# Arrowsmith Hydrogen Project (AHP)

## Consultation Report

Karst Formation, Cave Systems and Fauna Habitat

Stakeholder Engagement
Western Australian Speleological Group (WASG)

## Consultation Report: IGE Management Outcomes

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| **Project Acronym** | AHP |
| **Project Title** | Arrowsmith Hydrogen Project |
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| **IGE File No.** | ARWD - AHP |
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| **Check by:** | Michael Hutt |
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**Revision History**

| Rev | Description | Date | Author | Checked | Appr |
|---|---|---|---|---|---|
| A | Changes as per EPA requirements | 15/02/24 | PG | MH | SG |
| 1 | Update for Re-submission to EPA | 20/02/25 | PG | MH | SG |

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

*Relevant Legislation:*

*Environmental Protection Act 1986*

Section 40(2)(a): Notice Requiring Information For Assessment

EPA Requirements

*Provide evidence of consultation with the Western Australian Speleological Group (WASG) regarding potential impact to karst formation and cave systems. Evidence must include a summary of the discussion and outcomes (including any concerns raised, resolutions, and agreement to mitigation and management actions).*

*In response to the Western Australian Speleologist Group (WASG ) identified concerns, IGE have modified their turbine layout design and relocated their plant infrastructure to avoid water bodies, CBC foraging habitat, bat habitat, cave systems and karst formations. Within the construction envelope*

*AHP-1 Wind Turbine Array Layout Modifications*
*Wind turbine technology is constantly evolving, particularly through advanced modularity in design. An extensive list of design options are available to create customised solutions to suit the requirements of unique project challenges. Technical Improvements allows increased energy production while utilising fewer turbines and a potential turbine reduction from 25 to18 turbines at the AHP-1 site.*
*The proposed wind turbine layout plan has been redesigned utilising multi-objective optimisation, revealing the most efficient distribution variables while addressing surrounding water bodies and cave and karst location constraints. This strategy has enabled IGE to take advantage of technology changes providing greater certainty regarding environmental impact mitigation, turbine relocation options and constructability of the Project.*

*Turbine siting, wake modelling insights and functional expertise have been utilised within the development area to select the optimal turbine array locations. IGE has revised its turbine site layout to minimise impacts including areas adjacent to bat and avifauna habitat thus lowering the risk of turbine strike.*

*Geotechnical Investigation and an intensive drilling investigations prior to turbine installation will be initiated including 15- to 25-meter-deep boring investigations per turbine. Advanced geotechnical modelling will provide an indication of the size of void verses depth that may be problematic, and ongoing laser scanning and 3D mapping will be implemented to evaluate the surrounding turbine array footprint within the limestone karst geology.*

*Further Mitigatrion Measures*
*IGE have taken into consideration the WASG concerns and direction regarding environmental impacts to surrounding landforms, and fauna habitat and have proposed mitigation management measures addressing these concerns.*
*Potential bat impacts as a consequence of habitat loss, and possible turbine strike will be mitigated within the project area. IGE understand the flight path/movements of bats are likely to be towards a food source or foraging habitat areas that may be located adjacent to cave systems. Consequently IGE intend to utilise radar technology to understand both wind turbine impacts and turbine blade strike mortality. This is critical to recognising and implementing bat strike impact mitigation strategies within the wind turbine development envelope.*

*Radar has vastly increased the quality and accuracy of data with its ability to distinguish mammals by both size, behavioural profiles and population numbers. This technology will provide IGE with a detailed profiles of individual bat species/types/populations, smart curtailment strategies, refining our understanding of bat behaviours adjacent to windfarms and cave systems.*

# 1 Cavers Report Outcomes

*Ecoscape consultants has concluded via sound monitoring technology field studies that at least 5, possibly 6 species of bats inhabit the caves on the property. During the current work, WASG revisited a cave chamber recorded as containing bats. During the last site visit (5 years ago), a number of bats were viewed within the cave systems*. (Ecoscape 2021)

