buildings, and operational zones will integrate with the surrounding landscape. It also highlights potential aesthetic changes, environmental considerations, and the overall project footprint, promoting informed decision-making and fostering transparent communication about the project's integration into the local environment.

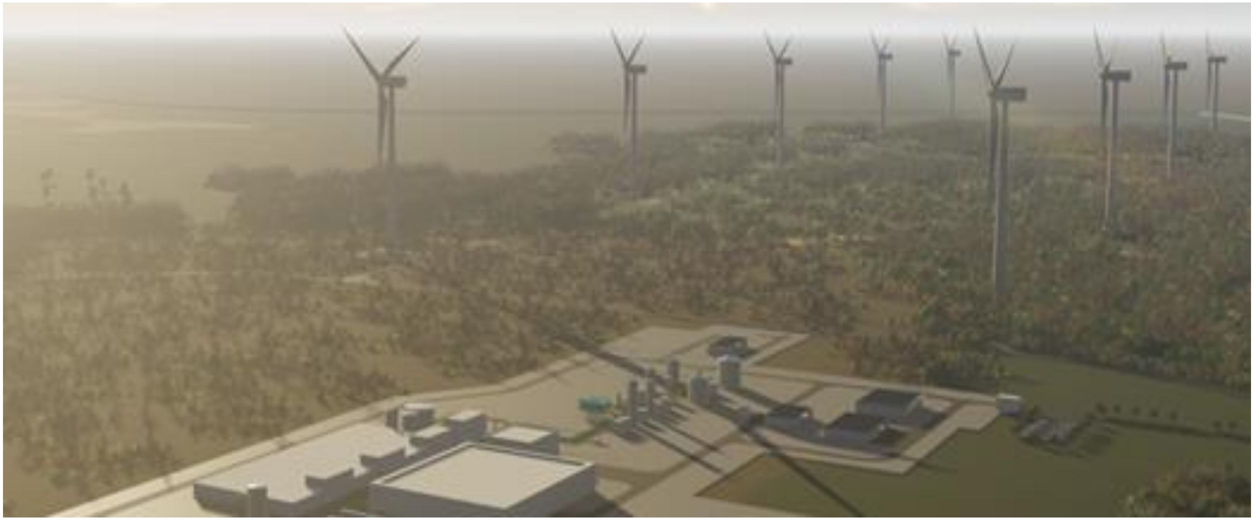


Figure 33: Indicative AHP Site Visualisation

The layout of the wind turbines within the visualisation is carefully crafted to achieve multiple objectives simultaneously: maximising wind yield, mitigating visual impacts, and minimising impacts on priority native vegetation clearing and/or Carnaby's Black Cockatoo foraging habitat.

Maximising Wind Yield: The placement of turbines is strategically optimised to capture the maximum available wind energy. This involves thorough analysis of wind patterns, speeds, and turbulence across the site to identify areas with optimal wind resources. Turbines are positioned in these high-yield zones to ensure efficient and effective energy generation.

Mitigating Visual Impacts: The layout considers visual aesthetics and landscape integration to minimise the visual impact of the turbines. Techniques such as clustering turbines, utilising natural screening elements like vegetation or landforms, and employing color schemes that blend with the surroundings are employed. This approach aims to harmonise the wind farm with the visual character of the landscape, reducing its visual footprint.

Minimising Native Vegetation Clearing and Carnaby's Cockatoo Habitat Impacts: Special attention will be given to avoid or minimise impacts upon priority native vegetation and Carnaby's Black Cockatoo (CBC) foraging habitat. Areas with significant ecological value have been identified and will be protected and managed during clearing activities.

17.1 Landscape Aesthetics

The visualisation places significant emphasis on detailing the layout of the wind turbines, including aspects like tower height, blade dimensions, and their strategic arrangement across the site. This realistic depiction allows stakeholders to grasp the scale and potential visual landscape impacts of windfarms while enhancing their understanding of the project.

Furthermore, aesthetic considerations play a crucial role in the visualisation's design. Factors such as colour schemes, shading techniques, and integration with the natural environment are carefully considered. The goal is to create a layout that seamlessly blends with the surrounding landscape, minimising visual disruptions and preserving the aesthetic appeal of the area.

By incorporating these aesthetic elements into the visualisation, the layout becomes not only informative but also visually engaging. This approach is instrumental in facilitating discussions and decision-making processes among stakeholders and the public. It provides a clear and appealing representation of the project's design and its environmental considerations, fostering a more informed and constructive dialogue about the development's impact and benefits.

17.2 AHP Landscape

The assessment of Landscape Character Types (LCTs) evaluates the Green Hydrogen Production Facility and associated infrastructure, considering its integration with both the immediate landscape within the Development Envelopes and the broader surrounding areas. Key elements, including solar arrays, wind turbines, and access roads, were examined for their visual and spatial impact on the landscape character. This analysis focused on ensuring that the facility's design and placement harmonised with the natural and built environment, thereby reducing potential adverse effects on the visual aesthetics and ecological context of the surrounding landscapes. By carefully assessing the LCTs, the project team aimed to preserve the area's intrinsic landscape qualities while facilitating sustainable development, prioritising minimal disruption to visual amenity and ecological values.

LCT's are defined as units of land use and landscapes that share similar characteristics, described across various scales ranging from regional to local and site-specific levels. This classification system helps in understanding the diversity and uniqueness of landscapes, including their visual qualities, land uses, ecological features, and cultural significance.

In the context of the Green Hydrogen Production Facility and its associated infrastructure, the assessment of Landscape Character Types (LCTs) involved analysing how project components contributed to or altered the existing landscape character. This comprehensive analysis included evaluating visual impacts, changes in land use patterns, and potential effects on biodiversity and cultural heritage values. By incorporating LCTs into the planning process, stakeholders and planners gained a nuanced understanding of the relationship between the proposed development and the surrounding landscapes, enabling informed decisions that promoted responsible and harmonious development. This approach ensured that the project was integrated into its setting in a way that respected and preserved the distinct visual, ecological, and cultural attributes of the area, thereby supporting sustainable and contextually compatible development practices.

The installation of eighteen wind turbines, a solar array, and the Green Hydrogen Production Facility(GHPF) will introduce new visual elements into the local landscape, altering the view and adding features to the rural character of the area. However, the overall scale and significance of this impact are anticipated to be low for several reasons:

- Regional Context and Valued Views: The primary valued sites and regional views in the area are typically coastal, characterised by dynamic seascapes. The project's inland location means that these coastal views are largely shielded from direct turbine visibility due to intervening topography.

- Rural Landscape Integration: The rural/agricultural character of the study area is predominant, with views dominated by farmland and remnant vegetation, observable from most main roads and residential locations. The wind turbines and hydrogen plant will add new features to this rural landscape but are expected to be perceived only intermittently, as the primary roadways in the region run north-south, while east-west routes are limited to minor access roads. Consequently, most road users will experience only sporadic views of the wind farm.

- Site Layout and Topography: The hydrogen plant is strategically positioned in the north western part of the site, which has the lowest elevation, thereby naturally reducing its visual prominence. Additionally, surrounding vegetation will provide a visual buffer, further minimising its impact on the landscape.

- Distance Effects on Visual Impact: The prominence of the wind turbines diminishes significantly with distance, reducing their impact for observers further away. Dongara, located approximately 10 to 12 km from the project site, is partially shielded from turbine views due to topography, natural vegetation, and the built environment within the town, which together reduce the visual impact on the town's residents.

- Alignment with Local Values and Existing Familiarity: The installation of wind turbines aligns with the Shire's commitment to green energy and sustainable development. Additionally, the community is familiar with wind turbines due to the existing coastal wind farms, potentially reducing sensitivity to the new installations.

- Mitigating Shadow and Visual Impact: For nearby residences where the turbines are within direct view, potential shadow flicker and visual impacts can be mitigated by strategically planting tall vegetation to provide natural screening if necessary.

Through these considerations, the project design seeks to balance renewable energy development with visual impact minimisation, respecting both the natural landscape and the values of the local community.

18 Bushfire Regimes

The Proposal is situated within a Bushfire-Prone Area, designated as such by an order of the Fire and Emergency Services Commissioner under section 18P of the Fire and Emergency Services Act 1998 (as amended). These designated areas are delineated on the Map of Bush Fire Prone Areas, accessible on the Department of Fire and Emergency Services website at www.dfes.wa.gov.au/bushfireproneareas. All clearing activities related to bushfire mitigation within the Development Envelopes (DE) will adere to the regulations outlined in the Bush Fire Act 1954.

Designation of an area as bushfire prone reflects the potential of bushfire to affect that site. It acts as a mechanism for initiating further assessment in the planning process.

The Bushfire Management Plan (BMP) will be submitted as part of the Planning/Development Approval process (DAP). The BMP will assess potential hazards impacting the Development Envelopes and will outline the management targets and actions that will be implemented to minimise the impacts of a bushfire event.

An Emergency Response Plan will be included in the Bush Management Plan (BMP) for both the project construction and operational phases. This plan will delineate the appropriate response to emergency situations, including fire incidents.

The proposed project construction activities and the updated site layout will modify the existing fire regimes within the Development Envelopes, including the establishment of new fire breaks. These modifications are essential to facilitate access for firefighting vehicles during bushfire suppression operations and create fuel-free zones for planned burns.

Although there is an increased fire risk during the construction phase, comprehensive management measures will be implemented to minimise potential impacts. These measures include:

- Fire Risk Assessments: Conducting thorough fire risk assessments to identify potential hazards and develop mitigation strategies.
- Firebreaks and Clear Zones: Establishing firebreaks and clear zones around construction sites to prevent the spread of fires.
- Firefighting Equipment: Ensuring that firefighting equipment, such as extinguishers, hoses, and water tanks, is readily available on-site and that personnel are trained in their use.
- Emergency Response Plan: Developing and implementing an emergency response plan that includes procedures for fire detection, reporting, evacuation, and coordination with local fire services.
- Controlled Ignition Sources: Regulating activities that may generate sparks or heat, such as welding and cutting, and ensuring that these activities are conducted in designated areas with appropriate safety measures.
- Vegetation Management: Regularly clearing and maintaining vegetation around the site to reduce fuel loads and potential fire sources.
- Weather Monitoring: Monitoring weather conditions, especially during high-risk periods, and adjusting work schedules to minimise fire risks during adverse conditions.

Awareness and Training: Providing fire safety training and awareness programs for all construction personnel to ensure they understand fire risks and know how to respond appropriately.

By implementing these measures, the construction phase will be managed to significantly reduce fire risks and protect both the project and surrounding environment..

18.1 Bushfire Access Points and Service Roads

The project Development Envelopes will include a single, Main Roads Western Australia (MRWA)-approved primary access and exit point, along with multiple designated emergency exit areas to facilitate safe and efficient movement for routine operations and emergency responses. A durable bitumen finish will be applied to the main access trucking loop and the hydrogen facility pad, enhancing road resilience and ensuring reliable vehicle access during high-traffic periods. This approach not only supports operational efficiency but also strengthens emergency preparedness by providing well-constructed, accessible routes for personnel and equipment.

Strict speed limits will be enforced across all roads and tracks within the Development Envelopes to maintain safety standards for both personnel and equipment. The main access roads, used regularly for daily transport operations, will provide the primary routes for logistics and facility access. Meanwhile, the tracks located between the solar farms and wind turbine installations will serve as critical pathways for fire breaks, routine inspections, and maintenance tasks. This infrastructure is essential not only for the reliable operation of the facility but also for ensuring rapid response capabilities in the event of an emergency, thereby safeguarding both the facility and the surrounding environment.

18.2 Changes to Fire Regimes

As delineated in the Flora and Vegetation section, anthropogenic activities inherent in construction and operational phases may exacerbate the bushfire hazard. To counteract this risk, the strategy involves the optimisation of the bushfire track network to enable rapid and efficient responses to fire outbreaks. Moreover, IGE will craft intricate Fire and Emergency Management protocols aimed at implementing robust prevention measures and expedited response tactics to mitigate bushfire incidents.

18.3 Bush Fire Emergency Escape Route Plan: Approved by the Shire of Northam DFES

The existing main site access gate, located to the north of the Development Envelopes, will be enhanced to provide improved access to the Green Hydrogen Production Facility (GHPF). This upgrade will optimise proximity to key work areas, improve logistical efficiency, and enhance the overall site layout. The modifications are designed to ensure quick and safe evacuation in case of a bushfire emergency. Additionally, five secondary emergency DFES fire access gates will be established to provide supplementary emergency access points throughout the site. These gates will be strategically placed to reduce ecological disturbances, maintain traffic flow, and ensure that emergency vehicles can easily navigate the site during construction and operational phases. The design also incorporates measures to minimise the impact on surrounding ecosystems, maintaining a balance between safety and environmental stewardship.

