Australasian Cave and Karst Management Association Inc. (ACKMA) Position Statement on the Nullarbor Plain karst, November 2023

About ACKMA

ACKMA is an association concerned with the conservation, presentation and management of caves, their contents, including cave dependent fauna, and the histories they provide, and karst landforms generally. It has members from five continents, with most members from Australia and New Zealand but ranging as far away as the UK, South Korea, the USA, Canada and South Africa. Members include scientists, managers of show cave and karst areas, guides, rangers, indigenous communities, and cavers. ACKMA also has strong links with ISCA (International Show Caves Association) and the UIS (Union Internationale de Spéléologie).

Overview

This position statement provides expert guidance on the natural and cultural heritage of the Nullarbor Plain, Australia's largest karst area and the largest arid karst in the world. We first review the heritage values of the Nullarbor Plain and comment on areas where our knowledge is deficient at present. We next outline a case for a number of sites of significance to be inscribed on the National Heritage List of Australia. This leads naturally to a consideration of the applicability of natural criteria under the World Heritage Convention to the Nullarbor Plain.

We conclude that the Nullarbor Plain in both Western Australia and South Australia contains sites of both natural and cultural significance to Australia and the world. A serial nomination under the World Heritage Convention should be developed so that this outstanding karst area may be conserved for future generations.

There are a number of green hydrogen projects under development in Australia and one of these is proposed to cover almost the entire Nullarbor plain in Western Australia. While supporting rapid introduction of renewable energy sources, we conclude that any new projects should be subject to rigorous environmental, social and economic analyses to ensure that they are located in the right places. In particular, they should not be located in areas of outstanding natural or cultural heritage, whose values would be debased by the extensive construction work involved in both wind, solar farms and hydrogen production plants.

In addition many areas on the South Australian Nullarbor, especially in the Nullarbor Resources Reserve, are subject to mineral exploration and potential mining.