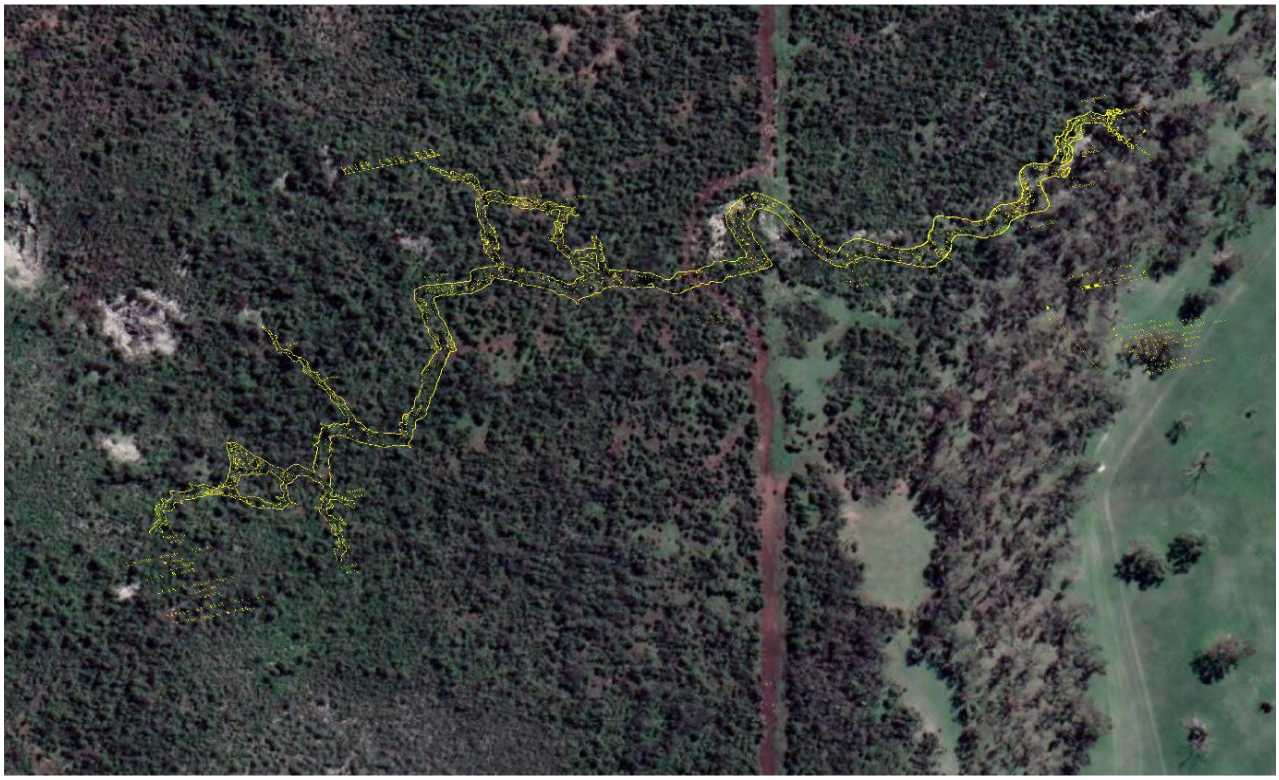
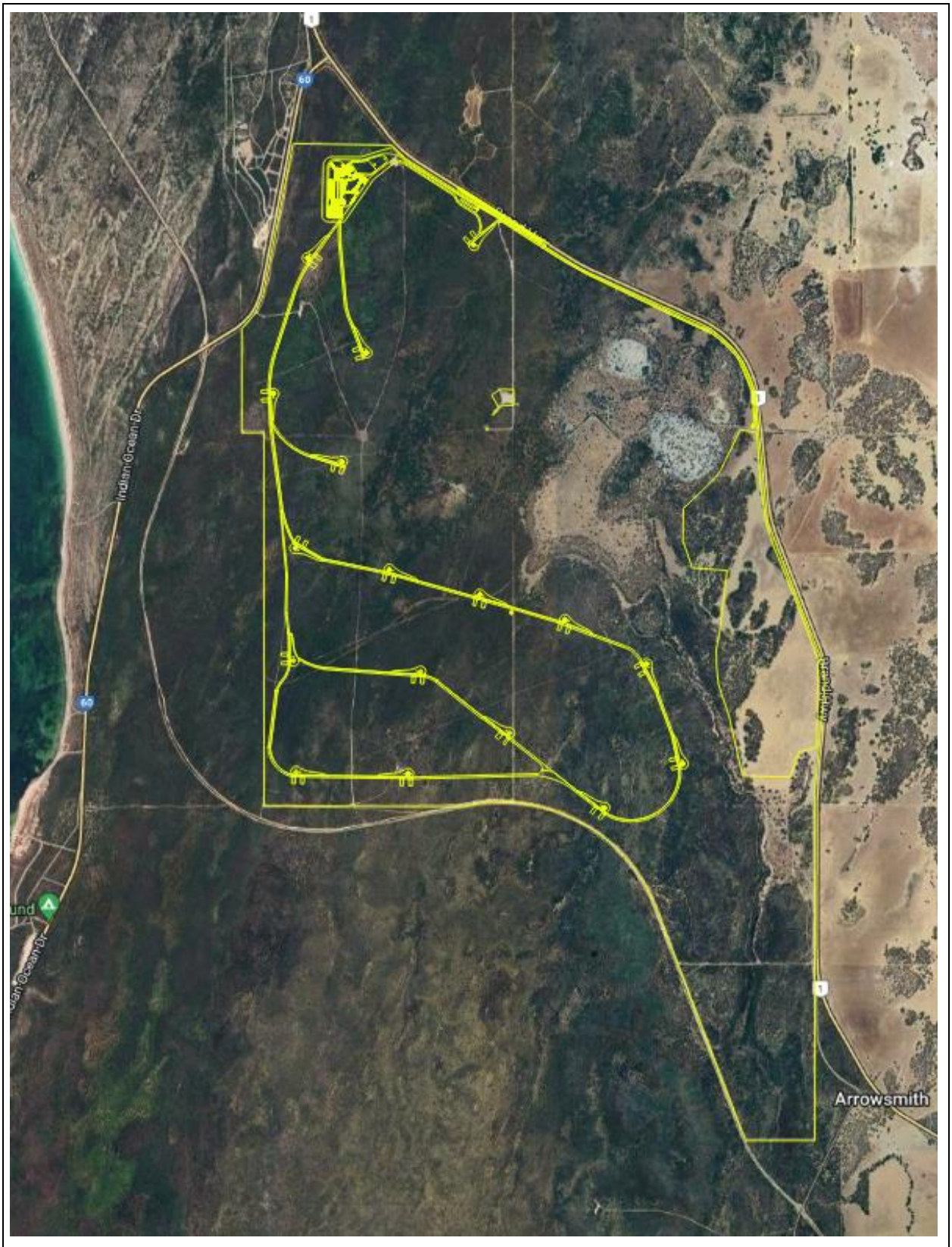


Figure 1 River Caves Map

## Bat Monitoring

IGE intend to utilise radar technology to understand both windfarm environmental impacts and bat turbine blade strike mortality. This is critical to recognising and implementing impact mitigation strategies within the wind turbine development envelope. Radar has vastly increased the quality and accuracy of data with its ability to distinguish mammals by both size, profile and population numbers. This technology will provide IGE with a detailed profile of individual bat species/types/populations, improving our mitigation adaption and improving our understanding of bat behaviours around windfarms and cave systems.