For site access from the eastern side of the Development Envelopes, including the enhanced northern gate, careful planning has been undertaken to ensure uninterrupted access to key project locations, even during periods of flooding in the lake. This routing will minimize disruption to construction activities, ensuring operational continuity while safeguarding the workforce and maintaining emergency preparedness.

18.4 Fire Emergency Access Roads Escape Routes

Fire emergency access roads and escape routes play a critical role in ensuring the safety and operational efficiency of the facility. These routes are designed to provide rapid accessibility in the event of a fire or other emergencies, enabling emergency responders to quickly reach affected areas and facilitate the safe evacuation of personnel. Additionally, these access roads allow for routine inspections, maintenance, and servicing of equipment located throughout the facility, ensuring that critical infrastructure, such as turbines or hydrogen production systems, remains operational and in optimal condition.

The ability to swiftly address repairs and respond to emergencies is essential for minimising downtime, preventing fire spread, and maintaining the reliability of the facility. Moreover, well-maintained fire access roads reduce the risk of further environmental damage by providing clear, navigable pathways that prevent emergency vehicles from impacting sensitive areas like wetlands or habitats. In this context, the design and maintenance of fire emergency access roads are crucial for both safety management and facility operation continuity. Construction of roads and tracks will involve minimal ground and topsoil disturbance due to an existing limestone cap rock substrate including Marl. Marl is a type of sedimentary rock composed of clay and calcium carbonate and has the ability to compact to suitable load requirements under certain conditions. When properly compacted, marl can offer sufficient strength and stability to support various loads, including structures, roads, and other infrastructure.

18.5 Fencing and Security

Access to the site will be tightly controlled, with only authorised personnel permitted entry. The Green Hydrogen Production Facility (GHPF) will be enclosed by fencing, and access will be granted through a secure gate. IGE has implemented a comprehensive security surveillance system around the proposed site, which is remotely monitored from our office in Perth. Additionally, boundary security fences will be installed around facility infrastructure, including the solar farm and turbine facility, to further restrict access to the site.

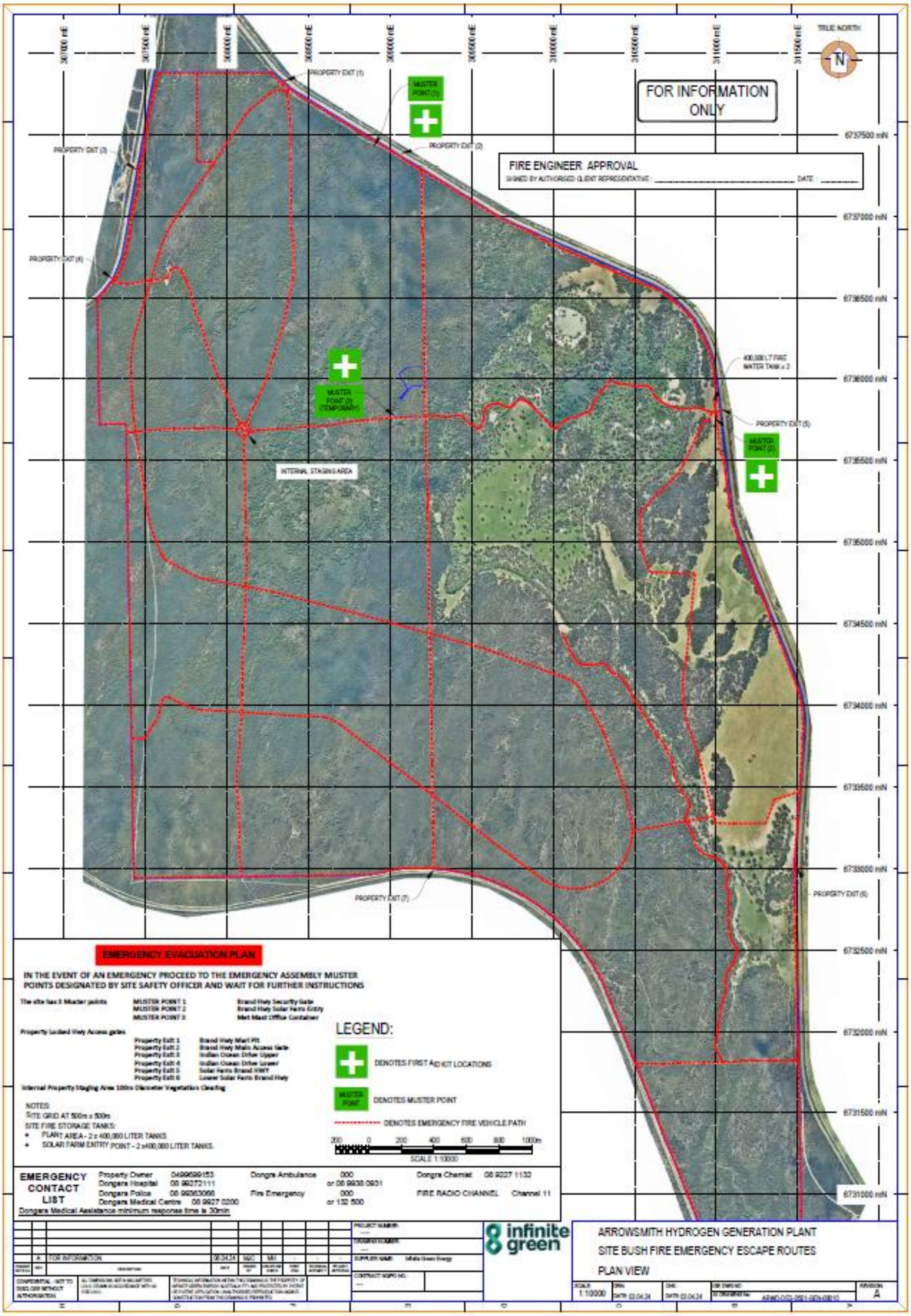


Figure 34 Fire Emergency Access Routes

19 Storm/Wastewater Management

19.1 Wastewater

Wastewater management infrastructure will be addressed through premises works approvals or licences under Part V, Division 3 of the Environmental Protection Act 1986 (EP Act). These legal instruments are issued by the Department of Water and Environmental Regulation (DWER) in Western Australia and are designed to regulate activities at industrial or development sites that have the potential to cause emissions or discharges to the environment, including air, land, or water. By obtaining these approvals, the project will ensure that water management practices meet environmental standards and minimise the risk of negative impacts on surrounding ecosystems.

The IGE Green Hydrogen Production Facility is seeking to satisfy Part V Environmental Approval conditions under the EP Act1986, Prescribed Premises Category 31 (Chemical Manufacturing) in Western Australia,

A comprehensive Wastewater Management Plan (WWMP) will be developed to address potential wastewater impacts within the project's Development Envelopes (DE). The plan will incorporate advanced measures to ensure effective management of wastewater volumes, geotechnical conditions, and critical construction/operational engineering and Environmental factors.

19.2 Stormwater

A comprehensive Stormwater Management Plan (SMP) will be developed to address potential stormwater impacts within the project's Development Envelopes (DE). The plan will incorporate advanced measures to ensure effective management of stormwater volumes, geotechnical conditions, and construction/operational engineering/Environmental factors that could influence stormwater behaviour within the DE.

Notably, the project's infrastructure has been strategically relocated to avoid wetland areas, demonstrating a proactive approach to environmental stewardship.

The SMP will consider critical catchment characteristics, including topography, landforms, and vegetation types, to establish a robust drainage framework. These measures aim to prevent contaminated runoff from entering the stormwater system and to mitigate the impacts of erosion, sedimentation, and altered drainage patterns. Strict drainage practices will be implemented to ensure the protection of adjacent water bodies and the broader environment.

The stormwater drainage systems will be meticulously designed and constructed in compliance with the following standards and guidelines:

- AS/NZS 3500.3: Plumbing and drainage standards.
- Australian Rainfall and Runoff: National guidelines for flood estimation and stormwater management.
- Council Design Standards (AUS-SPEC): Local council requirements for infrastructure design.
- National Construction Code (NCC): Ensuring structural and operational compliance.

By adhering to these standards, the SMP will not only manage stormwater efficiently but also ensure alignment with regulatory requirements and industry best practices. This integrated approach will safeguard the site's hydrological integrity while minimizing environmental impacts throughout the project's lifecycle.

Stormwater Volumes, Geotechnical, and Construction/Operational Engineering Details will form part of the regulatory approvals process. Infinite Green Energy (IGE) will integrate detailed stormwater volumes, geotechnical analyses, and construction and operational engineering plans within the Part V, Division 3 Licence and Works Approvals Submission, as mandated under the Environmental Protection Act 1986 (WA). These details will form a critical component of the commissioned Stormwater Management Plan

The table below, titled "Range of typical pollutant concentrations in stormwater," provides an overview of pollutant concentration ranges found in stormwater across different land uses (forest, rural, and urban) and weather conditions (dry and wet).

Table 35: Range of typical Pollutant concentrations within Stormwater (Australian Guidelines)

Pollutant	Land Use	Dry Weather Concentrations (mg/L)	Wet Weather Event Mean Concentrations (mg/L)
Suspended Solids	Forest	1-20	1-140
	Rural	3-270	4-200
	Urban	1-350	20-1000
Total Phosphorus	Forest	0.0006-0.24	0.01-0.42
	Rural	0.0008-0.81	0.03-1.3
	Urban	0.0001-2.2	0.12-1.6
Total Nitrogen	Forest	0.04-1.2	0.27-0.66
	Rural	0.12-4.2	0.23-5.1
	Urban	0.1-11.6	0.6-8.6

19.3 Sustainable Wastewater Discharge Options:

Waste and excess water management infrastructure will be tailored based on forthcoming Geo-Tach engineering decisions and the specific types of water management infrastructure implemented. These determinations will guide the selection of water management strategies, ensuring that systems are optimally designed to handle site-specific needs. The approach will consider factors such as the nature of water outputs, discharge requirements, and regulatory compliance, allowing for effective and flexible management of waste and excess water in alignment with project goals and current environmental standards.

The following options are some of the strategies currently under consideration:

19.4 Closed-Loop Water Recycling System

Description: Recycle water used in the electrolysis and cooling processes within a closed-loop system to minimise discharge. This approach significantly reduces the volume of excess water, as treated water can be continually reused for non-potable applications such as cooling, washing, or electrolysis.
Environmental Benefit: Limits the discharge to the environment, reducing potential contamination and lowering water demand from external sources.

19.5 Brine Treatment and Reuse

Description: Treat filtered brine water to remove any residual salts and impurities, making it suitable for reuse within the facility. Treated brine may be repurposed for cooling towers, irrigation, or even returned to the electrolysis process if it meets required purity standards.

Excess salt and minerals generated during the water treatment or desalination processes may be recycled and removed from site. Salt emissions volume are based on current geotechnical investigations at an output maximum of approximately 1100kg per day.

These method ensures that potentially harmful residues are managed responsibly, preventing their accumulation in the environment and reducing the risk of contamination to soil and groundwater. Bagging these byproducts facilitates easier handling, storage, and eventual disposal or potential repurposing according to regulatory guidelines, contributing to a sustainable approach to waste management on the project site.

Environmental Benefit: Reduces waste generation by reusing brine, thereby decreasing the amount of water discharged to the environment.

19.6 Reverse Osmosis (RO) and Brine Minimisation

Description: Use reverse osmosis to further purify excess water, thereby producing clean water for reuse and a smaller volume of concentrated brine for disposal. The concentrated brine may then be handled in a controlled manner, such as with stock dams for evaporation or solidification.

Pre-treating water to remove calcium carbonate before it enters the Reverse Osmosis (RO) system enhances RO efficiency by reducing scaling, extending membrane life, and lowering maintenance costs. After RO treatment, the clean permeate can be discharged through a smaller infiltration basin, minimising land use while protecting groundwater.

Environmental Benefit: Significantly reduces discharge volumes and concentrates brine, lowering the environmental footprint of water disposal.

Calcium Concentrate Disposal: By separating and directing the calcium-rich water to existing stock dams for evaporation, the project can safely manage and dispose of calcium waste without impacting the RO system or the environment. Calcium Concentrate Disposal: By separating and directing the calcium-rich water to stock dams, the project can safely manage and dispose of calcium waste without impacting the RO system or the environment.

19.7 Stock dams for Discharge and evaporation

Description: The project site has three existing stock dams that serve to manage excess water discharge. These Dams allow water to evaporate naturally, leaving behind solid residues that can be appropriately managed. Each pond is designed with impermeable liners and bunds to prevent infiltration, ensuring that the surrounding soil and groundwater are not contaminated.