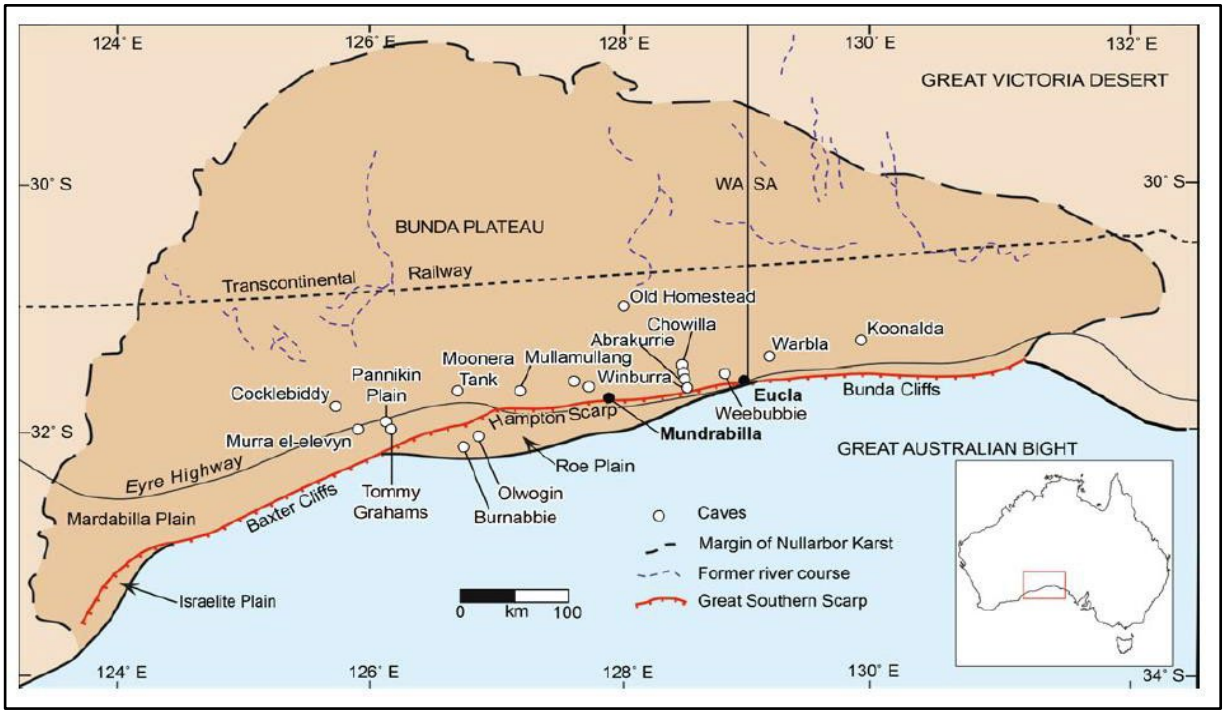
The Nullarbor karst

The Nullarbor Plain is Australia's largest karst area and perhaps the most intensively studied. The region has an arid to semiarid climate with an annual rainfall between 150 and 250 mm with a winter maximum. Relief is

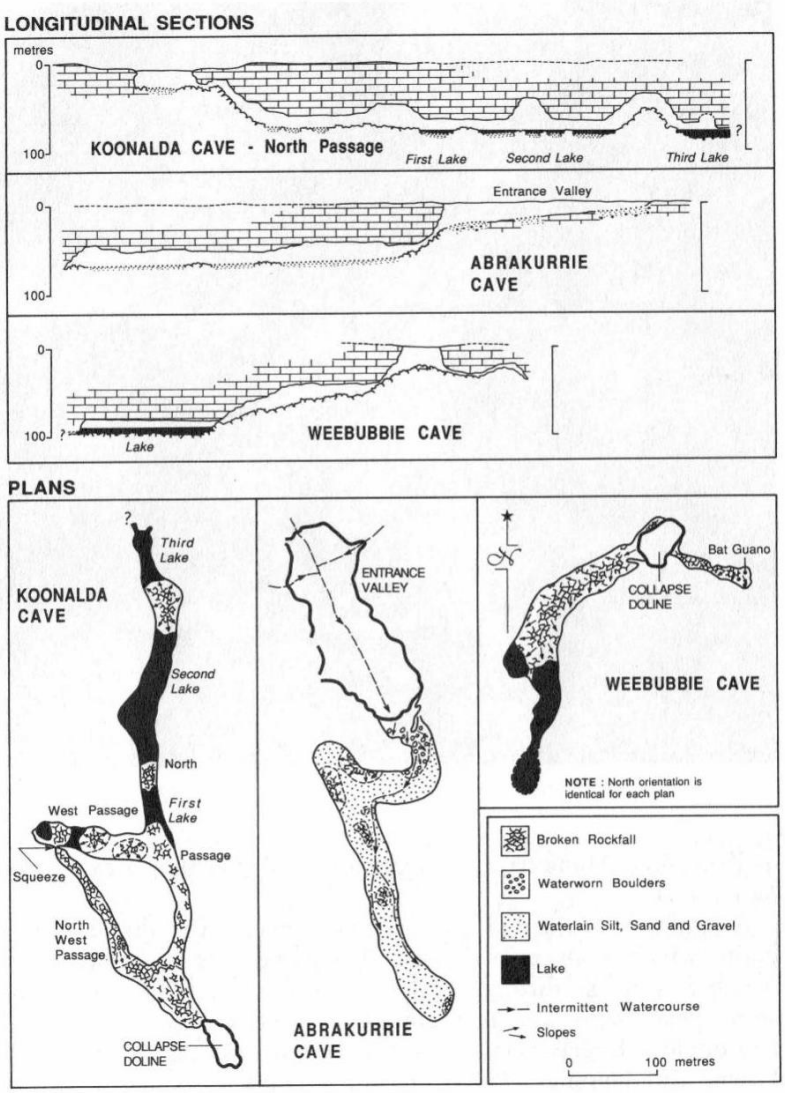
generally low, less than 5 m and the Nullarbor has little or no surface drainage. However relict stream channels are found on the northern and western flanks of the plain, these have meandering traces and are filled with alluvium and aeolian deposits. There is at least one abandoned valley which traverses the limestone.