Arrowsmith Hydrogen Project
(AHP) Indicative Clearing Extents
and Layout

Author : Peter Galloway
Date : January 2025

Figure 2 Project Layout Update

## 2 Key Cave identifier Area Mitigation Management

See WASG Map (Figure 3)

WASG Requests and IGE Management Actions

- WASG Map Area E-23: River Caves

Review final plans to confirm that any works in the River Cave catchment area will not cause sediment to flow into the cave in times of flood.

*IGE response: No planned construction work within this area*

Review of final plans to confirm that the current track over the cave will be restricted to small vehicles only.

*IGE response: The track area is not intended be utilised, but will be restricted to small vehicles access only (if required)*

Review of final plans to confirm that any plans for infrastructure passing over the cave (even overhead powerlines) consider the expected unknown voids, the risks of erosion into the multiple small cave entrances due to earthworks, and the preservation of the unique geological values of the cave.

*IGE response: Project site Infrastructure has been relocated to avoid the river cave area and surrounds*

Trenching should not be carried out over the course of River Cave or in the vicinity of any of the known cave and karst features.

*IGE response: No trenching will be undertaken within the river cave area*

It is expected that any significant construction would be preceded by a detailed survey and include reporting procedures for any voids found.

IGE response: *Wallbridge Gilbert Aztec (WGA) Engineering will undertake a certified Geotechnical site assessment and drilling survey of the intended turbine development envelope prior to construction, optimising civils and earthworks outcomes.*

Survey complete: Ecoscape detailed survey. Site Safety procedures will identify voids within the development envelope with ongoing monitoring

*IGE response: Ecoscape Flora and vegetation survey complete: Ecoscape detailed survey. Desktop bat and Avifauna survey complete.*

In response to the Western Australian Speleologist Group (WASG ) identified topics, IGE have adjusted their turbine layout design and relocated their construction model to avoid cave systems and karst formations and impacts to both terrestrial and subterranean landforms.

IGE have taken into consideration WASG concerns and direction regarding environmental impacts to surrounds including fauna and ground/ surface water impacts and have proposed mitigation measure addressing all of these concerns.

# 3 Other significant Cave/Karst Areas recommendations and IGE response

- WASG Map Area E-153

*The presence of a collapse suggests voids could be present in the area. This area requires further investigation for possible voids.*

***IGE response: No wind turbine construction planned within this area***

- WASG Map *Area WP17 and WP16: Turbine locations*

No surface karst features found. No further recommendation required.

- WASG Map Area WP15

*This location is close to E-182 a large karst area 50m long and 20m wide with multiple holes 3–6m deep. This turbine location is the one of greatest concern to WASG.*

***IGE response: No planned construction within this area***

- *Relocation or elimination of turbine* WASG Map Area *WP15*

*WASG strongly urges relocation or elimination of turbine WP15. Additionally, no heavy vehicle road or* trenching should occur between WP14 and the Sodar station.

***IGE response: No wind turbine construction within this area and /or heavy vehicle access. Area restricted to light vehicle movement only***

- River Cave and WASG Map Area E-183

Close to the edge of the cleared area, this line passes between the main entrance to River Cave and E-183, a large karst area 35m long and 25m with multiple, blind solution pipes 3–4m deep

*IGE response: No wind turbine construction planned within this area*

- WASG Map Area*: WP11 and line heading north crossing over River Cave*

*IGE Management action: Cranes or heavy vehicles required for turbine construction should not be allowed to proceed along the tracks (old or new) north of WP11 as this area contains fragile voids.*

IGE response: Roads between known cave locations will be restricted to light vehicles only and no trenching of power cables should be permitted.

- WASG Map Area *: Areas between WP2 and WP3 and between WP9 and WP10*

*Current development plans show no development in this area and WASG recommends that this area is never developed.*

*IGE response: No construction within this area planned*

*IGE response: No wind turbine construction within this area*

## 4 WASG Map Area E-91 and E-144, known bat caves

*WASG strongly urges relocation or elimination of turbine WP15. Additionally, no heavy vehicle road or trenching should occur between WP14 and the Sodar station.*

*IGE response: The planned WP15 turbine construction has been relocated away from this area*