Using the stock dams as a discharge point for excess treated water from the electrolysis process area could offer environmental and operational benefits, provided it’s managed carefully to protect the ecological integrity of the Surrounding area. Here’s a closer look at this potential approach and the considerations involved

Environmental Benefit: Potential Benefits of Discharging Treated Water

- **Replenishment of stock dams**: By carefully discharging excess treated water into the dams, the facility can help maintain the water levels during drier periods, supporting the ecosystem's natural cycles.

- **Enhanced Habitat for Wildlife**: Increased water levels can improve habitat conditions for various species, including migratory birds and aquatic flora and fauna, by creating stable water bodies that support biodiversity.

- **Sustainable Water Management**: Discharging treated water from the hydrogen production facility provides a way to manage water outputs responsibly and reduce costly alternative disposal methods.

- **Improved Water Quality**: If the discharged water is thoroughly treated to meet environmental standards, it can dilute existing concentrations of certain nutrients or pollutants in the stock dams, thereby potentially improving water quality if carefully controlled.

Environmental Considerations and Compliance

- **Water Quality Standards**: For discharging treated water from the electrolysis process, the water must meet strict environmental standards, as outlined under the Environmental Protection Act 1986 (Part V). Regular testing for pH, salinity, and contaminants (such as heavy metals or residual chemicals) is essential to ensure the discharged water does not harm wetland ecosystems.

Stock Dam Summary

Using existing stock dams for discharging excess treated water is a sustainable water management strategy that can provide ecological, operational, and community benefits. However, it must be carefully regulated and monitored to protect wetland health and comply with environmental standards. With appropriate infrastructure, quality standards, and a commitment to adaptive management, this approach can integrate the hydrogen facility's water needs with the surrounding natural environment in a way that benefits both the project and the ecosystem.

19.8 Zero Liquid Discharge (ZLD) System

Description: Implement a Zero Liquid Discharge system to fully eliminate water discharge by using a combination of evaporation, crystallisation, and other technologies to reclaim all water for reuse. Solid residues are safely disposed of separately.

Environmental Benefit: Ensures no liquid discharge, making this a highly effective method for achieving stringent environmental compliance.

19.9 Soil Infiltration Basins

Description: Direct excess water into soil infiltration basins designed to allow water to percolate naturally into the soil, filtering contaminants before reaching groundwater. This approach is suitable if the water quality meets specific standards and the site's soil and geology are conducive to safe infiltration.

Environmental Benefit: Promotes natural filtration and groundwater recharge, minimising the need for external discharge infrastructure.

19.10 Advanced Filtration and Treatment to meet discharge standards

Description: Use advanced filtration techniques (e.g., ultrafiltration, ion exchange) to treat water before discharge, ensuring that it meets all chemical and quality standards. Chemical treatments can be used to neutralise or remove any remaining contaminants.

Environmental Benefit: Ensures that discharged water is of a high quality, reducing the risk of contaminating surrounding ecosystems.

19.11 Above-Ground Sewage Treatment Plant

Description: An above-ground treatment plant is a compact, self-contained system designed to treat and safely discharge or recycle wastewater. The plant would typically use aerobic or anaerobic processes to break down sewage, making the effluent safe for disposal or reuse.

The IGE AHP project site sewage treatment options with an anticipated output of approximately 3,750 litres per day based on a maximum of 15 employees,

Benefits:

- Flexibility: Easily scalable to meet future changes in staff numbers or sewage volumes.
- Controlled Process: Allows close monitoring and control over wastewater treatment, ensuring compliance with environmental standards.
- Efficiency: Treats wastewater to a high quality, reducing environmental impact.

Considerations:

- Energy Usage: May require a continuous power source, increasing operational costs slightly.

- Maintenance: Regular maintenance by qualified personnel will be required to ensure efficiency and regulatory compliance.
- Suits sites where above-ground space is available and where a centralised, manageable treatment solution is preferred.

19.12 Leach Drain System

Description: A leach drain system disperses treated wastewater into the soil, where natural filtration and biological processes further purify the water as it percolates through the ground. The suitability of this system depends heavily on further Geotechnical assessments to ensure proper absorption.

Benefits:

- Low Maintenance: Once installed, leach drains typically require minimal upkeep.
- Energy Efficiency: This system is passive, requiring little to no energy to operate, reducing operating costs.
- Environmental Integration: Returns water to the ground naturally, which can support nearby vegetation if soil absorption rates are appropriate.

Considerations:

- Soil and Geotechnical Requirements: The system's effectiveness is contingent on soil absorption rates. Geotechnical assessments are essential to confirm feasibility.
- Capacity Limitations: May need careful design adjustments to handle peak loads.
- Suits locations with suitable soil characteristics for absorption and low groundwater contamination risk.

19.13 Hybrid System: Above-Ground Treatment with Leach Drain Discharge

Description: This option combines the benefits of both an above-ground treatment system and leach drains. Wastewater is treated first in an above-ground system and then discharged to a leach drain for further filtration.

Benefits:

- Enhanced Treatment: By treating wastewater before it enters the leach drain, this system ensures that only high-quality effluent reaches the soil, minimising the risk of groundwater contamination.
- Adaptability: Provides an adaptable solution for areas where leach drains alone may not fully meet environmental standards.

Considerations:

- Installation Costs: This option may have higher initial costs due to the need for both systems.
- Space Requirements: Requires above-ground space for treatment plant installation and an appropriate area for the leach drain field.
- Suits sites requiring a high level of environmental protection where soil absorption is sufficient but needs additional treatment for regulatory compliance.

19.14 Packaged Sewage Treatment Plant with Effluent Disposal (Surface Irrigation/Other Use)

Description: A packaged treatment plant can treat sewage to a high standard, producing effluent suitable for surface irrigation or use in dust suppression, thereby reducing discharge volumes.

Benefits:
- Multi-Use Output: Treated effluent can be used in landscaping, for dust suppression, or other non-potable uses, especially in arid or dusty environments.
- Portable: Packaged units are modular and can be relocated or expanded as needed.

Considerations:
- Regulatory Requirements: Treated effluent must meet strict standards if used for surface irrigation.
- Environmental Sensitivity: Careful consideration is needed to prevent excessive nutrient loading or runoff in irrigation areas.
- Suits Projects with high effluent reuse potential in dust suppression or landscaping.

Summary

Adaptive Management is key for the AHP project, both the above-ground treatment plant and leach drain options are viable, pending geotechnical data. The hybrid system offers a balanced approach, combining advanced treatment with ground disposal, while the packaged treatment plant with effluent reuse provides additional resource efficiency. Each option can be finalised Part V, Division 3 Licence and Works Approvals Submission, with geotechnical assessments guiding the most sustainable choice.

19.15 Groundwater Quality

Groundwater quality in the superficial aquifer varies from fresh (460mg/L total dissolved salts (TDS)) to marginal (4,560mg/L TDS). The fresher groundwater is in the east and the more saline nearer the coast. There is a saline water interface beneath and to the east of the coastline. This water will not be utilised for hydrogen production purposes.

Groundwater quality in the Yarragadee aquifer varies from fresh (520mg/L TDS) to saline (27,600mg/L TDS). Water bore drilling has identified an increase in salinity with depth in some areas. The high salinity recorded in Leeman Shallow 30A is due to proximity to the ocean and a saline interface that is located to the east of the coastline. The two highest salinity bores are located to the west of the Mountain Bridge Fault.

20 Cave Systems

Caves are natural cavities or systems of chambers beneath the earth's surface, large enough for human exploration. A cave system refers to a collection of caves interconnected by enterable passages or linked hydrologically, or a cave with an extensive network of chambers and passages.

In Western Australia, the largest caves and caverns are predominantly formed in limestone. Limestone dissolves under the influence of rainwater and groundwater, which contain carbonic acid (H2CO3) and naturally occurring organic acids. This dissolution process creates a distinctive landform known as karst, characterized by features such as sinkholes and underground drainage systems.

Karst caves, also known as solutional caves, are the most commonly occurring caves within the proposed Development Envelopes. These caves were formed through the dissolution of bedrock by naturally acidic groundwater, which slowly moved through joints, faults, bedding planes, and other surface openings. Over geological epochs, these cracks in the rock expanded to form the large caves and cave systems now present at the project site. While solutional caves are typically found in soluble rocks like limestone, they can also occur in other rock types such as marble, chalk, gypsum, dolomite, and salt.

Arramall and River Caves were first explored by speleologists in 1960. Arramall Cave was mapped in 1973, with further mapping in the 1990s. River Cave has not been mapped but it has stronger surface connections, allowing for more even input of organic matter but also more drying in summer and autumn (Susac 2007). Thus, Arramall Cave is likely to be more important troglofaunal habitat than the River Cave.

The Arramall Cave and Lake System are located adjacent to the Brand Highway, approximately 30 km South of Dongara within ancient aeolian calcarenite limestone. Two major geological systems have been formed as a result of the overflow of Lake Arramall – River Cave and Arramall Cave, the latter containing the largest chambers that extends for approximately 1.8 km.

Arramall caves flood infrequently and only when rains of sufficient volume flood the Lake Arramall cave system. This rainwater will then flow into the surrounding cave system. Details of the occurrence of selected fauna in Arramall and other caves in the surrounding area can be found in the Western Australian Speleological Group website.

Surface activities including human interaction, changes to hydrology, removal of vegetation, pollution and land development can potentially impact caves, and are potentially significant if they result in the loss of environmental values supported by caves or cave systems.

20.1 Cave Impacts

Potential Impacts and Management Associated with Construction and Operational Activities Affecting Cave Systems

The construction and operational phases of the AHP proposal has the potential to impact cave systems such as Arramall Cave, River Caves, and their associated environmental values. These impacts may arise from the following sources:

Construction Activities: Excavation, blasting, and other construction activities can directly impact cave systems by altering the surrounding geology, potentially leading to collapses or destabilization of cave structures.

Changes to Hydrology: Alterations to surface water flow patterns, such as modifications in drainage systems or water diversion practices, can impact the hydrological equilibrium within cave systems. These alterations have the potential to cause water ingress or drying of caves, depending on the nature and extent of the changes.

Vegetation Removal: Clearing of vegetation in the vicinity of cave entrances can lead to increased surface runoff and erosion, potentially introducing sediment and pollutants into the cave environment.

Pollution: Pollution from construction activities, nearby industrial operations, or agricultural run-off has the potential to degrade water quality within cave systems, impacting cave-dwelling organisms and overall ecosystem health.

Land Development: Urbanisation or land development in the vicinity of cave systems can lead to increased human activities, which may include vandalism, unauthorised cave exploration, and littering, posing direct threats to cave ecosystems.

Cumulative Impacts: The cumulative effects of multiple construction and operational activities, as well as existing or future developments in the surrounding area, may exacerbate the impacts on cave systems and their associated environmental values.

By considering these factors and implementing appropriate management provisions, the potential impacts on cave systems associated with the development proposal can be minimised, allowing for sustainable development while preserving the environmental values supported by caves and cave systems.

20.3 Mitigating Cave System Impacts

By carefully assessing and addressing cave impact factors during the construction of the Green Hydrogen Production Facility, including wind turbines and solar arrays, the potential impacts on sensitive cave systems can be significantly minimised. These considerations involve thorough geotechnical surveys to map and understand the extent and structure of cave systems, ensuring that infrastructure layouts avoid identified caves and karst features. Measures such as implementing buffer zones, restricting heavy machinery and vehicular access near cave entrances, and avoiding construction activities on or near cave surfaces are critical in preserving the structural integrity and ecological significance of these systems.

Additionally, integrating ongoing monitoring and real-time risk mitigation strategies, such as radar technology for avifauna and bat activity near turbine areas, further ensures minimal disruption to the cave ecosystems and associated fauna. The application of erosion and sedimentation controls, as well as water discharge management, prevents indirect impacts, such as sediment infiltration or hydrological alterations, that could affect the caves' environmental values. By combining advanced planning, state-of-the-art monitoring systems, and adaptive management strategies, the development achieves a balance between sustainable infrastructure growth and the preservation of the unique ecological and geological features supported by the caves and surrounding landscapes. This proactive approach demonstrates a commitment to environmental stewardship while facilitating sustainable energy initiatives.

Caves	Cave Description	Mapped Cave Areas Hydrogen Facility AHP Development Envelopes
River Cave	*River cave has over 500m of mapped passage and is therefore deemed a significant cave in the Mid-West of WA. It has multiple small and inconspicuous inflow and solution-pipe-type entrances that are close to cleared farmland.* *The cave passage follows a shallow path beneath the caprock and passes below two firebreak tracks and a new track to the west of the entrance constructed by IGE*	

<table>
<tr>
<td>Arramall Cave</td>
<td>Arramall Cave is the longest known cave on private property in Western Australia.
The cave passage splits and passes under Brand Highway in two locations and passes close to several known features on the neighbouring property (although no other entrances are known).