Elsewhere there are linear depressions with clay pans, which are presumably of structural origin. These clay pans, locally known as dongas, act to channel slow runoff and direct it into dolines and blowholes. Any changes to this surface hydrology will adversely affect the karst hydrological system. Dolines are sparse and steep- sided, and show evidence of collapse into underlying cavities. Blowholes are very numerous, and are fed by deep solution pipes of complex origin. The caves are extensive, much modified by salt wedging and collapse processes and commonly descend gently to near static pools and lakes which are brackish to saline. A low- gradient water table underlies the plain and depth ranges from 30 m in the north to 120 m in the south. The flooded tunnels of Cocklebiddy Cave are in excess of 6 km long, most of it only explorable by cave divers.

Withdrawal of hydrostatic support in times of low sea level has led to collapse into these water-table caves, allowing entry into large caverns such as Koonalda, Abrakurrie and Weebubbie caves. A particular feature of the Nullarbor caves is the abundance of halite (sodium chloride) which produces both speleothems and many weathering forms through wedging during recrystallisation. Speleothems (cave crystal decorations) are also abundant with calcite speleothems being less obvious, largely because of their destruction through salt wedging. Speleothem history has made significant contributions to the study of past climates.



Main features of the Nullarbor karst. From Webb and James (2023).



Plans and long sections of some Nullarbor Plain caves. From Gillieson (2021).

Today exposed outcrops are merely pitted by raindrops and no solution rills. There are, however some solution pans, some of which have contributed to the development of rockholes used by First Nations people as water sources. At present some solution of limestone does occur in the coastal fringe of the Nullarbor plain, and mixing corrosion may be important in this context. The large caves of the Nullarbor may have been initially formed by enhanced solution at the mixing zone between fresh and saline groundwater. The groundwater of the Eucla basin has a very high salinity and some solution may also be occurring in great depth in the limestone. Inland, periodic low intensity rainfall may cause some solution on the margins of clay pans, and calcretes are forming. Overall rates of solution must be very low indeed. Of more significance are the intrusions of rain depressions of tropical origin, which occur two or three times a decade and are associated with tropical cyclones. These have the capacity to release large amounts of water on the western Nullarbor, flooding claypans and perhaps maintaining epiphreatic passages in several caves such as Thampanna and Old Homestead.

During the last two glacial-interglacial cycles, sea level dropped at least twice to 135 m below present, steepening the hydraulic gradient and this promoted a shift in the rainfall isohyets as reflected in pollen stratigraphy. Thus during the last glacial maximum the chenopod shrubland of the interior plain extended

across terrain which today lies close to the coast and supports eucalypt woodland. Conversely during the last interglacial, eucalypt woodland would have extended further inland than it does today and this may have enhanced solution processes. These changes in the vegetation cover may have acted to destabilise the continental dune fields to the north of the Nullarbor and allowed reddened quartz sands to accumulate downwind in caves on the eastern portion of the plain. Cave infills on the eastern margin of the Nullarbor are dominantly red aeolian quartz sand with well-developed oxide coatings penetrating the grains. At least three different pedogenic cycles are involved, with some loess additions. These sands have their origin in the Great Victoria Desert and suggest a wind regime quite different to the predominantly southerly and south-westerly airflow of today. The distribution of the sands in a narrow belt around the Diprose caves suggests that they may have moved as sand streaks across the gravelly plain. The most recent disturbance in the sands, dated by thermoluminescence, is less than 360 years ago and may reflect the increased fire frequency consequent on pastoralism and the spread of rabbits across the Nullarbor Plain.

The calcite formations of the Nullarbor Caves are usually dark brown to black in colour. The black colour was shown to be due to humic compounds and is also seen on the surface and down to the water table. Uranium series dating indicated that its deposition ceased more than 350 000 years before present. Flowstones of black calcite over a metre thick suggest that its deposition extended over a long period of time. More recent dating using the Uranium–Lead isotope method (Woodhead et al. 2006; Sniderman et al. 2016) provides dates well into the Pliocene, between 3.4 and 5.6 million years ago. The fossil pollen records preserved in speleothems from the Nullarbor reveal an abrupt onset of warm and wet climate early within the Pliocene, driving complete ecological change. Pliocene warmth thus clearly represents a discrete interval which reversed a long-term trend of late Tertiary cooling and drying.