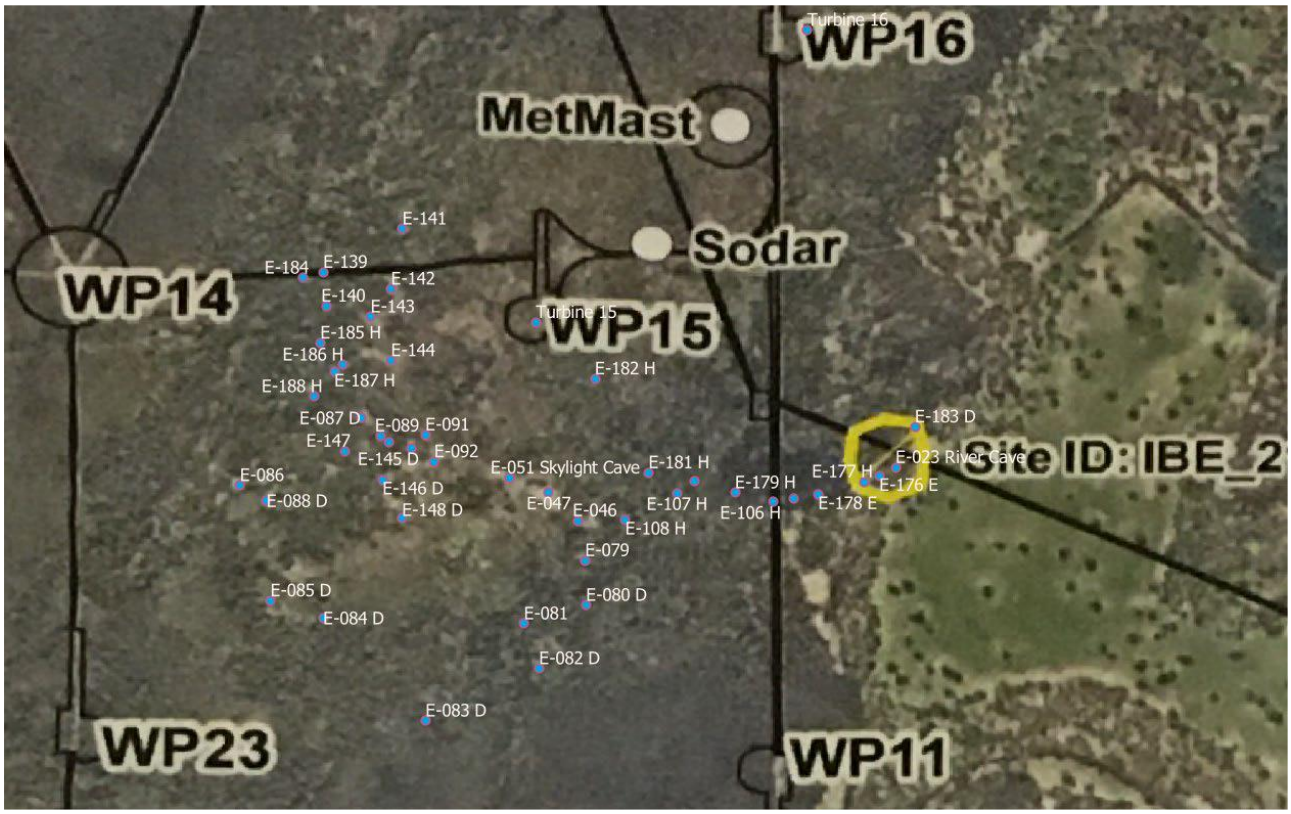



Figure 3 River Caves Map Area showing superseded turbine layout

## 5 River Cave map overlaid onto aerial image

The line between the Sodar station and the solar array should be relocated further north, away from the known karst area, closer to the existing shed.

*IGE response: No planned construction within this area*

WASG recommends that surveys of the bat population should be conducted by suitably qualified personnel before, during and after construction because of the potential impact of bat turbine strike. Surveys should consider the development area as a whole.

*IGE response: Bat Survey data will be collected by the implementation of Bird/Bat Radar technology and data analysed/utilised to mitigate turbine strike if any.(Automatic Wind Turbine curtailment)*

WASG have requested ongoing access to the caves on the property for reference and mapping purposes.

*IGE response: Access to the caves within the development envelope will be conditional and at the discretion of IGE due to a range of construction site regulatory and heritage requirements, including impacts to sensitive environmental values.*


Figure 4 River Caves Map showing superseded proposed development (Courtesy WASG)