There are also several other known caves and features near the entrance to Arramall, including Sponge cave.

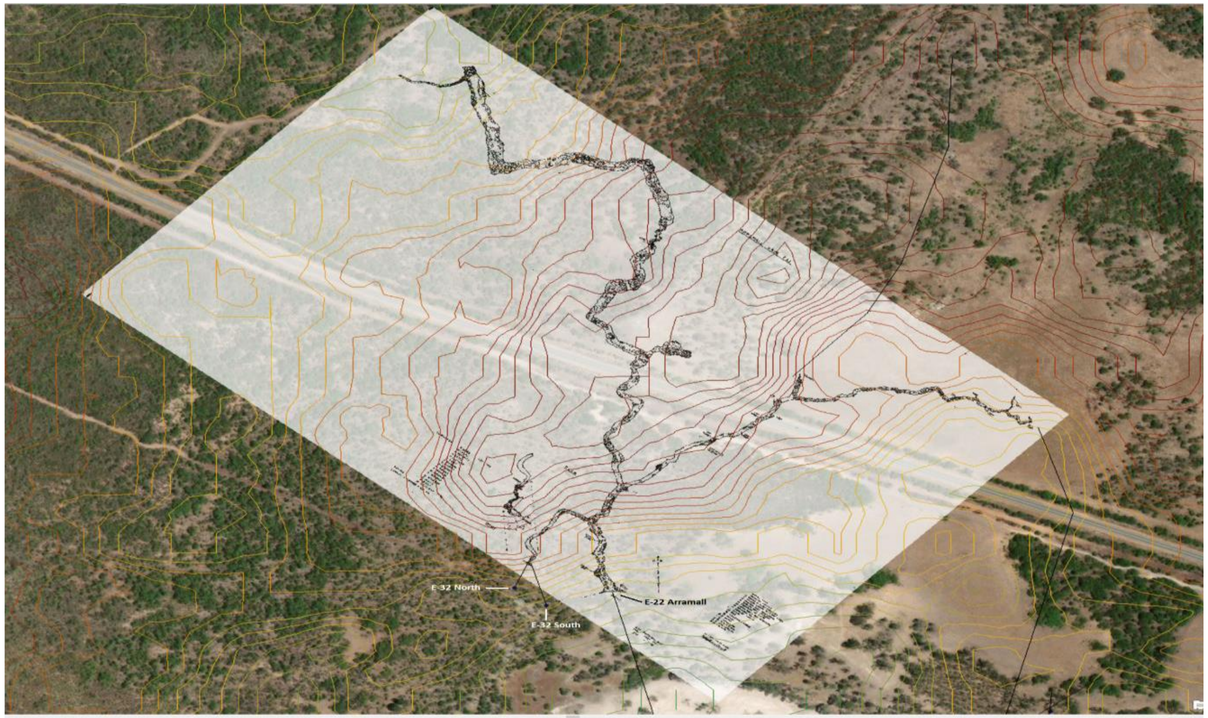
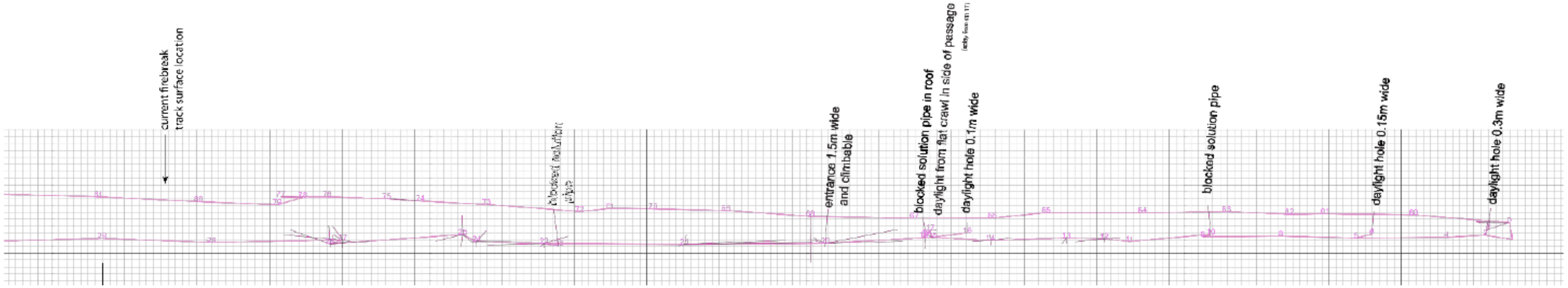
IGE commits to avoid the cave system and will not undertake any construction within the area.</td>
<td>Mapped Cave Areas crossing the Brand Highway

</td>
</tr>
<tr>
<td colspan="3">Average roof thickness above River Cave

</td>
</tr>
</table>

Figure 35 *Cave Systems Extents within the Development Envelopes*

21 Landform Environmental Objective

The EPA's environmental objective for the factor Landforms is to maintain the variety and integrity of significant physical landforms to ensure environmental values are protected.

21.1 Objective

This objective recognises that the geology and morphology of a landform can have value in their own right, as well as the important role significant landforms often have in supporting environmental values.

Landforms can support numerous and varied environmental values which can include being a foundation for particular ecosystems, being sites of special scientific interest related to geology and geomorphology and representing examples of important physical landscape processes.

Landforms can also embody social and cultural values. They can have strong historical and cultural associations and provide enjoyment through aesthetics or active use (e.g. tourism, climbing, hiking, etc.).

21.2 Project AHP Landform Aspects

- *Soil-landscape Zones*
- *Limestone Formations*
- *Soil types*
- *Limestone Cave Systems*

21.3 Landform Subregions

The Mid-West includes seven of the Interim Biogeographic Regionalisation for Australia (IBRA) subregions as defined by Trackway and Cresswell (1995); Geraldton Sandplains, Yalgoo, Murchison, Avon Wheatbelt, Gascoyne, Little Sandy Desert, and Gibson Desert. Each subregion is associated with a defining topographical feature of the Mid West region. The project area discussed in this report is located within the Yalgoo and Murchison bioregions in the southern rangelands of Western Australia, that cover a combined area of approximately 331,775 km2. The Yalgoo and Murchison bioregions are characterised by sand and alluvial plains, low ranges and lakes, low granitic hills and mesas separated by flat colluvium and alluvial plains. Mulga or bowgada shrublands dominate in the east. Western parts include sand plains, heathlands and some eucalypt shrublands (Department of Environment 2008a; 2008b).

The landforms vary to a certain extent due to the geographical features within the region. The region contains several major drainage systems, creek lines and gullies that relate to the Greenough River and is characterised by level land featuring low hill expressions and isolated mesas and buttes separated by flat colluvium and alluvial plains. The geology of the Yilgarn Block consists primarily of Archaean granites and gneisses as well as minor infolded belts of metamorphic sedimentary and igneous rocks (Beard, 1976). These metamorphic rocks are comprised of an array of volcanic and sedimentary assemblages which include banded ironstone formation, jaspilite, and chert, as well as shale, siltstone, and sandstone. It is these metamorphic formations which constitute the low ranges of hills present in the region. This is as opposed to the granites and gneisses which are less durable and thus tend to underlie the plains (Beard, 1976).

Sand plains are bordered by low scarp with valleys between these exposed laterite formations slowly filling with sand and alluvium as well as gypsum and calcium carbonate as a result of flooding. These flat, floodway plains are often associated with low woodland vegetation, and soil comprise.

21.4 Values

Potential construction and operational activities, impacts and their management associated with Other Environmental Factors relevant to the proposal but not considered Key Environmental Factors.

The significance of these Environmental Factors are considered in accordance with:

- Values, sensitivity, and quality of the environment which is likely to be impacted
- Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts
- Consequence of the likely impacts (or change)
- Resilience of the environment to cope with the impacts or change
- Cumulative impact with other existing or reasonably foreseeable activities, developments, and land uses
- Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment
- Level of confidence in the prediction of impacts and the success of proposed mitigation
- Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and public information that informs the EPA's assessment.

21.5 Landforms as described by the EPA

The distinctive, recognisable physical features of the earth's surface having a characteristic shape produced by natural processes. A landform is defined by the combination of its geology (composition) and morphology (form).

The EPA considers a landscape to be:

All the features of an area that can be seen in a single view, which distinguish one part of the earth's surface from another part. Landscapes can be either natural (largely unaffected by human activity) or anthropogenic (created or largely modified by human activity).

During an Environmental Impact Assessment (EIA), the Environmental Protection Authority (EPA) emphasises the evaluation of impacts on potentially significant landforms, recognising them as critical components of the landscape. Landforms are valued not only for their geophysical and ecological significance but also for their contribution to cultural, aesthetic, and heritage values.

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Cumulative Impacts

22 Cumulative Impacts

22.1 Vegetation

Potential cumulative impacts to flora and vegetation relates to clearing of native vegetation within the Proposal Development Envelopes.

Overall, the Proposal area is not considered to contain any significant species exclusively or groups of species not recorded elsewhere in the region. Clearing under this proposal is likely to have a minimal cumulative impact on the overall biodiversity of the Geraldton Sandplains IBRA Bioregion and the local area. The identified vegetation systems are anticipated to be minimally impacted by the Proposed Disturbance Footprint.

Table 36: Proposal impacts upon existing vegetation systems. (Ecoscape 2022)

Vegetation System Association	Pre-European Vegetation (ha)	Current Regional Extent (ha)	Extent Remaining (%)	Area to be impacted by Proposal (ha)	Proportion of the Impact Area to the Extent Remaining (%)
Cliff Head_255	3,064.34	2,933.06	95.72	39.49	1.35
Illyarie_377	63,099.54	62,724.44	99.41	3.82	0.00
Illyarie_433	32,460.48	14,746.34	45.43	96.00	0.01
Illyarie_619	154.54	50.80	32.87	0.00	-
Total	98,778.90	80,454.64		1288.23	-

While Priority Species may be impacted by clearing activities during project construction at an individual level, surveys have shown that these species type are abundant and common within the region (Ecoscape, 2023). Therefore, the impacts upon those species are anticipated to be minimal.

22.2 Terrestrial Fauna

Potential cumulative impacts to terrestrial fauna relate to the clearing of habitat and impacts associated with wind turbine strike within the Development Envelopes. Overall, the Proposal area is not considered to contain any significant species exclusively or groups of species not recorded elsewhere in the region. Clearing under this proposal is likely to have a minimal impact upon the overall fauna habitat of the Geraldton Sandplains IBRA Bioregion and the local area.

There are no other wind turbine facilities within the vicinity of the Proposal. The closest facility is the Walkaway Wind Farm (approx. 65 km to the North of the AHP project site) and the Badgingarra Wind Farm (approx. 100 km to the South). Therefore, cumulative blade strike impacts on local Avifauna populations are expected to be minimal.

22.3 Inland Waters

There are no identified cumulative impacts upon surface water features including creek lines and lakes from the proposal activities.

Considerations have been given to potential cumulative impacts to groundwater from two additional groundwater users nearby the proposal area under different scenarios (Cardno 2021c).

Table 37 Potential cumulative impacts from nearby groundwater abstraction.

Proposal	Distance / Aquifer	Annual Volume (ML)	Potential cumulative impacts
VRX	6 km east / Superficial	900.00	Cumulative extent of 0.2 m drawdown will potentially extend to the eastern boundary of the proposal area, however due to minor changes in groundwater levels no impacts to GDE are anticipated.
Triangle	5 km north / Yarragadee	128.28	Modelling has shown that the Triangle bores will not interact with the drawdown from the production bore in the Proposal area.

22.4 Social Surrounds

The Proposal Development Envelopes has been surveyed for cultural artefacts/values and heritage significance. The APH-1 disturbance footprint will not interfere with identified cultural or heritage values and consequently cumulative impacts upon cultural values are unlikely within the disturbance footprint.

There are no other wind turbine facilities within the vicinity of the Proposal Development Envelopes that would affect visual amenity. The nearest industrial facilities located within close proximity to the AHP Development Envelopes, are the Walkaway Wind Farm and the Badgingarra Wind Farm as afore mentioned

Both direct and indirect cumulative impacts would be unlikely due to the distance between the two wind turbine facilities and sequential impacts would be limited for the majority of journeys along main roads and highways between populated areas.

Due to the remote location of the development hub, it is anticipated that there will be minimal cumulative impacts from visual amenity upon Social Surrounds at residential locations.

A limited summary of known impacts from other developments in close proximity to the AHP Proposal are provided in the table below (Table 39):

Cumulative Impacts

Table 38: Cumulative Impact Summary within the Mid-West regional area.