National Heritage criteria

The Nullarbor karst meets several criteria against which the heritage values of a place are assessed by the Commonwealth government:

a. the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history

b. the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history

c. the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history

d. the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons

e. the place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.

There are already three sites inscribed on the National Heritage list:

Koonalda Cave, Old Eyre Highway, Cook, SA

Koonalda Cave is of outstanding national heritage significance for the role it has played in the evolution of our contemporary understanding of the age of Aboriginal art, archaeology and occupation in Australia. As the first site of its kind to be reliably dated to the mid Pleistocene (circa 22 000 BP), Koonalda Cave has been at the forefront of enquiry into the art and archaeology of Aboriginal culture in Australia. The site proved that Aboriginal people survived in the semi-arid region during the Last Glacial Maximum, which was previously thought to be impossible due to the harsh environmental conditions at that time.

Koonalda Cave, entrance chamber(left). Photo by David Gillieson.

Bunda cliffs, Nullarbor Plain, South Australia (right). Photo by David Gillieson

Bunda Cliffs, Nullarbor National Park, Eyre Highway, Nullarbor via Yalata, SA

The park preserves a large area of the unique Nullarbor Plains topography including caves and spectacular coastal cliffs. The largest conserved population of the hairy-nosed wombat is found within the park confines. The numerous caves and blowholes contain a wealth of fossils, many of which are well preserved. Much of the fauna is uniquely dependent on the cave environments for survival.

Spider Cave, No 5 Bore via Nullarbor, SA

The site is the only known existing habitat of the cave-dwelling (troglobitic) spider *Troglodiplura lowryi*. This species is the only troglodytic representative of the suborder Mygalmorphae (the trapdoor/funnel web spider group) recorded in Australia. Its closest living relatives are a subfamily of spiders from South America, the Diplurinae. This makes the species an important relic of the Gondwanan connection with South America. The place is the type locality for *Troglodiplura lowryi* and is an important research site for studies into the species, troglobitic evolution and biology and the evolution and biogeography of mygalamorph spiders.

Species of National Significance

There are a number of Species of National Significance listed for the Nullarbor Plain and adjacent marine areas in the Great Australian Bight. These have been compiled by the Commonwealth Department of Climate

Change, Energy, the Environment and Water (DCCEEW) in October 2022. Such a listing is necessary for any development application to trigger the EPBC Act. There are currently no threatened ecological communities listed for the Nullarbor Plain. Most of the listed species are migratory birds, cetaceans which seasonally inhabit the Great Australian Bight below the Bunda and Baxter sea cliffs, a very small number of endangered plant species and a single marsupial, the Sandhill Dunnart. There are no obligate cave species (troglobites) currently listed for the Nullarbor Plain.

In general the caves with the richest faunas are humid and have reliable sources of organic matter such as plant roots or bat guano. Humidity is also critical and remains high near the water table where there are permanent pools and lakes, and also on sediment banks saturated by water flows following heavy rainfall. Caves with small entrances, or blind passages with limited air flow, are more likely to retain humidity.

More than 280 invertebrate species have been recorded from caves, and around one-quarter of species (24%) had an association with guano (Eberhard and Moulds 2007). The troglobite fauna consists of at least 30 species in 19 genera. There are several large troglobites that are highly cave-adapted and belong to genera that are endemic to the Nullarbor karst.

The largest, rarest and most unusual troglobite is a mygalomorph spider, *Troglodiplura*, which is of considerable biogeographic interest because it is the only known troglobitic mygalomorph in Australia. Troglodiplura includes at least four species, with each species known only from a single cave. A second iconic Nullarbor cave spider, *Tartarus*, includes four described species. They spin a beautiful cone shaped and fragile web that is easily destroyed by the air currents from a human breath or body heat. Another large and highly specialized troglobite is the blind cockroach, *Trogloblattella nullarborensis*, which manages to survive even in the most remote and energy-poor parts of caves. This atypically slow-moving cockroach is completely blind and shows no reaction to light (Eberhard, 2023).