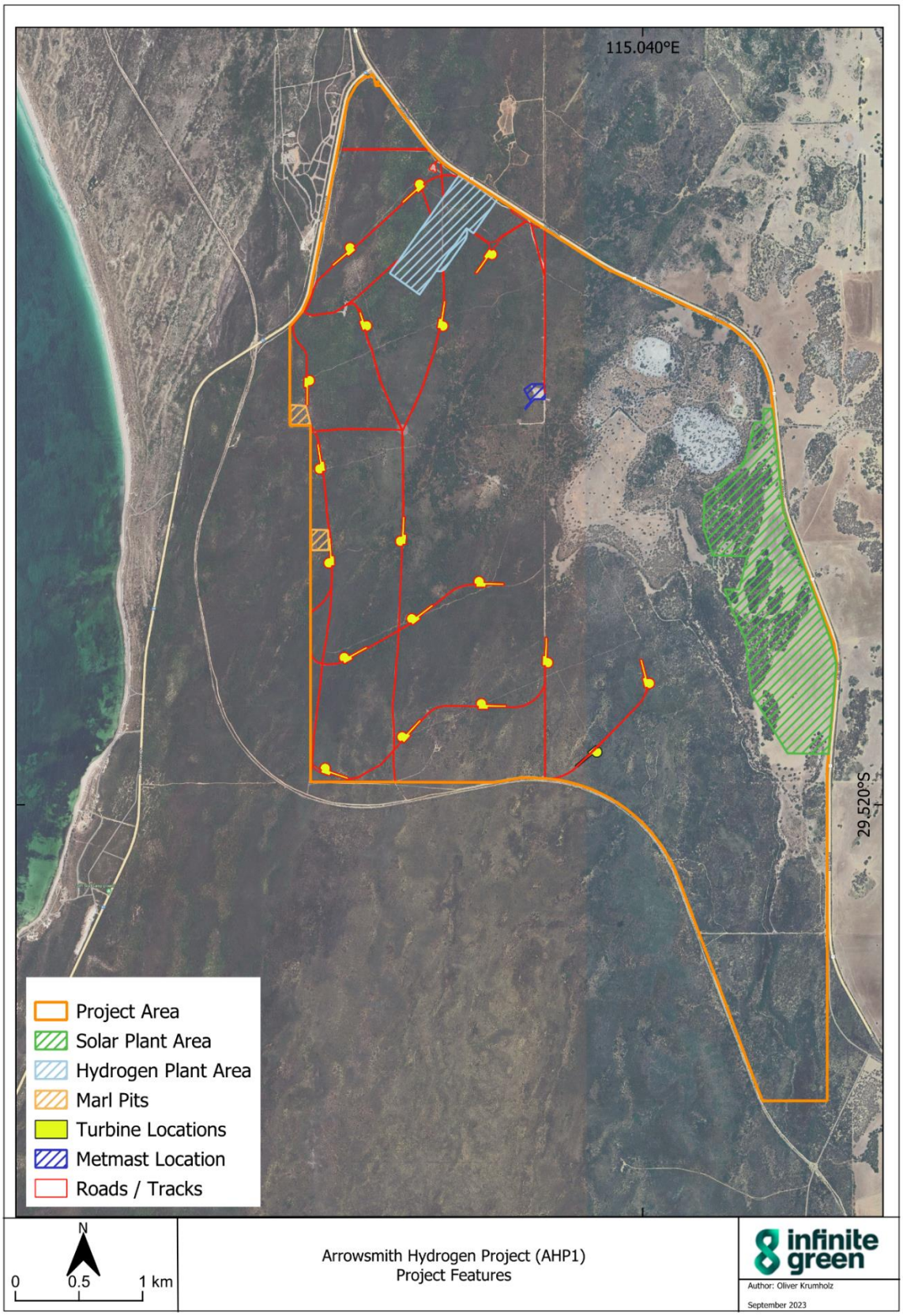
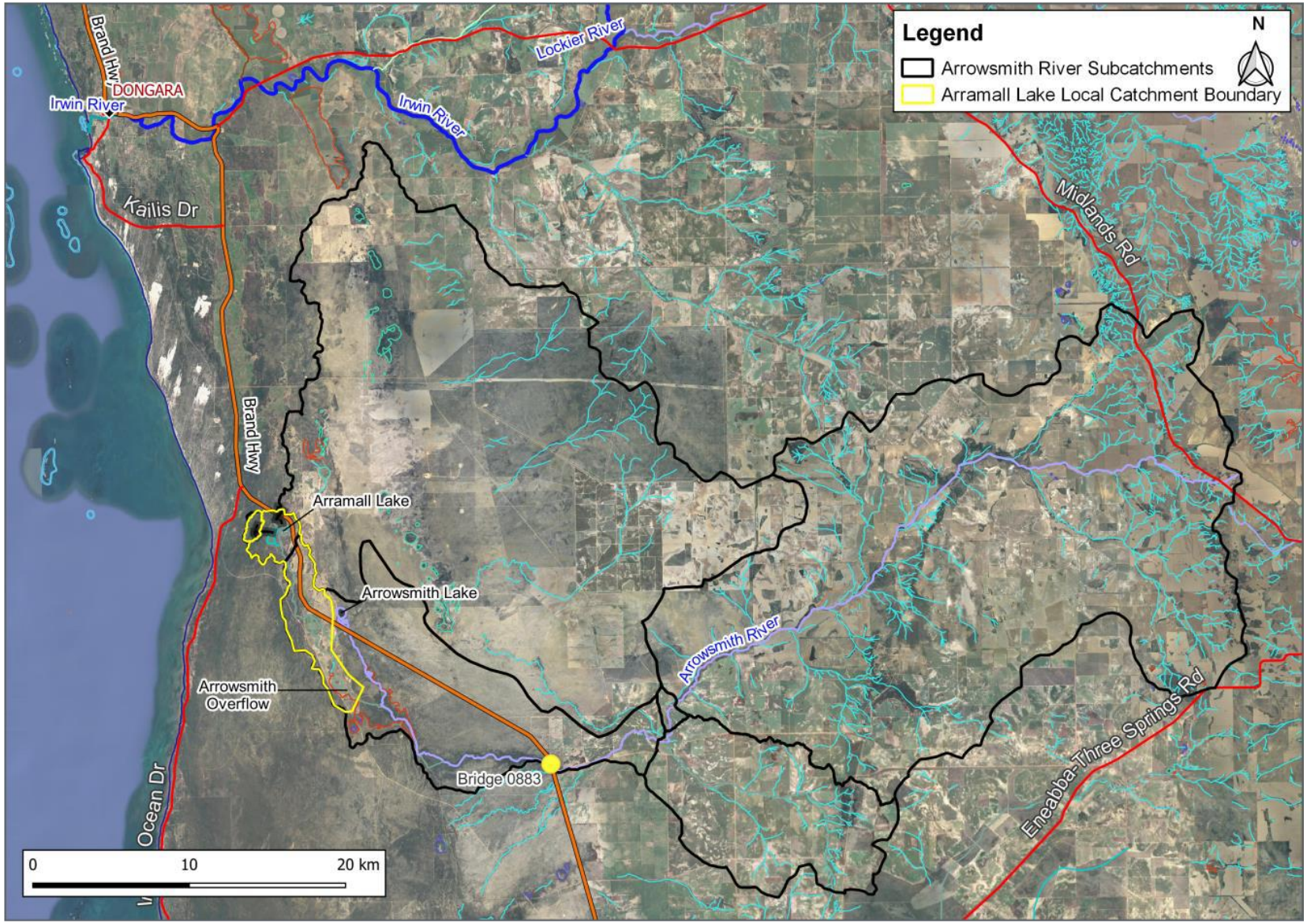



Figure 5 Previous Layout Features

Figure 6 Arrowsmith River Catchment Plan (Cardno 2021)