Variable / Company	Infinite Green	Perpetual Resources	VRX Silica	Strike Energy Ltd	Iluka	Beach Energy
Project name	AHP	Arrowsmith West	Arrowsmith North	West Erregulia & Project Haber	Rare Earth Refinery	Waitsia
Type	Green Hydrogen & Renewables Energy	Silica Sands	Silica	Gas	Rare Earth: Mineral Sands	Gas
Location	Arrowsmith Shire of Irwin	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Three springs	Arrowsmith Hub Shire of Carnamah	Arrowsmith Hub Shire of Irwin
IBRA Bioregion	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain
Total vegetation cleared	127.13 ha Native Vegetation	x	x	x	x	x
Conservation significant flora affected	five Priority-listed flora (Eucalyptus foecunda subsp. aeolica, P2; Scholtzia calcicola, P2; Beyeria cinerea subsp. cinerea, P3; Dampiera tephrea, P3; Eucalyptus zopherophloia, P4) vegetation type **EobEorEzMOMF** is likely to be representative of the Coastal sands dominated by Acacia rostellifera,	*Anthocercis intricata* (P3) *Beyeria cinerea* subsp. cinerea (P3) *Eucalyptus zopherophloia* (P4).		*Eucalyptus zopherophloia* (P4).		

	Eucalyptus oraria and Eucalyptus obtusiflora (Geraldton area) P1 PEC,					
Terrestrial/Avian Fauna	Carnaby's Cockatoo (*Zanda latirostris*) Conservation significant: Sharp Tailed Sandpiper Rainbow bee-Eater Long-tailed dunnart (*Sminthopsis longicaudata)* (Priority 4) Microbats: *Austronomus australis* and *Vaspadelus baverstock* Avifauna and bat turbine strike: Minimal impacts due to operational Radar planned installation adjacent to wind turbine impact strike zone. Outcome: Future design and construction will avoid areas of threatened fauna habitats and/or minimise direct and indirect impacts as much as practicable. This strategy will include consideration of appropriate buffers from areas of known threatened/ conservation species habitat or vulnerable water bodies.	Carnaby's Cockatoo (*Zanda latirostris)*	Carnaby's Cockatoo (*Zanda latirostris)*	Carnaby's Cockatoo (*Zanda latirostris)*	Carnaby's Cockatoo (*Zanda latirostris)*	Carnaby's Cockatoo (*Zanda latirostris)*

Subterranean Fauna	There are two types of subterranean fauna: **Stygofauna** – aquatic organisms that live in groundwater **Troglofauna** – air breathing animals that live in caves and rock/soil voids. Collections from Arramall Cave have shown the presence of regionally significant species of troglofaunal such as *Neotemnopteryx douglasi*, *Protochelifer cavernarum* and *Laevophiloscia* spp. Outcome: No impacts to cave system impacts as no construction activities will be conducted in the vicinity of cave systems.					
Inland Waters	The Yarragadee Aquifer water extraction required for Green Hydrogen Production Facility operation: Optimised groundwater Abstraction Extraction volumes: 2,340 kL per day Outcomes: Zero water extraction from the superficial aquifer Minimal Draw down upon the Yarragadee Aquifer Avoid impacts to drainage/waterlines,	Groundwater Extraction Maximum of 464 ML p/a	Groundwater Extraction The Yarragadee Aquifer water extraction Abstraction of 0.9 GL per year.	Groundwater Extraction The Yarragadee Aquifer water extraction required for operations.	The Yarragadee Aquifer, a deep, confined aquifer system located in Western Australia, is a key water resource. It is proposed to support operational water extraction for Infinite Green Energy's (IGE) Green Hydrogen Production Facility (GHPF). This aquifer has been selected due to its capacity to sustainably provide the required volumes of water without	Groundwater Extraction

	wetlands or ephemeral waterbodies Relocation of wind turbines and facility placement design avoiding wetland areas. Underlying groundwater within fresh to brackish. Eneabba Plains has an annual allocation limit of 22.5 GL.				significantly impacting regional hydrological systems or groundwater-dependent ecosystems (GDEs).	
Social Surrounds	Yamatji cultural heritage/ Ethnographic and archaeological information revised: Outcomes: No Impacts to Heritage values/sites within the Development Envelopes Women's Heritage Consultation and site walk complete and heritage report updated to include updates to requested information. W.A speleological group (WASG): Consultation complete and cave impacts concerns addressed: Relocation of wind turbines and site layout to avoid cave systems.	Dust Emissions air quality Visual Amenity Noise	Dust Emissions air quality GHG emissions	Yamatji cultural Heritage/ Ethnographic and archaeological survey required Carbon Emissions	Dust Emissions Dust generation can occur during site preparation, construction, and operational activities, Air Quality Air quality impacts primarily relate to construction-phase emissions, including dust, vehicle exhaust, and emissions from machinery. GHG emissions The GHG emissions profile of the project will be influenced by construction and operational phase activities	Carbon Emissions GHG emissions

	Dust: Clearing Air quality: predicted low ambient Concentrations Noise: Noise sensitive receptors Minimal locational amenity impacts					
Flora and Vegetation	Detailed assessment indicates that there is native vegetation within the surveyed area that provides minimal foraging habitat for protected/endangered fauna Outcome: Proposal extents and indicative Proposal infrastructure including wind turbines/solar farm infrastructure. placement, has been designed/optimised to mitigate impacts to surrounding flora and vegetation accordingly. Clearing extents will be optimised by utilising pre-cleared fire tracks and areas with degraded vegetation. Native Vegetation clearing will be off set where required					

Variable / Company	Cockburn Cement	Tronox	Triangle Energy	Pilot Energy	Mitsui E&P	MinRes Energy
Project name	Arrowsmith	Dongara Project	Mt. Homer/Cliff Head	Arrowsmith Cliff Head	Waitsia	Lockyer Deep 1
Type	Lime sand	Mineral Sands	Oil &Gas	Oil	Gas	Gas
Location	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Mt. Homer/Cliff Head Arrowsmith hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Arrowsmith Hub Shire of Irwin	Lockyer Shire of Mingenew
IBRA Bioregion	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain	Geraldton Sandplains GES02, Lesueur Sandplain
Total vegetation cleared	Proposed 73 ha of native vegetation clearing					
Conservation significant flora affected	*Terminalia supranitifolia* (P3) (4 individuals) and *Rhynchosia bungarensis* (P4)					
Conservation significant ecological communities affected	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris) Mallee Fowl	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris	*Carnaby's Black Cockatoo* (Calyptorthynchus Latirostris
Terrestrial Fauna	Carnaby's Cockatoo (Calyptorthynchus Latirostris) Sharp Tailed Sandpiper Rainbow Bee-Eater	Carnaby's Cockatoo	Carnaby's Cockatoo	Carnaby's Cockatoo	Carnaby's Cockatoo	Carnaby's Cockatoo
Inland Waters	Groundwater Yarragadee Aquifer					
Social Surrounds	Heritage Values					

22.5 Holistic Impact Assessment

In previous sections, each key environmental factor has been addressed individually, focusing on isolated impacts to air quality, water resources, vegetation, fauna, and cultural heritage. However, these impacts do not occur in isolation, as ecosystems are inherently complex and interconnected. Each environmental component interacts within a dynamic web, where changes to one factor can have cascading effects on others.

To fully understand the Proposal's comprehensive environmental impact, the final phase will integrate findings from all studies to assess cumulative and synergistic effects. By considering the interdependencies within and between ecosystems, this holistic assessment will offer a more accurate measure of the Proposal's overall impact. This approach will support decision-makers in implementing strategies that prioritise sustainability and environmental resilience across the project lifecycle.

A preliminary assessment of holistic impacts has identified the following potential impacts as having effects and interactions with multiple key environmental factors:

- Clearing of native vegetation may impact local vegetation communities including Threatened and Priority Flora, Threatened and Priority fauna, fauna habitat, surface water flows, visual amenity, heritage values and social surrounds
- Groundwater abstraction has the potential to lower groundwater levels that may impact GDE's, wetland values, vegetation condition, flora & fauna habitat and heritage values.
- Construction and facility operations may increase dust dispersal and alter air quality regimes, potentially impacting native flora, fauna, amenity and heritage values.
- Impacts on CBC's may result in impacts to terrestrial fauna, social surrounds and heritage values.

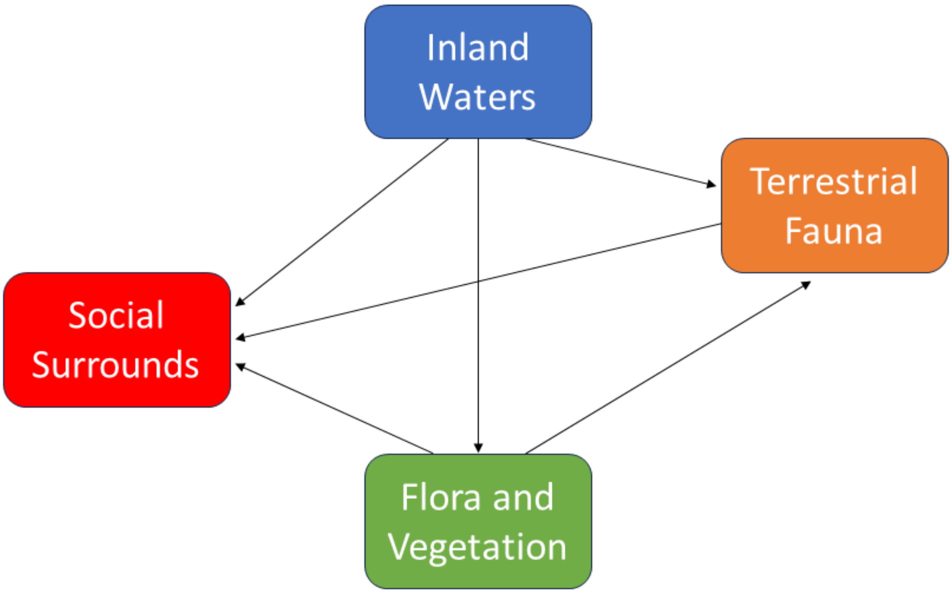

Figure 36: Indicative representation of the interaction between identified key and relevant environmental factors

Figure 36 provides is a diagram illustrating the interconnectedness of various environmental factors. Here's an explanation of the relationships shown:

Inland Waters: The diagram shows that inland waters have an influence on both terrestrial fauna and flora and vegetation. This makes sense as water bodies support life directly by providing drinking water and indirectly by influencing the surrounding habitat and ecosystem health.

Terrestrial Fauna: This factor is influenced by both inland waters and flora and vegetation, highlighting that animals depend on water and plants for survival. Terrestrial fauna also affect the condition and distribution of flora and vegetation, likely through activities like grazing or seed dispersal.

Flora and Vegetation: These are impacted by both inland waters and terrestrial fauna. Plants rely on water from inland sources for growth, while animals can either promote or inhibit plant growth through grazing or pollination. Flora and vegetation also influence inland waters by affecting soil stability and water quality through processes like transpiration and filtration.

Social Surrounds: Social surrounds are influenced by all the other factors—flora and vegetation, terrestrial fauna, and inland waters—indicating that human communities are deeply interconnected with and impacted by the state of the natural environment. Social surrounds can also affect these environmental factors, possibly through land use, conservation efforts, or pollution.

This diagram effectively demonstrates the holistic approach to environmental management by emphasising the interdependence of these factors and the need to consider all of them when making decisions that affect the environment.

IGE recognise there may be inherent connections and interactions between environmental factors, but we have confidence that each environmental factor can be managed individually utilising simultaneous mitigation strategies and recognising impact interactions, and therefore a significant effect on the environment is unlikely through this interconnectivity approach.

22.6 Holistic Approach

A holistic approach to environmental management recognises the interconnectedness of various environmental factors and the importance of addressing them in a comprehensive manner. By considering the broader ecological context, this approach ensures that all potential impacts are identified and managed in a coordinated way, leading to more effective and sustainable outcomes. Here's how this approach contributes to environmental protection and the mitigation of potential impacts associated with the proposed development:

- Identification of Connections and Interactions: The first step in our holistic approach was to identify the connections and interactions between different environmental factors. This involved understanding how changes in one aspect of the environment affected others, creating a comprehensive picture of potential impacts.

- Stakeholder Engagement: Comprehensive environmental management involves engaging with a wide range of stakeholders, including local communities, regulatory bodies, and environmental organizations. This inclusive process helps identify potential concerns, gather diverse perspectives, and build consensus on the best ways to protect the environment while achieving development goals.

- Integrated Management and Mitigation Measures: Based on the identified connections and interactions, management and mitigation measures have been designed to address multiple environmental factors simultaneously. Rather than treating each aspect of the environment in isolation, measures will be integrated to achieve synergistic effects and minimise trade-offs.

- Alignment with Legislative Principles and Objectives: The management and mitigation measures are designed to meet the principles outlined in the Environmental Protection Act (EP Act) and the objectives set by the Environmental Protection Authority (EPA). This ensures that environmental protection efforts are consistent with legal requirements and regulatory standards.