In Western Australia a small number of cave entrances have limited protection as part of the Nuytsland Nature Reserve. Surveys of cave biology by Eberhard & Moulds (2007) have resulted in six species of Nullarbor cave fauna, five spiders and one crustacean, being listed on Schedule 1 (Fauna that is rare or is likely to become extinct) of the Western Australian *Wildlife Conservation Act 1950* [*Specially Protected Fauna Notice 2006 (2)*].

These are:

Nullarbor Cave Trapdoor Spider *Troglodiplura lowryi* Mullamullang
Cave Spider *Tartarus mullamullangensis*
Murdoch Sink Cave Spider *Tartarus murdochensis* Thampanna
Cave Spider *Tartarus thampannensis* Nurina
Cave Spider *Tartarus nurinensis*
Pannikin Plains Cave Isopod *Abebaioscia troglodytes*

The Genus *Troglodiplura* now has additional described troglobitic species from the Nullarbor. One of the three new species has been found in several caves 30 km apart, which provides strong evidence for subsurface connectivity via meso-cavernous network. Virtually all other described troglobitic species would qualify for listing on Schedule 1, including *Speothalpius grayi, Speozuphium poulteri, Nurina poulteri, Cryptops (Trigonocryptops) roeplainsensis,* and *Neotemnopteryx wynnei*. Most of the undescribed troglobitic species would also qualify for listing on Schedule 1. The troglobitic cockroach *Trogloblatella nullarborensis* is not listed, presumably because the morphotype is widespread (15 caves) although the possibility of cryptic speciation in this genus cannot be discounted.

World Heritage significance of the Nullarbor karst

A report commissioned by the then Commonwealth Department of The Arts, Sport, The Environment & Territories (Davey et al. 1992) found that all four World Heritage natural criteria were met by the features of the Plain. It also suggested that the cultural values of the Plain, including the National Heritage listed Koonalda Cave, would also meet World Heritage criteria. It is unusual for any tentative nomination to meet both natural and cultural criteria. Internationally well recognised cave and karst scientists have questioned why Australia has not proceeded with a World Heritage nomination for the whole Nullarbor Plain. *Thus, for example, karst World Heritage sites are poorly represented in arid, semiarid, and periglacial environments*. (Williams, 2011).

The executive summary from Davey et al. (1992) states:

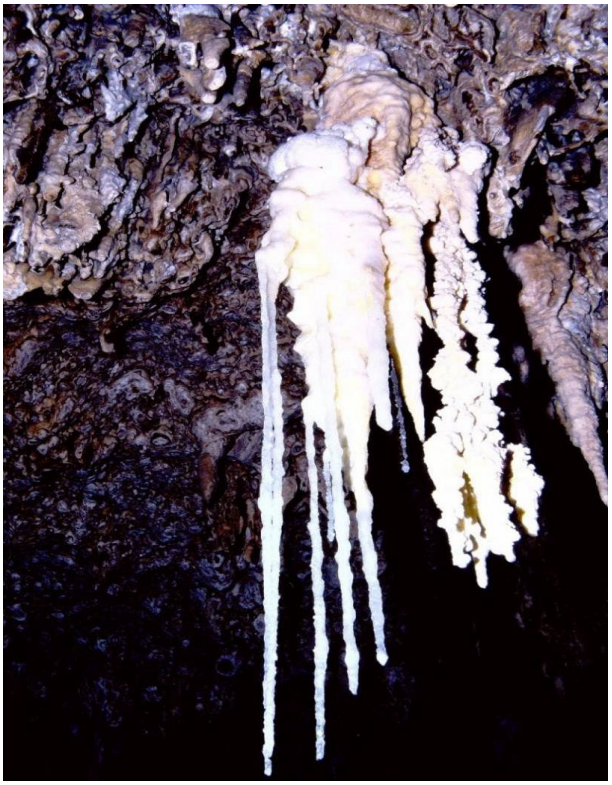
The Nullarbor region is a vast area of low relief adjacent to the Great Australian Bight on the southern Australian coast. It comprises the world's largest contiguous karst area, and by far the largest arid karst. The caves and other karst features of the region - together with the lakes, sediments, minerals, sub-fossils, biota and archaeological materials within them - are of outstanding international interest. This significance is mainly for karst geomorphology, mineralogy, cave meteorology, biospeleology and archaeology. In addition, the outstanding aesthetic qualities of many of the caves and their contents, together with the physical challenges of their considerable extent - both in airspace and in submerged passages - attracts cave divers, speleologists and others interested in this fascinating subterranean environment from all over the world.