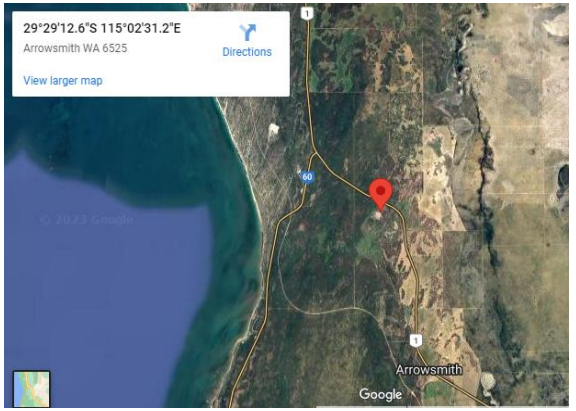


# 6 Arramall Cave and Lake System

Arramall Cave is located just off the Brand Highway, around 30 km south of Dongara in ancient aeolian calcarenite limestone. Two major systems have been formed as a result of the overflow of Lake Arramall – River Cave and Arramall Cave, the latter of which contains the largest chambers and extends for approximately 1.8 km. Arramall caves flood infrequently when rains of sufficient volume to flood Lake Arramall are received.

Figure 7 Arramall Cave map showing aerial image with other karst features highlighted


Cave System Locations



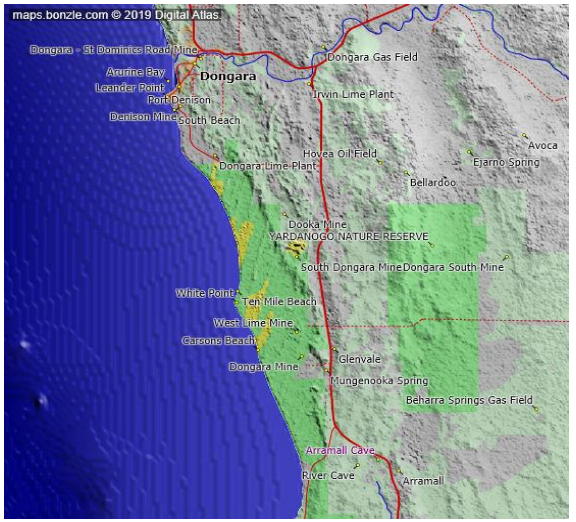



Figure 8 Overlay of E-91 and E-144 cave maps

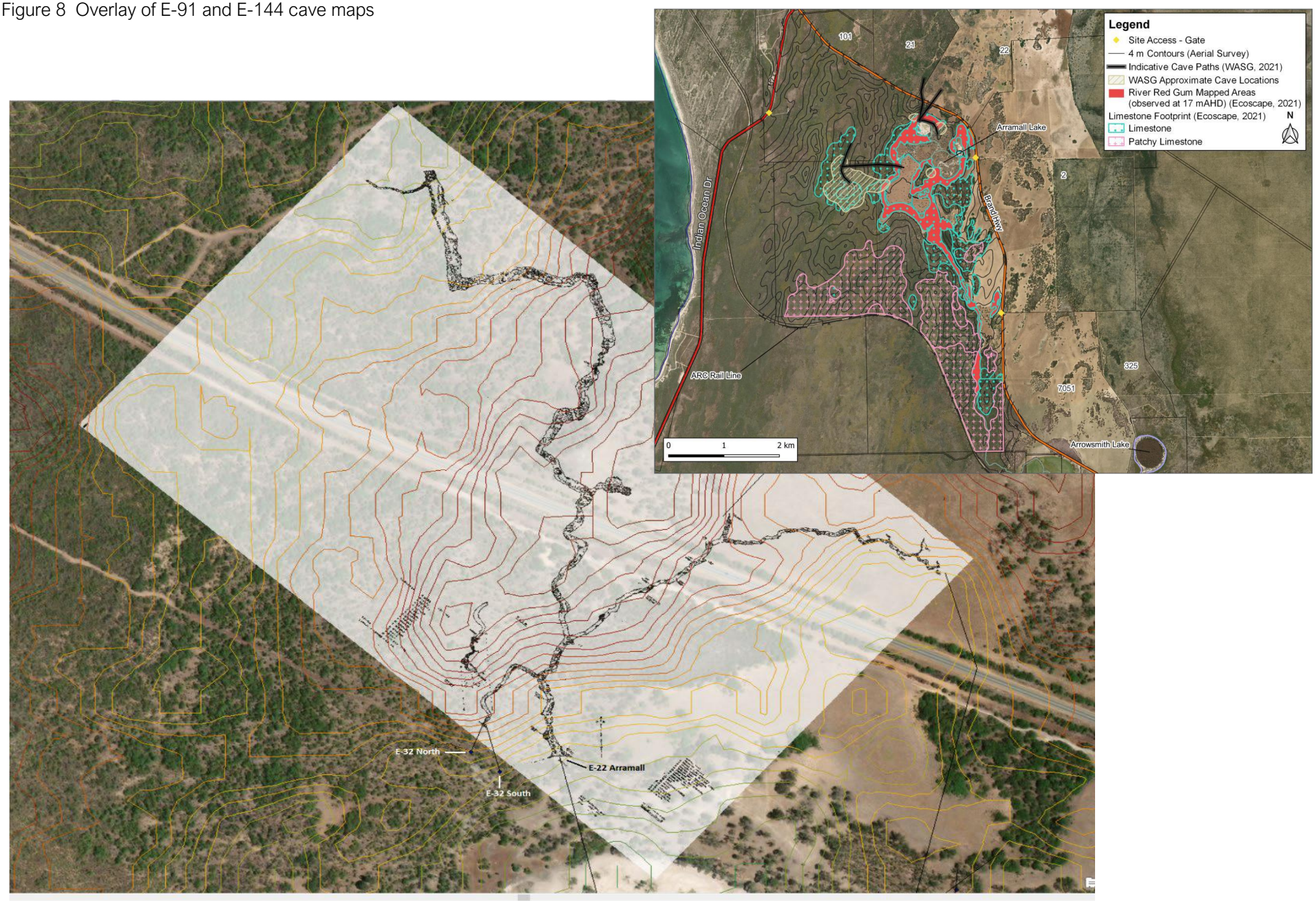


Table 1 IGE Management Provisions to Minimise Impacts to Karst Formation and Cave Systems