- Proactive Approach: The proactive approach to environmental protection involves anticipating potential impacts and implementing measures to mitigate them before they occur. By considering various environmental factors and their interactions early in the planning process, the AHP project can avoid or minimise adverse effects on the environment.

- Balancing Development Objectives and Environmental Conservation: The ultimate goal of a holistic approach is to achieve a balance between development objectives and environmental conservation. This requires careful consideration of trade-offs and compromises, as well as finding innovative solutions that optimise both economic and environmental outcomes.

- Sustainable Resource Use: By considering the full lifecycle of the development, from planning through operation to decommissioning, a holistic approach promotes the sustainable use of natural resources. This minimizes waste, reduces environmental footprints, and ensures that resources are available for future generations.

- Climate Change Resilience: Addressing environmental factors in an integrated manner helps build resilience to climate change by protecting ecosystems that provide critical services, such as carbon sequestration, flood regulation, and temperature moderation. This reduces the vulnerability of both the environment and the development to climate-related risks.

Overall, a holistic approach to environmental management demonstrates a commitment to comprehensive environmental protection and sustainable development. By considering the interconnectedness of environmental factors, integrating management measures, and aligning with legislative requirements, the project aims to minimise its environmental footprint and contribute to long-term environmental conservation.

23 Conclusions

23.1 Flora and Vegetation

There will be minor residual impact to flora and vegetation and CBC foraging habitat from the Proposal. Therefore, potential offset requirements have been identified by IGE in accordance with the relevant Offset Policy and Guidelines (Government of WA, 2011, 2014)

The technical elaboration regarding the minor residual impact to flora, vegetation, and Carnaby's Black Cockatoo (CBC) foraging habitat, along with potential offset requirements, involves several key considerations:

- Impact Assessment: A detailed impact assessment was conducted to evaluate the potential effects of the proposal on flora, vegetation communities, and CBC foraging habitat. This assessment included field surveys, habitat mapping, and analysis of ecological data.

- Residual Impact: The assessment determined that while there would be some impact on flora, vegetation, and CBC foraging habitat due to the proposal, these impacts were assessed as minor. This conclusion is based on the extent and severity of the disturbances relative to the overall habitat and population of CBC in the area.

- Offset Requirements: In accordance with relevant Offset Policy and Guidelines, offset requirements were identified by Infinite Green Energy (IGE). These requirements are designed to mitigate the residual impacts on flora, vegetation, and CBC foraging habitat through offsetting measures.

- Offset Strategies: Offset strategies may include habitat restoration, conservation initiatives, revegetation programs, or other measures aimed at enhancing and protecting CBC foraging habitat and associated flora and vegetation. These strategies will be developed based on foraging values and best practices in ecological restoration.

- Monitoring and Compliance: Implementation of offset measures will be accompanied rigorous monitoring and compliance protocols. This ensures that the intended environmental benefits are achieved and maintained over time, contributing to the overall conservation and sustainability goals of the project.

- Stakeholder Engagement: Stakeholder engagement, including consultation with environmental authorities, conservation groups, and Indigenous communities, is integral to the offset process. Collaboration ensures that offset strategies align with regulatory requirements, community expectations, and conservation priorities.

- By addressing the minor residual impact through identified offset requirements and implementing effective offset strategies, the proposed development aims to achieve environmental sustainability while minimising adverse effects on flora, vegetation, and CBC foraging habitat.

23.2 Terrestrial Fauna

There will be no significant residual impact to terrestrial fauna from the Proposal. Therefore, no offset requirements have been identified in accordance to the relevant Offset Policy and Guidelines (Government of WA, 2011, 2014).

23.3 Inland Waters

There will be no significant residual impact to groundwater and surface water resources from the Proposal. Therefore, no offset requirements have been identified in accordance to the relevant Offset Policy and Guidelines (Government of WA, 2011, 2014).

23.4 Social Surrounds

There will be no significant residual impact to social surrounds from the Proposal. Therefore, no offset requirements have been identified in accordance to the relevant Offset Policy and Guidelines (Government of WA, 2011, 2014).

Matter of National Environmental Significance (MNES)

24 Matters of National Environmental Significance Referral Decision

Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The Australian Government Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) covers the assessment of proposals which may have a significant impact on Matters of National Environmental Significance (MNES). A Proposal may be deemed a ‘Controlled Action’ under the EPBC Act if it impacts on matters of MNES.

A previous desk-top assessment, conducted in collaboration with the Department of Climate Change, Energy, Environment and Water (DCCEEW), aimed to determine the likelihood or presence of Matters of National Environmental Significance (MNES) within the Proposal AHP Development Envelopes. The assessment concluded that no significant impacts on MNES were identified for this proposal. As a result, it was not referred to the Commonwealth Department of Climate Change, Energy, Environment and Water (DCCEEW) under the Environment Protection and Biodiversity Conservation (EPBC) Act.

This evaluation also included a survey commissioned by Infinite Green Energy (IGE) to assess potential direct or indirect impacts on Carnaby's Black Cockatoo (CBC) habitat. Through these assessments, IGE aimed to ensure compliance with environmental regulations and minimise any adverse effects on sensitive environmental factors.

24.1 Overview of the EPBC Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the primary national environmental law in Australia. It provides a legal framework for the protection and management of nationally and internationally significant flora, fauna, ecological communities, and heritage places. Matters of National Environmental Significance (MNES) under the EPBC Act include:

- World Heritage properties
- National Heritage places
- Wetlands of international importance
- Threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- Water resources, in relation to coal seam gas development and large coal mining development.

24.2 Matters of National Environmental Significance (MNES)

Referral to DCCEW under the EPBC Act is triggered if a proposed action has or potentially has a significant impact on any Matter of National Environmental Significance (MNES), which are factors that require legislated protection in order to conserve biodiversity, protect World Heritage and National Heritage Places, and comply with international treaties.

24.3 EPBC Act Referral Process

Under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), any proposed action that has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance (MNES) must be referred to the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW). The department then determines whether the action requires formal assessment and approval from the Environment Minister.

24.4 What's protected under the EPBC Act?:

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Australia's main environmental law. It gives us a legal framework to protect and manage unique plants, animals, habitats and places. These include heritage sites, marine areas and some wetlands. The Act also protects listed threatened and migratory species.

The assessment process involves identifying whether the proposed development could potentially impact any of these MNES. This typically involves desktop studies, field surveys, and consultation with relevant experts and stakeholders.

24.5 Evaluation of Potential Impacts

If MNES are identified within or adjacent to the proposed Development Envelopes, the next step is to assess the potential impacts of the development on these factors.

Assessment considers both direct and indirect impacts, as well as cumulative effects from the proposed action in conjunction with other existing or foreseeable activities in the area.

24.6 Referral Decision (EPBC Act)

Infinite Green Energy (IGE) conducted a Self-Assessment in accordance with the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to evaluate the presence and potential impacts of Matters of National Environmental Significance (MNES) within or adjacent to the Development Envelopes.

Key Findings:

MNES Identification:

- MNES were identified within or in close proximity to the Development Envelopes, including critical habitats and ecological communities protected under the EPBC Act.

Impact Assessment:

- A comprehensive assessment determined that the Proposal's activities are unlikely to result in significant impacts upon MNES.
- Mitigation measures incorporated into the Proposal supporting documentation are designed to avoid, mitigate, and manage potential adverse effects on MNES.

24.7 Referral Decision and Rationale

Referral Decision: Based on the self-assessment findings below, and a thorough evaluation of potential impacts, Infinite Green Energy (IGE) has determined that the AHP proposal does not require referral to the Department of Climate Change, Energy, the Environment, and Water (DCCEEW) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

24.8 Rationale for Non-Referral:

Negligible Impacts on MNES:

The assessment found no significant impacts on MNES, including:

- Threatened species.
- Ecological communities.
- Migratory species protected under international agreements.

All potential impacts are determined to be negligible due to the site characteristics and proactive measures embedded in the project design.

Proactive Environmental Management:

The proposal incorporates comprehensive environmental management strategies to mitigate impacts effectively. These include:

- Habitat preservation for at-risk species.
- Strict controls on land clearing and vegetation disturbance.
- Measures to protect water quality and surrounding ecosystems.

Ongoing Monitoring and Adaptive Management:

A robust environmental monitoring framework is in place to ensure continuous compliance with environmental objectives. Adaptive management techniques will address unforeseen impacts, reinforcing the negligible risk to MNES.

Stakeholder Engagement:

IGE has actively engaged with:

- Ecological experts to ensure biodiversity considerations are thoroughly addressed.
- Cultural heritage specialists to safeguard sites of significance.
- Local communities and stakeholders, ensuring transparency and alignment with environmental values.

Implications:

- IGE will continue to implement and monitor the environmental management measures outlined in its strategy to ensure MNES are safeguarded.
- While not referred under the EPBC Act, the Proposal remains subject to rigorous State-level environmental approvals and oversight to maintain environmental integrity.

This decision aligns with IGE's commitment to sustainable project development while ensuring compliance with applicable environmental regulations and protecting biodiversity values.

25 Self-Assessment Guidelines

The EPBC Act guidelines provide a self-assessment process to help proponents decide whether their project needs to be referred. This process involves:

- **Identifying MNES:** Determining if any MNES are present within the project area.
- **Assessing Potential Impacts:** Evaluating whether the project is likely to have a significant impact on those MNES.
- **Making a Referral Decision:** Deciding if the potential impacts warrant a referral to the DCCEEW.

Criteria for Significant Impact

A significant impact on MNES is one that is important, notable, or of consequence, having regard to its context or intensity. Key factors considered in the self-assessment include:

- **Scale and Nature of the Impact:** Whether the impact is minor or major, temporary or permanent.
- **Sensitivity of the Environment:** The ecological significance of the environment and its ability to recover.
- **Mitigation Measures:** The effectiveness of proposed measures to avoid, reduce, or manage impacts.

IGE Self-Assessment

1 Justification for Non-Referral

Based on the comprehensive environmental Surveys commissioned for the Arrowsmith Hydrogen Project(AHP), the following summary justifies the decision not to refer the project to the DCCEEW under the EPBC Act:

Thorough Environmental Assessment

IGE commissioned number of detailed environmental surveys and impact assessments, including:

- A Reconnaissance-level flora, fauna and vegetation survey (Ecoscape 2020).
- Black Cockatoo Assessment (Bamford consulting 2022)
- Surface and Groundwater Assessments (Cardno 2021)
- Hydrogeological Assessment (Cardno 2021)
- A Detailed/Targeted Faun, Flora and Vegetation survey incorporating a basic-level fauna survey (Ecoscape 2022), focusing on Carnaby's Black Cockatoo (CBC) foraging habitat.

These surveys provided robust scientific data on the presence and distribution of MNES within the Development Envelopes.

Limited Presence of MNES

The surveys confirmed the presence of foraging species, including:

- Carnaby's Black Cockatoo (CBC): Foraging habitat for CBC was identified, but no breeding or significant roosting habitats were found within the disturbance footprint.
- The overall clearing extents is Impacting less than 5.0% of the Development Envelopes vegetation with 60% of the site either degraded completely degraded or unvegetated.
- Foraging Extents: Low-quality, low foraging value, limited extent of CBC foraging habitat and proteaceous species.
- Migratory Species: Sharp-tailed Sandpiper and Common Sandpiper were found in wetland areas that will not be impacted by the project.
- Marine Species: The Rainbow Bee-Eater was observed, but its habitat is predominantly found along drainage and will not be disturbed.

2 Environmental Impact Assessment Summary

The Environmental Impact Assessment (EIA) including various field surveys commissioned for the Arrowsmith (AHP) project have confirmed the presence of several significant species within or near the Development Envelopes. These include migratory species, marine species, and one endangered species. Despite these findings, the proposed development is anticipated to have no significant impact on Matters of National Environmental Significance (MNES). This assessment based on robust scientific evidence, thorough analysis, and compliance with relevant legislative requirements.

Key Findings from the Environmental Impact Assessment

Presence of Significant Species

Migratory Species:

- The surveys identified several migratory bird species that utilise the area for foraging and as a stopover during migration.

Marine Species:

- The proximity of the development to coastal and marine environments indicated the presence of marine species that could be affected by construction and operational activities.

Endangered Species:

- One endangered species, the Carnaby's Black Cockatoo, was confirmed within the project area, particularly utilising the foraging habitats provided by native vegetation.

Impact Analysis and Mitigation Measures

Robust Scientific Evidence and Thorough Analysis

- Comprehensive Surveys: Detailed flora, fauna and surveys were conducted to establish baseline conditions and identify the presence of significant species.