The karst is set in a dramatic landscape which includes a spectacular 600 km cliffline and a vast flat naturally treeless plain. Surrounding the Nullarbor, and running onto it to some extent, is a remarkably well-preserved ancient drainage network which has been inactive since the last effectively wetter climatic period in the early Pleistocene. As well, the north-eastern margin of the plain is edged by a substantial length of Tertiary coastal sand dunes. This ancient shoreline feature is now 250 km from the sea, in a desert setting. The excellent state of preservation of these ancient drainage and coastal landforms in the arid Nullarbor environment is remarkable.

This report examines the geological and geomorphic context of these and related aspects of the region. The report does not address aspects such as flora and fauna (except in the caves), or human history. The report concludes that an excellent case can be made out for a defined property within the region to be put forward as "natural heritage" and so considered for World Heritage listing. The property arguably qualifies (any one of which would be sufficient) and satisfies the required conditions of integrity. The report analyses the nature and extent of significance under each criterion.

The recommended candidate World Heritage property comprises about half of the region, in a single contiguous area shared approximately equally between the states of Western Australia and South Australia. It consists overwhelmingly of existing and already proposed parks and reserves, but also includes substantial areas of the Yalata and Maralinga Aboriginal lands and significant parts of four pastoral leases (affecting three separate pastoral operations.

There is now growing support for the nomination of at least the South Australian part of the Nullarbor Plain as World Heritage. This would most likely be as a mixed serial site incorporating both natural and cultural values at a number of key locations across the arid karst. There are already several sites on the National Heritage List: Koonalda Cave, Spider Cave and the Bunda seacliffs. Natural values would include the largest arid karst area in the world (filling a significant gap in global coverage), spectacular caves with saline lakes, very well-preserved marsupial bone deposits and speleothems yielding long environmental histories back to at least the Pliocene.



Ancient black calcite column being shattered by halite (salt) wedging (right). Photo by Kirsty Dixon

Cultural values include ice-age flint quarries and parietal art, ancient songlines and sacred sites as well as a long-established association with country for the Mirning people. It will be absolutely critical to gain active Indigenous involvement in any nomination process, while State and Federal support is also critical. It is to be hoped that the Heritage section of the Federal Department of Environment will have learnt from their earlier efforts to develop a WH nomination for Cape York Peninsula, which foundered on a hard place due to a lack of meaningful dialogue and involvement of the traditional owners.

Five million years of the progressive drying of Australia. Halite stalactites overgrowing gypsum stalactites, in turn overgrowing salt wedged calcite formations(left). Photo by David Gillieson.

World Heritage Criteria – Natural Values

A property nominated for inclusion in the Natural World Heritage List will be considered to be of outstanding universal value if the World Heritage Committee finds that it meets one or more of the following criteria, provided it also meets the conditions of integrity (UNESCO 2008, Clauses 77 and 78):

(vii) To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

(viii) To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms or significant geomorphic or physiographic features

(ix) To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal, and marine ecosystems and communities of plants and animals

(x) To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

ACKMA argues that the Nullarbor karst and surrounds has values which meet all four criteria.

Renewable energy in Australia's karstlands

There is tremendous scope for Australia to meet most of its renewable energy needs by constructing extensive wind and solar energy farms across the extensive grazing lands, known as rangelands, which occupy roughly two thirds of the continent. ACKMA supports this transition from fossil fuel to renewable energy so that Australia can meet its zero emission targets and limit the effects of climate change, which are already being expressed as widespread bushfires and floods. There are currently between 60 and 70 green hydrogen projects under development in Australia, combining extensive arrays of wind turbines with solar farms, providing electricity to hydrogen and ammonia plants. Given that there are extensive rangelands where such installations could provide a viable economic alternative to traditional pastoralism, it is important that a strategic approach it taken to this industrialisation of the rangelands. This involves not only land capability assessment but also environmental impact assessment and a thorough economic analysis. Given the inevitability of transition from dependency on mining and natural gas extraction for many rural communities, these new industries may provide better environmental, social and economic futures for rural communities.