| Management Provisions | |
|---|---|
| EPA: The EPA Objective for this key environmental factor is to minimise impacts to Karst Formation and cave systems and provide evidence of consultation with the Western Australia Speleological group (WASG) | |
| **Assessment Objective:**<br><br>Supplement the results of the reconnaissance flora and fauna survey undertaken by Ecoscape circa 2021,<br>To minimise impacts to Karst Formation and cave systems<br>Provide evidence of consultation with the Western Australian Speleological Group (WASG) regarding potential impacts to karst formation and cave systems | |
| Key environmental values:<br>Bats<br>Karst and Cave landforms<br>Carnaby's Black Cockatoo Foraging Flora and vegetation | |
| **Direct Impacts** | **Indirect impacts** |
| - Key Environmental Impacts<br><br>- Bird and Bat strike during wind turbine operation<br>- Impacts to bat habitat during construction<br>- Loss of vegetation and flora through clearing and earthworks activities<br>- Bat Foraging disturbance<br>- Landform impacts: Karst area and cave systems | - Potential reduction in fauna health as a result of construction activities<br>- Changes to Fauna Behaviour within the development envelope<br>- Altered surface water drainage patterns and surface water flows due to clearing/ and construction of infrastructure<br>- Impacts to surrounding Beekeepers nature reserve<br>- Potential collapse cave/Karst<br>- Bat Behavioural/population Impacts<br>- Sedimentation within caves/Karst areas<br>- Erosion and sediment control<br>- Karst track usage |

## Impact Management

| Management action | Management Target | Monitoring | Reporting |
|---|---|---|---|
| **Clearing around Karst and Cave areas** | Minimal clearing | Pre-Clearing survey<br>Visual inspection | Weekly environmental Report |
| Site layout design has been updated to avoid Cave systems and Karst areas<br><br>Demarcate development envelope boundary using appropriate visual markers prior to ground disturbing activities.<br><br>Visual inspection and approval of development envelope boundary prior to ground disturbing activities.<br><br>Visual inspection and record of cleared areas to be undertaken post-clearing to ensure no over clearing.<br><br>Vehicles and equipment access limited to designated roads/access tracks and cleared areas to avoid karst and cave formations.<br><br>All site personnel to be inducted regarding environmental responsibilities.(Including Karst and cave locations)<br><br>Geotechnical site assessment and drilling survey of the intended turbine development envelope | No clearing of vegetation outside of the development envelope during and attributable to construction.<br><br>No impact to landforms outside of the development envelope.<br><br>No Impacts to bat population and Habitat | Daily inspection of Development envelope boundary demarcation during clearing activities.<br><br>Pre-clearance inspections, with any variations between pegged clearing area and approved plans to be investigated and resolved prior to clearing.<br><br>Inspection of clearing extents during clearing activities to confirm<br>No over clearing.<br>Monitor potential impact to surrounding caves | Report unauthorised clearing as soon as practicable after identified.<br><br>Monitor fauna impacts and monthly environmental reporting.<br>Induction records.<br><br>Report turbine strike casualties (Radar)<br>Download radar data |

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| Bat Management | | | |
| Install Avifauna and bat Radar technology to mitigate fauna strike and obtain data to further understand bat behaviour within the development envelope, including assignment observations on flight speed, foraging behaviour, populations, and turn capability<br><br>Avoid activities and demarcate Karst and Cave areas if required, within the development envelope<br><br>All site personnel to be inducted on environmental responsibilities including landform recognition<br><br>Bat Survey:<br>Bat/Avifauna Desk-top survey complete<br>Surveys of bats based on acoustic recordings of echolocation calls were undertaken during the Ecoscape survey 2021 (See desktop study)<br><br>The proposed radar Installation will be a live survey installation generating research data for ongoing bat research including bird and bat behaviour, population, and species clarification. | Zero avifauna or bat fatalities within the development envelope<br><br>Compile research data for ongoing bat population studies within the Arrowsmith development hub<br><br>Understanding of the distribution and ecology of Western Australian bats<br><br>The status of cave occupancy of bats within the development envelope cave systems<br><br>Assess by compiling radar data regarding bat tracking radar<br><br>Restrictions:<br>Analysis of habitat-use will be confined to species presence/absence data within the development envelope and surrounds<br><br>This analysis assumes that spatial distribution reflects an underlying correlation with environmental factors (Austin 1991; Clarke 1993), | Weekly spot checks of cave/karst areas<br><br>Management program_ Fauna inspections<br><br>Monitor potential impact to fauna<br><br>Monitoring Radar data studies on aerodynamics, foraging strategy and call design has added a new dimension to the understanding of bat behaviour and flight paths.<br><br>Repeated sampling depended on logistical opportunities within the area | Visual inspection and approval of development envelope boundary prior to ground disturbing activities.<br><br>Reporting on bat behaviour: Reports extracted from radar monitoring data within the development envelope and peripheral landscape<br>Radar Data Monitoring reporting |