- Habitat Assessments: Specific assessments were undertaken to understand the quality and extent of habitats critical to these species, particularly for the endangered Carnaby's Black Cockatoo.
- Impact Modelling: Predictive modelling and impact assessments were carried out to evaluate the potential effects of construction and operation activities on these species.

3 Compliance with Legislative Requirements

Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act):

- **Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act):** The project was assessed under the EPBC Act to ensure that any potential impacts on MNES were identified and addressed. This included a rigorous assessment process involving public consultation and independent expert review.

- **State Regulations:** Compliance with state-level environmental regulations and guidelines, ensuring a comprehensive approach to environmental management and species protection.

Conclusion of no Significant Impact

Based on the detailed assessments and analyses, the following conclusions were drawn:

Impact on Migratory Species:

- The **Sharp-tailed Sandpiper** (*Calidris acuminata*) and **Common Sandpiper** (*Actitis hypoleucos*), both migratory species, were identified in wetland areas within the Development Envelopes due to their ecological reliance on specific habitats that provide suitable foraging and resting conditions during their migratory journeys. These species are typically associated with freshwater and brackish wetlands, including floodplains, riverbanks, and seasonal water bodies, which are often present in development areas like the Arramall lake wetlands or adjacent coastal region.

- The Arramall Lakes and surrounding wetlands play a crucial role in supporting migratory species like the Sharp-tailed Sandpiper and Common Sandpiper. The Arrowsmith Hydrogen Project incorporates robust conservation measures to ensure these habitats remain undisturbed. By avoiding direct and indirect impacts, the project aligns with international conservation goals and commitments under agreements protecting migratory birds. This approach underscores the project's commitment to ecological stewardship in the Arrowsmith coastal area.

- The project submission documentation incorporates comprehensive fauna mitigation management measures to avoid and minimise habitat disturbance. The presence of alternative Carnaby's cockatoo foraging and stopover sites in the region reduces the potential impact upon these species.

- State of the art Avifauna Radar detector systems will be installed across the project site to mitigate potential turbine strike

Impact on Marine Species:

- Fauna impact assessments concluded that the construction and operation activities are of sufficiently distant from critical marine habitats.

- Mitigation measures, such as optimising vegetation clearing and the avoidance of wetland areas, further reduce the risk of adverse effects.

- Avifauna Radar detector systems to mitigate turbine strike

Impact upon Endangered Species (Carnaby's Black Cockatoo):

- Specific conservation measures have been implemented to protect and enhance CBC foraging habitats. These include habitat restoration offsets, reduced habitat disturbance by optimising turbine layout design, and an ongoing monitoring programs to ensure the CBC population is not adversely affected.

How Radar Monitoring Mitigates Bird Strike:

Real-Time Detection:

- The radar system continuously scans the airspace around the project site, identifying birds' flight paths, altitudes, and speeds. This real-time detection allows operators to anticipate bird movements and assess potential collision risks.

Automated Response Systems:

- When the radar detects bird activity approaching the turbines, automated systems can temporarily adjust turbine operations, such as slowing down or shutting off specific turbines, to reduce the likelihood of collisions.

Behavioural Insights:

- The radar collects data on bird behaviour patterns, including migration routes, flock movements, and high-risk times of the day or year. This information can inform operational strategies, such as altering turbine operations during peak migration periods.

Minimizing Impact to Sensitive Species:

- The radar system specifically benefits sensitive or threatened avifauna, like migratory species, by ensuring their protection during critical periods. This aligns with environmental commitments to safeguard biodiversity.

Non-Invasive Monitoring:

- Radar technology offers a non-invasive way to monitor avian activity without disrupting natural bird behaviour or habitats, making it a sustainable and wildlife-friendly solution.

Enhanced Site-Specific Mitigation:

- By understanding site-specific bird activity patterns through radar data, targeted measures such as turbine layout adjustments, habitat enhancements, or additional operational changes can be implemented to further reduce risks.

4 Mitigation Measures and Monitoring

Habitat Protection:

- Designation of no-go zones to protect critical habitats from construction activities.
- Restoration and enhancement of native vegetation to support foraging and breeding activities.

Construction Management:

- Implementation of best practice construction techniques to minimise environmental disturbances, such as controlled access routes, noise reduction measures, and erosion control.

Operational Controls:

- Ongoing management and monitoring to ensure compliance with environmental commitments, including regular biodiversity surveys and adaptive management strategies to address any unforeseen impacts.

Community and Stakeholder Engagement:

- Continuous engagement with local communities, indigenous groups, and stakeholders to incorporate their input and address any concerns related to environmental impacts.

Summary

The AHP project's comprehensive Environmental surveys, supported by robust scientific evidence and thorough analysis, has demonstrated that the proposed development will have no significant impact upon Matters of National Environmental Significance.

By adhering to stringent legislative requirements and implementing effective mitigation measures, the project is committed to ensuring the protection and conservation of migratory, marine, and endangered species within and near the AHP Development Envelopes. These efforts reflect IGE's dedication to sustainable development and environmental stewardship.

Continued Monitoring and Compliance:

Ongoing monitoring and compliance with environmental regulations are essential for the projects ongoing environmental management.

By following environmental due diligence processes and conducting ongoing detailed technical analysis, the assessment process for the proposed development can effectively mitigate potential impacts. This approach ensures that environmental considerations remain central to decision-making and that appropriate mitigation measures are implemented throughout the project lifecycle.

Table 39 MNES Significance Criteria Assessment

Matter of National Environmental Significance	Presence / Potential Presence within Development Envelopes
World Heritage Properties	None Present
National Heritage Properties	None Present
Wetlands of International Importance	None Present
Nationally Threatened Species and Ecological Communities	Carnaby's Black Cockatoo IGE have Identified endangered species Carnaby's Black Cockatoo (*Zanda latirostris*) present on the eastern portion of the Development Envelopes. Direct Impacts There is no breeding habitat, no night roosting habitat and limited quality/density foraging habitat within the Disturbance Footprint. Anticipated minimal direct impact upon significant CBC habitat as defined in (DoE, 2013). The proposed disturbance footprint has minimal foraging value and the overall Disturbance Footprint is less than 6.0 % of the overall Development Envelopes area Indirect Impacts Whilst it is possible for CBC to be struck by wind turbine blades, there is limited information on actual impacts upon CBC's. Available monitoring reports indicate low risk to CBC from turbine strike (Ecoscape, 2021b).
Migratory Species	Impact Assessment on Sharp-Tailed Sandpiper The Sharp-Tailed Sandpiper (Calidris acuminata) is a migratory bird species that has been identified seasonally on the shore of Lake Arramall. This species is known to frequent wetlands, including freshwater and brackish marshes, where it forages for food during migration. Potential Impacts of the AHP Project Direct Habitat Disturbance: Assessment: The proposed AHP project will avoid the entire wetland area, which includes the shore of Lake Arramall, identified as a habitat for the Sharp-Tailed Sandpiper. By not encroaching upon the wetland, direct habitat disturbance is minimised. Mitigation: Strict Adherence to the plan to avoid wetland areas will ensure that the habitat remains undisturbed, thereby preserving the foraging and resting grounds essential for the migratory Sharp-Tailed Sandpiper. Indirect Impacts: Water Quality and Hydrology: Construction and operational activities near wetlands could potentially affect water quality and hydrology, impacting the habitat indirectly. Mitigation: Implementation of erosion control measures, proper waste management practices, and monitoring of water quality will minimise the risk of indirect impacts on the wetland ecosystem.

Matter of National Environmental Significance	Presence / Potential Presence within Development Envelopes
	Disturbance from Construction Activities: Noise and Visual Disturbance: Construction noise and visual presence can disturb the sandpipers, causing them to avoid the area. Mitigation: Scheduling construction activities outside of peak migration periods and using noise reduction techniques will help reduce disturbance to the sandpipers. Impact Analysis and Justification for Minimal Impact Seasonal Presence: The Sharp-Tailed Sandpiper is a seasonal visitor to Lake Arramall, and its presence is limited to specific times of the year. This seasonality can be leveraged to schedule construction activities to minimise overlap with the bird's presence. Habitat Avoidance: By avoiding the entire wetland area, the project design inherently reduces the risk of significant impacts on the Sharp-Tailed Sandpiper. This proactive measure ensures that the habitat remains intact and functional for the species during its seasonal visits. Monitoring and Adaptive Management: Continuous environmental monitoring will be conducted to assess any unforeseen impacts on the habitat. If necessary, adaptive management strategies will be employed to address and mitigate any emerging issues promptly. Conclusion Based on the planned avoidance of the wetland area, implementation of mitigation measures, and adherence to environmental management practices, the AHP project is anticipated to have negligible impact on the Sharp-Tailed Sandpiper. The strategy of avoiding critical habitats, coupled with ongoing monitoring and adaptive management, ensures that the proposed development will not significantly affect the migratory patterns or habitat quality of this species. Thus, the project complies with relevant environmental protection standards and sustains the ecological integrity of Lake Arramall for the Sharp-Tailed Sandpiper and other migratory species.
	Impact Assessment: Common Sandpiper Identification and Habitat of Common Sandpiper The Common Sandpiper (Actitis hypoleucos) is a migratory bird species that has been identified as potentially visiting Lake Arramall. This species typically frequents freshwater and coastal wetlands, where it forages along the shores and mudflats. Potential Impacts of the AHP Project Direct Habitat Disturbance: Assessment: The proposed AHP project will avoid the entire wetland area, including the shores of Lake Arramall, which serve as potential habitat for the Common Sandpiper.

Matter of National Environmental Significance	Presence / Potential Presence within Development Envelopes
	Mitigation: Ensuring that construction activities do not encroach upon the wetland will protect the habitat and reduce the risk of direct disturbance to the Common Sandpiper's foraging and resting areas. Indirect Impacts: Water Quality and Hydrology: Construction activities could affect water quality and hydrology, potentially impacting the wetland ecosystem indirectly. Mitigation: Implementing erosion control measures, maintaining proper waste management practices, and continuously monitoring water quality will help mitigate any indirect impacts on the wetland and, consequently, on the Common Sandpiper. Disturbance from Construction Activities: Noise and Visual Disturbance: Construction noise and the presence of equipment and workers can disturb the sandpipers, causing them to avoid the area. Mitigation: Scheduling construction activities to avoid peak migration periods and using noise reduction techniques will help minimise disturbances to the sandpipers. Impact Analysis and Justification for Minimal Impact Seasonal Presence: The Common Sandpiper is a migratory species that may only visit Lake Arramall during specific times of the year. This seasonality allows for the scheduling of construction activities to minimise overlap with the bird's presence, further reducing potential impacts. Habitat Avoidance: By planning to avoid the entire wetland area, the project design inherently reduces the risk of significant impacts on the Common Sandpiper. This avoidance strategy ensures that the habitat remains undisturbed, maintaining its suitability for the species during its visits. Monitoring and Adaptive Management: Continuous environmental monitoring will be conducted to detect any unforeseen impacts on the habitat. Adaptive management strategies will be employed as needed to address and mitigate any emerging issues promptly. Conclusion Based on the planned avoidance of the wetland area, implementation of robust mitigation measures, and adherence to comprehensive environmental management practices, the AHP project is anticipated to have minimal impact on the Common Sandpiper. The strategy of avoiding critical habitats, coupled with ongoing monitoring and adaptive management, ensures that the proposed development will not significantly affect the migratory patterns or habitat quality of this species. Consequently, the project complies with relevant environmental protection standards, safeguarding the ecological integrity of Lake Arramall for the Common Sandpiper and other migratory species.

Matter of National Environmental Significance	Presence / Potential Presence within Development Envelopes
Marine Species	Impact Assessment on Rainbow Bee-Eater Identification and Habitat of Rainbow Bee-Eater The Rainbow Bee-Eater (Merops ornatus) is a colorful and migratory bird species found across Australia, including the AHP project area. It typically nests in sandy banks and other loose soil areas, often near water sources, such as drainage lines. Echoscope's surveys have identified possible disused nests of this species along drainage lines within the project site. Potential Impacts of the AHP Project Direct Habitat Disturbance: Assessment: Construction activities, particularly those involving earthmoving, could disturb the drainage lines and nesting sites. Mitigation: Avoiding construction activities near identified nests, even if they appear disused, will minimise direct impacts on potential nesting sites. Indirect Impacts: Water Quality and Hydrology: Changes in drainage patterns or water quality due to construction could indirectly affect the nesting and foraging habitats of the Rainbow Bee-Eater. Mitigation: Implementing erosion and sediment control measures, along with maintaining natural drainage patterns, will help protect these habitats. Disturbance from Construction Activities: Noise and Visual Disturbance: Construction noise and human activity could disturb the Rainbow Bee-Eaters, potentially causing them to avoid the area. Mitigation: Limiting construction activities during the breeding season and using noise reduction techniques can help reduce disturbances to the birds. Impact Analysis and Justification for Minimal Impact Avoidance of Critical Habitats: Nesting Sites: By planning to avoid construction activities near potential nesting sites along drainage lines, the project significantly reduces the risk of directly impacting the Rainbow Bee-Eater's habitat. Drainage Lines: Ensuring that drainage lines are left undisturbed protects the ecological integrity of these potential nesting areas.