There are extensive areas of limestone in the semiarid and arid regions of Australia, particularly in Western Australia, South Australia and north-west Queensland. Traditionally these areas have been used for predominantly sheep and more recently cattle grazing, if adequate sources of groundwater can be found and extracted economically. They are often regarded as marginal lands by the pastoral industry. However recent documentation and mapping by speleologists, ecologists and other scientists is revealing extensive cave systems containing significant natural heritage, in the form of speleothems and cave adapted fauna. Analysis of the speleothems is providing crucial evidence of climate change and vegetation adaptation over the last five to six million years. Surveys of cave fauna are finding many endemic cave-adapted invertebrates new to science, whose taxonomic and evolutionary affinities are with the fragments of Gondwana, and in some cases even more ancient continents surrounding the Tethys Sea some 150 million years ago. Cave systems in the Pilbara, western Northern Territory and the Barkly Tablelands of Queensland are critical habitats and maternity sites for the endangered Ghost Bat, *Macroderma gigas*.

Thus any proposals to create extensive wind and solar energy installations in karst areas should be subjected to detailed environmental, social and economic analysis before any approvals are given by State or Federal governments.

Threats to the Nullarbor karst

The primary threat to the Nullarbor's natural and cultural values is currently on the Western Australian side of the Nullarbor, The Western Green Energy Hub is aiming to produce up to 50GW of wind and solar power to make 3.5 million tonnes a year of hydrogen, solely for export to Singapore as ammonia. They propose to construct around 3,000 wind turbines, 50 major solar complexes, hydrogen electrolysis plants together with extensive roads, buried cabling and piping, and transmission powerlines. This infrastructure is designed to produce liquid ammonia solely for export to Korea. There will also be construction of a major deep sea port, worker's villages and much else. Thus Eucla will be a permanent town of up to 5000 people, not a FIFO setup. A desalinisation plant will pump fresh water up the escarpment to the electrolysis plants.

Very many caves and related karst geomorphic features (in excess of 7000) have been identified on the Nullarbor – yet it has not been completely explored and will take many more years to do so. There are significant cave dependent faunas, and many more species likely to be present. ACKMA believes that the proponents (Western Green Energy Hub) greatly underestimate the extent and density of caverns (which range in size from tens of centimeters to many tens of metres). These will present major engineering difficulties, further destroying both the surface and underground environments, and compromising the Nullarbor's natural and cultural values.

The proponents of the Western Green Energy Hub project are rather *naïve* about the extent of karst features and caves on the Nullarbor Plain. They would appear to be ignorant of the extent and density of shallow caves and blowholes over the entire area. The quantity of interconnected cave passage with no entrance to the surface is clearly unknown. However, given the extensive caves that have already been explored and the nature of their geomorphology, there are extensive areas where any cave passage will be inaccessible. These areas far exceed the known cave extents.

They seem to be placing heavy reliance on remote sensing and geophysical techniques. These may pick up large cavities but are unlikely to pick up small interconnected voids within a few metres of the surface. The proposal has significant construction risks in terms of safety and loss of expensive equipment into cavities large and small, which will incur high costs to recover the equipment and remove all contaminants from caves or karst features. The development poses significant risks to the Nullarbor karst environment and many of these will seemingly be irreversible. This level of threat to the caves and karst of the Nullarbor is highly contentious, given its potential impact on the geoheritage, biodiversity and scenic amenity of the region, and any development proposal must take these considerations into account. ACKMA is therefore opposed to the Western Green Energy Hub proposal.

A pdf of this statement, which includes all the references can be found on the ACKMA webpage under 'Documents'.
https://ackma.org/Documents/ACKMANullarborPositionStatement.pdf