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| **Management action** | **Management Target** | **Monitoring** | **Reporting** |
| **Surface Drainage** | | | |
| Local drainage to be considered during site design and layout to mitigate erosion and sediment build up.<br><br>Disturbances to drainage lines will be minimised where practicable.<br><br>GDE management<br>Ephemeral waterbody management and awareness | Minimise indirect impacts to surrounding/adjacent areas from altered surface water drainage and flows. | Monthly visual inspections for environmental compliance. | Monthly environmental compliance inspection reports. |
| Waterline and, wetlands and drainage avoidance during construction | Uninterrupted Surface Waterflow | Site walk/inspection<br>Monitoring waterflow and drainage | Monthly Environmental Report |
| **Infrastructure Layout/Landforms** | | | |
| Current tracks over the river caves will be restricted to small vehicles only. | Zero impacts to caves or Karst areas | Site walk<br>Development envelope site inspections | Monthly Environmental Report<br>Daily inspections |

| | | | |
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| No construction work in the River cave catchment area | No sediment flow into the cave catchment area | Flood conditions<br>Rainfall events<br>Overall Weather Conditions | Weekly Environmental Inspection<br>Weather Observations |
| Avoid tracks over Karst areas (Track over river Cave): No Access to site personnel<br>No construction will commence within the Karst area | No vehicle movement within this area | Inspect and restrict access<br>Weekly inspection | Monthly Environmental Report |
| Infrastructure Layout plans reviewed<br><br>Infrastructure Layout Change:<br>Turbines relocated away from vulnerable Karst/cave areas<br>No Earthworks or construction within Karst areas | Preservation of the unique geological values of the cave systems.<br><br>Zero Karst impacts<br>Zero impacts to caves | Inspect for voids within the Development Envelope and the construction area<br>Weekly Environmental Inspection | Monthly Environmental Report |
| No trenching or civil works near the course of River Cave or in the vicinity of any of the known cave and karst features. | Zero Impacts to Karst or caves | Monitor Erosion impacts or water channeling within the Development Envelope and the specific construction area | Monthly Environmental Report |
| Clearing and Construction/Earthworks survey | No voids within construction area | Pre-Clearing site survey walk | Monthly Environmental Report |
| All construction work including turbine placement have been relocated west of the Karst/Cave area<br>Mapping Reviewed<br>Site plans updated<br><br>Layout of windfarm revised and optimised to avoid Impacts to Karst/Cave locations/water bodies | No impacts to Karst formations and cave systems<br>No Impacts to caves or Fauna habitat | Ongoing Monitoring of development Envelope | Monthly Environmental Report |

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| WASG Map Area: E-153<br>No Development planned<br>Presence of a collapse suggests voids | Zero development/construction within this area<br><br>Demarcation/signage | Monitoring Area: E-153<br>Site inspection | Monthly Environmental Report |
| WASG Map Area E-182<br>No Construction Planned for this area | Zero development/construction within this area | Visual Inspection<br>Monitoring Area E-182<br>Implement Signage | Monthly Environmental Report |
| WASG Map Area Area E-183<br>No Development planned | Zero development/construction within this area<br><br>Demarcation/signage | Visual Inspection<br>Monitoring Area E-183<br>implement Signage | Monthly Environmental Report |
| Line heading north crosses over River Cave<br>WASG Map Area E-082D<br>No Development planned | Area contains fragile voids and will be demarcated | (Close to Area E-082D)<br>Visual Inspection | Monthly Environmental Report |
| WASG Map Areas between (Formerly WP2 and WP3 and between WP9<br>and WP10)<br><br>No Development planned | No development | Area: Areas between (Formerly WP2 and WP3 and between WP9<br>and WP10) | Monthly Environmental Report |
| Bat Survey Recommended:<br>Desk-top and field survey Complete<br>Radar will enable survey data requirements<br>Radar will be installed to mitigate Avifauna Strike and collect Avifauna data | WASG recommends bat survey: Bat population<br><br>Radar technology will be installed to fulfil survey requirements | Ongoing Monitoring<br>Visual Inspection | A survey of the bat population was completed 2021 |
| Review Site Access | Speleologists : Conditional access to the caves | Construction site escort<br>Visual Inspection | Monthly Environmental Report<br>Inductions |

Outcome

Geotechnical Surveys to be undertaken before construction work commences. Including advanced geotechnical modelling of proposed turbine siting
Redesigned Project layout to mitigate Cave systems and Karst formation environmental impacts
Install Radar technology: to Improve Avifauna and bat tracking data, habitat monitoring and mitigate fauna strike
Speleological specified Karst/Cave: update Mapped areas
Relocate turbine layout to avoid avifauna habitat especially the Carnaby's Black Cockatoo
Relocate turbine array to mitigate impacts to drainage lines, water courses and water bodies
Stakeholder resolution and agreement regarding potential impacts
During pre-construction, radars are used as a reliable and long-term measurement tool, gathering scientific data on bird and bat movements in the area, as well as migration activity. They automatically detect and log hundreds of birds and bats simultaneously, including their size, speed, direction and flight path.

Historically, this type of information would be gathered by human observers over one or more limited observation periods. But the long-term radar data generated by having avian or bat radar present on-site, 24/7, is far more accurate and useful when it comes to Environmental Impact Assessments (EIAs).

The information on bird activity, based on radar data, is compared both pre- and –post construction to measure the true impact on the local and migratory bird and bat population.
And unlike human observers, radars don't need to rest, and they can see in all weather conditions, day or night.

For operational wind farms, radars can automatically curtail turbines switching off and on again. And depending on the situation, they can do this for both single turbines and groups.

## References

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