Matter of National Environmental Significance	Presence / Potential Presence within Development Envelopes
	Seasonal Considerations: The Rainbow Bee-Eater is a seasonal breeder. Adjusting construction schedules to avoid the breeding season will further mitigate potential impacts on the species. Habitat Restoration and Monitoring: Habitat Restoration: If any nests are inadvertently disturbed, habitat restoration efforts, such as re-vegetating disturbed areas with native flora, can help mitigate the impacts. Ongoing Monitoring: Continuous monitoring of the project area for Rainbow Bee-Eater activity will allow for adaptive management practices to be implemented promptly if any new nests are identified. Conclusion Based on the avoidance of identified nesting sites, implementation of mitigation measures, and adherence to best environmental management practices, the AHP project is anticipated to have minimal impact on the Rainbow Bee-Eater. The strategy of avoiding critical habitats, combined with ongoing monitoring and adaptive management, ensures that the proposed development will not significantly affect the nesting and foraging behavior of this species. Consequently, the project complies with relevant environmental protection standards, safeguarding the ecological integrity of the drainage lines for the Rainbow Bee-Eater and other species.
Commonwealth Marine Areas	Not Applicable
Great Barrier Reef Marine Park	
Nuclear Actions	
A water resource, in relation to coal seam gas development and large coal mining development	

25.1 Assessment of the AHP Project's Impact upon Carnaby's Black Cockatoos

25.1.1 Criteria for Determining Significant Impact on Critically Endangered or Endangered Species

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) outlines specific criteria to determine whether a proposed action is likely to have a significant impact on a critically endangered or endangered species, such as the Carnaby's Black Cockatoo (Zanda latirostris). Below is an analysis of how the AHP project addresses each of these criteria, demonstrating why the proposal is not expected to have a significant impact on this species.

25.1.2 Construction Activities Leads to a Long-Term Decrease in the Size of a Population

Assessment:

- Habitat Surveys: Detailed surveys identified minimal low density foraging habitat within the proposed disturbance footprint.
- Impact Mitigation: The project includes mitigation measures such as habitat revegetation and the relocation of infrastructure, to protect potential CBC foraging habitats.
- Avifauna detection radar installation: The installation of avifauna detection radar systems is a strategic approach to minimising the impact of wind turbines on bird populations. These systems are designed to detect birds in the vicinity of wind turbines and trigger curtailment measures to prevent collisions, thereby ensuring the protection of avifauna, including species of conservation concern like the Carnaby's Black Cockatoo.
- Conclusion: With these mitigation measures, the project is unlikely to cause a long-term decrease in the population size of Carnaby's Black Cockatoo.

25.1.3 Reduce the Area of Occupancy of the Species

Assessment:

- Extent of Disturbance: The proposed disturbance footprint impacts less than 5.0% of the overall Development Envelopes, which comprise of low quality/density proteaceous foraging habitat but contains no breeding or nighty time roosting habitat.
- Habitat Management: Preservation of surrounding habitats and revegetation strategies will ensure no significant reduction in the species' area of occupancy.
- Conclusion: The project will not significantly reduce the area of foraging for Carnaby's Black Cockatoo.

25.1.4 Fragment an Existing Population into Two or More Populations

Assessment:

- Connectivity: The project area does not contain key breeding or roosting sites that are critical for maintaining population connectivity.
- Mitigation Strategies: Maintenance of habitat corridors and buffer zones ensures continued movement and interaction of the Cockatoo transitionary inhabitants

- **Conclusion:** The project is unlikely to fragment the existing population of Carnaby's Black Cockatoo.

25.1.5 Adversely Affect Habitat Critical to the Survival of a Species

Assessment:

- **Critical Habitat Identification:** No critical foraging habitats located within the disturbance footprint, Foraging vegetation has been carefully mapped in detail and occurs sporadically within the project's disturbance footprint.

- **Protection Measures:** Implementation of habitat protection and restoration strategies and the minimises adverse effects upon critical habitats.

- **Conclusion:** The project will not adversely affect habitat critical to the survival of Carnaby's Black Cockatoo.

25.1.6 Disrupt the Breeding Cycle of a Population

Assessment:

- **Breeding Habitat:** No breeding or nesting habitats for Carnaby's Black Cockatoo were identified within the disturbance footprint.
- **Noise and Disturbance Mitigation:** Noise reduction and controlled access during are planned to avoid disruption.
- **Conclusion:** The project will not disrupt the breeding cycle of Carnaby's Black Cockatoo.

25.1.7 Modify, disturb, Remove, Isolate, or Decrease the Availability or Quality of Habitat to the Extent that the Species is Likely to Decline

Assessment:

- **Habitat Impact:** The disturbance footprint involves minimal modification or disturbance to suitable CBC habitat.
- **Quality Preservation:** Habitat restoration and enhancement revegetation are designed to maintain or improve habitat quality.
- **Conclusion:** The project will not significantly modify, disturb, remove, isolate, or decrease habitat quality to the extent that Carnaby's Black Cockatoo is likely to decline.

25.1.8 Result in Invasive Species that are Harmful to a Critically Endangered or Endangered Species Becoming Established in the Endangered or Critically Endangered Species' Habitat

Assessment:

- **Invasive Species Management:** Strict biosecurity measures and ongoing monitoring are planned to prevent the introduction of invasive species.
- **Control Programs:** Effective control programs for existing invasive species will be implemented.
- **Conclusion:** The project will not result in harmful invasive species becoming established in Carnaby's Black Cockatoo habitat.

25.1.9 Introduced Disease that May Cause the Species to Decline

Assessment:

- **Disease Management Protocols:** Protocols to prevent disease introduction and spread include strict hygiene measures for workers and equipment.
- **Monitoring:** Continuous health monitoring of Carnaby's Cockatoo populations will be conducted.
- **Conclusion:** The project will not introduce diseases that may cause Carnaby's Black Cockatoo populations to decline.

25.1.10 Interfere with the Recovery of the Species

Assessment:

- **Recovery Plans:** The project aligns with existing recovery plans for Carnaby's Black Cockatoo, including habitat restoration and protection measures.
- **Support for Conservation Efforts:** The project may include funding and resources for ongoing conservation efforts.
- **Conclusion:** The project will not interfere with the recovery of Carnaby's Black Cockatoo.

25.1.11 Conclusion

The AHP project's comprehensive environmental assessments, stringent mitigation measures, and alignment with legislative requirements ensure that the proposed development will not have a significant impact on Carnaby's Black Cockatoo. Based on the robust scientific evidence and thorough analysis, the project is designed to protect and enhance the species' habitats, maintain population stability, and support ongoing conservation efforts, thus meeting the EPBC Act criteria for non-referral.

25.2 Adaptive Management and Review of Procedures

An adaptive management approach seeks to minimise impacts by establishing a continuous cycle of monitoring, reporting, and implementing corrective actions when necessary. This document adheres to the principles of adaptive management by incorporating a structured framework for monitoring environmental and operational performance, tracking corrective actions, and applying adjustments to practices as new information or circumstances arise. By fostering flexibility and responsiveness, this approach ensures that environmental management remains effective and aligned with project goals and regulatory requirements throughout the project's lifecycle.

25.3 Environmental Monitoring and Corrective Actions

Environmental incidents and non-compliances will be promptly identified and documented by relevant personnel as soon as practicable. Where feasible, incidents will be mitigated or rectified within 48 hours of detection to minimise potential impacts. Any non-conformances will be reported immediately to the Construction Manager or equivalent authority to ensure swift action and compliance with project standards. This approach underscores the project's commitment to maintaining high environmental and operational standards through proactive and timely incident management.

25.4 Management Review

This management update is intended to be dynamic and may be updated to reflect changes in management practices. redesign, or environmental regulatory changes. This will also allow flexibility to adopt new management measures and change of scope.

Amendments to management actions and targets will be completed on an as needs basis. This will include revision/amendment of management actions that are not achieving desired outcomes. This will include revising monitoring schedules, identifying additional impacts, changes to relevant legislation or process improvements.

25.5 Environmental Incidents/Non-Compliance

Environmental incidences and non-compliances will be identified and recorded as soon as practicable by the relevant personnel. Incidents will be mitigated or rectified where possible within 48 hours of being identified. Non-conformances will be reported to the Construction Manager and/or equivalent immediately.

Construction environmental performance activities and the identification of auditing requirements will be assessed by IGE prior to and throughout the construction period. All documents pertaining to environmental management will be maintained the IGE document control system.

Reporting requirements will be undertaken in accordance with regulatory requirements including annual reporting. If a significant non-conformance occurs, the regulator will be notified of the non-compliance and subsequent investigation.

26 Summary

Outlined below are various key aspects of the proposed development and the measures taken to minimise potential impacts upon the environment:

26.1 Fauna Protection:

The project recognises the presence of significant fauna species, including Carnaby's Black-Cockatoo, and has implemented targeted measures to protect their habitats. Critical Infrastructure relocation efforts have been made to avoid critical roosting and foraging areas, significantly reducing the risk of turbine strikes and habitat disruption. Furthermore, the installation of an avifauna and bat radar detection system will enhances protection for both bird and bat populations by providing real-time monitoring, allowing for timely mitigation actions when avian species are detected near turbine areas. This proactive approach underscores the project's commitment to minimising impacts on local wildlife.

26.2 Flora and Vegetation Protection:

The proposal acknowledges the presence of high-quality vegetation, including CBC foraging habitat, Banksia sessilis, Banksia prionotes, priority species and Priority Ecological Communities (PECs) within the project Development Envelopes . By implementing optimised construction strategies and targeted disturbance mitigation measures, the project aims to minimise significant impacts on these essential flora and vegetation values. This approach ensures that key ecological communities are preserved to the greatest extent possible, supporting biodiversity conservation while balancing project development needs.

26.3 Groundwater Impacts:

Potential impacts upon groundwater levels and groundwater-dependent ecosystems from production bores are anticipated to be minimal. Mitigation measures and optimised abstraction strategies from the Yarragadee aquifer have been implemented to ensure sustainable water extraction and to minimise any adverse effects on groundwater resources. These strategies include monitoring groundwater levels, adjusting extraction rates as necessary, and aligning water use with ecosystem requirements, ensuring that groundwater-dependent ecosystems remain protected and resilient throughout the project's lifecycle.

26.4 Wetlands and Sensitive Areas Protection:

The modified infrastructure layout of the proposal avoids impacting Arramall Lake and associated wetlands, reducing potential impacts upon sensitive receptors and environmental values. The Relocation of abstraction bores avoiding sensitive environmental areas also contributes to protection measures.

26.5 Cultural Heritage Protection:

Efforts to avoid disturbance to Aboriginal Cultural Heritage sites are reinforced by the presence of Yamatji Monitors during ground disturbance activities, providing a proactive approach to safeguarding cultural heritage values. The Yamatji Monitors, as representatives of the local Indigenous community, play a vital role in overseeing construction activities, ensuring compliance with cultural heritage protection protocols, and providing an additional layer of oversight. Their presence allows for real-time monitoring and response, should any previously unidentified cultural heritage features be encountered, thereby upholding respect for the cultural significance of the area and fostering collaboration with the Yamatji community.

26.6 Visual Impact and Noise Management:

Visual impact on local amenity will be meticulously managed through strategic turbine placement to minimise visibility from prominent vantage points. Additional mitigation measures, such as painting turbines in landscape-compatible colours and incorporating community-driven art installations on towers or turbine bases, have been explored to align with community preferences and enhance visual integration within the local environment. To address potential noise concerns, noise assessments will be conducted to ensure levels at sensitive receptors remain within regulatory limits, thus maintaining compliance and reducing any disturbance to nearby residents. This approach prioritises both aesthetic harmony and community well-being, fostering a balanced integration of the project into the surrounding landscape..

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28 Appendices

Appendix 1 Speleological Consultation Report (Discussion and Outcomes)

Appendix 2 Noise Study

Appendix 3 Women's Survey

Appendix 4 WASG Endorsement Letter

Appendix 5 DBCA Consultation

Appendix 6 YSRC Heritage Survey

Appendix 7 IGE Avifauna and Bat Impact Assessment

Appendix 8 Ecoscape Detailed Flora and Vegetation survey 2022

Appendix 9 IGE Social Surrounds Survey

Appendix 10 WASG Arrowsmith Karst Investigation

Appendix 11 Environmental Management Review Framework (EMRF)

Further Referral Information

IBSA Data Package Surveys: Ecoscape

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